Air Resources Board

PUBLIC MEETING AGENDA

September 28, 2006

9:00 a. m.

Agenda Items to be heard;

06-8-1: 06-8-2: 06-8-3:

06-8-4: 06-8-5:

Visit our Web Site

@ www.arb.ca.gov

California Environmental Protection Agency

ELECTRONIC BOARD BOOK

California Environmental Protection Agency

Air Resources Board

PUBLIC MEETING AGENDA

LOCATION:
Air Resources Board
Byron Sher Auditorium, Second Floor
1001 I Street
Sacramento, California 95814

This facility is accessible by public transit. For transit information, call (916) 321-BUSS, website: http://www.sacrt.com
(This facility is accessible to persons with disabilities.)

September 28, 2006
9:00 a.m.

Item #

06-8-1: Report to the Board on a Health Update: Indoor Air Chemistry and Implications for Health

The indoor use of certain common cleaning products and air fresheners can cause an increase in indoor concentrations of gaseous and particulate pollutants. In a study sponsored by ARB and conducted by Dr. Bill Nazaroff of UC Berkeley, cleaning products used in the presence of ozone resulted in the production of formaldehyde, ultrafine particulate matter, and hydroxyl radicals from the indoor chemistry reactions.

06-8-2: Public Hearing to Consider a Research Proposal

"Ventilation and Indoor Air Quality (IAQ) in Small and Medium Commercial Buildings (SMCB) Phase II Field Study," University of California, Davis, Proposal No. 2610-252.

06-8-3: Public Hearing to Consider Amendments to the Hexavalent Chromium Airborne Toxic Control Measure (ATCM) for Chrome Plating and Chromic Acid Anodizing Operations

The staff is proposing amendments to the Chromium Plating ATCM to reduce the cancer risk posed by hexavalent chromium emissions. Hexavalent chromium is a human carcinogen. The proposed amendments would phase-in best available control technology to reduce hexavalent chromium emissions from chromium plating and chromic acid anodizing facilities.

06-8-4: Public Hearing to Consider Technical Status and Proposed Revisions to Malfunction and Diagnostic System Requirements and Associated Enforcement Provisions for Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles and Engines On-Board Diagnostic (OBD II) and Emission Warranty Regulation

This proposal would update the OBD II requirements for light-duty and medium-duty gasoline and diesel vehicles. Most of the proposed new requirements are aimed at making the diesel monitoring requirements consistent with those in the recently adopted heavy-duty OBD regulation. The proposal would also update the emission warranty regulations, specifically the references to emission-related parts to account for emission control technology that is used today.

06-8-5: Public Hearing to Consider Adoption of California's Heavy-Duty Diesel In-Use Compliance Regulation

ARB, the U.S. EPA, and the Engine Manufacturers Association have developed a manufacturer-run heavy-duty diesel engine in-use compliance program. In this program, manufacturers will test heavy-duty diesel engines in-use with on-board measurement systems under the Not-to-Exceed testing concept. A fully enforceable manufacturer-run compliance program for ARB and U.S. EPA will begin in 2007. Earlier, in 2005 and 2006, the same testing protocol is being used in a pilot program to generate data and gain experience.

OPPORTUNITY FOR MEMBERS OF THE BOARD TO COMMENT ON MATTERS OF INTEREST.

Board members may identify matters they would like to have noticed for consideration at future meetings and comment on topics of interest; no formal action on these topics will be taken without further notice.

OPEN SESSION TO PROVIDE AN OPPORTUNITY FOR MEMBERS OF THE PUBLIC TO ADDRESS THE BOARD ON SUBJECT MATTERS WITHIN THE JURISDICTION OF THE BOARD.

Although no formal Board action may be taken, the Board is allowing an opportunity to interested members of the public to address the Board on items of interest that are within the Board's jurisdiction, but that do not specifically appear on the agenda. Each person will be allowed a maximum of five minutes to ensure that everyone has a chance to speak.

TO SUBMIT WRITTEN COMMENTS ON AN AGENDA ITEM IN ADVANCE OF THE MEETING GO TO:
http://www.arb.ca.gov/lispub/comm/bclist.php

IF YOU HAVE ANY QUESTIONS, (916) 322-5594
PLEASE CONTACT THE CLERK OF THE BOARD FAX: (916) 322-3928
1001 I Street, 23rd Floor, Sacramento, CA 95814 ARB Homepage: www.arb.ca.gov

To request special accommodation or language needs, please contact the following:

- **For individuals with sensory disabilities, this document is available in Braille, large print, audiocassette or computer disk. Please contact ARB's Disability Coordinator at 916-323-4916 by voice or through the California Relay Services at 711, to place your request for disability services.**
- **If you are a person with limited English and would like to request interpreter services to be available at the Board meeting, please contact ARB's Bilingual Manager at 916-323-7053.**

THE AGENDA ITEMS LISTED ABOVE MAY BE CONSIDERED IN A DIFFERENT ORDER AT THE BOARD MEETING.

SMOKING IS NOT PERMITTED AT MEETINGS OF THE CALIFORNIA AIR RESOURCES BOARD

California Environmental Protection Agency

Air Resources Board

PUBLIC MEETING AGENDA

INDEX

LOCATION:
Air Resources Board
Byron Sher Auditorium, Second Floor
1001 I Street
Sacramento, California 95814

This facility is accessible by public transit. For transit information, call (916) 321-BUSS, website: http://www.sacrt.com
(This facility is accessible to persons with disabilities.)

September 28, 2006
9:00 a.m.

TITLE 17. CALIFORNIA AIR RESOURCES BOARD

NOTICE OF PUBLIC HEARING TO CONSIDER AMENDMENTS TO THE HEXAVALENT CHROMIUM AIRBORNE TOXIC CONTROL MEASURE FOR CHROME PLATING AND CHROMIC ACID ANODIZING OPERATIONS

The Air Resources Board (ARB or Board) will conduct a public hearing at the time and place noted below to consider adopting amendments to the existing Hexavalent Chromium Airborne Toxic Control Measure (ATCM) for Chrome Plating and Chromic Acid Anodizing Operations (Chromium Plating ATCM). The amendments are proposed to further reduce the public's exposure to hexavalent chromium by reducing hexavalent chromium emissions.

DATE: September 28, 2006

TIME: 9:00 a.m.

PLACE: California Environmental Protection Agency
Air Resources Board
Byron Sher Auditorium, Second Floor
1001 I Street
Sacramento, California 95814

This item will be considered at a two-day meeting of the Board, which will commence at 9:00 a.m. on September 28, 2006, and may continue to 8:30 a.m., September 29, 2006. Please consult the agenda for the meeting, which will be available at least ten days before September 28, 2006, to determine the day on which this item will be considered.

For individuals with sensory disabilities, this document is available in Braille, large print, audiocassette, or computer disk. Please contact ARB's Disability Coordinator at (916) 323-4916 by voice or through the California Relay Services at 711, to place your request for disability services. If you are a person with limited English and would like to request interpreter services, please contact ARB's Bilingual Manager at (916) 323-7053.

INFORMATIVE DIGEST OF PROPOSED ACTION AND POLICY STATEMENT OVERVIEW

Sections Affected: Proposed amendments to section 93102, title 17, California Code of Regulations (CCR), and proposed adoption of new sections 93102.1 to 93102.16, title 17, CCR.

Background: In 1986, the Board identified hexavalent chromium as a Toxic Air Contaminant (TAC). Hexavalent chromium was determined to be an extremely potent human carcinogen with no known safe level of exposure. It was found that exposure over a lifetime to very low ambient hexavalent chromium concentrations could very substantially increase a person's chance of developing cancer from the hexavalent chromium emissions. Subsequent to that finding and to control hexavalent chromium emissions, the Board adopted the Chromium Plating ATCM (title 17, CCR, section 93102). The regulation set forth the requirements for reducing hexavalent chromium emissions based on the type of operation. Most hard chromium plating facilities were required to reduce hexavalent chromium emissions by 99 percent or more. This was achieved through installation of add-on air pollution control devices. Decorative chromium plating and chromic acid anodizing facilities were required to reduce emissions by 95 percent; however, they were not required to use add-on air pollution control devices.

The Chromium Plating ATCM was amended in 1998 to include provisions for controlling emissions of trivalent chromium from trivalent chromium plating facilities. The 1998 amendments also added requirements for monitoring, inspection, maintenance, recordkeeping, and reporting. These amendments were necessary to establish equivalency with the federal regulation for chromium plating and chromic acid anodizing facilities.

Due to the carcinogenicity of hexavalent chromium, and in response to community concerns, ARB staff undertook an evaluation of the Chromium Plating ATCM. The staff evaluated if people located near chromium plating or chromic acid anodizing facilities were adequately protected from emissions of hexavalent chromium. Staff also evaluated if technologies were available to reduce hexavalent chromium emissions, if necessary. As part of the evaluation, staff determined that 43 percent of the hexavalent chromium operations are located within 100 meters of a sensitive receptor, such as a residence or school. By conducting an emissions testing program and air quality modeling, staff determined that these sensitive receptors may be exposed to unacceptable hexavalent chromium concentrations. ARB staff also found that reliable add-on air pollution control devices such as high efficiency particulate arrestor (HEPA) filters are now available and are used by many facilities to reduce hexavalent chromium emissions. Use of HEPA filters, or other combinations of controls that are as effective as HEPA filters, represents best available control technology (BACT) for intermediate and large throughput facilities. BACT for small facilities is represented by use of ARB specified chemical fume suppressants.

Several facilities in California currently use the trivalent chromium process to perform decorative chromium plating. Therefore, staff also evaluated if using this alternative process could be employed for all decorative chromium plating operations. Trivalent chromium is not considered to be a human carcinogen. If feasible, use of the trivalent chromium process would potentially eliminate the cancer risk from decorative chromium plating operations. However, although improvements in the process have been made, use of trivalent chromium is not available for all applications.

The staff determined that estimated cancer risk from intermediate and large production facilities now controlled with chemical fume suppressants alone could be reduced very substantially by requiring the use of HEPA filter systems or the equivalent. By applying this approach to all but very small sources, an additional 40 percent of facilities would be able to control their emissions of hexavalent chromium by over 99 percent. This would result in reducing estimated cancer risk from current levels up to 85 percent for individual facilities. Finally, ARB staff determined that the hexavalent chromium emissions from chromium plating and chromic acid anodizing are not solely from electroplating or anodizing, but also from fugitive dust containing hexavalent chromium that is reintroduced into outside air. Implementing housekeeping measures to reduce dust accumulation can reduce these fugitive emissions.

As allowed by State law, in 2003 the South Coast Air Quality Management District (South Coast AQMD) amended its Rule 1469, Control of Hexavalent Chromium Emissions from Chrome Plating and Chromic Acid Anodizing Operations (Rule 1469), and made the rule more protective than the then-applicable ATCM. The amended rule requires hexavalent chromium facilities located within 25 meters from a sensitive receptor or within 100 meters from a school to reduce hexavalent chromium emissions such that the residential cancer risk will be no more than ten chances per million people. The rule also requires facilities located greater than 25 meters from a sensitive receptor or 100 meters from a school to reduce emissions such that cancer risk will be no more than 25 chances per million people. Rule 1469 establishes production thresholds that allow the use of chemical fume suppressants added to the plating bath as the sole control method (as is currently allowed by the Chromium Plating ATCM). However, the only chemical fume suppressants that can be used are those that are "certified" to reduce hexavalent chromium emissions from the plating bath to no more than 0.01 milligrams/ampere-hour at specified surface tensions. Rule 1469 also establishes housekeeping requirements. The amended rule is in full effect.

There are also federal regulations for chromium plating and chromic acid anodizing facilities; these regulations are discussed in this notice under the heading "Comparable Federal Regulations."

<u>Description of the Proposed Regulatory Action:</u> The proposed amendments to the Chromium Plating ATCM would require use of more stringent add-on air pollution control devices such as HEPA filters or equivalent systems to further reduce the public's exposure to hexavalent chromium from most chromium plating and chromic acid anodizing facilities. This add-on air pollution control equipment requirement would apply to facilities over time, except for facilities with very low throughput (measured in annual permitted ampere-hours), that would be required to use chemical fume suppressants.

The existing Chromium Plating ATCM establishes different control requirements based on the type of operation, with hard chromium plating operations subject to the most stringent limits. Rather than continued bifurcation of requirements, staff is proposing that all facilities using the hexavalent chromium process, whether they perform decorative plating, hard plating, or chromic acid anodizing, be subject to the same requirements.

Very low production (≤ 20,000 ampere-hours per year) facilities could continue to reduce hexavalent chromium emissions through use of ARB specified chemical fume suppressants to lower surface tension of the plating or anodizing bath. Using specified chemical fume suppressants to lower surface tension reduces hexavalent chromium emissions to 0.01 milligrams/ampere-hour.

Requiring HEPA filters or the equivalent for all other facilities translates to the use of control technologies rated at 99.97 percent efficient for collecting particles of 0.3 micrometers in diameter. This is the control efficiency achieved through installation of a HEPA add-on air pollution control device. The emission limitation equivalent to this level of control is 0.0015 milligrams/ampere-hour. Therefore, the proposed amendments would require all facilities that have greater than 20,000 annual ampere-hours to achieve this emission limitation. The timing for requiring compliance with the emission limitation for each facility would be based on its annual production and proximity to sensitive receptors.

Intermediate-sized facilities (> 20,000 and ≤ 200,000 permitted ampere-hours per year) would have five years to comply if the facility is located more than 100 meters from a sensitive receptor. To protect sensitive receptors at the earliest possible time, other intermediate-sized facilities located at or within 100 meters of a sensitive receptor would be required to meet the emission limitation in two years. All intermediate-sized facilities would have the option to demonstrate compliance with the emission limitation without the installation of add-on air pollution control devices.

The largest facilities (greater than 200,000 permitted ampere-hours per year) would be required to install add-on air pollution control device(s) and to comply with the emission limitation of 0.0015 milligrams/ampere-hour within two years.

As proposed, a facility would be defined as modified if throughput levels increased such that the facility would be subject to a more stringent emission limitation. Modified facilities would be required to demonstrate compliance with the emission limitation of 0.0015 milligrams/ampere-hour by using an add-on air pollution control device(s).

For new facilities, no new facility would be allowed to operate unless it is located outside of an area that is zoned for residential or mixed use and is located at least 150 meters from the boundary of any area zoned for residential or mixed use. All new facilities would also be required to install HEPA add-on air pollution control device(s) and to comply with an emission limitation of 0.0015 milligrams/ampere-hour.

Accounting for the reductions in emissions and cancer risk achieved by South Coast AQMD Rule 1469, the proposed amendments to the Chromium Plating ATCM would further reduce the statewide emissions of hexavalent chromium from chromium plating and anodizing facilities by over 50 percent. Intermediate and large production facilities required to install BACT would control emissions by over 99 percent and this would result in a reduction in estimated cancer risk from current levels up to 85 percent for individual facilities.

Proposed Additional Amendments

1. A number of new and modified definitions are proposed to implement the new requirements and clarify existing definitions. In particular, a definition is being proposed to define "sensitive receptor." As proposed, a "sensitive receptor" would be defined as: "any residence including private homes, condominiums, apartments, and living quarters; education resources such as preschools and kindergarten through grade twelve (k-12) schools; daycare centers; and health care facilities such as hospitals or retirement and nursing homes. A sensitive receptor includes long term care hospitals, hospices, prisons, and dormitories or similar live-in housing."

2. The proposed amendments would specify the chemical fume suppressants that could be used by very small facilities to comply with the surface tension requirement. Some intermediate-sized facilities would also be required to use the specified chemical fume suppressants if they can demonstrate compliance with the emission limit without the installation of add-on air pollution control devices.

3. Housekeeping measures would be required to reduce fugitive hexavalent chromium emissions.

4. Training on the Chromium Plating ATCM and the requirements, conducted by ARB staff, would be required for employees of chromium plating and chromic acid anodizing facilities every two years. This requirement would not apply to personnel who attend the South Coast AQMD's training class for Rule 1469.

5. As described under "Comparable Federal Regulations," the federal regulation was recently amended. Therefore, staff is proposing to incorporate most of these changes into the Chromium Plating ATCM. However, staff is not proposing to incorporate the provision to allow hard chromium plating facilities to use chemical fume suppressants as the sole source of controlling hexavalent chromium emissions unless they have production levels less than 20,000 ampere-hours.

6. Staff is proposing amendments that would apply to chromium plating and chromic acid anodizing kits. The amendments would prohibit the sale, supply, offer for sale, or manufacture for sale in California of any chromium plating or chromic acid anodizing kit. In addition, any use of such kits to perform chromium electroplating or chromic acid anodizing would be prohibited unless these activities are performed at a permitted facility that complies with the requirements of the Chromium Plating ATCM.

7. New, modified, and some existing facilities would be required to conduct a site specific analysis if annual hexavalent chromium emissions exceed a specified weight.

8. A number of minor or nonsubstantive changes are proposed to re-number and re-organize subsections within the Chromium Plating ATCM. For example, the existing ATCM is contained in a single section (section 93102) but the amended Chromium Plating ATCM would be contained in sections 93102-93102.16. These changes are necessary to accommodate the new provisions and provide clarity.

COMPARABLE FEDERAL REGULATIONS

On January 25, 1995, the United States Environmental Protection Agency (U.S. EPA) promulgated, in 40 Code of Federal Regulations (CFR) Part 63, Subpart N, "The National Emission Standards for Chromium Emissions from Hard and Decorative Chromium Electroplating and Chromium Anodizing Tanks" (Chromium Plating NESHAP). On July 19, 2004, U.S. EPA amended the Chromium Plating NESHAP. The amendments allow the use of chemical fume suppressants as the sole method to control chromium emissions from hard chromium plating facilities as an alternative to the existing concentration emission limit. The existing Chromium Plating ATCM requires hard chromium plating facilities to reduce hexavalent chromium emissions by using add-on air pollution control devices. An exemption exists for facilities with annual ampere-hours below 500,000, if approved by the air pollution control or air quality management district (air district). Among other provisions the amended Chromium Plating NESHAP also established an alternative standard for hard chromium plating tanks equipped with enclosed hoods and modified the surface tension parameter testing to accommodate the margin of error between the use of a stalagmometer or tensiometer.

On March 15, 1999, ARB was granted equivalency to the 1995 Chromium Plating NESHAP under section 112(l) of the federal Clean Air Act (See 64 Federal Register (FR) 12762, March 15, 1999; 40 CFR section 63.99). This approval by U.S. EPA means that chromium plating and chromic acid anodizing facilities in California do not need to comply with the federal Chromium Plating NESHAP. Instead, these facilities must comply with California's Chromium Plating ATCM, in lieu of the federal Chromium Plating NESHAP. ARB staff is confident that requirements of the amended Chromium Plating ATCM are at least as stringent, or more stringent, than the amended Chromium Plating NESHAP.

Under the U.S. Department of Labor, the Occupational Health & Safety Administration (OSHA) published a Permissible Exposure Limit (PEL) to protect workers from hexavalent chromium exposures. On February 28, 2006, OSHA approved changes to the hexavalent chromium rule to establish a time-weighted average PEL of 5 micrograms per meter cubed ($\mu g/m^3$), measured and reported as hexavalent chromium (see 71 FR 10100). OSHA also adopted other ancillary provisions for employee protection such as preferred methods for controlling exposure, respiratory protection, protective work clothing and equipment, housekeeping measures, hygiene areas and practices, medical surveillance, hazard communication, and recordkeeping. The OSHA's PEL for chromic acid and chromates is found in 29 CFR 1910.1000, Table Z-2.

ARB staff is also proposing to include housekeeping measures in the Chromium Plating ATCM. The housekeeping measures are designed to prevent dust that may contain hexavalent chromium from becoming re-entrained into the ambient air. The OSHA measures are designed to protect workers. The measures proposed by ARB would not be in conflict with those required by OSHA to protect workers.

AVAILABILITY OF DOCUMENTS AND AGENCY CONTACT PERSONS

The ARB staff has prepared an "Initial Statement of Reasons for the Proposed Amendments to the Airborne Toxic Control Measure for Chrome Plating and Chromic Acid Anodizing Operations" (Staff Report) for the proposed regulatory action, which includes a summary of the potential environmental and economic impacts of the proposal.

Copies of the Staff Report and the full text of the proposed regulatory language may be obtained from the Public Information Office, Air Resources Board, 1001 I Street, Visitors and Environmental Services Center, 1st Floor, Sacramento, California 95814, (916) 322-2990 at least 45 days prior to the September 28, 2006, hearing. The Staff Report is also available on the internet at the website listed below, or by contacting the staff listed below.

Upon its completion, the Final Statement of Reasons (FSOR) will be available and copies may be requested from the agency contact persons in this notice, or may be accessed on the website listed below.

Inquiries concerning the substance of the proposed regulation may be directed to the designated agency contact persons, Carla Takemoto, Manager of the Technical Evaluation Section, at (916) 324-8028 or by email at ctakemot@arb.ca.gov, or Shobna Sahni, Air Pollution Specialist, at (626) 575-7039 or by email at spandhoh@arb.ca.gov.

Further, the agency representative and designated back-up contact persons to whom nonsubstantive inquiries concerning the proposed administrative action may be directed are Artavia Edwards, Manager, Board Administration & Regulatory Coordination Unit, (916) 322-6070, or Alexa Malik, Regulations Coordinator, (916) 322-4011. The Board has compiled a record for this rulemaking action, which includes all the information upon which the proposal is based. This material is available for inspection upon request to the contact persons.

This notice, the Staff Report, and all subsequent regulatory documents, including the Final Statement of Reasons, when completed, are available on the ARB Internet site for this rulemaking at www.arb.ca.gov/regact/chrom06/chrom06.htm

COSTS TO PUBLIC AGENCIES AND TO BUSINESSES AND PERSONS AFFECTED

The determinations of the Board's Executive Officer concerning the costs or savings necessarily incurred by public agencies and private persons and businesses in reasonable compliance with the proposed regulations are presented below and in specific detail in the Staff Report.

The ARB Executive Officer has determined that the proposed regulatory action will not create costs or savings, as defined in Government Code section 11346.5(a)(5) and 11346.5(a)(6), to any State agency or in federal funding to the State, costs or mandate to any school district whether or not reimbursable by the State pursuant to Part 7 (commencing with section 17500), Division 4, title 2 of the Government Code, or other nondiscretionary savings to State or local agencies.

The proposed regulatory action will impose a mandate upon and create costs to local agencies (i.e., air districts). The air districts will be required to implement and enforce the ATCM, or adopt and enforce their own rules that are at least as stringent. However, such administrative costs to the air districts are recoverable by fees that are within the air districts' authority to assess (see Health and Safety Code sections 42311 and 40510). Therefore, the Executive Officer has determined that the proposed regulatory action imposes no costs on local agencies that are required to be reimbursed by the State pursuant to part 7 (commencing with section 17500), Division 4, title 2 of the Government Code, and does not impose a mandate on local agencies that is required to be reimbursed pursuant to Section 6 of Article XIII B of the California Constitution.

In developing this regulatory proposal, the ARB staff evaluated the potential economic impacts on representative private persons or businesses. The Executive Officer has initially determined that there will be a potential cost impact on private persons or businesses directly affected as a result of the proposed regulatory action. The cost impact on the businesses will vary depending on how much a facility is already in compliance with the proposed requirements. As explained below, the proposed amendments may have a significant adverse impact on some individual businesses but the overall statewide impacts are not expected to be significant.

There are currently about 226 chromium plating and chromic acid anodizing facilities in California, with about 170 of those located in the South Coast AQMD. The estimated first year cost impacts for chromium plating or chromic acid anodizing owners or operators ranges from $450 to $217,000. The lower cost represents facilities that would have to file a one-time compliance status report, while the upper cost represents amortized costs for purchasing add-on air pollution control device(s), plus the operational and maintenance costs of the device(s). The average annual cost for a facility required to install an add-on air pollution control device(s) would be about $53,000. The average one-time cost for facilities that are already almost fully compliant is $5,300, with the highest cost being about $21,000. About 60 percent of existing facilities would have no appreciable compliance costs after the first year.

Some smaller volume plating or anodizing businesses may decide to cease chromium plating or anodizing operations rather than make the investments needed to comply. In order to minimize the economic impact to chromium plating and chromic acid anodizing facility owners or operators, a loan guarantee program has been established through the Business, Transportation, and Housing Agency.

Apart from the impacts described above on individual chromium plating and chromic acid anodizing businesses, the Executive Officer has made an initial determination that the proposed regulatory action will not have a significant statewide adverse economic impact directly affecting businesses, including the ability of California businesses to compete with businesses in other states, or on representative private persons.

In accordance with Government Code section 11346.3, the Executive Officer has initially determined that the proposed amendments should have minimal impacts on the creation or elimination of jobs within the State of California, minimal impacts on the creation of new businesses and the elimination of existing businesses within the State of California, and minimal impacts on the expansion of businesses currently doing business within the State of California.

The Executive Officer has also determined, pursuant to title 1, CCR, section 4, that the proposed regulatory action will affect small businesses.

In accordance with Government Code sections 11346.3(c) and 11346.5(a)(11), the Executive Officer has found that the proposed reporting requirements of the ATCM which apply to businesses are necessary for the health, safety, and welfare of the people of the State of California.

Before taking final action on the proposed regulatory action, the Board must determine that no reasonable alternative considered by the Board or that has otherwise been identified and brought to the attention of the Board would be more effective in carrying out the purpose for which the action is proposed or would be as effective and less burdensome to affected private persons than the proposed action.

A detailed assessment of the economic impacts of the proposed regulatory action can be found in the Staff Report.

SUBMITTAL OF COMMENTS

The public may present comments relating to this matter orally or in writing at the hearing, and in writing or by e-mail before the hearing. To be considered by the Board, written submissions not physically submitted at the hearing must be received **no later than 12:00 noon, September 27, 2006**, and addressed to the following:

Postal mail is to be sent to:

Clerk of the Board, Air Resources Board
1001 I Street, Sacramento, California 95814

Electronic submittal: http://www.arb.ca.gov/lispub/comm/bclist.php

Facsimile submittal: (916) 322-3928

The Board requests but does not require 30 copies of any written statement be submitted and that all written statements be filed at least ten days prior to the hearing so that ARB staff and Board Members have time to fully consider each comment. The Board encourages members of the public to bring to the attention of staff in advance of the hearing any suggestions for modification of the proposed regulatory action.

STATUTORY AUTHORITY AND REFERENCES

This regulatory action is proposed under the authority granted to the ARB in Health and Safety Code sections 39600, 39601, 39650, 39658, 39659, 39666, and 41511. This action is proposed to implement, interpret, or make specific Health and Safety Code sections 39650, 39658, 39659, 39666, and 41511; and 40 Code of Federal Regulations Part 63, subpart N.

HEARING PROCEDURES

The public hearing will be conducted in accordance with the California Administrative Procedure Act, title 2, division 3, part 1, chapter 3.5 (commencing with section 11340) of the Government Code.

Following the public hearing, ARB may adopt the regulatory language as originally proposed or with nonsubstantial or grammatical modifications. The Board may also adopt the proposed regulatory language with other modifications if the text as modified is sufficiently related to the originally proposed text that the public was adequately placed on notice that the regulatory language as modified could result from the proposed regulatory action. In the event that such modifications are made, the full regulatory text, with the modifications clearly indicated, will be made available to the public for written comment at least 15 days before it is adopted.

The public may request a copy of the modified regulatory text from the ARB's Public Information Office, Air Resources Board, 1001 I Street, Visitors and Environmental Services Center, 1st Floor, Sacramento, California 95814, (916) 322-2990.

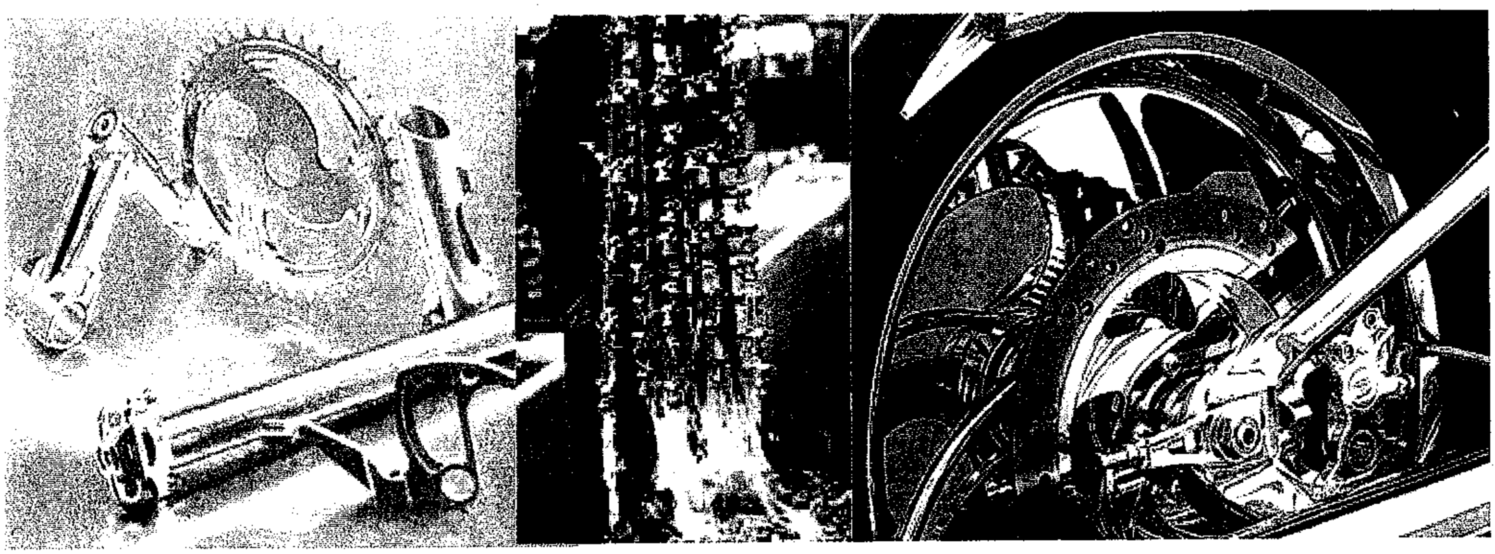
CALIFORNIA AIR RESOURCES BOARD

Catherine Witherspoon
Executive Officer

Date: August 1, 2006

California Environmental Protection Agency
AIR RESOURCES BOARD

PROPOSED AMENDMENTS TO THE HEXAVALENT CHROMIUM AIRBORNE TOXIC CONTROL MEASURE FOR CHROME PLATING AND CHROMIC ACID ANODIZING OPERATIONS



Stationary Source Division
Air Quality Measures Branch

Release Date: August 11, 2006

To Be Considered by the Board: September 28, 2006

State of California
AIR RESOURCES BOARD

STAFF REPORT: INITIAL STATEMENT OF REASONS FOR PROPOSED RULEMAKING

Public Hearing to Consider

ADOPTION OF THE PROPOSED AMENDMENTS TO THE HEXAVALENT CHROMIUM AIRBORNE TOXIC CONTROL MEASURE FOR CHROME PLATING AND CHROMIC ACID ANODIZING OPERATIONS

To be considered by the Air Resources Board on September 28, 2006, at:

California Environmental Protection Agency
Headquarters Building
1001 "I" Street
Sacramento, California

Stationary Source Division:

Robert Fletcher, P.E., Chief
Robert D. Barham, Ph.D., Assistant Division Chief
Janette Brooks, Chief, Air Quality Measures Branch
Carla D. Takemoto, Manager, Technical Evaluation Section

Acknowledgements

Contributing Authors

Shobna Sahni, M.P.H. (Lead)
Carla Takemoto
Reza Mahdavi, Ph.D.
Tony Servin, P.E.
Robert Barrera

Legal Counsel

Robert Jenne, Esq., Office of Legal Affairs

We are particularly grateful to Mr. Jose Mauro Saldana for his untiring assistance in the preparation of this report.

We also wish to acknowledge the participation and assistance of:

Metal Finishing Association of Southern California
Surface Technology Association

We would also like to acknowledge the participation and assistance of air pollution control and air quality management districts. In particular, we would like to thank the individuals at the following districts that participated in the ARB/District Working Group:

Richard Wales, Antelope Valley Air Quality Management District
Randy Frazier, Bay Area Air Quality Management District
Karla Sanders, Feather River Air Quality Management District
Jose De Guzman and Mark Loutzenhiser,
Sacramento Metropolitan Air Quality Management District
Archie de la Cruz, Cara Bandera, Dave Byrnes,
San Diego County Air Pollution Control District
Chay Thao, Martin Keast, John Copp,
San Joaquin Valley Air Pollution Control District
Shasta County Air Quality Management District
Robert Gottschalk, Andrew Lee, Jay Chen, Susan Nakamura, Marco Polo,
Thomas Liebel, Joan Niertit, Jill Whynot, Mike Garibay, David Jones, and
Sam Vergara, South Coast Air Quality Management District
Terri Thomas, Ventura County Air Pollution Control District

For the emissions testing program we want to acknowledge the invaluable assistance of: Mr. Dominic Nole, Mr. Dan Cunningham, Mr. Dean High, Mr. Paramo Hernandez, Mr. Ray Lucas, Mr. Chad Medico, Mr. John Martin, and Mr. Ralph Hersher

We also acknowledge the assistance of the tested facilities: Sigma Plating, Excello Plating, Van Nuys Plating, Alta Plating, Sherm's Custom Chrome, Clovis Specialty Plating, Walker Custom Chrome

Numerous ARB staff helped in the emissions testing program and in development of this report. In particular we acknowledge: Alex Barber; Ron Barros; Nicholas Berger; Darryl Burns; Chris Clark; Monique Davis; Steve Eve; Cynthia Garcia; Marline Hicks; Chris Nguyen; Olufemi Olaluwoye; Johnnie Raymond; Don Ridgley; Betsy Ronsse; Peter Samra; Dale Shimp; David Todd, Source Testing Lead; Roxana Walker; Evan Wong; Glen Villa; Zuzana Vona

Table of Contents

List of Tables

List of Figures

List of Appendices

Executive Summary

The Air Resources Board (ARB) staff is proposing amendments to the Hexavalent Chromium Airborne Toxic Control Measure for Chrome Plating and Chromic Acid Anodizing Operations (Chromium Plating ATCM or ATCM). The amendments are proposed as a result of our evaluation of the 226 chromium plating and chromic acid anodizing facilities in California.

In 1986, the Board identified hexavalent chromium as a toxic air contaminant (TAC). Hexavalent chromium was determined to be an extremely potent human carcinogen with no known safe level of exposure. Only dioxin is a more potent carcinogen than hexavalent chromium. Exposure over a lifetime to very low hexavalent chromium concentrations can substantially increase a person's chance of developing cancer.

Due to its potential cancer risk, ARB has adopted a number of control measures for hexavalent chromium sources, including chromium plating and chromic acid anodizing facilities. The current ATCM reduced emissions of hexavalent chromium by over 90 percent, and in some cases by over 99 percent. Other air district programs have also reduced emissions of hexavalent chromium. As a result, ambient levels of hexavalent chromium are low and have been reduced by about 60 percent since the early 1990s.

Based on community concerns and the potency of hexavalent chromium, the staff has re-evaluated the current Chromium Plating ATCM. We found that people living near many of these facilities are exposed to unacceptable concentrations of hexavalent chromium. Our evaluation showed that 43 percent of chromium plating and chromic acid anodizing operations are located within 100 meters of sensitive receptors and about 30 percent of the facilities have emissions sufficient to produce a potential cancer risk of greater than ten per million exposed people. The data also show that the chromium plating facilities are often located in low income and ethnically diverse communities.

In the evaluation, we also found that reliable add-on air pollution control devices, such as high efficiency particulate arrestor (HEPA) filters, are available. These controls now represent best available control technology (BACT) for intermediate and large sized facilities that can result in higher community risks. BACT for smaller facilities, those with emissions that can relatively easily be controlled to the levels needed to keep community risk low (under one per million), is use of specific chemical fume suppressants. In our proposal, all 226 facilities would be affected; 89 of those facilities would need to meet an emission limit equivalent to that achieved by HEPA filters and another 48 facilities would have to use specific chemical fume suppressants. The other facilities are in substantial compliance. The requirements would be phased-in over time, with facilities close to receptors having to install BACT in two years, versus five years for other facilities.

By requiring BACT for all facilities, remaining cancer risks would be reduced by up to 85 percent in communities close to facilities. We also estimate that adoption of the staff's proposal will reduce the estimated cancer risk for about 75 percent of facilities to no more than one per million exposed persons, with 92 percent of facilities having estimated cancer risks of less than ten per million exposed persons. The proposal would also isolate new chromium plating or chromic acid anodizing facilities from people and require housekeeping measures to address fugitive emissions.

Staff has determined that costs for some individual businesses are expected to be significant and may adversely impact their profitability. Some smaller volume plating or anodizing businesses may decide to cease chromium plating or anodizing operations rather than make the investments needed to comply. This analysis assumes that affected facilities would install HEPA filters, although there may be less costly equivalent options available, and the facilities cannot recover their costs through increased prices.

This Executive Summary provides an overview of the staff's proposal, including the basis and rationale, key provisions, and the environmental and economic impacts. The staff report, entitled "Proposed Amendments to the Hexavalent Chromium Airborne Toxic Control Measure For Chrome Plating and Chromic Acid Anodizing Operations," presents detailed information related to the staff's proposal, as well as the proposed regulation order.

A. Background

1. What is chromium plating and chromic acid anodizing?

Hexavalent chromium plating, or simply chromium plating, is the electrical application of a coating of chromium onto a surface for decoration, corrosion protection, or for durability. An electrical charge is applied to a tank (bath) containing an electrolytic salt (chromium anhydride) solution. The electrical charge causes the chromium metal particles in the bath to fall out of solution and deposit onto objects placed in the plating solution. The most familiar type of chromium plating is the decorative chromium plating process which provides a bright, shiny finish onto objects such as wheels and plumbing fixtures. During chromic acid anodizing, an oxidation layer is generated on the surface of the part. These electrolytic processes cause mists containing hexavalent chromium to be ejected from the plating tank which are eventually emitted into outdoor air.

2. What is hexavalent chromium?

Hexavalent chromium is the cation of a metal salt and does not occur naturally. Generally, hexavalent chromium ions are produced under strong oxidizing conditions from metallic chromium, with the most common ions being chromate ion (CrO_4^{-2}) or dichromate ion ($Cr_2O_7^{-2}$). Unlike many pollutants which are gases, hexavalent chromium is a particle.

3. How is hexavalent chromium emitted from the plating/anodizing process?

In the chromium plating process, only about 20 percent of the electrical current applied actually deposits chromium onto the part. The remaining current forms bubbles, hydrogen gas at the cathode and oxygen at the anode, that rise to the surface of the bath. As these bubbles burst, hexavalent chromium is emitted into the air.

4. Why are we concerned about emissions of hexavalent chromium?

Hexavalent chromium is a known human carcinogen. Prolonged exposure causes lung cancer. The Board identified hexavalent chromium as a TAC in 1986. A cancer unit risk factor of 0.15 $(\mu g/m^3)^{-1}$ was developed in support of the TAC identification by the Office of Environmental Health Hazard Assessment (OEHHA) and approved by the Scientific Review Panel on TACs. This value means that a person's chance of developing cancer due to exposure to 1 $\mu g/m^3$ of hexavalent chromium over a 70 year lifetime would be 146,000 chances per million people, almost 15 percent. Only one other identified TAC, dioxin, has been determined more likely to cause cancer than hexavalent chromium. When the Board designated hexavalent chromium as a TAC, they further determined that there was no known level of exposure that would be considered safe.

5. What does State law require ARB to do to reduce the public's exposure to toxic air contaminants?

Health and Safety Code section 39666 requires ARB to adopt control measures to reduce emissions of TACs. When adopting or amending ATCMs for TACs, if no safe threshold exposure level is identified, the ATCM is to reduce emissions to the lowest level achievable through the application of BACT or a more effective control method, in consideration of health risk and cost.

6. What does the current ATCM require?

Originally adopted in 1988 and amended in 1998, the Chromium Plating ATCM set forth the requirements for reducing hexavalent chromium emissions based on the type of operation. Most hard chromium plating facilities were required to reduce hexavalent chromium emissions by 99 percent or more. This was achieved through installation of add-on air pollution control devices. Decorative chromium plating and chromic acid anodizing facilities were required to reduce uncontrolled emissions by at least 95 percent. However, they were not required to use add-on air pollution control devices. A brief summary of the requirements follows:

- Hard chromium plating facilities are required to install add-on air pollution control devices to meet emission limits ranging from 0.15 milligrams/ampere-hour to 0.006 milligrams/ampere-hour, depending on levels of throughput. An alternative surface tension limit was provided for hard chromium plating facilities with throughput levels of 500,000 ampere-hours or less; and
- Decorative plating and chromic acid anodizing facilities must comply with either an emission limit using add-on air pollution control devices or meet a surface tension limit. Most facilities comply by using chemical fume suppressants to meet the surface tension limit.

The ATCM was amended in 1998 to establish equivalency with the National Emission Standards for Chromium Emissions from Hard and Decorative Chromium Electroplating and Chromium Anodizing Tanks (Chromium Plating NESHAP) (U.S. EPA, 1995).

Therefore, chromium plating and chromic acid anodizing facilities are only subject to California's Chromium Plating ATCM.

7. Why did ARB staff decide to evaluate the existing ATCM?

Due to the carcinogenicity of hexavalent chromium, and in response to community concerns, ARB staff undertook an evaluation of the Chromium Plating ATCM. The staff evaluated if people located near chromium plating or chromic acid anodizing facilities were adequately protected from emissions of hexavalent chromium. Staff also evaluated if technologies were available to reduce hexavalent chromium emissions, if necessary. As part of the evaluation, staff determined that 43 percent of the operations are located within 100 meters of a sensitive receptor, such as a residence or school. By conducting an emissions testing program and air quality modeling, staff determined that these sensitive receptors may be exposed to unacceptable hexavalent chromium concentrations. ARB staff also found that reliable add-on air pollution control devices such as HEPA filters are now available and are used by many facilities to reduce hexavalent chromium emissions.

Concurrent with the review of the Chromium Plating ATCM, unexpectedly high concentrations of hexavalent chromium were measured during an air monitoring study conducted near chromium plating facilities in San Diego. Through further air monitoring, the source of the high concentrations was determined to be the decorative chromium plating facility.

8. Have other regulatory actions affected the chromium plating and chromic acid anodizing industry?

Yes. In 2003, the South Coast Air Quality Management District (SCAQMD) adopted amendments to Rule 1469, entitled Hexavalent Chromium Emissions from Chromium Plating and Chromic Acid Anodizing Operations (SCAQMD, 2003). The amended rule requires hexavalent chromium facilities located within 25 meters of a sensitive receptor or within 100 meters of a school to reduce hexavalent chromium emissions so that the residential cancer risk will be no more than ten chances per million people. The rule also requires facilities located greater than 25 meters from a sensitive receptor or greater than 100 meters from a school to reduce emissions such that off-site worker cancer risk would be no more than 25 chances per million people. The amended rule is in full effect. To help meet the requirements, SCAQMD staff conducted a chemical fume suppressant certification program which established a list of products that could be used to meet an emission rate of 0.01 milligrams/ampere-hour.

As mentioned previously, a federal control measure is also in place to control emissions of chromium compounds from chromium plating and chromic acid anodizing facilities (U.S. EPA, 1995). The ARB has achieved equivalency with the Chromium Plating NESHAP.

The United States Department of Labor Occupational Safety and Health Administration (OSHA) established a Permissible Exposure Limit (PEL) to protect workers from hexavalent chromium exposures. OSHA's time-weighted average PEL is 5 µg/m^3, measured and reported as Chromium VI and an action level of 2.5 µg/m^3 for the general industry.

B. The Chromium Plating and Chromic Acid Anodizing Industry in California

9. What are the results of the industry survey?

ARB staff conducted a survey of chromium plating and chromic acid anodizing facilities for calendar year 2003. Staff collected information on types of operations performed, emission rates, throughput in terms of annual ampere-hours, methods for controlling hexavalent chromium emissions, and economic information. Staff also conducted an emissions testing program to better characterize emissions of hexavalent chromium from decorative chromium plating operations.

Results of our survey showed that there were 228 active facilities, and 12 of these conduct more than one electroplating process. These 228 facilities perform 240 chromium related operations. This means, for example, that some facilities conduct both decorative and hard chromium plating. Ten operations use the trivalent chromium plating process to conduct decorative chromium plating. Of these ten operations, six facilities conduct only trivalent chromium plating. Four trivalent chromium operations are part of a facility that also conducts hexavalent chromium plating. The other 230 operations use the hexavalent chromium process. Of these operations 58 are hard chromium plating, 127 are decorative chromium plating, and 45 are chromic acid anodizing operations. Our survey findings are shown graphically in Figure ES-1 below.

Figure ES-1. Location and Type of Operation Performed at Chromium Plating and Chromic Acid Anodizing Facilities in California (2003)

Chart A: Facility Location

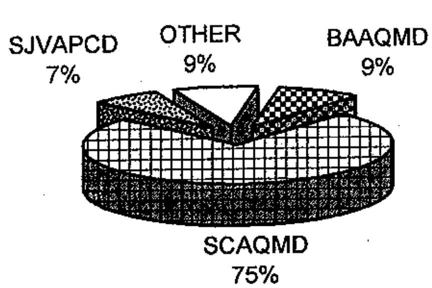


Chart B: Type of Operation

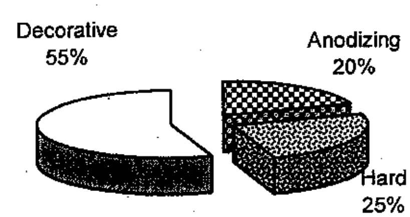
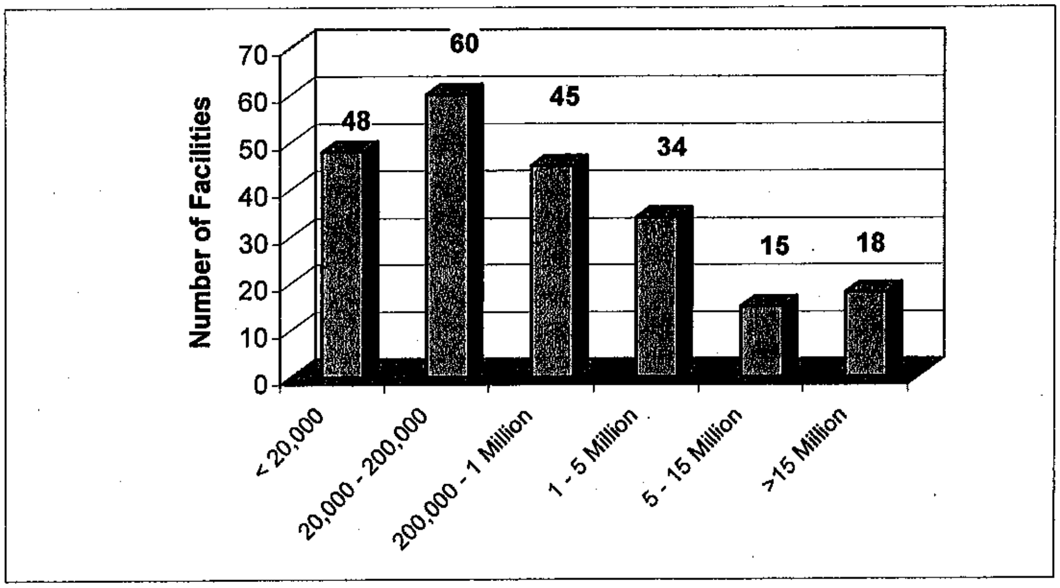


Figure ES-2 shows the distribution of the 222 hexavalent chromium plating and chromic acid anodizing facilities based on throughput. The six facilities conducting only trivalent chromium plating are not represented. Throughput is presented in ampere-hours. An ampere-hour is a unit of amperes integrated over time. It is an important variable because it is used to determine the amount of hexavalent chromium emissions from a facility. The ampere-hours are multiplied by an emission rate to calculate emissions.

Figure ES-2. Throughput (in Ampere-hours) for Chromium Plating and Chromic Acid Anodizing Facilities in California (2003)



As shown in Figure ES-2, about 48 (about 20 percent) of facilities have annual throughput of 20,000 annual ampere-hours or less. Sixty facilities (27 percent) have throughput of between 20,000 to 200,000 annual ampere-hours. Over 50 percent of facilities have annual ampere-hours over 200,000.

10. What are the results from the decorative chromium plating emissions testing program?

The goal of the emissions testing program was to establish an emission rate for chromium plating and chromic acid anodizing tanks controlling hexavalent chromium emissions with chemical fume suppressants. Staff conducted six tests to estimate emissions based on normal facility operations. Averaging the emission rates from these six tests results in a hexavalent chromium emission factor of 0.04 milligrams/ampere-hour. These data are representative of 'real world' conditions.

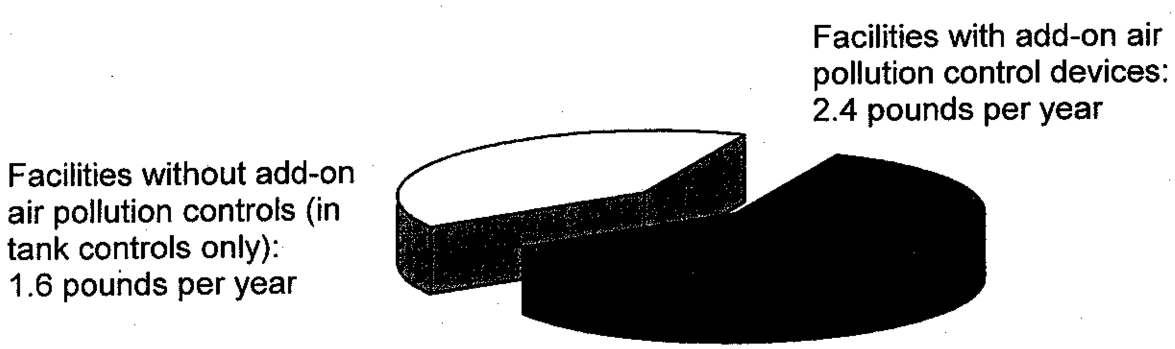
Concurrent with our testing program, the SCAQMD tested the ability of chemical fume suppressants to reduce emissions under carefully controlled conditions. The purpose of this testing was to determine parameters that yielded optimum emission reductions. The SCAQMD demonstrated that hexavalent emissions can be further reduced if certain chemical fume suppressants are used. In fact, the SCAQMD demonstrated that several chemical fume suppressants could reduce emissions of hexavalent chromium to no more than 0.01 milligrams/ampere-hour. The surface tension at which this emission rate is achieved is at lower surface tension than currently required by the ATCM.

A seventh test was done to verify the SCAQMD results. The seventh test was conducted using the chemical fume suppressant Fumetrol 140®. The SCAQMD certified this chemical fume suppressant to reduce hexavalent chromium emissions to no more than 0.01 milligrams/ampere-hour when surface tension is maintained below 40 dynes/centimeter. In test seven, ARB was able to duplicate this emission rate. Based on this test result, as well as an evaluation of the SCAQMD source test data from their chemical fume suppressant certification program, ARB staff determined which chemical fume suppressants could be used as the sole control by some facilities to comply with the ATCM. These chemical fume suppressants have been shown to reduce hexavalent chromium emissions to no more than 0.01 milligrams/ampere-hour at specified surface tensions.

11. What are the emissions of hexavalent chromium from chromium plating and chromic acid anodizing facilities?

Staff developed the emission inventory for chromium plating and chromic acid anodizing facilities by using data from the survey. As explained previously, emissions of hexavalent chromium are determined based on throughput and are quantified in milligrams/ampere-hour. To develop the emission inventory, staff developed two emission factors for hexavalent chromium plating facilities controlling emissions by using chemical fume suppressants. We estimated emissions for these facilities by using the emission rate of 0.04 milligrams/ampere-hour for facilities outside SCAQMD. We used the emission factor of 0.01 milligrams/ampere-hour for SCAQMD facilities. The SCAQMD facilities are required to use chemical fume suppressants that meet this emission rate. Emissions from facilities with add-on air pollution control devices are based on source test results or regulatory requirements.

Figure ES-3. Baseline Hexavalent Chromium Emissions are About Four Pounds (2005)



As shown in Figure ES-3, staff estimates that emissions of hexavalent chromium from chromium plating and chromic acid anodizing facilities in 2005 totaled 4.0 pounds, or about 1,800 grams.

12. Why is staff concerned about 4.0 pounds per year of emissions?

While the 4.0 pounds (1,800 grams) per year of emissions seems low, even a very small amount of hexavalent chromium can result in a substantial cancer risk. For example, staff found that as little as two grams of annual emissions would yield an estimated cancer risk of ten per million people exposed. As shown in Table ES-1, the maximum individual cancer risk (MICR) was determined for each chromium plating and chromic acid anodizing facility in California based on these 4.0 pounds of emissions. It should be noted that the MICR is calculated using the highest concentration of hexavalent chromium downwind of a facility that is predicted by an air quality model. People may not be living at the MICR point. Table ES-1 reflects implementation of the current ATCM and air district rules, including Rule 1469 for facilities in the South Coast Air Basin.

Table ES-1. Sixty-three Facilities have Estimated Cancer Risk of Over 10 per Million Exposed People (2005 Baseline)

Number of Facilities by Cancer Risk

	≤1 per million	>1 ≤10 per million	>10 ≤100 per million	>100 per million
Baseline 2005	90	67	57	6

As shown in Table ES-1, 90 facilities (about 41 percent) have estimated cancer risk less than one per million exposed people. However, Table ES-1 also shows that 57 facilities (about 26 percent) have an estimated cancer risk of over ten per million exposed people. Six facilities (about 3 percent) may have an estimated cancer risk of over 100 per million people exposed.

Based on these results, staff determined that further risk reduction measures are necessary. While Rule 1469 reduced the estimated cancer risk for facilities in the SCAQMD, the rule had no impact on facilities in the rest of the state. We have also determined that Rule 1469 did not achieve the maximum reduction feasible because BACT was not required for all facilities.

13. Are sensitive receptors located within 100 meters of a chromium plating and chromic acid anodizing facility?

Yes. Near source exposures to chromium plating and chromic acid anodizing facilities are our primary health concern. ARB staff and the air districts worked together to determine the location of chromium plating and chromic acid anodizing facilities, and to determine the distance to the nearest residence, school, hospital, day care center, or similar sensitive receptor location. Figure ES-4 shows the proximity of facilities to sensitive receptors.

Figure ES-4. Forty-three Percent of Facilities are Located Near Sensitive Receptors

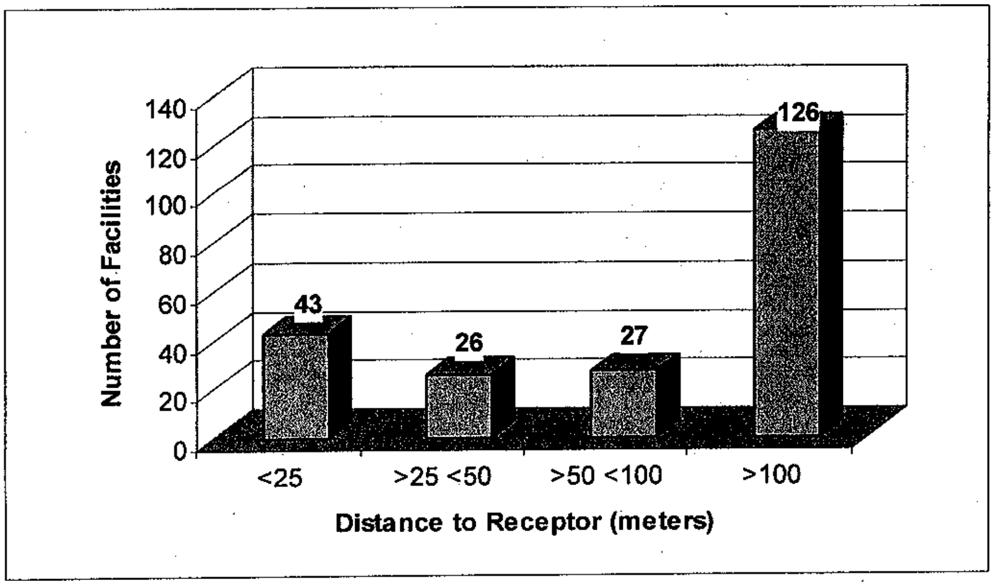


Figure ES-4 shows that 96 chromium plating and chromic acid anodizing facilities are located within 100 meters of a sensitive receptor. This represents 43 percent of the facilities. Forty-three facilities are located within 25 meters of a sensitive receptor.

C. Staff's Proposal to Amend the Chromium Plating ATCM

14. How did staff determine the most effective approach to control?

Staff evaluated available add-on air pollution control technologies and alternative processes for hexavalent chromium plating and chromic acid anodizing to determine if cancer risk could be reduced or eliminated. While alternatives exist for some applications, their use is limited. Thus, we concluded that alternative technologies are not available that enable a phase-out of the hexavalent chromium process at this time. However, our analysis also shows that effective add-on air pollution control devices are readily available. These devices minimize the cancer risk to the extent technology allows.

Staff also conducted modeling analyses to determine how hexavalent chromium is dispersed from chromium plating and chromic acid anodizing facilities. The concentration of hexavalent chromium is highest near the facility, but the impacts of the emissions appear to be localized. We found that at 100 meters from the source hexavalent chromium concentrations are reduced by up to 90 percent.

To develop the proposal, staff conducted the health risk assessment in a manner which is very health protective in estimating cancer risks for a range of reasonably foreseeable exposure scenarios. Staff believes this health protective approach is necessary due to the very high potency and resultant serious health hazards associated with hexavalent chromium emissions. The goal of this proposal is to reduce cancer risk to as low as technology allows. Use of BACT will meet this goal.

15. What is best available control for (BACT) chromium plating and chromic acid anodizing facilities?

Staff has evaluated various types of add-on air pollution control devices. We also have evaluated the effectiveness of chemical fume suppressants through our emissions testing program. We have determined that BACT for very small facilities is use of specific types of chemical fume suppressants. BACT for intermediate and larger sized facilities is use of add-on air pollution control devices with the final capture device being HEPA filters. Use of HEPA filters will reduce hexavalent chromium emissions to no more than 0.0015 milligrams/ampere-hour. HEPA filters reduce emissions by over 99.9 percent. Any other combination of control devices that can meet this emission rate would be considered equivalent to BACT. These technologies are already employed by many chromium plating and chromic acid anodizing facilities. These control technologies are described below.

a. Chemical Fume Suppressants

Surface tension is the force that keeps a fluid together at the air/fluid interface. It is expressed in force per unit of width such as dynes/centimeter. Chemical fume suppressants that contain 'wetting agents,' or surfactants, reduce this surface tension. By reducing surface tension in the plating/anodizing bath, gas bubbles become smaller and rise more slowly than larger bubbles. Slower bubbles have reduced kinetic energy such that when the bubbles do burst at the surface the hexavalent chromium is less likely to be emitted into the air, and the droplets fall back onto the surface of the bath (Bayer®).

The most common types of surfactants used in chromium electroplating and chromic acid anodizing are fluorinated or perfluorinated compounds or fluorosurfactants (U.S. EPA, 1998). As proposed, the types of chemical fume suppressants that could be used for compliance with the ATCM would contain fluorosurfactants.

b. HEPA (High Efficiency Particulate Arrestor) Filters

HEPA filters are specifically designed for the collection of submicrometer particulate matter at high collection efficiencies. HEPA filters are rated at 99.97 percent effective in capturing particles 0.3 μm in diameter. When used in particulate air pollution control, HEPA filters are best utilized in applications with a low flow rate and low pollutant concentration. Typically, HEPA filters are installed downstream of another control device to lessen loading on the filter, thereby lengthening its life. HEPA filters are considered the most effective control of hexavalent chromium emissions from chromium plating and chromic acid anodizing.

16. What are the goals of the proposed amendments?

The goals of the proposed amendments are to achieve the maximum hexavalent chromium emission reduction from chromium plating and chromic acid anodizing facilities, ensure that new facilities are isolated from sensitive receptors, and reduce fugitive hexavalent chromium emissions.

17. How would the proposed amendments achieve these goals?

The proposed amendments would require use of BACT for all facilities. Use of HEPA filters, or other combinations of controls that are as effective as HEPA filters, represent BACT for intermediate and large throughput facilities. BACT for very small facilities is the use of ARB specified chemical fume suppressants. The requirements would be phased in based on throughput and proximity to sensitive receptors. Sensitive receptor locations include residences, schools, daycare centers, hospitals, hospices, retirement or nursing homes, prisons and dormitories.

The proposal would also prevent new hexavalent chromium plating and chromic acid anodizing facilities from operating in areas zoned as residential or mixed use or within 150 meters (~500 feet) of these zones. Any new facility would also be required to install state-of-the-art add-on air pollution control devices prior to beginning operations.

Proposed housekeeping provisions would reduce fugitive emissions of hexavalent chromium from all facilities by establishing housekeeping measures.

18. What would the proposed amendments require for existing hexavalent chromium plating and chromic acid anodizing facilities?

Staff is proposing to amend the Chromium Plating ATCM by phasing in BACT. The timing for application of BACT would be related to throughput and proximity to sensitive receptors. The requirements and timing are shown in Table ES-2 below.

Table ES-2. Proposed Hexavalent Chromium Emission Limits for Existing Facilities

Tiers of Annual Permitted Ampere-Hours	Sensitive Receptor Distance	Emission Limitation	Effective Date
Tier 1 ≤ 20,000	Any	Use Chemical Fume Suppressant as specified in section 93102.8	[Six Months after Effective Date]
Tier 2 > 20,000 and ≤ 200,000	≤ 100 Meters	0.0015 milligrams/ampere-hour	[Two Years after Effective Date]
Tier 3 > 20,000 and ≤ 200,000	> 100 Meters	0.0015 milligrams/ampere-hour	[Five Years after Effective Date]
Tier 4 > 200,000	Any	0.0015 milligrams/ampere-hour	[Two Years after Effective Date]

As shown in Table ES-2, very low throughput (less than 20,000 ampere-hours per year) facilities would be required, at a minimum, to reduce hexavalent chromium emissions through use of specified chemical fume suppressants to lower surface tension of the plating or anodizing bath. This represents BACT for these facilities, and would generally ensure that the maximum cancer risk near the facility is under one in a million.

Intermediate-sized facilities (greater than 20,000 but less than 200,000 ampere-hours per year) would be required to meet an emission limitation of 0.0015 milligrams/ampere-hour. These facilities, however, would have the option to demonstrate compliance without installation of add-on air pollution control devices. This proposal, along with providing additional time to comply for those facilities more than 100 meters from a sensitive receptor, could reduce compliance costs for some small businesses.

The largest facilities (more than 200,000 ampere-hours per year) would be required to comply with the emission limitation of 0.0015 milligrams/ampere-hour within two years using an add-on air pollution control device(s). After application of BACT, facilities with remaining cancer risk over 25 per million exposed people would be required to conduct a site specific analysis of their facility's risk to determine if further control measures are necessary.

19. What would the proposed amendments require for any new facility?

The proposal would prevent new chromium plating or chromic acid anodizing facilities from operating in areas zoned residential or mixed use or within 150 meters (~500 feet) of an area zoned residential or mixed use. At this distance, modeling for point sources shows that the hexavalent chromium concentration has dropped off by about 80 percent. New facilities would also be required to conduct a site specific analysis to ensure their emissions do not cause adverse impacts.

20. What is staff proposing to limit fugitive emissions?

Fugitive dust emissions also likely impact people residing near chromium plating and chromic acid anodizing facilities. Therefore, staff is proposing that all facilities implement housekeeping measures to reduce dust emissions.

21. Are other changes proposed?

Yes. Training explaining the Chromium Plating ATCM and the requirements, conducted by ARB staff, would be required for employees responsible for compliance every two years. The training offered by SCAQMD would fulfill this requirement.

The proposal would also prohibit the sale or use of chromium plating or chromic acid anodizing materials unless sold or used by individuals or businesses under air district permit to conduct such operations.

Staff is proposing to require use of specific types of chemical fume suppressants for complying with the surface tension limits. The chemical fume suppressants that could be used have been shown to reduce hexavalent chromium emissions to more than 0.01 milligrams/ampere-hour at the proposed surface tensions.

To implement the new hexavalent chromium emission reduction requirements, a definition for "sensitive receptor" is proposed. A "sensitive receptor" is proposed to be defined as "any residence including private homes, condominiums, apartments, and living quarters;

education resources such as preschools and kindergarten through grade twelve (k-12) schools; daycare centers; and health care facilities such as hospitals or retirement and nursing homes. A "Sensitive Receptor" includes individuals housed in long term care hospitals, hospices, prisons, and dormitories or similar live-in housing."

D. Health Benefits Resulting from the Proposed Amendments

Adoption of the proposed amendments would significantly reduce both emissions and cancer risk from chromium plating and chromic acid anodizing facilities.

22. How would emissions and cancer risk be reduced if the staff's proposal were to be adopted?

If the staff's proposal were to be adopted, an additional 40 percent of facilities would be reducing emissions by over 99 percent. Estimated cancer risk for residents and off-site workers living or working near chromium plating and chromic acid anodizing facilities would be reduced by up to 85 percent depending on the individual facility.

Table ES-3 below shows how excess cancer risk would be reduced beyond the risk reduction achieved by implementation of current ARB and district rules.

Table ES-3. Adoption of Staff's Proposal Significantly Reduces the Estimated Cancer Risk from Hexavalent Chromium Emissions

Number of Facilities by Cancer Risk

	≤1 per million	>1 ≤10 per million	>10 ≤100 per million	>100 per million
Staff Proposal	162	41	17	0
Baseline	90	67	57	6

As shown in Table ES-3, by adopting the staff's proposal about 162 facilities (74 percent) would have remaining cancer risk of no more than one per million exposed persons. This represents an additional 72 facilities compared to the baseline. Only 17 facilities (about 8 percent) would have estimated cancer risk of over ten per million exposed people. No facilities would have cancer risk exceeding 100 per million exposed people. Under the staff's proposal each facility with residual cancer risk over 25 per million exposed people would need to do a site specific analysis to determine if further control measures are needed. Total hexavalent chromium emissions from all chromium plating and chromic acid anodizing facilities would decrease, by 55 percent, to 1.8 pounds per year.

Non-cancer health risks were also evaluated. Our analysis found that each facility's hazard index was well below the level of concern (hazard index = 1). Adoption of the proposal would only lower further the potential for any adverse non-cancer effects to occur.

E. Public Outreach

23. In developing the proposal what actions did staff take to consult with all stakeholders?

Staff worked with the air districts, industry, the environmental community, and other affected parties through public workshops, meetings, telephone calls, and mail-outs. Major outreach activities included:

- Forming an ARB/Air District Working Group;
- Forming an ARB/Stakeholder Working Group and conducting meetings in Northern and Southern California;
- Conducting site visits to numerous chromium plating and chromic acid anodizing operations;
- Creating a website and maintaining a List-Serve to automatically update interested parties about proposed ATCM developments;
- Conducting surveys of chromium plating and chromic acid anodizing facilities, chemical fume suppressant manufacturers providing chemicals and services to the chromium plating and chromic acid anodizing facilities in California, and conducting an economic survey of the industry;
- Mailing workshop notices and posting workshop materials on ARB's website;
- Conducting public workshops, with conference call tie-in, in Northern and Southern California; and
- Preparing a fact sheet regarding the development of the proposed ATCM and making it available to the public.

F. Economic Impacts of the Staff's Proposal

Staff has evaluated the financial impact on California businesses that would result from adoption of the proposed amendments. Staff conducted a very conservative cost impact assessment. While some businesses may be able to demonstrate compliance without purchasing a HEPA system, it was assumed for the purpose of our economic impact analysis that all facilities required to meet the 0.0015 milligrams/ampere-hour limit would purchase a HEPA filtration system.

24. How many businesses are impacted by the staff's proposal?

All of the 226 facilities affected by the proposed amendments to the ATCM will have some compliance costs. [Two facilities have closed down since conducting the survey.] Up to 89 facility owners would be required to expend significant capital to meet the requirements. About 60 percent of facilities however, are already in substantial compliance.

25. What would be an individual facility's cost to comply?

During the first year, all facilities would have compliance costs. Costs will vary depending on the extent an individual business is already in compliance with the proposed amendments. We estimate that costs in the first year would range from $450 to $217,000, with an average cost of $23,000. In subsequent years, costs would range from near zero to $217,000, with an average cost of $53,000. After the first year, 60 percent of the facilities would have no additional compliance costs.

26. How would the Return on Owner's Equity be affected?

All of the chromium plating and chromic acid anodizing businesses affected by these proposed amendments are California businesses. Businesses are affected by the proposed amendments to the extent that costs associated with implementation of the regulation may reduce their profitability.

Profitability impacts were estimated by calculating the decline in the return on owner's equity (ROE). A decline in ROE of 10 percent or more is one indication that the ATCM could result in a significant adverse impact. The proposed amendments to the ATCM are expected to result in an average ROE decline of nine percent.

Staff has determined that costs for some individual businesses are expected to be significant and would adversely impact their profitability. For the 89 businesses that would likely need to install or upgrade add-on air pollution control devices, the estimated decline in profitability ranges from 3 to 41 percent. Twenty-eight of these are small businesses. The average estimated compliance cost for these businesses is about $53,000. Some smaller volume plating or anodizing businesses may decide to cease chromium plating or anodizing operations rather than make the investments needed to comply.

27. Is there any assistance available to help small businesses secure the necessary capital to comply?

The Governor, in 2005, signed legislation (Assembly Bill 721, Nunez) to establish a loan guarantee program for decorative chromium plating operations to purchase pollution control equipment. The program is administered by the Business, Transportation, and Housing Agency. The program will provide loan guarantees of up to $100,000 to owners of decorative chromium plating small businesses that are not able to qualify for a conventional loan. The loan guarantee program is now in effect. In July 2006, the Governor signed into law amendments to the loan guarantee program. The loan guarantee program is now available for all metal plating facilities.

28. Are manufacturers of chromium plating and chromic acid anodizing suppliers adversely impacted by the proposed amendments?

We do not expect manufacturers of chromium plating and chromic acid anodizing materials to incur any costs. However, the staff's proposal to prohibit sales of chromium plating kits to non-permitted facilities may result in lost revenue for these businesses. The proposed amendments would potentially impact the chemical manufacturers in a positive way through increased sale of chemical fume suppressants. Add-on air pollution control device manufacturers, as well as the metal fabricating industry would also benefit from the proposed amendments as controls and ductwork for ventilation systems is purchased.

29. Would consumers be impacted by the proposal?

The potential impact of the proposed amendments to the ATCM on consumers depends upon the extent to which affected businesses are able to pass on the increased cost to consumers in terms of higher prices for their goods and services. If all costs are passed onto the consumers, we expect the cost per ampere-hour to increase from near zero to about $2.20 per ampere-hour. These costs are estimated based on facilities that would have to install add-on air pollution control devices. The lower end of this cost would represent a large throughput facility, while the upper end cost would represent a small throughput facility.

To put these costs into perspective, consider that chromium plating an automobile bumper (a decorative chromium application) requires 50 ampere-hours to chromium plate. This would mean the increased cost to plate a bumper would increase from near zero to about $110. If re-plating a bumper costs $400 at present time, the cost of the bumper would increase from about $400 to as much as $510.

30. Are there any costs to public agencies?

Yes. The air districts, as a result of the proposed amendments, would incur costs for reviewing initial compliance status reports; reviewing or revising permit modifications for facilities adding or upgrading to HEPA, or an equivalent level of control; reviewing source test protocols and results; and reviewing site specific analyses, if necessary. We estimate the new costs to air districts resulting from the proposed amendments to the ATCM to be approximately $685,000. However, air districts can recover these costs through fees charged to the facilities.

31. What are the total costs of the proposed amendments to the Chromium Plating ATCM?

Total capital costs for purchase of add-on air pollution control devices are estimated at $9.6 million. Total recurring costs are estimated at $3.6 million. An additional $1.0 million in costs is estimated for reports, source testing, permit fees, and site specific analyses. In total costs are estimated to be $14.2 million.

G. Evaluation of Alternatives

32. What alternatives to the proposed amendments to the Chromium Plating ATCM did staff consider?

Staff considered four alternatives to the proposed amendments. The alternatives were evaluated in terms of applicability, risk reduction, enforceability, and cost.

a. Require decorative chromium plating facilities to use the trivalent chromium plating process

One alternative to the staff's proposal would be to require the use of the trivalent chromium plating process for all decorative chromium plating facilities. Requiring all decorative chromium facilities to use the trivalent chromium process would eliminate the remaining cancer risk from the hexavalent chromium emissions from decorative chromium plating facilities. Staff has evaluated the trivalent chromium process and has determined that it is not a universal replacement for all decorative chromium plating applications. Therefore, staff has determined this is not a technologically feasible alternative.

b. Require HEPA filtration systems, or an equivalent add-on air pollution control device, for all facilities

Another alternative would be to require installation of HEPA filtration systems, or an equivalent add-on air pollution control device for all facilities. Staff determined that this alternative would result in no appreciable additional benefit because the very small facilities would have estimated cancer risk of no more than one per million exposed people after implementation of the proposal. This option would add additional equipment costs of over $4.0 million. As a result staff chose not to pursue this alternative.

c. Adopt the provisions of SCAQMD Rule 1469 statewide

A third alternative considered was to adopt the provisions of SCAQMD Rule 1469 statewide. In 2003, the SCAQMD amended its Rule 1469, Control of Hexavalent Chromium Emissions from Chrome Plating and Chromic Acid Anodizing Operations (Rule 1469). The rule requires hexavalent chromium facilities located within 25 meters of a sensitive receptor or within 100 meters of a school to reduce hexavalent chromium emissions such that the residential cancer risk will be no more than ten chances per million people. The rule also requires facilities located greater than 25 meters from a sensitive receptor or 100 meters from a school to reduce emissions such that off-site worker cancer risk would be no more than 25 chances per million people. The amended rule is in full effect.

Staff has evaluated this alternative and has found it does not provide the level of protection that would be achieved through adoption of the staff's proposal. Such an approach would not ensure that BACT is applied at all facilities. ARB staff has determined that BACT for very small facilities (≤ 20,000 ampere-hour throughput) is use of specific types of chemical fume suppressants. BACT for intermediate and larger facilities is use of add-on air pollution control devices with the final capture device being HEPA filters, or any other combination of controls that are as effective as HEPA filters.

d. Require no further control

Alternative 4 would be to require no additional control. Staff does not believe the *status quo* is protective of public health especially considering that 43 percent of operations are located within 100 meters of a sensitive receptor. Our goal is to achieve the maximum feasible health protection—especially when people are living, learning, working, or playing near chromium plating and chromic acid anodizing facilities. Thus, staff did not choose this alternative.

e. Summary

Table ES-4 compares alternatives three and four with the staff's proposal. Alternatives one and two are not presented. Alternative one is not technologically feasible. Alternative two essentially offers no benefit beyond the staff's proposal.

Table ES-4. Adoption of Staff's Proposal Offers the Greatest Reduction in Significant Community Cancer Risk

Number of Facilities by Cancer Risk

	≤1 per million	>1 ≤10 per million	>10 ≤100 per million	>100 per million
Staff Proposal	162	41	17	0
Rule 1469 Statewide	98	67	53	2
Baseline	90	67	57	6

Table ES-4 shows that the staff's proposal offers the best health protection. As shown, adopting the provisions of SCAQMD Rule 1469 statewide would result in 98 facilities (about 45 percent) with remaining cancer risk of no more than one per million exposed persons. This represents an additional 8 facilities compared to the baseline. Adoption of the staff's proposal would reduce the estimated cancer risk for 162 facilities (about 74 percent) to no more than one per million exposed persons.

Table ES-4 also shows that if the provisions of Rule 1469 were to be adopted statewide, 53 facilities (about 24 percent) would continue to have estimated cancer risk of over ten per million exposed people, and two facilities would have estimated cancer risk of over 100 per million exposed people. If the staff's proposal were adopted, 17 facilities (about 8 percent) would have estimated cancer risk of over ten per million exposed people and no facilities would have cancer risk exceeding 100 per million exposed people. Under the staff's proposal each facility with residual cancer risk over 25 per million would need to do a site specific analysis to determine if further control measures are needed.

f. Conclusion

We evaluated each of the alternatives and concluded that the alternatives did not meet the objective of Health and Safety Code section 39666 to reduce emissions to the lowest level achievable in consideration of cost, health risk, and environmental impacts. Staff believes the proposed amendments represent the best balance between costs and cancer risk.

H. Environmental Impacts

33. What are the expected environmental benefits if the proposed amendments are adopted?

The primary benefit from the proposed amendments is a large reduction in excess cancer risk from emissions of hexavalent chromium. We estimate that an additional 40 percent of facilities would be controlling emissions by over 99 percent and cancer risk would be reduced by up to 85 percent for individual facilities. Almost 75 percent of facilities would have cancer risk of less than one per million people exposed. Ninety-two percent of facilities would have cancer risk of less than ten per million people exposed. The proposal will also have a direct benefit for low income and ethnically diverse communities that may be heavily impacted by hexavalent chromium emissions from chromium plating and chromic acid anodizing operations.

34. Are there any significant adverse environmental impacts that would result from adopting the proposed amendments?

No. We evaluated the potential impacts on air quality, water and wastewater, and hazardous waste. We also evaluated the effect on the environment of the use of chemical fume suppressants.

Air Quality. The proposed amendments to the ATCM would result in a negligible improvement in air quality in terms of the weight of the emissions. While the proposed amendments reduce emissions of hexavalent chromium by about 55 percent, the actual reduction in mass is about 2.2 pounds per year. Remaining emissions are estimated to be 1.8 pounds per year.

It is also anticipated that there will be a temporary increase in emissions of criteria pollutants due to construction related activity involved in the installation of new add-on air pollution controls and the possible dismantling of current controls.

Water and Wastewater. Many of the add-on air pollution control devices required by the proposed amendments require periodic water washdown to clean and maintain the integrity of the system. Implementation of housekeeping measures would likely require fresh water usage as well. The increased water usage is difficult to quantify. However, we do not expect the increased use to be significant. We expect the amount of wastewater to also increase due to the proposed amendments related to housekeeping and equipment maintenance. Compliance with State Water Resources Control Board regulations would prevent this hexavalent chromium from being discharged to lakes, rivers, bays, or oceans.

Hazardous waste. The proposed amendments would require an additional 89 facilities to begin using add-on air pollution control devices with the final collection mechanism likely to be HEPA filters. These filters, as well as pre-filters designed to increase the useful life of HEPA filters, are considered hazardous waste to be disposed of in Class A landfills. HEPA filters are usually replaced at least annually, but replacement schedules depend upon the individual operation. Pre-filters are replaced more often. Assuming a typical filter volume of 4 cubic feet each, the resulting volume of hazardous waste generated is 2.9 cubic feet per day. We do not consider this to be a significant increase in the amount of hazardous waste to be landfilled.

In California, all hazardous waste must be disposed of at a facility that is registered with the Department of Toxic Substances Control (DTSC). Chromium plating and chromic acid anodizing facility wastes are classified as hazardous waste because they contain hexavalent chromium.

Use of Bioaccumulative Compounds. The fluorosurfactants used as active ingredients in chemical fume suppressants are often referred to as perfluorooctyl sulfonates (PFOS). While these products are highly effective at reducing hexavalent chromium emissions by reducing plating bath surface tension the compounds have been shown to be persistent, bioaccumulative, and toxic to mammals. Studies indicate that PFOS may have potential developmental, reproductive, and systemic toxicity (U.S. EPA, 2006). These compounds are being evaluated for addition to a Significant New Use Rule for perfluoroalkyl sulfonates (PFAS). Based on the staff's proposal we estimate a maximum increased use of chemical fume suppressants of about three gallons per year.

We expect these impacts to be minimal and believe that the significant reduction in cancer risk overrides any small adverse impact that would result from adoption of the staff's proposal.

35. Are any reasonably foreseeable mitigation measures necessary?

No. The California Environmental Quality Act requires an agency to identify and adopt feasible mitigation measures that would minimize any significant adverse environmental impacts described in the environmental analysis. The ARB staff has concluded that no significant adverse environmental impacts should occur from adoption of and compliance with the proposed amendments to the ATCM. Because no significant adverse impacts have been identified, no specific mitigation measures would be necessary.

36. Are there any reasonably foreseeable alternative means of compliance with the proposed amendments to the airborne toxic control measure?

Alternatives to the proposed amendments to the Chromium Plating ATCM are discussed in question 32. The ARB staff has concluded that the proposed amendments to the ATCM provide the most effective and least burdensome approach to reducing the public's exposure to hexavalent chromium emitted from chromium plating and chromic acid anodizing facilities.

37. How does the staff's proposal relate to ARB's community health and environmental justice programs?

Environmental Justice is defined as the fair treatment of people of all races, cultures, and incomes with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies. The ARB is committed to integrating environmental justice into all of our activities. The proposed amendments to the ATCM are consistent with our policies to reduce health risks from toxic air pollutants in all communities, including those with low-income and ethnically diverse populations, regardless of location. Potential health risks from hexavalent chromium emissions from chromium plating and chromic acid anodizing operations can affect both urban and rural communities. Therefore, reducing hexavalent chromium emissions from chromium plating and chromic acid anodizing operations will provide air quality benefits to urban and rural communities in the State, including low-income areas and ethnically diverse communities.

We have identified several communities that may be heavily impacted by hexavalent chromium emissions from chromium plating and chromic acid anodizing operations. The residents in these communities would realize a large portion of the benefits of the proposal.

To further address environmental justice and the public's concern regarding exposure to hexavalent chromium emissions, the proposed amendments to the ATCM would specify that any new facility would not be able to operate in any area zoned as residential or mixed use, or within 150 meters of a residential or mixed use zone.

I. Recommendation

We recommend that the Board adopt the proposed amendments to the Chromium Plating ATCM. Staff has determined that the proposed amendments are necessary to reduce cancer risk from hexavalent chromium emissions from chromium plating and chromic acid anodizing facilities. If adopted, about 75 percent of facilities would have estimated cancer risk of no more than one per million exposed people. Ninety-two percent of facilities would have estimated cancer risk of no more than ten per million exposed people. Staff also believes the proposal represents a balance between health risk and cost. The proposed amendments are contained in Appendix A.

Within six months of the amendments becoming legally effective, the air districts would be required to implement and enforce the proposed amendments to the ATCM or adopt an equally effective measure.

REFERENCES

Bayer ®. Product information Bayowet® FT 248 and FT 248R.

SCAQMD, 2003. South Coast Air Quality Management District. Rule 1469: "Hexavalent Chromium Emissions from Chrome Plating and Chromic Acid Anodizing Operations". Amended May 2, 2003

U.S. EPA, 1995. U.S. Environmental Protection Agency. 40 CFR Part 63 Subpart N: "National Emission Standards for Chromium Emissions From Hard and Decorative Chromium Electroplating and Chromium Anodizing Tanks". 1995.

U.S. EPA, 1998. U.S. Environmental Protection Agency. EPA/625/R-98/002: "Capsule Report Hard Chrome Fume Suppressants and Control Technologies". 1998.

U.S. EPA, 2006. U.S. Environmental Protection Agency. 40 CFR Part 721: "Perfluoroalkyl Sulfonates; Proposed Significant New Use Rule." 2006.

I. Introduction

Hexavalent chromium plating, or simply chromium plating, is the electrical application of a coating of chromium onto a surface for decoration, corrosion protection, or for durability. An electrical charge is applied to a tank (bath) containing an electrolytic salt (chromium anhydride) solution. The electrical charge causes the chromium metal particles in the bath to fall out of solution and deposit onto objects placed into the plating solution. During chromic acid anodizing, an oxidation layer is generated on the surface of the part. These electrolytic processes cause mists containing hexavalent chromium to be ejected from the plating tank which are eventually dispersed into outdoor ambient air.

Hexavalent chromium is a potent known human carcinogen. Consequently, the California Air Resources Board (ARB or Board) has regulated the hexavalent chromium emissions from chromium plating and chromic acid anodizing facilities since 1988. The existing control measure, the Hexavalent Chromium Airborne Toxic Control Measure for Chrome Plating and Chromic Acid Anodizing Operations (ATCM or Chromium Plating ATCM), is found in title 17, California Code of Regulations, section 93102.

ARB staff has determined that despite significant reductions, people living near chromium plating and chromic acid anodizing facilities are still exposed to unnecessarily high concentrations of hexavalent chromium. Therefore, this Initial Statement of Reasons sets forth the staff's proposal to amend the ATCM (contained in Appendix A) and the rationale for the proposal.

A. Overview

In 1986, based on a recommendation by the Scientific Review Panel (SRP) on Toxic Air Contaminants (TACs), the Board identified hexavalent chromium as a TAC (ARB, 1985). Hexavalent chromium was determined to be a potent human carcinogen with no known safe level of exposure. Subsequent to that finding, the Board adopted measures to control hexavalent chromium emissions, including an ATCM to reduce hexavalent chromium emissions from chromium plating and chromic acid anodizing operations. This ATCM reduced hexavalent chromium emissions from chromium plating and anodizing facilities by well over 90 percent.

While an over 90 percent reduction is significant, because of the potent carcinogenicity of hexavalent chromium, even minute amounts are cause for concern, particularly for near-source receptors. Hexavalent chromium emissions of as little as two grams per year can result in an estimated cancer risk of ten per million people exposed. Because of the potential for near-source unacceptable residual health risks, staff undertook an evaluation of the chromium plating and chromic acid anodizing industry and the existing ATCM to ensure that it continues to provide the maximum feasible health protection. These amendments are being proposed as a result of that evaluation. ARB staff has reviewed control technologies, emissions, population exposures, and remaining health risks, and has found that further control is feasible and warranted. This Initial Statement of Reasons (ISOR or Staff Report) sets forth the staff's proposal to amend the Chromium Plating ATCM and outlines the need and rationale for the proposal. This staff report for the proposed amendments includes:

- Background regulatory information and authority;
- Goals of the regulation and public outreach;
- Chromium plating and chromic acid anodizing industry characterization;
- Findings from the Industry Survey, Chemical Manufacturers Survey, Economic Survey, and Receptor Proximity Survey;
- Emission factor development and the decorative chromium plating emissions testing program;
- Potential exposure and risk from chromium plating and chromic acid anodizing operations;
- Availability and technological feasibility of potential control devices;
- Description of the proposed amendments;
- Economic impacts of the proposed amendments; and
- Environmental impacts of the proposed amendments.

B. Goals of the Proposed Amendments

The goal of the proposed amendments to the Chromium Plating ATCM is to minimize the public's exposure to hexavalent chromium emissions from chromium plating and chromic acid anodizing facilities. The amendments are designed to achieve the maximum hexavalent chromium emission reductions by using the most reliable controls available. The amendments are also designed to isolate people from new facilities. If adopted, the amendments would set more stringent requirements for all intermediate and large hexavalent chromium plating and chromic acid anodizing facilities by requiring best available add-on air pollution control technology (BACT). We have determined that BACT for very small facilities is the use of specific types of chemical fume suppressants. The requirements would be phased in based on throughput and proximity to sensitive receptors. Sensitive receptor locations include residences, schools, daycare centers, hospitals, hospices, retirement or nursing homes, prisons, and dormitories.

The proposal would also prevent new chromium plating and chromic acid anodizing facilities from operating in areas zoned as residential or mixed use or within 150 meters (~500 feet) of these zones. Any new facility would also be required to install state-of-the-art add-on air pollution control devices prior to beginning operations.

Proposed housekeeping provisions would also reduce fugitive emissions of hexavalent chromium from all facilities by establishing housekeeping measures. Personnel at plating operations would also be required to undergo ARB-sponsored training to ensure that parameter monitoring and recordkeeping are done properly. The amendments would also prevent sale of chromium plating chemicals and equipment to any individual that was not the owner or operator of a permitted facility.

The existing ATCM requirements are different based on the type of operation (decorative plating and anodizing or hard chromium plating). Under this proposal, all facilities using the hexavalent chromium process regardless of type of operation would be subject to the same control requirements. The proposed amendments are contained in Appendix A. Adoption of the staff's proposal would result in reducing cancer risk by up to 85 percent for individual facilities.

If adopted by the Board, the amended control measure would be implemented and enforced by the air pollution control and air quality management districts (air districts). The air districts may implement the proposed amendments to the ATCM, as adopted by the Board, or adopt an alternative rule at least as stringent as the ARB's ATCM.

C. Regulatory Authority

Legislation enacted in the 1980's delegated to ARB the authority and responsibility to identify and control toxic air contaminants. This section outlines the statutory authority to control toxic substances and includes a description of the processes that have been developed to fulfill the requirements of State law.

The ARB's statewide air toxics program was established in the early 1980's. Assembly Bill (AB) 1807 (Tanner, Chapter 1047, statutes 1983), *The Toxic Air Contaminant Identification and Control Act,* created California's Toxic Air Contaminant Identification and Control Program (Air Toxics Program) to reduce the public's exposure to air toxics. This law is codified in Health and Safety Code sections 39650 through 39675. AB 2588 (Connelly, Chapter 1252, statutes of 1987), *Air Toxics "Hot Spots" Information and Assessment Act,* supplements the Air Toxics Program by requiring a statewide air toxics inventory, notification of people exposed to a significant health risk, and facility plans to reduce these risks.

1. <u>Identification and Control of Toxic Air Contaminants</u>

The Air Toxics Program established a two step process to identify and then control air toxics to protect the health of Californians.

In the first step, a substance is formally identified as a TAC based on reviews by the ARB and the Office of Environmental Health Hazard Assessment (OEHHA). The agencies evaluate the health impacts of, and exposure to, substances, and identify as TACs those substances that pose the greatest health threat. The ARB's evaluation is made available to the public and is formally reviewed by the SRP on TACs established under Health and Safety Code section 39670. Following the ARB's evaluation and the SRP's review, the Board, at a public hearing, may formally identify a TAC.

In the second step, risk reduction, the ARB reviews the emission sources of a TAC to determine what regulatory actions are available and necessary to maximize health protection. Health and Safety Code sections 39658, 39665, 39666, and 39667 require ARB, with the participation of the air districts, and in consultation with affected sources and interested parties, to prepare a report on the need and appropriate degree of regulation for a TAC. In situations where no safe threshold level is found for a particular TAC, the control measures are to be designed to reduce emissions to the lowest level achievable through application of BACT or a more effective control method in consideration of health risk to the public and cost.

2. The "Hot Spots" Program

Under the AB 2588 program, stationary sources are required to report the types and quantities of certain substances that their facilities routinely release into the air. The goals of the "Hot Spots" Act are to collect emission data, identify facilities having localized impacts, determine health risks, and notify nearby residents of significant risks. In September 1992, the "Hot Spots" Act was amended by SB 1731 to address the reduction of significant risks. The bill requires that owners of significant-risk facilities reduce their risks below the level of significance as determined by air districts. Chromium plating and anodizing operations are subject to the "Hot Spots" program, and, as described below, are also subject to a technology-based ATCM to minimize emissions of hexavalent chromium.

3. Identification and Control of Hexavalent Chromium

In 1986, ARB identified hexavalent chromium as a TAC after peer review by the SRP. Hexavalent chromium was determined to be a potent known human carcinogen with a cancer unit risk factor of 1.5 X 10^{-1} microgram per cubic meter ($\mu g/m^3$) of air. This potency factor means that exposure to 1 $\mu g/m^3$ of hexavalent chromium over a lifetime would potentially result in 146,000 excess cancer cases per million exposed people. The Board also found that the available scientific evidence did not support a hexavalent chromium threshold exposure level below which significant adverse health effects would not be expected (title 17, California Code of Regulations, section 93000). Also, at this time, the Board did not find sufficient evidence to identify trivalent chromium as a TAC (ARB, 1985).

To reduce the risk from hexavalent chromium, the Board has adopted four ATCMs:

- 1988 - *Hexavalent Chromium Airborne Toxic Control Measure for Chrome Plating and Chromic Acid Anodizing Operations* (ARB, 1988);
- 1989 - *Airborne Toxic Control Measure for Hexavalent Chromium For Cooling Towers* (ARB, 1989);
- 2001 - *Airborne Toxic Control Measure for Emissions of Hexavalent Chromium and Cadmium From Motor Vehicle and Mobile Equipment Coatings* (ARB, 2001);
- 2005 – *Airborne Toxic Control Measure to Reduce Emissions of Hexavalent Chromium and Nickel From Thermal Spraying* (ARB, 2005).

This report describes staff's proposal to further reduce the public's exposure to hexavalent chromium from chromium plating and chromic acid anodizing facilities. To better understand the proposal it is important to first understand the requirements of the current ATCM.

D. Existing State Control Measure

The State's existing Chromium Plating ATCM was originally adopted in 1988 and amended in 1998. The regulation is set forth in title 17, CCR, section 93102. The ATCM adopted in 1988 set technology-based standards that focused primarily on hard chromium plating facilities and set limits based on BACT at that time. Implementation of this regulation resulted in hexavalent chromium emission reductions of over 90 percent. A brief summary of the requirements for the existing ATCM follows:

- Hard chromium plating facilities are required to install add-on air pollution control devices to meet emission limits ranging from 0.15 milligrams/ampere-hour (mg/amp-hr) to 0.006 milligrams/ampere-hour, depending on levels of throughput. An alternative surface tension limit was provided for hard chromium plating facilities with throughput levels of 500,000 ampere-hours or less; and
- Decorative plating and anodizing facilities must comply with either an emission limit using add-on air pollution controls or meet a surface tension limit. Most facilities comply by meeting the surface tension limit.

The ATCM also has recordkeeping requirements and operation and maintenance requirements. However, the existing ATCM does not take into account proximity of existing chromium plating and chromic acid anodizing facilities to people.

The ATCM was amended in 1998 to establish equivalency with the National Emission Standards for Chromium Emissions from Hard and Decorative Chromium Electroplating and Chromium Anodizing Tanks (Chromium Plating NESHAP) (U.S. EPA, 1995). The federal Chromium Plating NESHAP included control requirements for trivalent chromium operations because it is a hazardous air pollutant (HAP). Therefore, the focus of ARB's 1998 amendments was to include provisions for controlling emissions from trivalent chromium plating facilities (ARB, 1998). Also, prior to these amendments, chromic acid anodizing facilities were required to comply with the same provisions as hard chromium plating facilities. These amendments provided that chromic acid anodizing facilities could comply with the surface tension limit alone rather than the previous emission rate limit. Other conforming changes included:

- Parameter Monitoring requirements;
- Inspection and Maintenance requirements;
- Operation and Maintenance Plan requirements;
- Recordkeeping requirements; and
- Reporting requirements.

E. Federal Regulations

Because the ARB has achieved equivalency with the Chromium Plating NESHAP for chromium plating and chromic acid anodizing facilities, California's facilities are only required to comply with the State's ATCM (Approval of section 112 (l) Authority of Hazardous Air Pollutants; Chromium Emissions from Hard and Decorative Chromium Electroplating and Chromium Anodizing Tanks; State of California; Approved December 16, 1998, Volume 63, number 241, Page 69251-69256) (U.S. EPA, 1998a). However, a description of United States Environmental Protection Agency's (U.S. EPA) Chromium Plating NESHAP, as well as the Occupational Safety and Health Administration's (OSHA) permissible exposure level for hexavalent chromium is useful to understand how chromium plating facilities and chromic acid anodizing facilities are regulated.

1. Chromium Plating NESHAP

The 1990 federal Clean Air Act Amendments established a list of Hazardous Air Pollutants (HAPs) and directed the U.S. EPA to set standards for all major sources of air toxics. "Chromium Compounds," including hexavalent chromium and trivalent chromium are listed as HAPs. [In 1992, California AB 2728 (Tanner, Chapter 1161, statutes of 1992) specified that ARB must, by regulation, identify as TACs the 189 substances identified by the federal government as HAPs.]

For certain designated source categories, U.S. EPA has developed specific regulations referred to as the National Emission Standards for Hazardous Air Pollutants (NESHAPs). In January 1995, the U.S. EPA promulgated, in 40 Code of Federal Regulations (CFR) Part 63, Subpart N, the Chromium Plating NESHAP. Concentration standards were established for hard chromium plating facilities. These limits could be met by the addition of forced ventilation systems, but add-on air pollution control devices were not necessarily needed. Surface tension limits were established for decorative chromium plating facilities and chromic acid anodizing facilities (U.S. EPA, 1995).

On July 19, 2004, the U.S. EPA amended the Chromium Plating NESHAP. The changes are summarized below.

- Allowed the use of chemical fume suppressants to control chromium emissions from hard chromium plating facilities as an alternative to the existing concentration emission limit;
- Provided an alternative standard to the existing concentration emission limit for hard chromium plating tanks equipped with enclosed hoods;
- Modified surface tension parameter testing to accommodate the differences in measurement between the use of a stalagmometer and the tensiometer (stalagmometer requirement: < 45 dynes/centimeter; tensiometer requirement: < 35 dynes/centimeter);
- Expanded the definition of "chromium electroplating and anodizing" to include all of the ancillary hardware associated with the plating process. This includes such

items as the tank, "add-on" control equipment, rectifier, process tanks, ductwork, etc.; and

- Amended the pressure drop for composite mesh pads to ±2 inches of water column instead of ±1 inch of water column (U.S. EPA, 2004).

2. Federal OSHA Worker Exposure Limits

Under the U.S. Department of Labor, OSHA published a Permissible Exposure Limit (PEL) to protect workers from hexavalent chromium exposures. The exposures to hexavalent chromium are addressed in specific standards for maritime, construction, and general industries.

OSHA's PEL for chromic acid and chromates is found in 29 CFR 1910.1000, Table Z-2. On February 28, 2006, OSHA changed the hexavalent chromium rule by setting a time-weighted average PEL of 5 $\mu g/m^3$, measured and reported as Chromium VI, and an action level of half the PEL for the general industry. OSHA also adopted other ancillary provisions for employee protection such as preferred methods for controlling exposure, respiratory protection, protective work clothing and equipment, establishing hygiene areas and practices, medical surveillance, hazard communication, and recordkeeping (OSHA, 2006). More information can be found at the following webpage: http://www.osha.gov/SLTC/hexavalentchromium/standards.html.

F. Current Air District Rules

As required by State law, air districts are required to adopt, implement, and enforce rules that are equivalent to any State adopted ATCM, or may elect to adopt a rule that is more stringent. The air districts also are required to gather from facilities emissions information required by the "Hot Spots" Act. Some air districts also have adopted rules or policies that require existing facilities to reduce health risks below an air district specified level of significance. New facilities generally are not allowed to operate unless the potential health risk posed by the facility's emissions is below the air district's level of significance.

Chromium plating and chromic acid anodizing facilities operate under permits issued by each air district. Table I-1 lists air districts that have active chromium plating and/or chromic acid anodizing facilities and the rule with which facilities in that air district must comply.

Table I-1. Air Districts with Active Chromium Plating and/or Chromic Acid Anodizing Facilities and Corresponding Prohibitive Rule

District	Rule
Bay Area Air Quality Management District (BAAQMD)	Rule 11.8
Feather River Air Quality Management District (FRAQMD)	Rule 11.2
South Coast Air Quality Management District (SCAQMD)	Rule 1469
Sacramento Metropolitan Air Quality Management District (SMAQMD)	Rule 904
San Diego County Air Pollution Control District (SDCAPCD)	Rule 1201
San Joaquin Valley Air Pollution Control District (SJVAPCD)	Rule 7011
Shasta County Air Quality Management District	Rule 3:11
Ventura County Air Pollution Control District (VCAPCD)	Chromium Plating ATCM

Of particular interest for this rulemaking is the May 2003 amendments to Rule 1469 adopted by the South Coast Air Quality Management District (SCAQMD), Hexavalent Chromium Emissions from Chrome Plating and Chromic Acid Anodizing Operations (SCAQMD, 2003). These changes were designed to further reduce health risk by specifying lower emission rates for all facilities, and establishing more stringent requirements for facilities located near sensitive receptors than were in place at the time. The goal was to specify emission rates to reduce the potential cancer risk from all facilities below the air district's level of significance, a potential cancer risk of no more than 25 per million persons. However, more stringent requirements were specified for facilities located within 25 meters of a sensitive receptor, or 100 meters of an existing school. In these instances, potential cancer risks were to be reduced below ten per million persons. A summary of the changes is provided below:

- Set more stringent mass emission limits with increasing ampere-hours and distance to receptor;
- Established a fume suppressant certification program and an emission rate of 0.01 milligrams/ampere-hour for certified fume suppressants;
- Added housekeeping practices for all facilities;
- Prohibited the air sparging of chromium plating or anodizing tanks, unless in use;
- Prohibited removal of existing add-on air pollution control equipment, unless replaced with air pollution control techniques meeting higher control efficiencies;
- Provided optional emission limits for small facilities;
- Added alternative compliance options for all facilities; and
- Established an operator training requirement.

As part of the "Hot Spots" program, air districts have developed rules or policies designed to further reduce health risks from sources of toxic air pollutants. These rules are triggered at air district specified levels of significance and apply to both new and existing facilities. These rules establish the health risk levels that trigger the need for installation of BACT for Toxics (T-BACT). Generally, new facilities are subject to the more stringent requirements. All of these rules and policies have been useful in our evaluation of measures that are feasible to further reduce health risk from chromium plating and chromic acid anodizing operations. A synopsis of some of these rules is provided below.

SCAQMD Rule 1401, New Source Review of Toxic Air Contaminants applies to air permits for new, relocated, or modified sources that emit TACs. If the potential increase in cancer risk from a modification does not exceed one case per one million persons, T-BACT controls are not required to obtain an air permit. If the potential increase in cancer risk is between 1 and 10 per million persons, T-BACT controls are required to obtain an air permit. In addition, the cancer burden must not exceed 0.5 cases (SCAQMD, 1990).

SCAQMD Rule 1402, Control of Toxic Air Contaminants from Existing Sources, specifies an action risk level of 25 excess cases per million persons for cancer risk, a cancer burden of 0.5, or a total acute or chronic hazard index of 3.0 for any target organ system at any receptor location. [An acute or chronic hazard index is the ratio of the estimated level of exposure over a specified period of time to its acute or chronic reference exposure level.] Existing facilities that exceed the action risk level must develop risk reduction plans and implement measures to reduce risks to below the action level. The amendments to Rule 1469 were designed as an alternative for chromium plating and chromic acid anodizing facilities to meet the requirements of Rule 1402 (SCAQMD, 1994).

San Diego County Air Pollution Control District (SDCAPCD) Rules 1200, Toxic Air Contaminants – New Source Review, and 1210, Toxic Air Contaminant Public Health Risks – Public Notification and Risk Reduction, specify that if the potential increase in cancer risk does not exceed one per million persons, T-BACT controls are not required to obtain an air permit. If the potential increase in cancer risk is between 1 and 10 per million persons, T-BACT controls are generally required to obtain an air permit. If the potential increased cancer risk is greater than 10 but no more than 100 per million persons, it may still be possible to get an air permit if a facility can meet specific conditions (SDCAPCD, 1996).

The Bay Area Air Quality Management District (BAAQMD) does not have a specific rule for toxics permitting. However, BAAQMD's permitting policy is generally consistent with the SCAQMD and SDCAPCD toxics new source review rules. All permit applications for new or modified sources are screened for emissions of TACs and sources that may present significant health risks are required to install T-BACT to minimize TAC emissions (BAAQMD, 2005).

G. Barrio Logan, A Case Study of Near Source Impacts

In May of 2001, ARB, with cooperation of the SDCAPCD, began monitoring around two chromium plating facilities in the Barrio Logan neighborhood of San Diego. A residence was located between these facilities and numerous residences were in the area. Local concern about possible exposures to hexavalent chromium emissions from these facilities, as well as, the Children's Environmental Health Protection Act [Senate Bill 25, Escutia 1999 (SB 25)] prompted the study. SB 25 required ARB to evaluate the air that children are exposed to in places where they live and play and to determine if current regulations adequately protect them. One facility was a hard chromium plating operation with emissions controlled by a HEPA filter system. The other facility was a decorative plating operation with emissions controlled by using a chemical fume suppressant to reduce the surface tension of the plating bath.

In January 2002, unexpectedly high levels of hexavalent chromium were found at a number of monitoring sites. More intensive monitoring pinpointed the source of the elevated levels of hexavalent chromium to be from the decorative chromium plating facility. Through this study, we also found that fugitive dust emissions from the facility contributed to community hexavalent chromium exposures. For more detailed information, please refer to the Barrio Logan Report, "A Compilation of Air Quality Studies in Barrio Logan, November 2004" (ARB, 2004). The report can be found at the following address: http://www.arb.ca.gov/ch/programs/bl_11_04.pdf

H. Hexavalent Chromium Emissions Study and Conclusions

The results of air monitoring for hexavalent chromium in Barrio Logan indicated that emissions from decorative chromium plating facilities may be underestimated. To investigate this theory, we undertook a hexavalent chromium emissions testing program at decorative chromium plating facilities in various parts of the State to evaluate the emission factor for facilities using only in-tank controls. As a result of this testing, the emission factor for chemical fume suppressant controlled facilities (those complying with the surface tension limit[1]) has been revised and is used in this report to assess emissions of, and exposure to, hexavalent chromium from these facilities.

Through our evaluation, we have found that there are remaining significant public health risks associated with hexavalent chromium emissions from chromium plating and chromic acid anodizing facilities, especially when facilities are located near homes or schools. In assessing existing, readily available, control technologies for chromium plating and chromic acid anodizing facilities, staff believes further control is feasible and necessary to protect the health of California's residents, by reducing exposure to hexavalent chromium.

[1] Chemicals are added to the plating bath that reduce surface tension. Surface tension reductions also reduce hexavalent chromium emissions.

REFERENCES

ARB, 1985. Air Resources Board. "Staff Report: Initial Statement of Reasons for Proposed Rulemaking – Public Hearing to Consider the Adoption of a Regulatory Amendment Identifying Hexavalent Chromium as a Toxic Air Contaminant". 1985.

ARB, 1988. Air Resources Board. "Final Regulation Order – Hexavalent Chromium Airborne Toxic Control Measure (ATCM) for Chrome Plating and Chromic Acid Anodizing Operations". 1988.

ARB, 1989. Air Resources Board. "Final Regulation Order – Chromate Treated Cooling Towers". 1989.

ARB, 1998. Air Resources Board. "Staff Report – Proposed Amendments to the Hexavalent Chromium Control Measure For Decorative and Hard Chrome Plating and Chromic Acid Anodizing Facilities". 1998.

ARB, 2001. Air Resources Board. "Final Regulation Order - Airborne Toxic Control Measure for Emissions of Hexavalent Chromium and Cadmium From Motor Vehicle and Mobile Equipment Coatings". 2001.

ARB, 2004. Air Resources Board. "Barrio Logan Report: A Compilation of Air Quality Studies in Barrio Logan". 2004.

ARB, 2005. Air Resources Board. "Final Regulation Order - Airborne Toxic Control Measure to Reduce Emissions of Hexavalent Chromium and Nickel from Thermal Spraying". 2005.

BAAQMD, 2005. Bay Area Air Quality Management District. Regulation 2 Permits Rule 5: "New Source Review of Toxic Air Contaminants". 2005.

OSHA, 2006. Occupational Safety and Health Administration. 29 CFR Parts 1910, 1915, 1917, 1918, and 1926, "Occupational Exposure to Hexavalent Chromium; Final Rule". 2006

SCAQMD, 1990. South Coast Air Quality Management District. Rule 1401: "New Source Review of Toxic Air Contaminants". 1990

SCAQMD, 1994. South Coast Air Quality Management District. Rule 1402: "Control of Toxic Air Contaminants from Existing Sources". 1994

SCAQMD, 2003. South Coast Air Quality Management District. Rule 1469: "Hexavalent Chromium Emissions from Chrome Plating and Chromic Acid Anodizing Operations". Amended May 2, 2003

SDCAPCD, 1996. San Diego Air Pollution Control District: Rule 1200: "Toxic Air Contaminants – New Source Review". Revised June 12, 1996

U.S. EPA, 1995. U.S. Environmental Protection Agency. 40 CFR Part 63 Subpart N: "National Emission Standards for Chromium Emissions From Hard and Decorative Chromium Electroplating and Chromium Anodizing Tanks". 1995.

U.S. EPA, 1998a. U.S. Environmental Protection Agency. 40 CFR Part 63: "Approval of Section 112(l) Authority for Hazardous Air Pollutants; Chromium Emissions from Hard and Decorative Chromium Electroplating and Chromium Anodizing Tanks; State of California". 1998.

U.S. EPA, 2004. U.S. Environmental Protection Agency. 40 CFR Part 63: "National Emission Standards for Chromium Emissions From Hard and Decorative Chromium Electroplating and Chromium Anodizing Tanks". 2004.

II. Need for Further Regulation

In 1986, the Board identified hexavalent chromium as a Toxic Air Contaminant (TAC). Hexavalent chromium was determined to be an extremely potent human carcinogen with no known safe level of exposure. The Board found that exposure over a lifetime to very low ambient hexavalent chromium concentrations could substantially increase a person's chance of developing cancer from exposure to the hexavalent chromium emissions. Based on this finding, in 1988 the Board adopted a very stringent ATCM which resulted in reducing hexavalent chromium emissions from chromium plating and chromic acid anodizing facilities by well over 90 percent. While an over 90 percent reduction is significant, even minute amounts are cause for concern, particularly for near-source receptors because of the potent carcinogenicity of hexavalent chromium.

Ambient levels of hexavalent chromium measured from our air toxics monitoring network are routinely low, with many measurements below the level of detection. Thus, the general public's exposure to ambient hexavalent chromium concentrations is not considered significant. However, near-source exposures can be significant. In 2002, SCAQMD conducted limited ambient air sampling around several chromium plating and chromic acid anodizing facilities. Based on this monitoring, estimated cancer risks from five facilities ranged from 20 to 55 per million people exposed. Four facilities had cancer risks of less than ten per million exposed people. One facility had an estimated cancer risk of 450 per million exposed people (SCAQMD, 2003a). [SCAQMD worked with the facility with cancer risk of 450 per million exposed people to reduce the risk.] Although these data were collected prior to implementation of Rule 1469, the results demonstrate that measurable and elevated concentrations of hexavalent chromium are found near these sources. Due to implementation of SCAQMD Rule 1469, these estimated cancer risks from the facilities tested could be lower.

Information from our Barrio Logan study reinforce findings that hexavalent chromium emissions from chromium plating and chromic acid anodizing operations are measurable, but highly localized. The Barrio Logan study, also showed that dust containing hexavalent chromium can contribute to ambient, near-source concentrations. This result was confirmed by follow-up sampling conducted by the SDCAPCD. These fugitive emissions can not be quantified for all facilities, but could increase the cancer risk beyond what is calculated based on emissions from the plating operation alone.

Our modeling analyses also indicate that near-source concentrations are, in many cases, significant. Hexavalent chromium emissions of as little as two grams per year can result in an estimated cancer risk of ten per million people exposed. Thus, staff has found that emissions from some facilities still result in unacceptable health risks to near-by receptors. Based on our evaluation of chromium plating and chromic acid anodizing facilities, we found that it is common to find sensitive receptors near these facilities. In fact, we found that 43 percent of facilities are located within 100 meters of a sensitive receptor. For all of these reasons, staff has determined that, despite the fact that significant emissions reductions have been achieved, there is a need to further reduce emissions, if technologically feasible.

This Chapter contains a general summary of the physical and chemical characteristics of hexavalent chromium and chromium compounds. Emissions and sources of hexavalent chromium, as well as health effects from exposure to hexavalent chromium are also provided. For ease of the reader, we have summarized some of the information from earlier reports, and have updated information where appropriate. For further information, the reader is referred to the following documents:

- Staff Report: Initial Statement of Reasons for Proposed Rulemaking – Identification of Hexavalent Chromium as a Toxic Air Contaminant (ARB,1985);
- Proposed Hexavalent Chromium Control Plan (ARB, 1988a);
- Initial Statement of Reasons for Proposed Rulemaking – Proposed Airborne Toxic Control Measure for Emissions of Hexavalent Chromium from Chrome Plating and Chromic Acid Anodizing Operations (ARB, 1988b);
- Proposed Hexavalent Chromium Control Measure for Cooling Towers (ARB, 1989a);
- Toxic Air Contaminant Identification List Summaries (ARB, 1997);
- Airborne Toxic Control Measure for Emissions of Hexavalent Chromium and Cadmium from Motor Vehicle and Mobile Equipment Coatings: Initial Statement of Reasons for Proposed Rulemaking Executive Summary/Staff Report (ARB, 2001a); and
- Airborne Toxic Control Measure to Reduce Emissions of Hexavalent Chromium and Nickel from Thermal Spraying Initial Statement of Reasons for Proposed Rulemaking (ARB, 2004a).

In support of the need for further regulation, this Chapter also contains a synopsis of our Barrio Logan study findings and results from our survey to determine proximity of sensitive receptors to hexavalent chromium plating and chromic acid anodizing facilities.

A. Characteristics, Sources, and Ambient Concentrations of Hexavalent Chromium and Chromium Compounds

The chromium compounds of interest for this staff report are the TACs hexavalent chromium and trivalent chromium. Because hexavalent chromium is a TAC and has been identified as a human carcinogen with no known safe exposure level (ARB, 1985), the focus of the staff's proposal is to further reduce hexavalent chromium emissions from chromium plating and chromic acid anodizing facilities.

Trivalent chromium has been identified as a TAC by virtue of it being a hazardous air pollutant (HAP). By comparison to hexavalent chromium, it poses lesser health hazards. It is not a human carcinogen. Health hazards associated with use of trivalent chromium are presented to put these hazards in perspective to the health hazards associated with use of hexavalent chromium. Due to the comparatively lower toxicity impact, staff believes trivalent chromium plating (for decorative plating) to be a safer alternative to

hexavalent chromium plating. In fact, the trivalent chromium chemistry is already successfully in use at several California decorative chromium plating facilities. However, although improvements in the process have been made, use of trivalent chromium is not available for all applications.

1. Chemistry

Trivalent chromium occurs naturally in the mineral chromite (chrome ore). It is from chromite that chromium metal and other chromium compounds are formed. Of the various chromium oxidation states, trivalent chromium is the most stable. Hexavalent chromium is the cation of a metal salt and does not occur naturally. Generally, hexavalent chromium ions are produced under strong oxidizing conditions from metallic chromium, with the most common ions being chromate ion (CrO_4^{-2}) or dichromate ion ($Cr_2O_7^{-2}$). Hexavalent chromium ions are strong oxidizing agents and are readily reduced to trivalent chromium in acid or by organic matter (ARB, 1997).

2. Sources and Emissions

Chromium plating, chromic acid anodizing, thermal spraying, and firebrick lining of glass furnaces are all stationary sources of hexavalent chromium in California. In California, stationary sources are estimated to emit about 1,000 pounds per year of hexavalent chromium. Approximately 0.13 tons/year are emitted by gasoline vehicles and 0.83 tons/year by other mobile sources such as trains and ships (ARB, 2006a). Chapter V describes the emissions of hexavalent chromium in California from chromium plating and chromic acid anodizing facilities.

Based on staff's survey of the chromium plating and chromic acid anodizing industry it appears data used to compile the 2006 Almanac emission inventory overestimated the hexavalent chromium emissions contributed by chromium plating and chromic acid anodizing facilities. In the 2006 Almanac, emissions from chromium plating and chromic acid anodizing facilities were estimated to be about 30 pounds. Since publication of the 2006 Almanac, updated emission inventory information has resulted in a revision of the earlier estimate of 30 pounds to about 4.5 pounds. We estimate, based on our survey, that in 2005 emissions from chromium plating and chromic acid anodizing facilities were about four pounds. These data are provided in Chapter V. Information from the survey, along with updated emissions estimates from local air districts and other sources, will be used as the basis for emissions estimates in future Almanacs. Emission inventories are dynamic and are 'snapshots' in time. This reduction in hexavalent chromium plating and chromic acid anodizing facility emissions, that will be reflected in the next Almanac, will not appreciably reduce the total statewide stationary source estimated emissions.

3. Ambient Concentrations

Chromium compounds and hexavalent chromium are routinely monitored as part of the statewide ARB air toxics network. This monitoring meets U.S. EPA's standards for ambient monitoring. It does not reflect near source exposures which may be significant. Trivalent chromium compounds are not specifically monitored, but are accounted for as a fraction of total chromium. The monitoring results indicate that hexavalent chromium concentrations have declined in recent years. The statewide mean concentration of hexavalent chromium has decreased from 0.27 nanograms per cubic meter (ng/m^3) in 1992 to 0.091 ng/m^3 in 2005. For hexavalent chromium ambient monitoring, the limit of detection has also decreased from 0.2 ng/m^3 in 1992 to 0.06 ng/m^3 in 2002. Therefore, the mean concentrations for 2002 and later are based on more precise measurements of ambient concentrations (ARB, 2006a).

Table II-1 shows the hexavalent chromium mean concentration at various monitoring sites in air districts with chromium plating and anodizing facilities (ARB, 2006b).

Table II-1. Hexavalent Chromium Mean Concentration in Air Districts with Chromium Plating and Anodizing Facilities for the Year 2005

District	ARB's Air Toxics Network Monitoring Site	Mean Concentration (ng/m^3)
South Coast Air Quality Management District	Azusa-803 Loren Ave.	0.08
	Burbank – W. Palm Ave.	0.113
	North Long Beach	0.10
San Diego County Air Pollution Control District	Chula Vista	0.038
	El Cajon-Redwood Avenue	0.048
Ventura County Air Pollution Control District	Simi Valley-Cochran Street	0.05
Bay Area Air Quality Management District	Fremont-Chapel Way	0.05
	San Francisco-Arkansas Street	0.11
San Joaquin Valley Air Pollution Control District	Fresno-1st Street	0.063
	Stockton-Hazelton Street	0.12
Sacramento Metropolitan Air Quality Management District	Roseville-N Sunrise Blvd	0.058

As shown in Table II-1, mean concentrations range from 0.038 to 0.12 ng/m^3 in 2005. These values would yield a range of estimated cancer risk of about 6 per million to 18 per million people exposed.

The mean concentrations may be overestimated. This is because prior to 2002 monitoring results below the limit of detection are assumed to be one-half the limit of detection or 0.1 ng/m^3 (ARB, 2006a). Our ambient monitoring data show that the percentage of measurements that were below the detection limits increased steadily over the years, reaching a peak of over 96 percent in 1999. Starting in 2002, analysis was performed on composite samples representative of one quarter. This lowered the detection limit to 0.06 ng/m^3. Even with this lowering of the detection limit, the percentage of measurements below the detection limit has been steady at around 28 percent.

Therefore, we conclude that ambient concentrations of hexavalent chromium are low and are not a general public health concern. From these ambient data we are also able to infer that the emissions from chromium plating and chromic acid anodizing facilities are a near source-concern. As further support, in the SCAQMD ambient monitoring mentioned earlier, concentrations measured downwind of 10 chromium plating and chromic acid anodizing facilities ranged from 0.03 ng/m^3 to 2.99 ng/m^3, with an average of 0.44 ng/m^3 (SCAQMD, 2003a).

4. Indoor Sources and Concentrations

The extent of exposure to airborne hexavalent chromium in the indoor environment, other than in the workplace, is not known. There are no direct consumer uses of chromium that could lead to indoor emissions of hexavalent chromium compounds. During the emissions testing program conducted by the ARB, staff placed ambient air monitors inside the plating shops that were being source tested. Indoor levels of hexavalent chromium detected in the chromium plating facilities tested without forced ventilation systems in place ranged from four to 2,350 ng/m^3. These data are qualitative and the numbers should not be used as indoor air concentration numbers. However, the numbers clearly indicate that hexavalent chromium is emitted from plating tanks, and is present as an airborne particle. These data are presented in Chapter V.

Environmental Tobacco Smoke is known to contain hexavalent chromium in the particulate matter components (ARB, 2005a) The Board identified environmental tobacco smoke as a TAC in January 2006.

5. Atmospheric Persistence

Atmospheric reactions of chromium compounds were characterized in field reaction studies and laboratory chamber tests. These results demonstrated an average experimental half-life of 13 hours (ARB, 1997). Based on this, one would expect there to be minimal amounts of hexavalent chromium in the dust found in and around the plating facilities. However, during ARB's Barrio Logan study and later during a SDCAPCD study, indoor dust was collected at plating shops to determine if hexavalent chromium was present. Results of dust sample analyses indicated that hexavalent chromium was indeed present in the dust samples. Hexavalent chromium concentrations in samples collected near the plating tank ranged from 407 to 89,800 milligrams per kilogram. These results are summarized in Appendix G.

6. Particle Size of Hexavalent Chromium

The potential of hexavalent chromium to become airborne and disperse into ambient air is dependent on particle size. If the particles are large, they would likely not become airborne, or if they would become airborne they would rapidly deposit. Our indoor air data collected during the emissions testing program demonstrate that hexavalent chromium is present in ambient air inside the facilities. Our modeling analyses in Chapter VII are based on hexavalent chromium particles being small enough to behave as a gas such that they are emitted into ambient air. To verify this, we consulted the U.S. EPA's AP 42

3. Summary of Results and Findings

Analysis of samples implicated the decorative chromium plating operation as the source of the high ambient hexavalent chromium measurements. The data also showed that it was not only emissions from the daily plating process that were the cause of the high ambient hexavalent chromium readings. We also found that fugitive hexavalent chromium laden dust, that had accumulated within the shop was escaping through building openings and contributing to elevated outdoor hexavalent chromium concentrations (ARB, 2004).

This study was important to the evaluation of the Chromium Plating ATCM because results indicated that:

- Hexavalent chromium emissions from decorative chromium plating facilities may be underestimated;
- Poor 'housekeeping' practices may lead to fugitive hexavalent chromium emissions;
- Hexavalent chromium emissions from chromium plating create a local impact, a "Hot Spot," but the hexavalent chromium concentration drops off quickly; and
- Emissions from the HEPA controlled hard chromium plating facility were effectively reduced and not contributing to elevated levels of hexavalent chromium in the neighborhood.

D. Proximity of Facilities to Sensitive Receptors

As part of our evaluation, we collected data to determine proximity of sensitive receptors to all chromium plating and chromic acid anodizing shops. We learned from the Barrio Logan study that the receptors nearest volume emission sources (source without add-on air pollution control) are most affected.

ARB staff worked with the air districts to obtain receptor information for all chromium plating and chromic acid anodizing facilities. In instances when data were not available, ARB staff visited facilities and determined the distance to the nearest sensitive receptor. We are proposing to define sensitive receptor as a residence including private homes, condominiums, apartments, and living quarters; education resources such as preschools and kindergarten through twelve (K-12) schools; daycare centers; and health care facilities such as hospitals or retirement and nursing homes. A sensitive receptor would include long term care hospitals, hospices, prisons, and dormitories or similar live-in housing.

Out of 222 hexavalent chromium plating and chromic acid anodizing facilities, 19 percent are located within 25 meters of a sensitive receptor. We also found that 96 facilities (43 percent) are located within 100 meters of a sensitive receptor. Air quality modeling results, found in Chapter VII, indicate that receptors located within 100 meters of a chromium plating operation (volume source) may be exposed to significant levels of hexavalent chromium. The detailed data on proximity of sensitive receptors to chromium plating and chromic acid anodizing facilities are summarized in Chapter IV.

These data point to the need to further control hexavalent chromium emissions to protect near-source receptors, especially sensitive receptors such as children and the elderly.

REFERENCES

AJIM, 2000. American Journal of Industrial Medicine. HJ Gibb, PSJ Lees, PF Pinsky & BC Rooney. Lung Cancer Among Workers in Chromium Chemical Production. 38:115-126. 2000.

ARB, 1985. Air Resources Board. "Staff Report: Initial Statement of Reasons for Proposed Rulemaking – Public Hearing to Consider the Adoption of a Regulatory Amendment Identifying Hexavalent Chromium as a Toxic Air Contaminant". 1985.

ARB, 1988a. Air Resources Board. "Technical Support Document to Proposed Hexavalent Chromium Control Plan". 1988.

ARB, 1988b. Air Resources Board. "Staff Report: Initial Statement of Reasons for Proposed Rulemaking – Proposed Airborne Toxic Control Measure for Emissions of Hexavalent Chromium from Chrome Plating and Chromic Acid Anodizing Operations". 1988.

ARB, 1989a. Air Resources Board. "Proposed Hexavalent Chromium Control Measure For Cooling Towers". 1989.

ARB, 1997. Air Resources Board. "Toxic Air Contaminant Identification List – Summaries – Chromium and Compounds Hexavalent Chromium". 1997.

ARB, 2001a. Air Resources Board. "Airborne Toxic Control Measure For Emissions Of Hexavalent Chromium And Cadmium From Motor Vehicle And Mobile Equipment Coatings: Initial Statement Of Reasons For Proposed Rulemaking. Executive Summary/Staff Report". 2001.

ARB, 2003. Air Resources Board. "Ambient Monitoring for Hexavalent Chromium and Metals in Barrio Logan: May 2001 through May 2002". 2003.

ARB, 2004a. Air Resources Board. "Staff Report: Initial Statement of Reasons for Proposed Rulemaking – Airborne Toxic Control Measure to Reduce Emissions of Hexavalent Chromium and Nickel from Thermal Spraying". 2004.

ARB, 2004. Air Resources Board. "Barrio Logan Report: A Compilation of Air Quality Studies in Barrio Logan". 2004.

ARB, 2005a. Air Resources Board. "Proposed Identification of Environmental Tobacco Smoke as a Toxic Air Contaminant: Executive Summary". 2005.

ARB, 2006a. Air Resources Board. "The California Almanac of Emissions And Air Quality". 2006 Edition.

ARB, 2006b. Air Resources Board. Annual Statewide Toxics Summary-Hexavalent Chromium. 2006. (http://www.arb.ca.gov/adam/toxics/statepages/cr6state.html)

ATSDR, 2000. Agency for Toxic Substances and Disease Registry. "Toxicological Profile for Chromium". 2000.

SCAQMD, 2003a. South Coast Air Quality Management District. "Draft Staff Report - Proposed Amended Rule 1469-- Hexavalent Chromium Emissions from Chrome Plating and Chromic Acid Anodizing Operations and Proposed Rule 1426- Emissions from Metal Finishing Operations." 2003

U.S. EPA, 1996. U.S. Environmental Protection Agency. "Emission Factor Documentation for AP-42 Section 12.20 – Electroplating – Final Report". 1996.

U.S. EPA, 2000. U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC. 453/R-99-007: "National Air Toxics Program: The Integrated Urban Strategy, Report to Congress". 2000.

III. Public Outreach and Data Collection

Public participation is a key ingredient of ARB's regulatory process. Reliable data are also necessary to provide a sound basis for regulatory action. This Chapter summarizes our efforts to inform and involve all stakeholders in the regulatory process. We also summarize our data collection efforts.

A. Public Involvement

The full benefits of public participation are realized when all stakeholders are involved and informed, particularly those directly affected by a regulation. In addition, public outreach to low-income and ethnically diverse communities is an important tool for fulfilling ARB's goal to provide equal environmental protection to all Californians. Thus, throughout the development of the proposed amendments to the ATCM, staff worked with the affected industry and public organizations to offer opportunities to: 1) become informed about the proposed changes to the ATCM and the public process; 2) provide pertinent information for ARB staff consideration; and 3) discuss comments and concerns.

Staff has used Internet web page http://www.arb.ca.gov/toxics/chrome/chrome.htm and electronic and mail-out notices to alert and invite organizations and individuals to workgroup meetings, public workshops, and to the public hearing at which these proposed changes to the ATCM will be considered. In addition, outreach efforts have included personal contacts via telephone, electronic mail, U.S. mail, surveys, facility visits, and meetings. The following stakeholders have been involved in the process:

- Chromium plating and chromic acid anodizing facility owners and operators;
- Metal finishing industry associations;
- Chemical suppliers;
- Control equipment manufacturers;
- Representatives from federal agencies, including the U.S. EPA and OSHA;
- Representatives from State agencies, including the Department of Toxic Substance Control (DTSC), the Water Resources Control Board, and the Business, Transportation, and Housing Agency;
- Representatives from California Air Pollution Control and Air Quality Management Districts;
- Environmental and community groups; and
- Representatives from pollution prevention and public health advocate organizations.

Stakeholders were initially made aware of ARB's intention to evaluate the current ATCM in January 2002 when stakeholder workgroups meetings were held in Diamond Bar, Fresno, and San Francisco, California. Over the course of the evaluation of the industry, the emissions testing program, and regulatory concept development, stakeholders were given the opportunity to participate and comment. A summary of outreach activities is shown below:

- Forming a District Workgroup and conducting meetings and conference calls;
- Forming a Stakeholder Workgroup and conducting meetings throughout the state;
- Creating the Hexavalent Chromium mailing list, activity website and maintaining a List-Serve to update interested parties;
- Conducting site visits in various districts to familiarize ARB staff with chromium plating and chromic acid anodizing processes and to select facilities for the emissions testing program;
- Preparing and disseminating a fact sheet on chromium plating and chromic acid anodizing operations for community outreach meetings;
- Participating in the SCAQMD negotiated rulemaking process;
- Conducting surveys on industry throughput levels and economics by mail, facsimile and telephone;
- Conducting a survey of chemical fume suppressant manufacturers;
- Developing a compliance assistance compact disk;
- Mailing workshop notices and posting workgroup materials on ARB's website; and
- Conducting public workshops in various locations within the State.

Staff held numerous meetings with affected industry and the public. A chronology of meetings is compiled in Appendix B of this report. In addition as specified in Health and Safety Code 39665(c), relevant comments on the ATCM received by ARB on the proposed amendments to the ATCM have been included in the administrative record. They are listed as a reference at the end of this Chapter (ATCM comments) and are available from ARB staff upon request for public review and comment.

B. Data Collection Tools

ARB staff gathered information by conducting surveys of air districts, chromium plating and chromic acid anodizing operations, and chemical fume suppressant manufacturers. A brief summary of the types of information collected is summarized below.

1. <u>Air District Survey</u>

Chromium plating and chromic acid anodizing operations are located in eight air districts. Because air districts implement the ATCM, ARB staff worked with them throughout the evaluation process to gather information on chromium plating and chromic acid anodizing facilities. To characterize the industry, ARB staff requested permit information, ongoing compliance reports, source test results, and available risk assessment information for active chromium plating and chromic acid anodizing operations. These data were used to form an initial mailing list and preliminary emission estimates. To gather more information, ARB staff conducted facility surveys and a receptor survey.

2. Chromium Plating and Chromic Acid Anodizing Facility Survey

The first step in evaluating the existing ATCM was to characterize the facilities in California. A letter dated April 12, 2004, was sent to each facility informing them of ARB's effort to re-evaluate the Chromium Plating ATCM and included a brief questionnaire related to calendar year 2003. The list of questions included type of operation, annual throughput in ampere-hours, type of in-tank and add-on controls, manual or hoist lines, grinding and polishing operations, and questions on storage of chemicals. To collect the information on the questionnaire, ARB staff contacted all facilities by telephone. The results of the survey were used to characterize the industry (see Chapter IV) and assess technological feasibility (see Chapter VI). The survey is included as Appendix C to this report.

3. Chemical Fume Suppressant Manufacturers Survey

The ARB staff also conducted a survey of chemical fume suppressant manufacturers to gather information on chemical fume suppressants and recommendations on optimum tank conditions for efficient plating. The survey requested information on fume suppressant formulations, the primary mechanism of reducing hexavalent chromium emissions, and recommended surface tension. We also collected information on recommended tank contaminant levels to determine when bath clean-up was recommended, such that decorative chromium plating baths would operate most efficiently. The survey information is summarized in Chapter IV. The survey is included as Appendix D to this report.

4. Economic Questionnaire

The ARB is required by law to assess the economic impact of regulations on the affected industry. To assist with this requirement, ARB staff contacted the facilities by mail in February 2005. The letter included a brief economic questionnaire to collect financial information for calendar year 2003. Businesses were then contacted by telephone to complete the questionnaire. These data are summarized in Chapter IV. The questionnaire is included as Appendix E to this report.

REFERENCES

ATCM Comments. Comment letters received by ARB on the proposed amendments to the Chromium Plating ATCM.

IV. Chromium Plating and Chromic Acid Anodizing Operations

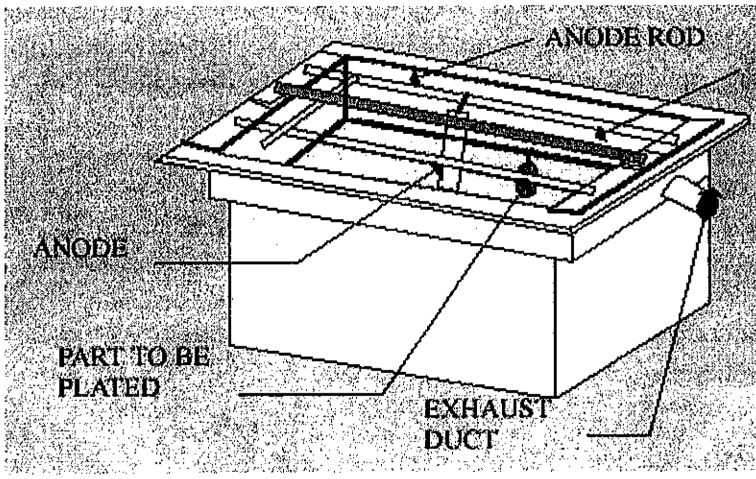
ARB has regulated chromium plating and chromic acid anodizing facilities since 1988. In this Chapter, we provide a brief summary describing the processes. A detailed review of the source category can be found in the original staff report (ARB, 1988b). As part of our evaluation of the effectiveness of the existing ATCM, staff conducted two facility surveys. This Chapter also summarizes the results of these surveys by providing an overview of chromium plating and chromic acid anodizing facilities in California in 2003. One goal of the proposed amendments is to further reduce hexavalent chromium emissions and exposure; therefore, this Chapter primarily describes information on hexavalent chromium plating and chromic acid anodizing operations.

A. Overview

Electroplating is a chemical or electrochemical process of surface treatment. A metallic layer is deposited onto a base material. In the chromium plating process, an electrical charge is applied to a plating bath containing an electrolytic salt (chromium anhydride) solution. The electrical charge causes the chromium metal in the bath to fall out of solution and deposit onto various objects (usually metallic) placed into the plating bath. In an anodizing process, an oxide film is formed on the surface of the part.

The hexavalent chromium plating process is only about 20 percent efficient. This inefficiency leads to excess generation of hydrogen and oxygen bubbles as electrical current is applied to the plating bath. The bubbles rise through the tank and burst at the surface, leading to emissions of hexavalent chromium. Facilities using trivalent chromium baths emit trivalent chromium in the process. Once emitted from the facility, hexavalent chromium can be inhaled and entrained in the lungs. In a similar manner hexavalent chromium mist is generated during chromic acid anodizing. Thus, hexavalent chromium emissions have the potential to adversely impact public health on a statewide basis, as well as at the local community level. A schematic diagram of a plating tank is shown in Figure IV-1.

Figure IV-1. Main Components of an Electroplating Tank



Source: Burgess WA Recognitions of Health Hazards in Industry – A Review of Materials & Processes, 2nd edition John Wiley & Sons Inc., 1995

From OHCOW, 1997

As shown in Figure IV-1, the part to be plated becomes the cathode in the circuit. In chromic acid anodizing, the part to be oxidized serves as the anode in the circuit.

B. Types of Chromium Operations

As mentioned above, facilities use either trivalent or hexavalent chromium baths. However, the trivalent chromium plating process is only available for decorative chromium plating applications. Facilities using hexavalent chromium baths can be divided into three types. These include hard chromium (or functional chromium) plating operations, decorative chromium plating operations, and chromic acid anodizing operations. Decorative plating includes black chromium plating which is selected both for its functional and decorative properties. It has a dull dark gray, or black finish when polished. It has numerous applications and can be used in military, aerospace, automotive or other applications. It is a semi hard, non-reflective, abrasion resistant, heat and corrosion resistant coating.

The same hexavalent chromium bath chemistry can be used for both hard and decorative chromium plating. Table IV-1 provides a summary of the three processes.

Table IV-1. Description of Hexavalent Chromium Operations

	HARD CHROMIUM PLATING	DECORATIVE CHROMIUM PLATING	CHROMIC ACID ANODIZING
Type of layer	Thick layer (2.5 µm – 760 µm)	Thin layer 0.003 µm-2.5 µm	Electrochemical conversion
Properties provided	Corrosion protection, wear resistance, lubricity and oil retention among other properties	A decorative and protective finish	Corrosion and abrasion resistant surface by forming an oxide coating
Type of parts	Engine parts, industrial machinery, and tools	Bath fixtures, faucets, automotive bumpers and wheels, furniture components, motorcycle parts	Architectural applications, landing gears, giftware and novelties, automotive trim and bumpers
Plating duration	Hours or days	Seconds or minutes	<1 – 5 minutes
Substrate	Typically plated on steel	Typically plated on Nickel	Aluminum

The most familiar type of chromium plating is decorative chromium plating which provides a bright, and shiny finish on objects such as faucets and wheels. Generally, the base material has been nickel-plated prior to plating the chromium.

C. Data Resources

To characterize the industry, ARB staff contacted all air districts with active chromium plating and chromic acid anodizing facilities. These operations are under permits to operate issued by air districts and must comply with applicable district rules or the Chromium Plating ATCM. Together with the air districts and utilizing other data sources, a list of 355 potential operations was developed. A letter was sent to these 355 facilities informing them of ARB's intent to review the ATCM, and requesting them to provide basic information about their business. Each facility was contacted by telephone to complete the questionnaire. From this survey, 222 active hexavalent chromium plating and chromic acid anodizing facilities and ten trivalent chromium plating operations were identified. Of the ten trivalent chromium operations, six facilities only plate using the trivalent chromium process, while the other four operations are part of a business that also conducts hexavalent chromium plating. ARB staff also conducted an economic survey to gather employee and economic information. Data on proximity of plating shops to receptors was also gathered with the assistance of the air districts. A summary of the data collected from our surveys is provided in the following sections.

D. Industry Characterization

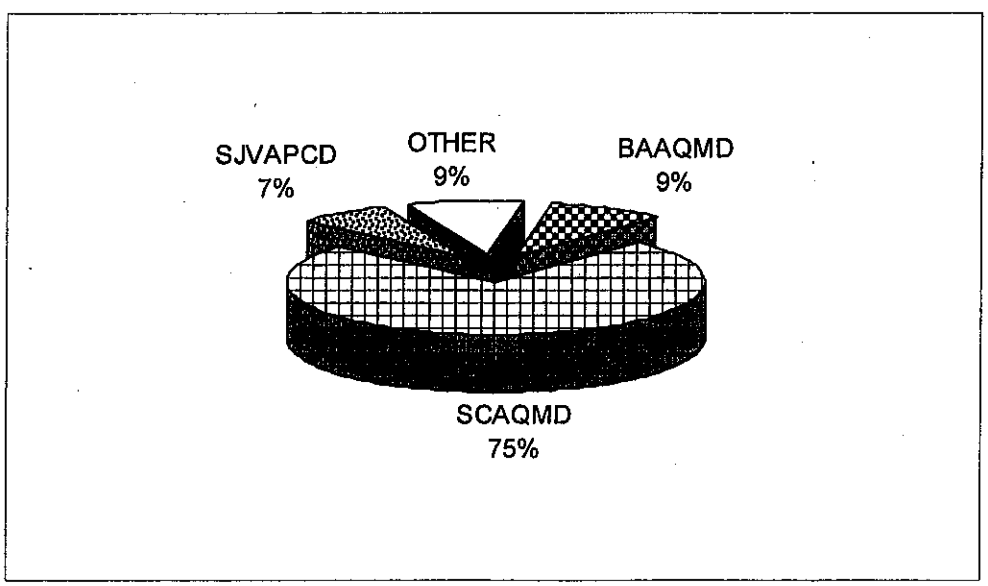
The following sections provide information collected from our calendar year 2003 industry survey. Note that a distinction is made between number of facilities and number of operations. This is necessary because some facilities perform multiple operations. For example, one facility may conduct chromic acid anodizing as well as hard chromium plating.

1. Location and Number of Plating and Anodizing Facilities

ARB staff determined that in 2003 there were 228 combined trivalent and hexavalent chromium plating and chromic acid anodizing facilities in California. Several of these facilities perform multiple operations using hexavalent chromium (230 operations) and trivalent chromium (10 operations). Four hexavalent chromium plating facilities also conduct trivalent chromium plating. There are six facilities that only conduct trivalent chromium plating. Most of this Chapter will focus on the 222 hexavalent chromium plating and chromic acid anodizing facilities. The facility list was verified by air districts. Therefore, we believe that the industry is fully represented. Information collected included: facility location; type of operation; total throughput; add-on air pollution control equipment; in-tank controls; source test information; type of plating line; and grinding and polishing activity information. In the following graphs, note the distinction between facility and operation as we characterize the industry.

Out of 240 operations, the majority are in located in the SCAQMD. Figure IV-2 below depicts the plating and anodizing operations by air district. Other air districts include Shasta, Sacramento, Ventura, and Feather River.

Figure IV-2. Distribution of Chromium Operations by District (2003)



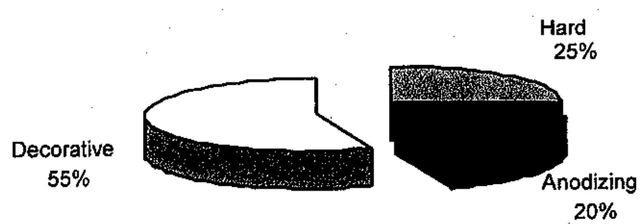
Out of 240 operations, 230 are hexavalent chromium plating or anodizing operations and ten are trivalent chromium plating operations. Table IV-2 below summarizes all active facilities by operation type. Note that there were 228 active chromium plating and chromic acid anodizing facilities in California in 2003 and twelve of them perform multiple operations.

Table IV-2. Number of Operations by Plating Type

Hexavalent Chromium Baths		
	Hard (Functional) Chromium Plating	58
	Decorative Chromium Plating	127
	Chromic Acid Anodizing	45
Trivalent Chromium Baths		
	Trivalent Chromium Plating	10
TOTAL		**240**

Figure IV-3 below shows that of the 222 active hexavalent chromium facilities, 55 percent of them perform decorative chromium plating, 25 percent perform hard (functional) chromium plating, and 20 percent conduct chromic acid anodizing.

Figure IV-3. Distribution of Hexavalent Chromium Operations by Type (2003)



Emissions of hexavalent chromium from plating and anodizing operations depend on total throughput in ampere-hours. An ampere-hour is a unit of amperes integrated over time. It is an important variable because it determines the amount of hexavalent chromium emissions from a facility. The ampere-hours are multiplied by the emission rate (milligrams/ampere-hour) to calculate emissions. This is discussed later in Chapter V on emissions. Table IV-3 provides a summary of throughput ranges and averages by plating type. Data were not available for two operations, therefore, the numbers in Tables IV-2 and IV-3 differ slightly.

Table IV-3. Hexavalent Chromium Plating Type and Ampere-hours (2003)

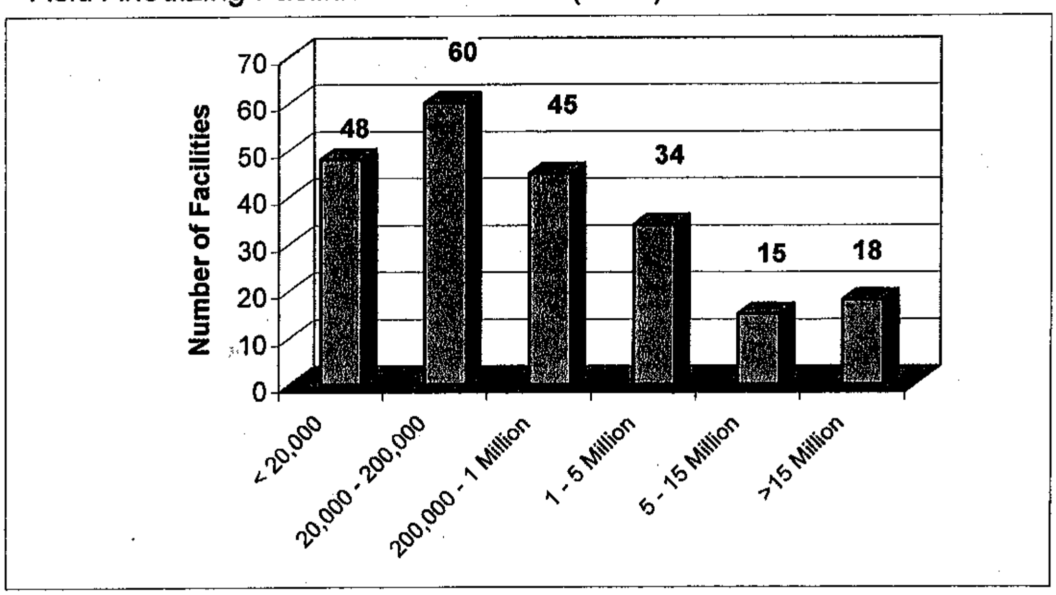
	Hard	Decorative	Anodizing
Number of operations	57	126	45
Range of Ampere-hours	1,200 – 79,000,000	120 – 82,900,000	260 – 2,000,000
Average (Mean) Ampere-hours	12,500	1,700,000	150,000
Median Ampere-hours	2,900,000	95,000	43,000

*Unknown throughput information for 2 plating or anodizing operations

Although the ranges appear similar for hard and decorative plating, generally ampere-hours from hard chromium plating operations are much higher than those from decorative chromium plating. This can be seen by comparing the mean and median ampere-hours shown in Table IV-3. The higher throughput levels, in ampere-hours, that are shown for hard chromium plating are related to the length of time required to build the thick chromium layer typical of hard chromium plating.

In terms of throughput, many chromium plating and chromic acid anodizing facilities are small operations. Figure IV-4 shows the level of throughput, in ampere-hours for the various operations.

Figure IV-4. Throughput (in Ampere-hours) for Chromium Plating and Chromic Acid Anodizing Facilities in California (2003)



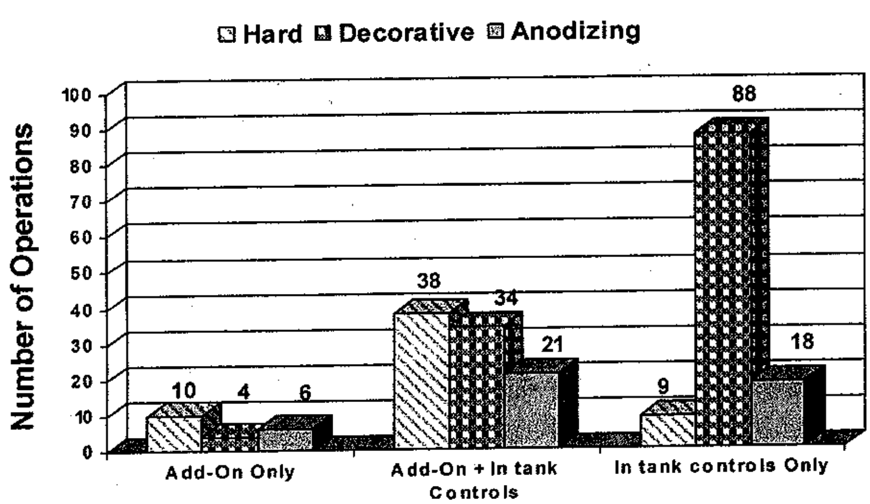
As shown in Figure IV-4, 48 (about 20 percent) facilities have annual throughput of 20,000 annual ampere-hours or less. Sixty facilities (27 percent) have throughput of between 20,000 to 200,000 annual ampere-hours. Over 50 percent of facilities have annual ampere-hours over 200,000.

2. Control Equipment

All chromium plating and chromic acid anodizing facilities already use a variety of controls to comply with the existing ATCM. Emissions control can be achieved through using add-on air pollution controls, such as filter systems, or in-tank controls, primarily chemical fume suppressants that reduce surface tension. The staff collected information on the types of emission controls in use based on visits to many plating and anodizing operations, and through the survey. The following section provides information on controls currently being used by the chromium plating and chromic acid anodizing industry. A description of these control types is provided in Chapter VI.

To comply with the existing ATCM, hard chromium plating facilities must use add-on air pollution control devices to meet emission limitations expressed in milligrams/ampere-hour (an alternative to meet a surface tension limit is provided for hard chromium plating facilities with less than 500,000 ampere-hours). Decorative plating and chromic acid anodizing facilities have the option of complying with an emission limit expressed in milligrams/dry standard cubic meter of air (mg/dscm) or meeting a surface tension requirement using a chemical fume suppressant with a wetting agent. Most have chosen the latter means of complying. Many facilities use a combination of controls to reduce emissions. Figure IV-5 shows distribution of current control options in use at the hexavalent chromium facilities in California.

Figure IV-5. Distribution of Emission Controls by Type of Chromium Operation



*Note no information about 2 operations that have shut down since 2003

As shown in Figure IV-5, in 2003, there are 113 operations controlling hexavalent chromium emissions with add-on air pollution control devices. Of facilities with add-on air pollution controls, 69 operations (14 chromic acid anodizing, 26 decorative chromium, and 29 hard chromium plating facilities), or 61 percent, had HEPA filters as their final control. Our survey also gathered source test emission rate information for facilities. Out of 113 operations with add-on air pollution control device(s), source test information was available for 71 (63 percent) of the operations.

Figure IV-5 also shows that the majority of operations used chemical fume suppressants as the sole source of emission control. As shown, 88 operations, or almost 70 percent of decorative chromium plating operations used chemical fume suppressants to control hexavalent chromium emissions. Note also that there are several hard chromium plating facilities using chemical fume suppressants. These are operations with throughput below 500,000 ampere-hours per year.

3. Housekeeping

Because of information gleaned from our Barrio Logan study, we also gathered information on grinding and polishing operations within facilities, and whether the plating line was automatic or manual. We are interested in this information because operations with grinding and polishing activities generate dust, which could act as a sink for hexavalent chromium mist being emitted from the plating or anodizing tank. Once disturbed by activities of the workers or ventilation within the operation, the dust can be re-entrained leading to fugitive emissions of hexavalent chromium.

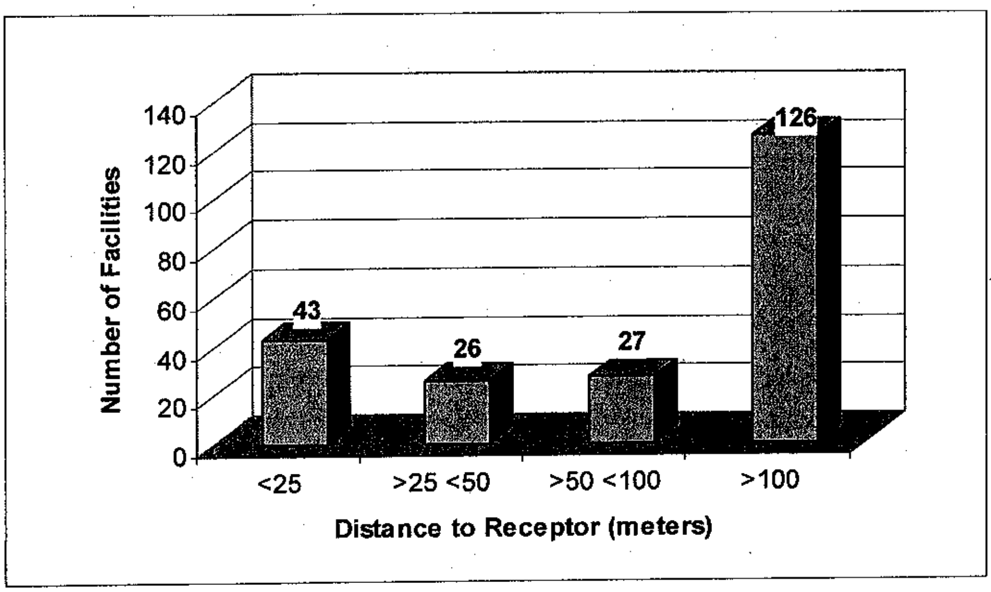
Through the survey, we found 145 facilities that performed grinding polishing or buffing on site and 72 that did not. No information was available for five facilities.

The manner in which parts are processed, particularly for decorative plating, also could lead to hexavalent chromium emissions as droplets of liquid from the plating tank may fall to the floor surrounding the tank. Again, this could lead to dust and fugitive emissions of hexavalent chromium. Automatic lines generally have tanks set up in a row but manual lines may not. We found that were 186 facilities with manual lines, 30 with automatic lines, and 3 facilities that had both manual and automatic lines. No information was available for 4 facilities.

4. Sensitive Receptor Distances

As we found in Barrio Logan, the impacts of hexavalent chromium emissions are highly localized. While ambient hexavalent chromium emissions may be low, emissions of hexavalent chromium from plating and anodizing could pose significant exposures to receptors living near the source. Therefore, to assess potential adverse impacts to near source receptors, with assistance from the air districts, ARB staff determined the distances to the nearest sensitive receptors for all facilities. Figure IV-6 provides distances, in meters, from the source to the nearest sensitive receptor for all hexavalent chromium facilities by type of operation. The receptors include: any residence including private homes, condominiums, apartments, and living quarters; education resources such as preschools and kindergarten through grade twelve (K-12) schools; daycare centers; and health care facilities such as hospitals, retirement and nursing homes, long term care hospitals, hospices, prisons, and dormitories or similar live-in housing.

Figure IV-6. Distance (in Meters) Between Hexavalent Chromium Facilities and the Nearest Sensitive Receptor

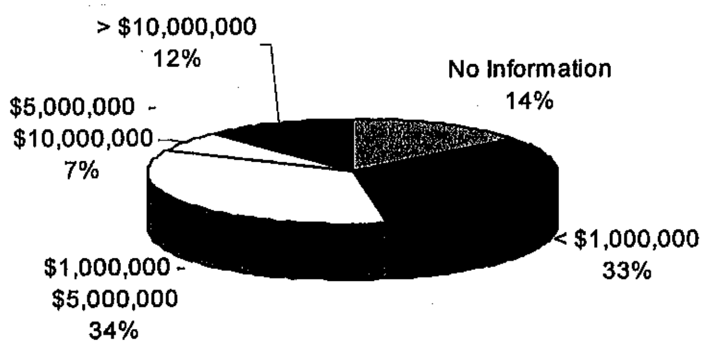


As shown in Figure IV-6, and as stated previously, 96 hexavalent chromium facilities are located within 100 meters of a sensitive receptor. This represents 43 percent of the facilities. Of these, 76 are decorative chromium plating and chromic acid anodizing facilities that generally control emissions with chemical fume suppressants. Figure IV-6 also shows that 43 of these facilities are located within 25 meters of a sensitive receptor.

5. Economic Survey

To characterize the industry financially, ARB staff contacted active facilities in February 2005 to obtain economic information. These data for the 2003 calendar year are summarized here and will be used to determine the economic impacts of the proposed amendments on chromium plating and chromic acid anodizing facilities. The financial information obtained is shown in Figure IV-7.

Figure IV-7. Gross Annual Revenue for Hexavalent Chromium Plating and Anodizing Facilities (2003)



As shown in Figure IV-7, out of 222 hexavalent chromium facilities, we found that one third had gross annual revenue of less than $1,000,000, while another third had revenues between $1,000,000 to $5,000,000. About 20 percent have annual revenue over $5,000,000. No information was received from 14 percent of the facilities.

Table IV-4 provides data on the number of people employed by various plating and anodizing businesses.

Table IV-4. Number of Employees at Chromium Plating and Chromic Acid Anodizing Facilities

Employee Number Range	Number of Facilities
1 – 10	60
11 – 25	46
26 – 100	61
>101	24
No information	31

As shown in Table IV-4, 25 percent (60 facilities) employ ten or fewer people. Seventy-five percent of facilities have less than 100 employees.

REFERENCES

ARB, 1988b. Air Resources Board. "Staff Report; Initial Statement of Reasons for Proposed Rulemaking – Proposed Airborne Toxic Control Measure for Emissions of Hexavalent Chromium from Chrome Plating and Chromic Acid Anodizing Operations". 1988.

OHCOW, 1997. Occupational Health Clinics for Ontario Workers Inc. "Electroplating – A Focus on Chrome Plating". 1997

V. Emissions

This Chapter presents a summary of our decorative chromium plating emissions testing program to investigate and, if needed, improve the emission factor for chemical fume suppressant controlled decorative plating facilities. Based on the emission factor developed through the testing program, this Chapter also includes 2003 estimated statewide emissions of hexavalent chromium from chromium plating and chromic acid anodizing facilities in California. As background, information on existing hexavalent chromium emission factors is also included.

A. Overview

One goal of characterizing the industry and estimating hexavalent chromium emissions was to assess the potential for significant near-source residual cancer risk resulting from chromium plating and chromic acid anodizing. The remaining risk, if any, would be from facilities already complying with the Chromium Plating ATCM and air districts rules. During our evaluation, it became clear that a better understanding of emissions occurring from decorative chromium plating was necessary. To comply with the ATCM, most decorative chromium plating facilities have used chemical fume suppressants to reduce the bath surface tension. Reducing the surface tension reduces misting and, therefore, hexavalent chromium emissions. However, the overall effectiveness of chemical fume suppressants to reduce emissions was not well quantified. Therefore, ARB staff undertook an emissions testing program to quantify hexavalent chromium emissions from decorative chromium plating facilities using chemical fume suppressants.

B. Emission Factor Background

ARB staff, in 1988, established for hexavalent chromium plating and chromic acid anodizing operations uncontrolled and controlled hexavalent chromium emission factors (ARB, 1988b). These factors were based on source tests available at the time. For hard chromium plating and chromic acid anodizing facilities, an uncontrolled emission factor of 5.2 milligrams/ampere-hour was established. Based on available data, an uncontrolled emission factor of 0.5 milligrams/ampere-hour was established for decorative chromium plating facilities. 'Controlled' emission factors were then developed based on efficiencies reported for various control methods. For example, at the time, chemical fume suppressants were thought to be 95 percent effective. Therefore, the controlled hexavalent chromium emission factor was believed to be 0.025 milligrams/ampere-hour, based on uncontrolled decorative chromium emissions of 0.5 milligrams/ampere-hour. Likewise, an emission factor of 0.006 milligrams/ampere-hour for hard chromium plating facilities was based on 99.8 percent control from an uncontrolled hard chromium plating emission factor of 5.2 milligrams/ampere-hour.

Controlled emissions for hard chromium plating operations have since been measured directly through source testing emissions downstream of add-on air pollution control devices. However, quantifying controlled emissions from decorative plating operations has been more difficult because most facilities do not have add-on air pollution control devices. To better assess residual health risk from decorative chromium plating facilities, improved information on emissions from tanks controlled with chemical fume suppressants was necessary. To that end, ARB undertook an emissions testing program.

In other developments, the SCAQMD also tested effectiveness of chemical fume suppressants to control hexavalent chromium emissions. (SCAQMD, 2004) From their testing, a list of chemical fume suppressant products was developed that under specified conditions, would result in emissions of no more than 0.01 milligrams/ampere-hour. The list of SCAQMD certified chemical fume suppressants can be found on the air district website at: http://www.aqmd.gov/prdas/chrome%20plating/chromeplating.htm

A summary of controlled and uncontrolled emission factors for decorative plating tanks that existed prior to our testing program is provided in Table V-1 below.

Table V-1. Decorative Chromium Plating Emission Factors in Existence Prior to ARB Testing Program (milligrams/ampere-hour)

	ARB (1988)	U.S. EPA (1996)	SCAQMD (2003)
Uncontrolled	0.5	2.14	4.4
Controlled with foam or foam plus scrubber	0.025	--	--
Controlled with chemical fume suppressants	0.025	0.008	--
Controlled with certified chemical fume suppressants	--	--	0.01
Controlled with HEPA filter			0.0015

In reviewing the data in Table V-1, it becomes clear that residual cancer risk would vary widely based on the emission factor chosen.

C. Emissions Testing Program

1. Overview

During our Barrio Logan study unexpectedly high concentrations of hexavalent chromium were measured outside a decorative chromium plating facility in San Diego (refer to Chapter II). These concentrations were higher than would have been predicted based on ARB's decorative chromium plating emission factor. In light of these findings, we conducted an emissions testing program at decorative chromium plating businesses to gather emissions information. The testing was conducted in two phases in consultation with the chromium plating industry and the air districts. Each test consists of three test runs. These individual runs are averaged to determine an emission rate. A summary of both phases and testing result summary tables are provided in the sections below. Appendix F contains further data on each test conducted.

2. Phase I

During Phase I of the testing program, ARB staff conducted four source tests at three decorative chromium plating facilities. These facilities had forced ventilation systems and were using a variety of controls which included chemical fume suppressants. All of these tests measured emissions after in-tank controls (chemical fume suppressants) alone. These in-tank control test results ranged from 0.0017 to 0.810 milligrams/ampere-hour, with an average of 0.21 milligrams/ampere-hour. After evaluating these data, staff determined that the presence of forced ventilation systems may have led to higher emission rates than would be representative of the overall decorative chromium plating industry. Table V-2 presents results of the Phase 1 testing.

Table V-2. Average Hexavalent Chromium Emission Rates and Selected Testing Parameters for Phase 1

Test Number	1	2*	2*	3	4
Date	1/2003	1/2003	1/2003	3/2003	4/2003
Mean Hexavalent Chromium Emission Rate (milligrams/ampere-hour)	0.19	0.28	0.003	0.003	0.159
SurfaceTension* (dynes/centimeter)	35.5	38.5	38.5	33.2	32.7
Chemical Fume Suppressant	CR 1700®	CR 1700®	CR 1700®	Fumetrol 140®	Dis Mist NP®
Other Controls	None	None	Composite Mesh Pad	Polyballs	None
Chromic Acid Concentration (ounce/gallon)	33.8	33.2	33.2	44.7	21.4

* Same test, emissions collected before and after the composite mesh pad.

These data were not used to develop an emission factor. However, we did find that, even though emissions off the tank varied widely, emissions after an add-on air pollution control device were consistently low. In one test we measured hexavalent chromium emissions before and after an add-on air pollution control device, a composite mesh pad system. The samples collected before the composite mesh pad system would be representative of a tank controlled with chemical fume suppressants. In this test, although the emission rate results collected before the composite mesh pad system varied for each of three test runs (0.0017 to 0.810 milligrams/ampere-hour), the emission rates measured after the composite mesh pad were consistent. Emission results ranged from 0.002 to 0.003 milligrams ampere-hour with an average of 0.003 milligrams/ampere-hour. These results provide evidence that add-on air pollution control devices provide a consistent level of control regardless of operating parameters. In another test, use of polyballs and chemical fume suppressant yielded an emission rate of 0.003 milligrams/ampere-hour. This test result indicates that polyballs combined with in-tank controls provides emission reduction benefits over that achieved with chemical fume suppressants alone.

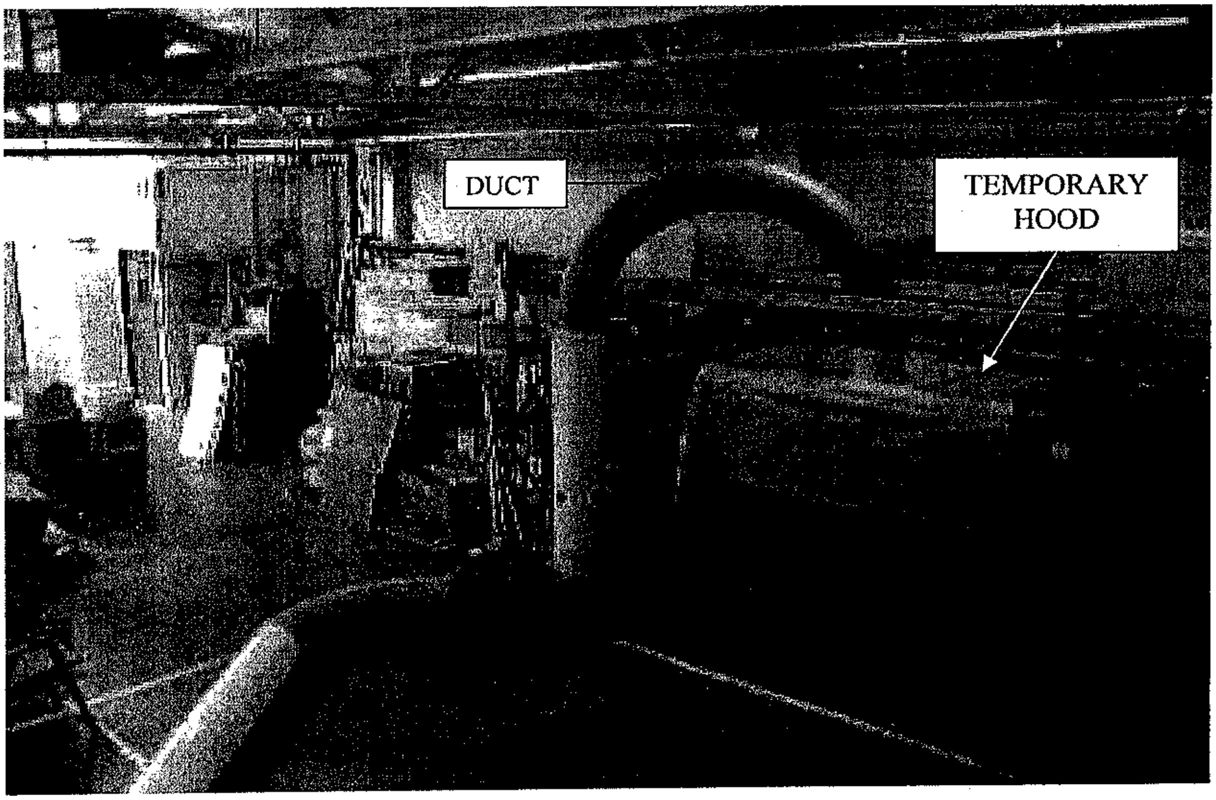
From these tests, we also evaluated differences in surface tension readings based on two types of instruments: a stalagmometer and a tensiometer. There was a difference observed between measurements with the two instruments. While all stalagmometer surface tension readings were higher than the tensiometer readings, no uniform difference was seen (*i.e.* they did not consistently vary by the same amount of dynes/centimeter). In developing the proposed amendments to the Chromium Plating NESHAP, U.S. EPA determined that measurements between the two instruments varied consistently by ten dynes/centimeter. Our testing did not confirm this.

We also learned that the emission rates from decorative chromium plating tanks were similar to those of hard chromium plating facilities with similar controls. We believe this indicates that uncontrolled emissions from decorative plating facilities were underestimated during the development of the original ATCM. This finding supports the proposal to have similar emission limits for all plating types.

3. <u>Phase II</u>

During Phase II of the testing program, ARB staff measured hexavalent chromium emissions at facilities with open tanks (*i.e.*, they do not have forced ventilation systems). These facilities all reduced hexavalent chromium emissions using chemical fume suppressants as the sole control source. These facilities are more representative of the decorative plating industry. Seven source tests were conducted at three facilities. To facilitate testing, ARB staff designed a temporary hood to capture emissions. The temporary hood set-up is shown in Figure V-1.

Figure V-1. Temporary 'Hood' for Capturing Hexavalent Chromium Emissions at Decorative Chromium Plating Facilities



The results of the first six tests were used to assess existing hexavalent chromium emissions from various decorative chromium plating tanks without forced ventilation. These tanks were all controlled with various chemical fume suppressants. The mean emission rate from these tests is representative of emissions existing prior to implementation of Rule 1469 in the SCAQMD. Table V-3 provides results for each of the first six tests.

Table V-3. Average Hexavalent Chromium Emission Rates and Selected Testing Parameters for Phase II

Test Number	1	2	3	4	5	6
Date	1/2004	2/2004	5/2004	10/2004	5/2005	6/2005
Mean Hexavalent Chromium Emission Rate (milligrams/ampere-hour)	0.009	0.004	0.050	0.050	0.052	0.065
SurfaceTension* (dynes/centimeter)	39.9	29.5	36.8	42	30.1	31.5
Chemical Fume Suppressant	Protab 1000®	Clepo Mist®	Protab 1000®	Chrome Foam®	Chrome Foam®	Chrome Foam®
Chromic Acid Concentration (ounce/gallon)	36	34.7	33.4	30.2	25	28.2

* Surface tension was determined using a stalagmometer

For consistency, several variables remained as constant as practicable for the six tests shown in Table V-3. [The seventh test was done to verify the results of the SCAQMD fume suppressant certification program. The results of this test will be discussed separately.] The plating tanks were of similar size, the ampere-hours per test were consistent, and the same number and types of parts were plated each time. More details on each of these six tests are included in Appendix F. In addition to evaluating the effectiveness of different chemical fume suppressants to control hexavalent chromium emissions, we also monitored several other parameters to determine the effect, if any, on hexavalent chromium emissions. A brief description of our findings is provided below.

a. Hexavalent Chromium Emission Factor for Chemical Fume Suppressant Controlled Plating Tanks Derived from the Emissions Testing Program

Using the results from the six tests shown in Table V-3, a hexavalent chromium emission factor was developed to quantify the emissions from chromium plating and chromic acid anodizing operations using chemical fume suppressants as the sole source of control. These data are representative of 'real world' conditions. The emission rates from six tests ranged from 0.004 to 0.065 milligrams/ampere-hour, with an average of 0.04 milligrams/ampere-hour. For establishing the 2003 statewide hexavalent chromium emissions, this average emission rate, 0.04 milligrams/ampere-hour, was used.

b. Assessing Chemical Fume Suppressants to be Used for Compliance with the ATCM

Concurrent with our testing program, the SCAQMD tested chemical fume suppressants under controlled conditions. The purpose of this testing was to determine parameters that yielded optimum emission reductions. The SCAQMD demonstrated that hexavalent emissions can be further reduced if certain chemical fume suppressants are used. In fact, the SCAQMD demonstrated that several chemical fume suppressants could reduce emissions of hexavalent chromium to no more than 0.01 milligrams/ampere-hour

(SCAQMD, 2004a). The surface tension at which this emission rate is achieved is at lower surface tension than currently required in the ATCM.

Our first six tests were used to estimate emissions based on how facilities normally operate using chemical fume suppressants. Test seven was designed to verify the SCAQMD results. The seventh test was conducted using the chemical fume suppressant, Fumetrol 140®. This chemical fume suppressant was certified by the SCAQMD to reduce hexavalent chromium emissions to no more than 0.01 milligrams/ampere-hour when surface tension is maintained below 40 dynes/centimeter.

The results of the this test yielded an average emission rate of 0.009 milligrams/ampere-hour. This emission rate was achieved when surface tension was maintained at 35 dynes/centimeter, just below the level of SCAQMD certification. ARB was able to confirm results of the SCAQMD fume suppressant certification program. Based on this test result, as well as an evaluation of the SCAQMD source test data from their chemical fume suppressant certification program, ARB staff determined the chemical fume suppressants that would reduce emissions of hexavalent chromium to no more than 0.01 milligrams/ampere-hour at specified surface tensions. (SCAQMD, 2004a) Table V-4 lists these chemical fume suppressants with the surface tension at which the emission rate of 0.01 milligrams/ampere-hour is achievable.

Table V-4. Chemical Fume Suppressants Approved for Use at Specified Surface Tensions

Chemical Fume Suppressant and Manufacturer	Stalagmometer Measured Surface Tension (dynes/cm)	Tensiometer Measured Surface Tension (dynes/cm)
Benchbrite CR 1800® Benchmark Products	<40	<35
Clepo Chrome® MacDermid	<40	<35
Fumetrol 140® Atotech U.S.A.	<40	<35

Note that Table V-4 does not list all chemical fume suppressants certified by the SCAQMD. The chemical fume suppressants that employ a foaming mechanism for reducing emissions are not included on this list. This foaming component is critical to the effectiveness of the chemical fume suppressant. Most of the chromium plating facilities that will use these chemical fume suppressants as sole source of control are decorative chromium plating facilities. Many of these facilities do not operate in a manner that would allow the foam blanket to form and be maintained on the surface of the plating bath. In instances when the foam blanket is not maintained, emissions are likely higher than 0.01 milligrams/ampere-hour.

Through the emissions testing program and data obtained in the SCAQMD certification program, staff has developed two emission factors for hexavalent chromium plating tanks using chemical fume suppressants. The emission factor of 0.04 milligrams/ampere-hour is developed for all tanks using chemical fume suppressants prior to 2005. The second emission rate of 0.01 milligrams/ampere-hour for chemical fume suppressant controlled facilities is used to evaluate the SCAQMD facilities in the 2005 baseline year, while the emission rate of 0.04 milligrams/ampere-hour is used for facilities in other parts of the State. Finally, to determine the benefits of adoption of the ARB staff's proposal, estimated cancer risk and emissions from facilities using chemical fume suppressants as the sole control will be calculated based on an emission factor of 0.01 milligrams/ampere-hour.

c. Effect of Surface Tension on Emission Rate

The requirement in the ATCM for controlling hexavalent chromium emissions with chemical fume suppressants specifies that surface tension is to be maintained below 45 dynes/centimeter. Hexavalent chromium emissions are lowered as surface tension is reduced. Therefore, part of our testing program was to determine if reducing surface tension further resulted in decreased emission rates. For tests one and two, we evaluated the effect of reduced surface tension on emissions. The emission rates presented in Table V-3 are the averages of three test runs. As shown, the mean emission rate for test one, run at a surface tension of ~ 40 dynes/centimeter, was 0.009 milligrams/ampere-hour, while for test two, run at a surface tension of ~ 30 dynes/centimeter, the mean was 0.004 milligrams/ampere-hour. While the average emission rate for test two is lower, as determined by the statistical t-Test, at a significance level where $\alpha=0.05$, the means, and therefore the emission rates, are not different.

Interestingly, the emission rates for tests five and six, conducted at the same facility with the same chemical fume suppressant and at similar surface tensions, are higher—not lower—than the emission rate calculated for test four at the same facility conducted at a higher surface tension. We believe this indicates that other factors and practices at individual operations also affect the rate of hexavalent chromium emissions.

We also evaluated emission rates with the type of chemical fume suppressant used. The chemical fume suppressants used in tests one through six all contain fluorinated surfactants as the active ingredients (further information on chemical fume suppressant chemistry is included in Chapter VI). Because of this, one would expect, if all other variables are similar, that emission rates would be similar. However, emission rates ranged from 0.004 to 0.065 milligrams/ampere-hour, with an average of 0.04 milligrams/ampere-hour. Recall that ARB's historical emission factor for hexavalent chromium emissions from decorative chromium plating tanks is 0.025 milligrams/ampere-hour.

d. Effect of Tank Contaminants on Emission Rate

Tests four, five, and six were conducted at the same facility and were designed to evaluate the effect of bath contaminant levels on hexavalent chromium emissions. Generally, as the level of metallic contaminants builds in the plating bath, the bath becomes less efficient, and more current is necessary to overcome the resistance caused by the contaminants. Increasing the current, in turn, produces more bubbling which could lead to an emissions increase. Table V-5 contains information obtained from our survey of chemical suppliers, as well as contaminant levels present in the plating bath for tests four, five, and six. We have also included the hexavalent chromium emission rates obtained from each test to allow for easy comparison.

Table V-5. Plating Bath Contaminants, Concentration Levels Where Bath Clean-up is Recommended, and Hexavalent Chromium Emission Rates

	Manufacturer Recommended Action Level*	Test 4	Test 5	Test 6
Metallic Contaminants (milligrams/Liter)	5000–7000 mg/L	15,000 mg/L	60 mg/L	700 mg/L
Trivalent Chromium	0.5–1 oz/gal	0.64 oz/gal	< 0.1 oz/gal	0.2 oz/gal
Chloride	50 mg/L	130 mg/L	14 mg/L	20 mg/L
Mean Hexavalent Chromium Emission Rate		0.050 mg/amp-hr	0.052 mg/amp-hr	0.065 mg/amp-hr

* Average from 5 suppliers of chemicals to the plating industry.

The data in Table V-5 summarize information on common contaminants. The largest concentrations of metallic contaminants are typically nickel, copper, and lead. Trivalent chromium and chloride are also common contaminants that reduce bath efficiency. Note that despite heavy contaminant levels in test four the emission rate was lower than the emission rates in the two subsequent tests. If contaminants play a role in increasing emissions, we would have expected test five, conducted with a freshly prepared plating bath with essentially no contaminants (same tank, old solution disposed of) to yield the lowest emission rate. While we did not find a correlation with contaminant levels and emission rates, we nevertheless recommend that bath contaminants be minimized by conducting routine maintenance.

D. Statewide Hexavalent Chromium Emissions

The emission factor of 0.04 milligrams/ampere-hour was used to estimate 2003 hexavalent chromium emissions and estimated cancer risk for facilities using chemical fume suppressants as sole control. This would reflect emissions prior to implementation of Rule 1469 in the SCAQMD.

Statewide emissions of hexavalent chromium were calculated based on information from the 2003 survey of chromium plating and anodizing operations. To calculate emissions, the following equation was used:

Emission Rate (milligrams/ampere-hour) **X** Throughput (ampere-hours/year) = Annual Facility Hexavalent Chromium Emissions

Emission rates were assigned as follows:

Volume (fume suppressant) Tank Emission Rate: 0.04 milligrams/ampere-hour

Point Source Emission Rate:

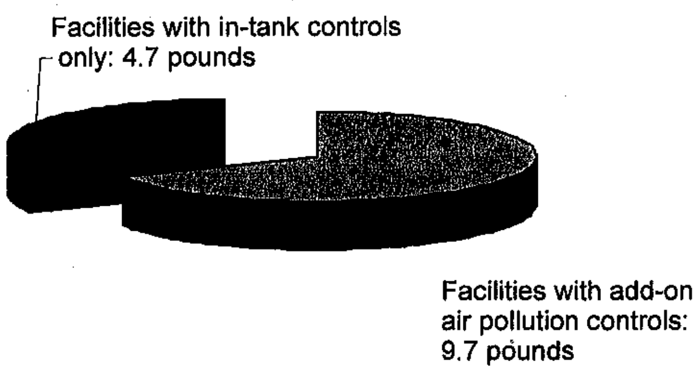
- Available emission rates from source tests

When source data were not available, emission rates were assigned based on type of controls corresponding to emission rates in the current ATCM as follows:

- HEPA or Mist Eliminator combination– 0.006 milligrams/ampere-hour
- Scrubber – 0.15 milligrams/ampere-hour

Figure V-2 shows the estimated statewide hexavalent chromium emissions in 2003.

Figure V-2. Statewide Hexavalent Chromium Emissions in 2003 Were 14.4 Pounds



As shown in Figure V-2, statewide emissions of hexavalent chromium from chromium plating and chromic acid anodizing operations totaled 14.4 pounds in 2003. Facilities with in tank controls emitting 4.7 pounds per year, are primarily decorative plating and chromic acid anodizing operations. Facilities with add-on air pollution controls, emitting 9.7 pounds per year, generally are hard chromium plating operations. However, for health risk reasons, a number of decorative chromium plating and chromic acid anodizing facilities are also controlled with add-on air pollution control devices. While this amount of hexavalent chromium emissions seems small on a statewide basis, the emissions are highly localized and the cancer potency of hexavalent chromium make these emissions a public health concern for sensitive receptors, especially those located in close proximity to plating and anodizing operations. It is also important to note that the emissions of hexavalent chromium shown in Figure V-2 do not include fugitive emissions of hexavalent chromium, which we have learned can be a significant part of a facility's overall impact.

E. Fugitive Emissions

In addition to hexavalent chromium emissions from the tank, chromium plating and chromic acid anodizing facilities also have fugitive emissions of hexavalent chromium, primarily dust. Dust accumulating in facilities from other operations such as grinding and polishing of parts prior to plating, and/or from poor housekeeping practices, provides a surface on which particles of hexavalent chromium from the plating operation may adhere. The hexavalent chromium may come directly from the plating process as mist is ejected from the bath. Other sources of hexavalent chromium may include droplets of chromic acid dripping onto other surfaces as plated parts are transferred to rinse tanks. This hexavalent chromium laden dust has the potential to become re-entrained due to air currents and activity in the plating or anodizing facilities.

Our Barrio Logan study confirmed that emissions of hexavalent chromium from a decorative plating shop were not only from the actual plating process, but from hexavalent chromium dust which became re-entrained. A study done by SDCAPCD also measured significant hexavalent chromium levels in dust of chromium plating and chromic acid anodizing facilities. This would indicate that the residence time might be longer for hexavalent chromium than was originally thought. During the emissions testing program, ARB staff also collected indoor air samples to qualitatively measure hexavalent chromium emissions. These studies are discussed individually and have prompted ARB to propose housekeeping requirements for hexavalent chromium plating and chromic acid anodizing facilities to minimize dust.

1. Barrio Logan Fugitive Emissions – Indoor Air Results

During the Barrio Logan study, indoor air samples were collected at two plating facilities. The first facility, a hard chromium plating facility had add-on air pollution control devices, including a HEPA filtration system. The second facility was a decorative chromium plating facility with no add-on air pollution control device or forced ventilation system. Indoor samples from the hard chromium plating facility averaged a hexavalent chromium concentration of 42.5 ng/m^3, while the average at the decorative plating facility was 393.4 ng/m^3. Continued indoor air sampling at the decorative plating facility yielded results as high as 2,315 ng/m^3. To put these numbers in perspective, the statewide annual average of ambient hexavalent chromium levels was 0.091 ng/m^3 in 2005. Key conclusions of this study are:

- High hexavalent chromium indoor air readings corresponded with high throughput (ampere-hour) at the decorative chromium plating facility;
- High levels of hexavalent chromium seen at ambient sites within the study area were consistent with high indoor levels at the decorative chromium plating facility,

indicating that the indoor hexavalent chromium emissions were emitted to the outdoors;

- Dust generated by clean up and construction activities was shown to contain high levels of hexavalent chromium (1200 mg/kg or higher), which exited the building; and
- The hard chromium plating facility, with add-on air pollution control devices, had low indoor concentrations of hexavalent chromium compared to those at the decorative chromium plating facility (ARB, 2003).

As a follow-up to the Barrio Logan study, SDCAPCD staff took additional samples at 10 other plating facilities in their district. These results are summarized in Appendix G. These data confirm that hexavalent chromium is in the dust at chromium plating and chromic acid anodizing facilities. This dust can become re-entrained in the indoor air and affect not only the workers at the facility, but also the receptors living near the facility when the dust is blown outside.

2. ARB - Indoor Air Samples During Source Testing

As we began the emissions testing program, we qualitatively measured indoor levels of hexavalent chromium during each test. Samples were taken during the source test and, for Phase II, samples were taken during the source test with the temporary hood in place. Background samples were also taken without the temporary hood for comparison. These results are summarized in Table V-6.

Table V-6. Summary of Indoor Air Results During Emissions Testing Program

Test Number	Samples	Range Indoor Air Concentration (ng/m3)	Average Indoor Air Concentration (ng/m3)
Facility 1	5	131* – 391*	262*
Facility 2	3	106 – 220	174
Facility 3	3	2.2 – 5.6	4
Facility 4	6	9.3 - 70	25
Facility 4 (background)	4	3.9 - 79	45
Facility 5	3	39 - 67	57
Facility 5 (background)	3	100 – 210	143
Facility 6	9	150-2350	976
Facility 6 (background)	4	120-460	248

*Total chromium numbers

Facilities four through six are those facilities that were tested by placing a temporary hood over the plating tank. While only qualitative, these data support that hexavalent chromium is being emitted from the plating tank during the electrolytic process. The data also indicate the presence of hexavalent chromium laden fugitive dust.

REFERENCES

ARB, 1988b. Air Resources Board. "Staff Report: Initial Statement of Reasons for Proposed Rulemaking – Proposed Airborne Toxic Control Measure for Emissions of Hexavalent Chromium from Chrome Plating and Chromic Acid Anodizing Operations". 1988.

ARB, 2003. Air Resources Board. "Ambient Monitoring for Hexavalent Chromium and Metals in Barrio Logan: May 2001 through May 2002". 2003.

SCAQMD, 2003a. South Coast Air Quality Management District. "Draft Staff Report - Proposed Amended Rule 1469-- Hexavalent Chromium Emissions from Chrome Plating and Chromic Acid Anodizing Operations and Proposed Rule 1426- Emissions from Metal Finishing Operations." 2003

SCAQMD, 2004. South Coast Air Quality Management District. Certified List of Fume Suppressants for Facilities Performing Chrome Plating and Chromic Acid Anodizing Operations. 2004 (http://www.aqmd.gov/prdas/ChromePlating/ChromePlating.htm)

SCAQMD, 2004a. South Coast Air Quality Management District. "Hexavalent and Total Chromium Emissions from a Decorative Chrome Plating Tank Controlled by Various Mist Suppressants". 2004

U.S. EPA, 1996. U.S. Environmental Protection Agency. "Emission Factor Documentation for AP-42 Section 12.20 – Electroplating – Final Report". 1996.

VI. Reducing Hexavalent Chromium Emissions

No new technologies or technology transfers would be required for facilities to comply with the proposed amendments to the Chromium Plating ATCM. Hard chromium plating facilities, for the most part, have used add-on air pollution control devices such as scrubbers, composite mesh pads, and HEPA filters. Decorative chromium plating and chromic acid anodizing facilities have mostly used in-tank controls, such as chemical fume suppressants and polyballs. These same technologies, or combinations of technologies, would allow facilities to comply with the proposed amendments. Generally, the proposed amendments would require wider use of add-on air pollution control devices. This Chapter describes the types of methods used to control hexavalent chromium emissions.

A. In-tank Controls

In-tank controls are the most widely used method of reducing hexavalent chromium emissions. In-tank controls include chemical fume suppressants which are added directly to the plating bath solution and mechanical fume suppressants which float on top of the plating bath. Each is described below, along with information on their effectiveness at reducing emissions and the number of facilities using them, based on our industry survey.

1. Mechanical Fume Suppressants

Mechanical fume suppressants are added to a plating bath's surface to form a physical barrier. These plastic balls (similar in appearance to ping-pong balls), called polyballs, act as a barrier to prevent mist from escaping the tank during plating. ARB's "Senate Bill (SB) 1731 Risk Reduction Audits and Plans Guidelines for Chrome Electroplating Facilities" assigns for polyballs a 70 percent emission reduction efficiency (ARB, 1997a).

To achieve this level of emission reduction requires complete coverage of the plating bath. Our survey results indicate that polyballs are used by about 60 facilities. Of these facilities, about 40 use them in combination with a chemical fume suppressant. One test in our emissions testing program evaluated the effectiveness of polyballs in conjunction with fume suppressants to reduce emissions. This test yielded an emission rate of 0.004 milligrams/ampere-hour. However, we cannot measure the efficiency of this combination because we did not test the uncontrolled emissions from the bath.

Polyballs can be a source of fugitive emissions if they are ejected from the tank when parts are removed and the solution on the polyballs dries on the floor of the facility. Plated parts must be removed from the tank carefully to avoid pulling polyballs out of the tank along with the plated part. Polyballs may be a partial control option for facilities where there is concern with 'pitting.'

2. Chemical Fume Suppressants

In the chromium plating process, only about 20 percent of the electrical current applied actually deposits chromium onto the part. The remaining current forms bubbles, hydrogen gas at the cathode and oxygen at the anode, that rise to the surface of the bath. As these bubbles burst, hexavalent chromium is emitted into the air. These bubbles can be reduced by adding chemical fume suppressants directly into the plating bath to reduce emissions. Emissions are controlled by reducing surface tension of the bath, by forming a physical foam blanket across the tank surface during plating, or by using a combination of foam blanket and reduced surface tension. The most used type of chemical fume suppressant in California's plating industry are chemicals that reduce surface tension.

a. Chemical Fume Suppressants Containing a Wetting Agent

Surface tension is the force that keeps a fluid together at the air/fluid interface. It is expressed in force per unit of width such as dynes/centimeter (dynes/cm). Chemical fume suppressants that contain 'wetting agents,' or surfactants, reduce this surface tension. By reducing surface tension, gas bubbles become smaller and rise more slowly than larger bubbles. Slower rising bubbles have reduced kinetic energy such that when the bubbles do burst at the surface the hexavalent chromium is less likely to be emitted into the air, and the droplets fall back onto the surface of the bath (Bayer®).

The most common types of surfactants used in chromium electroplating and anodizing are fluorinated or perfluorinated compounds or, collectively, fluorosurfactants. The active ingredients are compounds such as organic fluorosulfonate and tetraethylammonium perfluoroctyl sulfonate. The fluorosurfactant-based fume suppressant products used today represent an improvement over the previous hydrocarbon-based products. Fluorosurfactants are more hydrophobic than hydrocarbon surfactants and they are more surface active than hydrocarbon surfactants. Fluorinated sulfonate surfactants are effective in highly acidic solutions because they are resistant to hydrolysis by strong acids (U.S. EPA 1998). Fluorocarbon chains are also 'stiffer' than hydrocarbon chains so they are able to pack more closely. For these and other reasons, fluorosurfactants are able to reduce surface tension to levels that cannot be reached with hydrocarbon surfactants (JPCB, 1999).

These products are highly effective at reducing hexavalent chromium emissions by reducing plating bath surface tension. However, the compounds have been shown to bioaccumulate (see further discussion in Chapter XI). The fluorosurfactants used as active ingredients in chemical fume suppressants are often referred to as perfluorooctyl sulfonates (PFOS). On March 10, 2006, U.S. EPA published at 40 CFR Part 721.9582, a proposal to add certain PFOS into their Significant New Use Rule for perfluoroalkyl sulfonates (PFAS)(U.S. EPA, 2006). The PFOS proposed for addition include the PFOS commonly used in chemical fume suppressants. More information can be found on the following website: http://www.epa.gov/opptintr/pfoa/index.htm.

The notice for the amended Significant New Use Rule indicated that comments were being accepted to determine if these PFOS were in current use, such that a potential exception could be included. As of this writing, it is unclear as to what U.S. EPA's final action will be. However, it is clear that the PFOS used to control hexavalent chromium emissions from chromium plating and chromic acid anodizing have been in use since the early 1990's (P&SF, 2000). Should the U.S. EPA act to include the PFOS in the Significant New Use Rule without providing an exception for their use in electroplating, the manufacturer or importer would have to seek approval from U.S. EPA to allow their use in electroplating. ARB staff will continue to follow developments here, and would potentially have to propose regulatory changes depending on the final rule.

To put the magnitude of surface tension reduction required to suppress hexavalent chromium emissions into perspective, consider that the surface tension of water is about 72 dynes/centimeter. The current ATCM requirement is to reduce surface tension below 45 dynes/centimeter. Data suggest that lowering the surface tension below 45 dynes/centimeter reduces emissions further. In fact, product literature from a manufacturer of the fluorinated surfactants indicates that maximum emission reduction is achieved at 30 dynes/centimeter (Bayer ®). Our testing results did not statistically confirm that reducing surface tension to this level reduced emissions further. Balancing cost, staff is proposing that surface tension be maintained below 40 dynes/centimeter.

Another advantage of chemical fume suppressants containing fluorinated surfactants is that once a certain concentration is added to the tank, surface tension reduces rapidly (Kissa, 1994). Thus, a consistent level of emission reduction is provided. This is further justification for requiring facilities to use the chemical fume suppressants that rapidly reduce surface tension.

Earlier generation chemical fume suppressants were thought to cause pitting. Pitting is development of small holes or imperfections during plating. This was of particular concern in hard chromium plating applications due to the length of time necessary to build the desired chromium thickness. Earlier generation chemical fume suppressants, although perfluorinated, contained salts. These salts, when mixed with the fluoride ions in the plating bath, became suspended and caused roughness, porosity or cracking of the chromium plate leading to pits. The chemical fume suppressants in use today no longer contain these salts. Thus, chemical fume suppressants used today containing fluorosurfactants are no longer a source of 'pitting,' and are accepted for use even in hard chromium plating applications. However, if the plating bath contains other contaminants that may cause pitting, such as chloride, the chemical fume suppressant will accentuate the pit (P&SF, 2000 and Jones, 2006).

The main loss of fluorinated chemical fume suppressants is through dragout of solution because fluorinated surfactants are highly stable (U.S. EPA, 1993). Studies have shown that the carbon-fluorine (C-F) chemical bond can remain stable when exposed to acids, alkali, oxidation, and reduction at relatively high temperatures (Kissa, 1994). Therefore, it is not expected that the surface tension of a bath will increase after a few days of use, due to chemical breakdown, for these types of surfactants.

However, surface tension will increase as chemical fume suppressant is lost to drag out as parts are removed from the tank. The quantity of chemical lost will depend on workload and shop-specific parameters. Dragout can be minimized if electroplated parts are sprayed off over the tank, or drip trays are installed to return the surfactant to the tank along with the excess chromic acid.

b. Foam Blanket Chemical Fume Suppressants

Foam blanket chemical fume suppressants generate a layer of foam on the surface of the bath when current is applied. The foam blanket is formed by agitation from the hydrogen and oxygen gas bubbles generated during plating. The blanket reduces hexavalent chromium emissions by physically entrapping the mist in the foam.

There are some issues with use of foaming chemical fume suppressants. For example, foam blankets need time to form after the current is applied and may also need time to re-form after parts are removed, or makeup chemical fume suppressant is added to the bath. For shops that use their tanks intermittently, a consistent level of emission reduction is not achieved. Under the staff's proposal, chemical fume suppressants that rely on building a foam blanket for emission control could no longer be used.

Foam blankets also can entrap hydrogen gas, which may result in explosions if a spark is generated. This is more of a concern in hard chromium plating than in decorative chromium plating, because of the higher current densities and longer plating times associated with hard chromium electroplating operations. A foam blanket can also reduce the evaporative cooling of a bath, resulting in the need for increased cooling by other means (U.S. EPA, 1993).

c. Measuring Surface Tension

Because hexavalent chromium emissions are reduced only at lowered surface tensions, accurate measurement of the bath's surface tension is a critical compliance step. Surface tension has traditionally been measured either using a stalagmometer or a tensiometer. A du Nouy tensiometer is an instrument that measures surface tension by increasing force to a platinum-iridium ring in contact with the surface of the liquid. The tensiometer pulls on the ring and measures the force it takes to break the ring from the surface.

The stalagmometer is an instrument used to measure surface tension by determining the mass of a drop of liquid by weighing, a known number of drops or by counting the number of drops obtained from a known volume of liquid. Measuring surface tension with a stalagmometer is sometimes referred to as the 'drop weight' method. A stalagmometer is similar to a pipette (CDPHE 1999). Measuring surface tension with the stalagmometer is the most often used method, mostly because of cost considerations.

U.S. EPA's research found that measurements of surface tension with a tensiometer were approximately 20 percent lower than those obtained with a stalagmometer (U.S. EPA, 2002). Results of surface tension measurements from our emissions testing program also confirm that the tensiometer routinely gives lower surface tension readings than the stalagmometer. However, we did not see a consistent difference.

In 2004, U.S. EPA amended the Chromium Plating NESHAP. One of the changes establishes different surface tension standards, depending upon the type of measurement device used. If a facility uses a stalagmometer to measure surface tension, the surface tension should not exceed 45 dynes/centimeter. If a tensiometer is used, the surface tension limit is 35 dynes/centimeter (U.S. EPA, 2004).

Generally, the tensiometer is considered to provide the truer measure of surface tension. However, tensiometers can cost thousands of dollars, while stalagmometers only cost hundreds of dollars (Hensley, 1997).

Staff is proposing to incorporate the Chromium Plating NESHAP's revised surface tension requirements into the ATCM. For measuring surface tension the ATCM has referenced an U.S. EPA method, Method 306-B, contained in Appendix A of 40 Code of Federal Regulations, part 63. This Method 306-B requires use of ASTM Method D 1331-89, Standard Test Methods for Surface and Interfacial Tension of Solutions of Surface Active Agents, when surface tension is measured with a tensiometer. When measurements are taken with a stalagmometer, Method 306-B requires operators to use the instructions that came with the measuring device. For standardization, staff is proposing to include, as Appendix 8 to the ATCM, a standardized procedure for measuring surface tension with a stalagmometer. This method or a method approved by the permitting agency must be used to measure surface tension with a stalagmometer.

d. Fume Suppressants Used in California

As part of our survey of the chromium plating and chromic acid anodizing industry in California, ARB collected information on the types of fume suppressants used. The data are summarized in Table VI-1 below.

Table VI-1. Types of Chemical Fume Suppressants Used in California in 2003

Fume Suppressant Name	Numbers Using
Fumetrol 140®	108
Fumetrol 140® + Dis Mist®	16
Zero Mist®	10
Dis Mist NP®	23
Protab 1000® or Mactec Spray Stop®	5
Fumetrol 101®	5
Benchbrite®	4
Chrome Foam	4
Clepo Chrome Mist Control®	5
Foam Lok®, Harshaw MSP®, EconoChrome®	3

Of the 230 hexavalent chromium operations, 190 reported use of fume suppressant either as the sole control, or with other control devices. Table VI-1 shows the types of chemical fume suppressants reported as used by 183 operations for calendar year 2003. The other operations did not name the type of chemical fume suppressant used.

After the survey was conducted, SCAQMD amended their chromium plating and anodizing rule. They introduced the chemical fume suppressant certification program. The list of certified chemical fume suppressants can be found on their web site at: http://www.aqmd.gov/prdas/chromeplating/chromeplating.htm

Because the type of chemical fume suppressant used is critical to the chemical's ability to reduce and maintain lower surface tension, ARB staff also conducted a survey of chemical fume suppressant manufacturers to gather information on product formulation, mechanism of action, and the surface tension to be achieved for maximum effectiveness. The results of the survey are shown in Table VI-2, below.

Table VI-2. Summary of Chemical Fume Suppressant Mechanism of Control and Recommended Surface Tension

Chemical Fume Suppressant	Primary Mechanism and Surface Tension
Atotech USA	
Dis Mist NP®	Foam 1-2 inches
Fumetrol 140®	Surface Tension Reducer (30 dynes/cm with a tensiometer)
Benchmark	
Benchbrite CR-1800®	Surface Tension Reducer (40 dynes/cm)
Chemithon-Micel	
Chrome Foam®	Surface Tension Reducer (20-30 dynes/cm)
MacDermid	
Proquel 1299®	Surface Tension Reducer (40 dynes/cm)
Macuplex STR®	Surface Tension Reducer (40 dynes/cm)
Clepo Cr Mist Control®	Surface Tension Reducer (40 dynes/cm)
Enthone®	
Zero-Mist®	Surface Tension Reducer (30 dynes/cm)

(Source: Chemical Manufacturer Survey)

As shown in Table VI-2, almost all chemical fume suppressants used in California's chrome plating industry control hexavalent chromium emissions by reducing bath surface tension. It should also be noted that most manufacturers recommend operating baths at 40 dynes/centimeter or below for maximum effectiveness. The current ATCM requires surface tension to be maintained below 45 dynes/centimeter. The survey also indicates that the products that reduce surface tension all use fluorosurfactants as the active ingredient.

B. Add-on Air Pollution Control Devices

When the Chromium Plating ATCM was first adopted in 1998, hard chromium plating and chromic acid anodizing facilities were required to use add-on air pollution control devices to comply with hexavalent chromium emission limits (except for smaller operations). A number of decorative chromium plating facilities also use add-on air pollution control devices to comply with air district health risk rules. From our survey, 113 facilities reported using add-on air pollution control devices. Most facilities have either a one stage system consisting of composite mesh pad, mist eliminator or scrubber; or a two stage system which has a HEPA filter after the first stage. A brief description of the types of add-on air pollution control devices currently in use follows.

1. High Efficiency Particulate Arrestor (HEPA) Filter

High Efficiency Particulate Arrestor (HEPA) filters are specifically designed for the collection of submicrometer particulate matter at high collection efficiencies. First developed in the 1940's for the Manhattan Project to control radioactive contaminants, HEPA filters are rated at 99.97 percent effective in capturing particles 0.3 µm in diameter. Particles of 0.3 µm in diameter represent the most penetrating particle size, meaning that the 99.97 percent efficiency is the worst efficiency. Smaller or larger particles are trapped with higher efficiency (HHS, 2000). When used in particulate air pollution control, HEPA filters are best utilized in applications with a low flow rate and low pollutant concentration. Typically HEPA filters are installed downstream of another control device to lessen loading on the filter, thereby lengthening its life. These products do require maintenance. The filters should be replaced at least annually and disposed of as hazardous waste. For all but very small facilities, HEPA filters are considered the most effective control of hexavalent chromium emissions. They represent BACT and can reduce hexavalent chromium emissions to no more than 0.0015 milligrams/ampere-hour. About one-third of facilities are already using HEPA filters to reduce emissions.

2. Composite Mesh Pad or Dry Scrubber

A Composite Mesh Pad (CMP) system typically consists of several layers of more than one monofilament diameter and/or interlocked fibers densely packed between two supporting grids. Most systems do exist in two or three stages to ensure collection of re-entrainment caused by washdown. A 3 stage system will remove small particles from one to 3 µm at about 99 percent efficiency. Each stage can capably remove particles at this size but it will take at least 3 stages to reach this efficiency. Filters must be changed every one to six years and need to be disposed of as hazardous waste (CDPHE, 1999 and U.S. EPA, 1998).

3. Wet Scrubber

A wet scrubber is similar to a CMP system, or Dry Scrubber, except that before the first stage of filtration, there is a water washdown of the influent mist in order to increase the size of the particles in the mist. In this system, a packing media is used to coalesce these larger particles and allow them to drip off into a reservoir at the bottom of the scrubber. This "packing" can best be described as a big bag of polypropylene "whiffle" balls.

4. Fiber-bed Mist Eliminator

A Fiber Bed Mist Eliminator (FBME) removes contaminants from a gas stream through the mechanisms of inertial impaction, direct interception, and Brownian diffusion. A FBME consists of one or more fiber beds and each bed consists of a hollow cylinder formed from two concentric screens designed for horizontal, concurrent gas liquid flow through the fiber bed. It is typically installed downstream from another control device to prevent plugging (CDPHE, 1999). The filter should last four to six years and needs to be disposed of as hazardous waste. According to our survey, this control technology is not widely used today in California.

5. Enclosed Tank Covers

For hard chromium plating and chromic acid anodizing facilities, devices are available to totally enclose the plating tank. These containers, sometimes referred to as Merlin hoods, form a sealed system to capture the hexavalent chromium emissions within the enclosed area. Gasses resulting from plating are vented through a semi-permeable membrane which allows the hydrogen and oxygen to exit, but, due to its size, the hexavalent chromium does not pass through. Two facilities reported using this technology. This technology would not be feasible for decorative chromium plating due to the short periods of time that plating actually occurs.

C. Alternative Processes

Numerous processes are available, that in some cases, could be used as a replacement for some hexavalent chromium plating and chromic acid anodizing operations. Some of these processes are briefly described below.

1. Trivalent Chromium for Decorative Chromium

Decorative chromium consists of coatings typically 0.003 to 2.5 µm to provide a bright surface with wear and tarnish resistance when plated over a nickel layer. It is used for plating, for example, automotive trim/bumpers, bath fixtures and small appliances. An option staff considered for this proposal is to phase out hexavalent chromium for decorative chromium plating facilities and replace it with the trivalent chromium process. This option would eliminate cancer risk from decorative chromium plating facilities because trivalent chromium is not considered a carcinogen; however, it is still a toxic compound.

Trivalent chromium baths are currently commercially available for decorative chromium plating. In 2003, there were 10 active trivalent chromium operations in California. Of these, six are stand alone trivalent chromium operations and four perform both hexavalent and trivalent chromium plating for decorative applications. The double cell process developed in the 1970's is improved and has been changed to a single cell process, which is easier to maintain. There are many benefits to using a trivalent chromium process as well as potential issues. These are presented in the following paragraphs. We also provide an example of costs associated with converting from the hexavalent chromium decorative plating process to the trivalent chromium process.

a. Benefits and Issues

The greatest benefit to using a trivalent chromium process is reduction in health risk. Trivalent chromium is not a carcinogen like hexavalent chromium. However, it has toxic effects. As such, it is a U.S. EPA HAP and is a TAC. In the Chromium Plating NESHAP and ATCM, emissions from trivalent chromium baths are regulated because of this designation. The health effects associated with trivalent chromium are summarized in Chapter II.

In addition to the reduction in toxicity, the trivalent chromium process also has other environmental advantages for the plating facility. The total chromium concentration in a trivalent chromium bath is significantly less than that of a hexavalent chromium bath. This leads to less wastewater and sludge, decreasing the hazardous waste cost for the facility. The misting and odor is greatly reduced compared to a hexavalent chromium bath, thereby protecting the worker. Trivalent chromium also has better throwing power[2] reducing the number of rejects as well as buffing and polishing of parts (P&SF, 2003a).

In addition to benefits, there are some potential issues with the trivalent chromium process. The first issue is the color. The newer baths produce a deposit much closer in color to the hexavalent chromium deposit. If a standard trivalent chromium plated part is placed more than a few inches away from a hexavalent chromium plated part, most consumers would not be able to distinguish between the two deposits. If it placed adjacent, manufacturers and consumers might prefer the hexavalent chromium deposit. (P&SF, 2003a). To keep the color consistent, the trivalent bath requires careful monitoring (Mikhael, 2006).

The second issue is thickness and corrosion resistance. Trivalent chromium can be plated thick enough for decorative purposes. Adhesion and cohesion are as good as hexavalent chromium deposits up to at least 1.4 µm (P&SF, 2003a). However, some industry representatives believe that for automotive applications, the trivalent deposit is not thick enough to meet the step test requirements (Leehy, 2006). The manufacturers are working on acceptance of a trivalent finish for the automotive industry and have successfully changed the requirements for one company (MacDermid, 2006). Corrosion protection is also an issue for automotive applications. Hexavalent chromium ions themselves offer some corrosion resistance for the plated substrate by "chromating" the part. To achieve the same affect for parts plated with trivalent chromium, post-treatments/dips after plating can be used to produce an equivalent short-term corrosion resistance (P&SF, 2003a). Also, trivalent chromium coatings are often deposited over nickel layers. The subsequent coating is said to exhibit corrosion resistance comparable

[2] Throwing power is the ability to deposit chromium into the intricate recesses of a particular part.

to hexavalent chromium when using ASTM B117 salt spray test or the CASS test [1] (AF, 2000). However, some industry representatives still believe the trivalent plated deposit is "too soft" (Lucas, 2006) and will scratch easily. For the end user corrosion resistance is reduced and there is no "self healing" benefit (AF, 2001.)

Cost is another factor to consider when switching from hexavalent to trivalent chromium. Most of the equipment used for hexavalent chromium plating can be re-used when converting to trivalent chromium. A new synthetic tank lining, graphite anodes, and titanium or teflon spaghetti coils should be added for heating and cooling.

One major manufacturer estimated the costs associated with converting to trivalent chromium plating. The costs are shown below in Table VI-3.

Table VI-3. Cost Estimate for Conversion to Trivalent Chromium

Operating Cost:	Cost	Cost for 800 Gallon Tank
Operating cost (1,000,000 amp-hr)	$0.023/amp-hr	$23,000
Equipment/Chemicals:		
Bath make-up	$11/gallon	$8,800
Graphite anode cost	$2.50/gallon	$2,000
Ion exchange system	$6,000 to $10,000	$10,000
Filter (for carbon)	$5,000 to $10,000	$10,000
Air lines	$500	$500
Heating/cooling coil (titanium)	$2,000	$2,000
Amp-hour meter/feeder	$1,200	$1,200
Tank Liner	$2,000 to $5,000	$5,000
Conversion to flowing rinse from Hexavalent pre-dip	$2,000	$2,000
Additional Rinse Tanks	varies	varies
Subtotal		$41,500
Hazardous Waste Disposal: **		
Chromic Acid Disposal	$4.35/gallon	$3,480
	Total	$67,980

Source: Atotech
**Cost estimate from Filter Recycling Services

Table VI-3 provides an estimate of the initial costs to convert from the hexavalent chromium process to the trivalent chromium process for a decorative plating facility with an 800 gallon plating tank and operating 1,000,000 ampere-hours per year. Of course, conversion costs would vary depending on an individual operation. A facility converting would have one-time equipment and chemical cost of about $41,500 and a chromic acid disposal cost (in this example, about $3,500). A facility would also have recurring operating costs of $23,000 plus additional chemical costs which would vary depending on the operation. A facility may have to install additional rinse tanks. This could lead to additional costs to accommodate this tank(s) within an existing plating line (Atotech, 2006). These costs should only be viewed as an example. An individual facility's conversion costs will also vary based on type of parts plated (substrate and configuration), ambient temperatures, bath loading, and racking.

Staff has evaluated information from manufacturers of the trivalent chromium process, relevant literature, information from facility operators currently using the trivalent chromium process, and operators that feel they are unable to use the trivalent chromium process. We believe that the trivalent chromium process holds promise for the future. However, at this time, the trivalent chromium process is not feasible to replace all hexavalent decorative chromium plating applications.

2. Trivalent Chromium for Hard Chrome Plating

Trivalent chromium baths have not been used for hard chromium plating. There is difficulty in plating thick chromium coatings with the appropriate properties. Hard chromium coatings are typically 1.3 to 760 µm and provide functional properties such as hardness, corrosion resistance, wear resistance, and low coefficient of friction. Example applications include strut and shock absorber rods, hydraulic cylinders, crankshafts, and industrial rolls.

There has been some recent research funded by the U.S. EPA on developing a process for hard trivalent chromium plating. The project is ongoing and a company is working on a trivalent chromium process for hard chromium plating (P&SF, 2003). This process is not commercially available.

3. Other Alternatives

A number of other alternative processes exist for some chromium plating and chromic acid anodizing applications. Some of the alternative processes include:

- Type II Sulfuric Acid Anodizing – often referred to as "regular," "architectural," or "sulfuric" anodizing. Sulfuric anodize is formed by using an electrolytic solution of sulfuric acid at room temperature. The process produces a fairly clear coating and is normally used for decorative purposes and provides some corrosion protection (IHC, 2006).

- Electroless Nickel Phosphorous – an auto-catalytic process that deposits a layer of nickel alloyed with the reducing agent, phosphorous. The deposit thickness is uniform and free of edge buildup because no current is used. Deposits are generally semi-bright. The properties include excellent wear, good corrosion resistance in many environmental, good lubricity, and improved hardness on many substrates (PMPC, 2006).

- Nickel-Tungsten Electroplating – an electrodeposited alloy of nickel and tungsten. The plated deposit exhibits physical and chemical properties similar to chromium and electroless nickel. The process is simple to control and can be operated in equipment similar to that used for hard chromium plating. A bright or dull finish is produced depending on the substrate (Enthone, 2006).

- Tin-Cobalt Alloy or Tin-Nickel Alloy – Tin-Cobalt alloy is usually plated over bright nickel and provides a finish with the appearance of chromium. It is durable and wear resistant (Seachrome, 2006). Tin-Nickel deposits can be used as an etch resist. It's most common use is a replacement for hexavalent chromium in decorative applications (RPC, 2006).

REFERENCES

AF, 2000. Automotive Finishing. BA Graves. Alternatives to Hexavalent Chromium and Chromium Plating. Winter 2000:

AF, 2001. Automotive Finishing. PC Wynn, CV Bishop. Replacing Hexavalent Chromium Plating. Spring, 2001:

ARB, 1997a. Air Resources Board. "Senate Bill (SB) 1731 Risk Reduction Audits and Plans Guidelines for Chrome Electroplating Facilities". 1997

Atotech, 2006. Paul Cartwright. Email to ARB staff regarding cost comparisons between trivalent and hexavalent chromium electroplating systems. 2006.

Bayer ®. Product information Bayowet® FT 248 and FT 248R

CDPHE, 1999. Colorado Department of Public Health and Environment. Chromium Maximum Achievable Control Technology (MACT) guidance. Updated April 21, 1999. (http://www.cdphe.state.co.us/ap/chromium/html/index.html)

Enthone, 2006. Cookson Electronics: Enthone. ENLOY® Ni-500. 2006. (http://www.enthone.com/functional/index.aspx?Detail=../uc/enloy-ni-500.ascx)

Hensley, 1997. JE Hensley and D York. "Report on Observed Differences in Dynes/Centimeter Readings of Various Chromium MACT Method 306B Surface Tension Measuring Devices". presented at the 18th AESF/EPA Pollution Prevention & Control Conference. 1997.

HHS, 2000. U.S. Department of Health and Human Services. "Primary Containment for Biohazards: Selection, Installation and Use of Biological Safety Cabinets". 2000

IHC, 2006. IHC, Inc. Sulfuric Anodizing. 2006. (http://www.ihccorp.com/IHC-Sulf_Anod.htm)

Jones, 2006. Jones, A.R., Email Communication dated April 17, 2006.

JPCB, 1999. Journal of Physical Chemistry B. K Wang, G Karlsson and M Almgren. Aggregation Behavior of Cationic Fluorosurfactants in Water and Salt Solutions. A CryoTEM Survey. 103, 9237-9246. 1999

Kissa E, 1994. "Fluorinated Surfactants". Chapter 4, Marcel Dekker, Inc. 1994

Leehy, 2006. Air Resources Board staff telephone conversation with David Leehy, Grover Products. 2006.

Lucas, 2006. Ray Lucas. Email to ARB staff regarding feasibility of trivalent as an alternative to hexavalent chromium plating. 2006

MacDermid, 2006. Air Resources Board staff telephone conversation with Ken Kraemer of MacDermid. 2006

Mikhael, 2006. Air Resources Board staff telephone conversation with Fiyador Mikhael, Bronzeway Plating. 2006

P&SF, 2000. Plating and Surface Finishing. TD Ferguson, M Zellen, D Brennan and J Lutz. Use of Fume Suppressants in Hard Chromium Baths—Quality Testing. February 2000:67-72.

P&SF, 2003a. Plating & Surface Finishing. DL Snyder. Distinguishing Trivalent Chromium Deposits by Color. November 2003:34-39

P&SF, 2003b. Plating and Surface Finishing. RP Renz, JJ Fortman, EJ Taylor and ME Inman. Electrically Mediated Process for Functional Trivalent Chromium to Replace Hexavalent Chromium: Scale-up for Manufacturing Insertion. June 2003:52-58

PMPC, 2006. Precious Metals Plating Company, Inc. Electroless Nickel. 2006. (http://www.pmplating.com/electroless%20nickel.htm)

RPC, 2006. Reliable Plating Corporation. Tin/Nickel Plating. 2006. (http://www.reliableplating.com/tinnickel.html)

Seachrome, 2006. Seaboard Metal Finishing. Seachrome. 2006. (http://www.seaboardmetalfin.com/schrome.htm)

U.S. EPA, 1993. U.S. Environmental Protection Agency. EPA/453/R-93-030a: "Chromium Emissions from Chromium Electroplating and Chromic Acid Anodizing Operations - Background Information for Proposed Standards". 1993.

U.S. EPA, 1998. U.S. Environmental Protection Agency. EPA/625/R-98/002: "Capsule Report Hard Chrome Fume Suppressants and Control Technologies". 1998.

U.S. EPA, 2002. U.S. Environmental Protection Agency. "National Emission Standards for Chromium Emissions From Hard and Decorative Chromium Electroplating and Chromium Anodizing Tanks". 2002.

U.S. EPA, 2004. U.S. Environmental Protection Agency. 40 CFR Part 63: "National Emission Standards for Chromium Emissions From Hard and Decorative Chromium Electroplating and Chromium Anodizing Tanks". 2004.

U.S. EPA, 2006. U.S. Environmental Protection Agency. 40 CFR Part 721: "Perfluoroalkyl Sulfonates; Proposed Significant New Use Rule." 2006.

VII. Health Risk Assessment

This Chapter presents an overview of the health risk assessment (HRA) process that forms the basis for the proposed amendments to the Chromium Plating ATCM. The air quality modeling necessary to conduct the HRA is also summarized. Current cancer and non-cancer health impacts from exposure to hexavalent chromium from chromium plating and chromic acid anodizing operations is also included.

A. Overview

A health risk assessment (HRA) is an evaluation or report that a risk assessor (e.g., ARB, district, consultant, or facility operator) develops to describe the potential a person or population may have of developing adverse health effects from exposure to a facility's emissions. Some health effects that are evaluated include cancer, developmental effects, and respiratory illness. For hexavalent chromium, we evaluated the cancer and non-cancer health impacts and found that the cancer health impacts were far more significant than any non-cancer impacts. Therefore, the following sections focus on the cancer risk assessment. Section E contains a discussion of non-cancer health impacts.

Exposure to TACs can occur through pathways that include inhalation, skin exposure, and the ingestion of soil, water, crops, fish, meat, milk, and eggs. OEHHA has determined that hexavalent chromium is carcinogenic by the inhalation route only (OEHHA, 2003) and does not recommend using a mulitpathway methodology. The methods used in this risk assessment are consistent with the Tier 1 analysis described in the OEHHA Air Toxics "Hot Spots" Program Risk Assessment Guidelines, the Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments (OEHHA, 2003).

B. Health Risk Assessment Process

The following sections describe the steps in the HRA process and the resulting health risk estimates for chromium plating and chromic acid anodizing facilities .

1. <u>Hazard Identification</u>

Step one for the risk assessor is to determine whether a hazard exists. If so, the assessor identifies the pollutant(s) and the type of effect, such as cancer or respiratory effects. In this case, we have determined that hexavalent chromium is emitted from chromium plating and chromic acid anodizing facilities. In 1986, the Board formally identified hexavalent chromium as a TAC.

The Board determined that hexavalent chromium exposure causes cancer and there was no safe level of exposure where adverse health effects would not occur. When the Board identified hexavalent chromium as a TAC, a unit risk factor of 1.5 X 10^{-1} µg/m^3 was established in support of the identification. This means that a lifetime exposure to one µg/m^3 of hexavalent chromium would increase an exposed person's chance of developing cancer by about 15 percent. Exposure to hexavalent chromium is known to cause lung and nasal cancers, respiratory irritation, severe nasal and skin ulcerations and lesions, perforation in the nasal septum, liver and kidney failure and birth defects (ARB, 1985). Hexavalent chromium is also classified as a human carcinogen by the International Agency for Research on Cancer (IARC, 1997).

2. Dose-Response Assessment

The second step of risk assessment is for the risk assessor to characterize the relationship between a person's exposure to a pollutant and the incidence or occurrence of an adverse health effect. This step of the HRA is performed by OEHHA. OEHHA supplies these dose-response relationships in the form of cancer potency factors (CPF) and reference exposure levels (RELs.) A CPF is used when estimating potential cancer risks and RELs are used to assess potential non-cancer health impacts (OEHHA, 1999; OEHHA, 2002; OEHHA, 2003).

Cancer potency factors are the upper bound probability of developing cancer, assuming continuous lifetime exposure to a substance at a dose of one milligram per kilogram of body weight. To compare the potency of hexavalent chromium with other carcinogens, Table VII-1 lists cancer potency factors for various TACs.

Table VII-1. Inhalation Cancer Potency Factors for Common Carcinogens and Their Relative Potency to Hexavalent Chromium

Compound (in descending order)	Cancer Potency Factor $(mg/kg\text{-}day)^{-1}$	Relative Potency to Hexavalent Chromium
Dioxin	$1.3 \times 10^{+5}$	250
Hexavalent Chromium	$5.1 \times 10^{+2}$	1
Cadmium	$1.5 \times 10^{+1}$	.029
Arsenic (inorganic)	$1.2 \times 10^{+1}$	.024
Diesel Exhaust	1.1×10	.0022
Nickel	9.1×10^{-1}	.0018
Benzene	1.0×10^{-1}	.0002
Ethylene Dichloride	7.2×10^{-2}	.00014
Lead	4.2×10^{-2}	.000082
Formaldehyde	2.1×10^{-2}	.000041
Perchloroethylene	2.1×10^{-2}	.000041
Chloroform	1.9×10^{-2}	.000037
Acetaldehyde	1.0×10^{-2}	.000020
Trichloroethylene	7.0×10^{-3}	.000014
Methylene Chloride	3.5×10^{-2}	.000069

(OEHHA, 2003)

As shown in Table VII-1, only one other chemical, dioxin, has a higher potential to cause cancer than does hexavalent chromium.

An REL is used as an indicator of potential non-cancer adverse health effects, and is defined as a concentration level at or below which no adverse health effects are expected. RELs are designed to protect the most sensitive persons in the population by including safety factors in their development, and can be created for both acute and chronic exposures. An acute exposure is defined as one or a series of short-term exposures generally lasting less than 24 hours. Chronic exposure is defined as long-term exposure usually lasting from one year to a lifetime. Table VII-2 contains non-cancer RELs and toxicological endpoints for hexavalent chromium.

Table VII-2. Hexavalent Chromium Health Effects Values Used in Non-Cancer Health Risk Assessment

	Non-Cancer Reference Exposure Levels (RELs)	Toxicological Endpoints
Chronic – Inhalation	0.20 ($\mu g/m^3$)	Respiratory system
Chronic – Oral	0.02 (mg/kg-day)	Hematologic

*OEHHA 2003

As shown in Table VII-2, only non-cancer chronic RELs have been determined for hexavalent chromium. There is no non-cancer acute REL. Non-cancer impacts linked to hexavalent chromium exposure include respiratory irritation, severe nasal and skin ulcerations and lesions, perforation in the nasal septum, liver and kidney failure and birth defects (ARB, 1985).

3. Exposure Assessment

In an exposure assessment, step 3, the risk assessor estimates the extent of public exposure by determining people who will likely to be exposed, how exposure will occur (e.g., inhalation and ingestion), and the magnitude of exposure. For chromium plating and chromic acid anodizing facilities, the receptors (people) that are likely to be exposed are residents and off-site workers located near the facility. For this assessment, we focused on residential and off-site worker exposures.

Although on-site workers could be impacted by the emissions, they are not the focus of this HRA because the OSHA has jurisdiction over on-site workers. To protect worker safety, OSHA has established a PEL for hexavalent chromium of 5 $\mu g/m^3$. The PEL is the maximum, eight hour, time-weighted average concentration for occupational exposure. Because the proposed amendments to the ATCM will require the installation of ventilation systems and add-on air pollution control devices for many additional chromium plating and chromic acid anodizing facilities, on site-worker exposure to hexavalent chromium at the affected facilities would be reduced as well.

Hexavalent chromium is considered to be carcinogenic only when exposure occurs by the inhalation route (OEHHA, 2003.) Therefore, residential and off-site worker locations were evaluated via the inhalation pathway only.

One of the most reliable and cost-effective tools used by ARB staff to evaluate public exposures to a pollutant is to conduct air dispersion modeling simulations. The following sections summarize the air dispersion modeling conducted to evaluate the health impacts from exposure to hexavalent chromium. Further detail on the modeling simulations and the input parameters is contained in Appendix H of this report.

a. Air Dispersion Modeling

To assess the magnitude of exposure, ARB staff used a computerized air dispersion model to estimate downwind ground-level concentrations of hexavalent chromium at near source locations after it is emitted from a chromium plating or chromic acid anodizing facility. The downwind concentration is a function of the quantity of emissions, release parameters at the source, and appropriate meteorological conditions. ARB used the U.S. EPA's Industrial Source Complex Short Term (Version 02035) air dispersion model (ISCST3 model). The ISCST3 model estimates concentrations at specific locations around each facility, directly caused by each facility's emissions. The modeling inputs used are summarized below.

b. Emission Estimates

Modeled concentrations are based on unit emission rates and can be adjusted to reflect any emission rate scenario. Therefore, emissions of hexavalent chromium from chromium plating and chromic acid anodizing facilities for this modeling analysis were based on an unit emission rate of one gram per second. The mass emission estimates in the model are then scaled down to reflect emissions from each chromium plating and chromic acid anodizing facility. Thus, the modeling simulation does not "grow" an individual facility's emissions. By scaling the modeled concentrations we are able to determine how each facility's emissions are dispersed into ambient air and the resulting concentrations at various distances from the facility. For this analysis staff assumed an operating schedule of 9 hours per day, 7 days per week, 52 weeks per year.

c. Meteorological Data

Four sets of meteorological data representing various locations in California were used for this HRA. The data selected are representative of where the majority of chromium plating and chromic acid anodizing facilities are located. The four locations, and the years the meteorological data represented are Los Angeles area – Pasadena (1981), San Francisco Bay area – Oakland (1960-64), San Diego area –Inland (1967-71), Central Valley – Fresno (1985-89).

d. Physical Description of the Source and Emission Release Parameters

Six generic chromium plating and chromic acid anodizing facilities were modeled. These generic facilities were created from survey information, source test reports, and information obtained during site visits from ARB or district staff. Therefore, they are representative of the facilities in California. The modeling simulation predicted airborne concentrations of hexavalent chromium for potential receptor distances that ranged from 20 to 1,000 meters (66 – 3,280 feet) from the chromium plating and chromic acid anodizing facilities. The assumptions used for modeling emissions from generic facilities are shown in Table VII-3 and Table VII-4.

Table VII-3. Key Parameters for Air Dispersion Modeling and Health Risk Assessment

Air Dispersion Model:	U.S. EPA, Industrial Source Complex Short Term (ISCST3), Version 02035
Source Type:	Volume and Point
Dispersion Setting:	Urban
Receptor Height:	1.2 meters
Meteorological Data:	Los Angeles area - Pasadena San Francisco Bay area - Oakland San Diego area - Miramar Naval Air Station Central Valley - Fresno
Receptor's Hypothetical Exposure Time:	70 years, 365 days/year
Adult Daily Breathing Rates:	393 liters/kg body weight-day (high-end) 302 liters/kg body weight-day (80th percentile) 271 liters/kg body weight-day (mean)
Adult Body Weight:	70 kg
Cancer Inhalation Potency Factors:	Hexavalent Chromium – 510 $(mg/kg\text{-}day)^{-1}$
Non-Cancer Acute RELs – Inhalation:	Hexavalent Chromium – not established
Non-Cancer Chronic RELs – Inhalation:	Hexavalent Chromium – 0.20 ug/m^3
Non-Cancer Chronic RELs - Oral:	Hexavalent Chromium – 0.02 mg/kg-day

Table VII-4. Generic Facility Parameters for Air Dispersion Modeling and Health Risk Assessment

Stack Information (Point Sources):	
Stack Diameters	0.32, 0.66, and 0.92 meters
Stack Heights	9.1, 9.1, and 12.8 meters
Stack Temperatures	24 degrees Celsius
Stack Exhaust Velocities	10.4, 12.2, and 8.5 meters/second
Volume Source Parameters:	
Release Height	2.5 meters (ground level)
Lateral Dimension	2.3, 4.0, and 7.0 meters
Vertical Dimension	2.3 meters

Point sources are facilities that already use add-on air pollution control devices with forced ventilation systems to collect hexavalent chromium emissions. Exhaust air containing any uncollected hexavalent chromium is then vented through a stack. Table VII-4 shows the various stack parameters used in the modeling. Note that emissions are modeled from the stack, and the stack is assumed to be in the center of the building. A typical point source would be a hard chromium plating facility.

Volume sources are facilities that use only in-tank controls (*i.e.* chemical fume suppressants) to reduce hexavalent chromium emissions. Table VII-4 also shows the release parameters of the facilities that were used in the modeling. In this case, the source of emissions (the tank) is assumed to be in the center of the building and the emissions are modeled from that point. A typical volume source would be a decorative chromium plating facility.

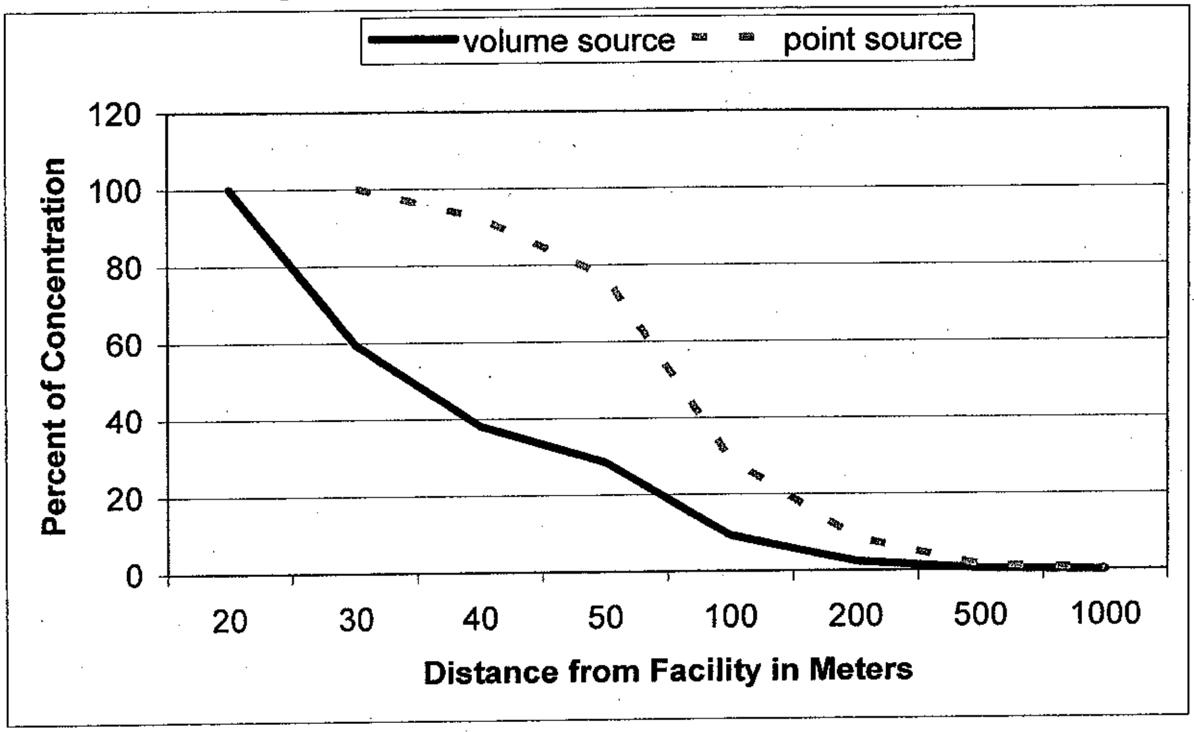
e. Pollutant Specific Health Effects Values

Dose-response or pollutant-specific health values are developed to characterize the relationship between a person's exposure to a pollutant and the incidence or occurrence of an adverse health effect. A CPF is used when estimating potential cancer risks and a REL is used to assess potential non-cancer health impacts. For ease of the reader, the current OEHHA-adopted health effects values for hexavalent chromium are repeated in Table VII-3. Note that the cancer inhalation potency factor is 510 (milligrams/kilogram-day)$^{-1}$.

Through computerized modeling simulations and using the inputs listed in Tables VII-3 and VII-4, ARB staff can estimate how concentrations of hexavalent chromium are dispersed and diluted into ambient air. These data are then used to determine health impacts from chromium plating and chromic acid anodizing facilities.

Figure VII-1 depicts how concentrations of hexavalent chromium are reduced as they are dispersed from the facility. The meteorological data used are from Pasadena.

<u>Figure VII-1</u>. Percent of Maximum Predicted Concentration of Hexavalent Chromium at Increasing Distances from the Source *



* Concentrations using Pasadena meteorological data set and small facility.

Figure VII-1 shows that concentrations of hexavalent chromium decrease rapidly as they are dispersed from a facility. For volume sources (facilities without add-on air pollution control devices), at 100 meters the concentration is reduced to 9 percent of the concentration at 20 meters. For point sources (facilities with add-on air pollution control devices), at 100 meters the concentration is reduced to about 30 percent of the concentration at 30 meters. Note also that at 150 meters the concentration from the point source has been reduced to about 20 percent of the initial concentration.

Because of the model's resolution, for volume sources a receptor is placed at 20 meters from the edge of the building. This is assumed to be the point of highest concentration, or as depicted in Figure VII-1,100 percent. While it is true that the concentration of hexavalent chromium would be higher at ten meters from the edge of the building, the model has not been validated to provide an accurate concentration at a distance less than 20 meters. For the modeled emissions from a small point source, the maximum concentration of hexavalent chromium is 30 meters from the edge of the building. This distance is the point of highest concentration, or 100 percent. Although not shown, a larger point source with a higher stack would have the highest concentration of hexavalent chromium at a distance of 50 meters from the source.

These data indicate that emissions from chromium plating and chromic acid anodizing facilities are localized and cancer risk is highest for near-source receptors.

4. Risk Characterization

To characterize the health risk, the risk assessor combines information derived from the previous steps. Modeled pollutant concentrations from the exposure assessment are combined with the CPFs (for cancer risk) and RELs (for non cancer effects) derived from the dose-response assessment. Risk characterization integrates this information to quantify the potential cancer risk and non-cancer health effects.

For our assessment, Table VII-5 displays the parameters used to calculate both cancer and non-cancer health impacts.

Table VII-5. Key Parameters for Assessing Estimated Cancer and Non-Cancer Health Impacts for Chromium Plating and Chromic Acid Anodizing Facilities

	Point Source	Volume Source
Exposure	Residential	Residential
Breathing Rate	80th percentile (302 l/kg)	80th percentile (302 l/kg)
Meteorological data set	Pasadena	Pasadena
Operating Schedule	9 hrs/day, 7 days/week	9 hrs/day, 7 days/week
Facility Size	Small (≤5,000,000 ampere/hrs) Medium (> 5,000,000 ≤50,000,000 ampere/hrs) Large (>50,000,000 ampere/hrs)	Small (3,000 ft^2)
Maximum Individual Cancer Risk (MICR) Distance	30 meters for small, 40 meter for medium, 50 meters for large	20 meters
Release Height	9.1 meters (stack height) for small and medium 12.8 meters for large	2.5 meters (ground level)

Baseline emissions (2005) of hexavalent chromium for assessing cancer and non-cancer impacts from each facility were calculated by multiplying reported throughput (in ampere-hours) by the facility's emission rate. For volume source facilities in the SCAQMD, we used the emission rate for their certified chemical fume suppressants of 0.01 milligrams/ampere-hour. All other volume sources in the State were assigned a chemical fume suppressant emission rate of 0.04 milligrams/ampere-hour. This is consistent with results from our emissions testing program. For point sources, when source test data were available, the reported emission rate was used. For other point source facilities, emission rates were assigned based on regulatory requirements.

Based on these assumptions, statewide baseline hexavalent chromium emissions for 2005 were estimated to be four pounds per year.

C. Factors that Affect Health Risk Assessments

The results of an HRA include an evaluation of potential adverse health impacts from exposure to a TAC. It is a complex process that requires the analysis of many variables to simulate real-world situations. For our purposes, we conducted health risk assessment analyses in a manner which is very health protective in estimating cancer risks for a range of reasonably foreseeable exposure scenarios. A recent study, funded by ARB, indicted that the model employed in this analysis may actually under-predict near-source concentrations (UCR, 2003). Staff believe this health protective approach is necessary due to the very high potency and resultant serious health hazards associated with exposure to hexavalent chromium emissions. There are a variety of factors that can affect the results of the HRA for chromium plating and chromic acid anodizing facilities. These include:

- Toxicity of hexavalent chromium;
- Emission rate of hexavalent chromium from the facility in milligrams/ampere-hour;
- Source release characteristics (e.g., height of stack, stack configuration, flow rate, and building dimensions);
- Facility operating schedule (duration of exposure);
- Local meteorological conditions;
- Distance to the receptor;
- Duration of exposure; and
- Inhalation rate of the receptor.

A combination of these factors will determine the potential health impacts. Due to the variability of these factors, the potential health impacts can also vary. For example, if the inhalation rate of the receptor were to increase (we have assumed the 80th percentile breathing rate), and all other factors were held constant, the resulting potential health impacts would also increase. The estimated cancer risks presented are representative of the maximum individual cancer risk (MICR). This implies calculation of a cancer risk where the concentration of hexavalent chromium is at its maximum upon being emitted from a facility. There may or may not be a receptor at this location.

D. Cancer Risk Assessment

While the 4.0 pounds (1,800 grams) per year of emissions seems low, even a very small amount of hexavalent chromium can result in a substantial cancer risk. For example, staff found that as little as two grams of annual emissions would yield an estimated cancer risk of ten per million people exposed. As shown in Table VII-6, the maximum individual cancer risk (MICR) was determined for each chromium plating and chromic acid anodizing facility in California based on these 4.0 pounds of emissions. It should be noted that the MICR is calculated using the highest concentration of hexavalent chromium downwind of a facility that is predicted by an air quality model. People may not be living at the MICR point. Table VII-6 reflects implementation of the current ATCM and air district rules, including Rule 1469 for facilities in the South Coast Air Basin.

Table VII-6. Sixty-three Facilities have Estimated Cancer Risk of Over 10 per Million Exposed People (2005 Baseline)

Number of Facilities by Cancer Risk

	≤1 per million	>1 ≤10 per million	>10 ≤100 per million	>100 per million
Baseline 2005	90	67	57	6

As shown in Table VII-6, 90 facilities (about 41 percent) have estimated cancer risk less than one per million exposed people. However, Table VII-6 also shows that 57 facilities (about 26 percent) have an estimated cancer risk of over ten per million exposed people. Six facilities (about 3 percent) may have an estimated cancer risk of over 100 per million people exposed.

Implementation of Rule 1469 in the South Coast Air Basin provided an improvement in cancer risk reduction for facilities located there. In 2003, we estimate that 30 percent of facilities had estimated cancer risk of less than one per million exposed people. Overall, about 55 percent of facilities had estimated cancer risks below ten per million exposed people. Eleven percent of facilities had estimated cancer risk of over 100 per million people exposed. These data are not shown graphically.

Based on these results staff has determined that while Rule 1469 reductions provided risk reduction benefits in the SCAQMD it had no impact in reducing cancer risk in other areas of the State. We also believe Rule 1469 did not achieve the maximum reduction feasible because BACT was not required for all facilities. The staff's proposal to reduce the cancer risk from chromium plating and chromic acid anodizing facilities is described in Chapter VIII.

E. Non-Cancer Risk Assessment

Non-cancer impacts linked to hexavalent chromium exposure include respiratory irritation, severe nasal and skin ulcerations and lesions, perforation in the nasal septum, liver and kidney failure, and birth defects (ARB, 1985). We performed a non-cancer risk assessment to evaluate potential non-cancer health impacts based on 2005 emissions. This year reflects implementation of Rule 1469 in the South Coast Air Basin. The assessment included potential impacts from long-term (chronic) exposures. Potential chronic and acute health impacts are expressed in terms of a hazard quotient (for a single substance.) Typically, a hazard quotient or hazard index that is greater than 1.0 is considered to be unacceptable. The parameters that were used to model emissions and estimate cancer risk are contained in Tables VII-3, VII-4, and VII-5.

The analysis indicated that no facility's hazard index exceeded 1.0 for either worker or residential exposure scenarios. In fact, no facility's hazard index exceeded 0.01. Therefore, staff has concluded that no additional measures would be necessary to reduce potential chronic non-cancer impacts related to long-term exposure to hexavalent chromium from chromium plating and chromic acid anodizing facilities.

We also analyzed the throughput threshold, in ampere-hours, that could result in a hazard index of 1.0. If we evaluate the hazard index for a generic facility and assume ampere-hours of 100,000,000 (higher than any facility's throughput in the State) and use the assumed emission rate of 0.0015 milligrams/ampere-hour (HEPA level of control), ampere-hours would have to increase 100-fold to reach a hazard index of 1.0.

REFERENCES

ARB, 1985. Air Resources Board. "Staff Report: Initial Statement of Reasons for Proposed Rulemaking – Identification of Hexavalent Chromium as a Toxic Air Contaminant". 1985.

IARC, 1997. World Health Organization – International Agency for Research on Cancer. Volume 49: "Chromium, Nickel and Welding, Summary of Data Reported and Evaluation". 1997.

OEHHA, 1999. Office of Environmental Health Hazard Assessment. "Air Toxics Hot Spots Program Risk Assessment Guidelines, Part I, The Determination of Acute Reference Exposure Levels for Airborne Toxicants". 1999.

OEHHA, 2002. Office of Environmental Health Hazard Assessment. "Air Toxics Hot Spots Program Risk Assessment Guidelines, Part II, Technical Support Document for Describing Available Cancer Potency Factors". 2002.

OEHHA, 2003. Office of Environmental Health Hazard Assessment. "Air Toxics Hot Spots Program Risk Assessment Guidelines, The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments". 2003.

UCR, 2003. Department of Mechanical Engineering, University of California, Riverside. "Draft Final Report: Validation of Concentrations Estimated from Air Dispersion Modeling for Source-Receptor Distances of less than 100 Meters". 2003.

VIII. Proposed Risk Reduction Approach and Benefits

Despite significant reductions in hexavalent chromium emissions, the cancer risks for some chromium plating and chromic acid anodizing facilities is still unacceptably high. This is largely due to the potent carcinogenicity of hexavalent chromium. As little as two grams of annual emissions can elevate the estimated cancer risk to ten per million exposed people. The location of many of the facilities also indicates that some low income and ethnically diverse communities in the State are disproportionately impacted by the emissions. This is of special concern given that 43 percent of facilities are located within100 meters of people. These factors compel staff to evaluate emission reduction scenarios that minimize or eliminate the cancer risks.

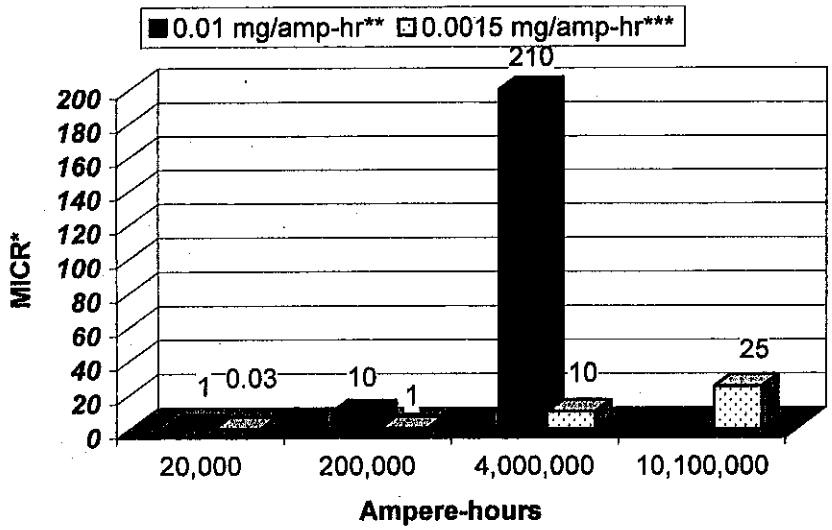
As described in Chapter VI, staff has evaluated various alternative processes for hexavalent chromium plating and chromic acid anodizing to determine if cancer risk could be eliminated. While alternatives exist for some applications, their use is limited. Thus, we conclude that alternative technologies are not available to require a phase-out of the hexavalent chromium process at this time. However, our analysis also shows that effective emission reduction alternatives are readily available and these approaches minimize the cancer risk to the extent technology allows.

A. Best Available Control Technology

Staff has evaluated BACT for chromium plating and chromic acid anodizing facilities. We also have evaluated the effectiveness of chemical fume suppressants through our emissions testing program. We have determined that add-on air pollution control devices with the final capture device being high efficiency particulate arrestor (HEPA) filters represents BACT for larger facilities, while use of chemical fume suppressants represents BACT for very small facilities. As described in Chapter VI, HEPA filters are rated at 99.97 percent efficient for collecting particles of 0.3 micrometers in diameter. Use of BACT for larger facilities would reduce hexavalent chromium emissions to no more than 0.0015 milligrams/ampere-hour. There is ample evidence to demonstrate that this is an effective method to reduce cancer risk. HEPA filter technology is already used in over 30 percent of the facilities to reduce hexavalent chromium emissions. In fact, we are aware that facilities currently using various combinations of controls, including HEPA filters, have emission rates lower than 0.0015 milligrams/ampere-hour.

By establishing this level of control, staff has found that emissions, and therefore cancer risk, can be minimized. This level of control is 85 percent more effective than the emission reductions achieved through use of chemical fume suppressants that have been shown to reduce emissions to no more than 0.01 milligrams/ampere-hour.
Figure VIII-1 shows graphically the effectiveness of HEPA filters compared to chemical fume suppressants.

Figure VIII-1. Comparison of Cancer Risks (MICR) Remaining After Application of Controls at Various Throughputs *



* Results are for the inhalation pathway and calculated for a residential receptor with a 70-year exposure duration, 80th percentile daily breathing rate and Pasadena meteorological data set

** Emission rate of a chemical fume suppressant (emission rate 0.01 mg/amp-hr) modeled using a small volume source

*** Emission rate of a HEPA filtering system, (emission rate of 0.0015 mg/amp-hr) modeled using a small point source

Figure VIII-1 shows various throughputs and compares the estimated MICRs resulting if emissions are reduced using chemical fume suppressants and by using HEPA filters or equivalent controls. Note that a facility using a chemical fume suppressant with throughput of 20,000 ampere-hours per year would pose a cancer risk of no more than one per million exposed people. This is based on the maximum exposed individual, which for volume sources is at 20 meters. At this risk level, chemical fume suppressants represent BACT.

A facility using a chemical fume suppressant and operating 200,000 ampere-hours per year poses a cancer risk of ten per million exposed people. However, when BACT for intermediate and larger-sized facilities is used, estimated cancer risk is reduced to less than one per million exposed persons. HEPA filters or equivalent controls meeting the 0.0015 milligrams/ampere-hour limit represents BACT.

Figure VIII-1 also shows that a facility with throughput of 4.0 million ampere-hours would have an estimated cancer risk of 200 per million exposed persons if emissions were controlled with chemical fume suppressants alone. However, if BACT is used, cancer risk would be reduced to ten per million exposed people.

Finally, Figure VIII-1 shows that once a facility's throughput exceeds 10.0 million ampere-hours, even after application of BACT, estimated cancer risk is greater than 25 per million exposed persons. This indicates that other risk reduction measures may be necessary for some facilities.

B. Emissions and Cancer Risk Reduction Benefits

Staff is proposing to amend the Chromium Plating ATCM by phasing in BACT. The timing for the application of BACT would be related to throughput and proximity to sensitive receptors. BACT for very small facilities would be defined as use of chemical fume suppressants.

The proposed amendments to the Chromium Plating ATCM are found in Appendix A to this report and are described in plain English in Chapter IX. As described below, staff estimates that by adopting this proposal estimated cancer risk from hexavalent chromium emissions could be reduced by up to 85 percent.

Very low throughput (less than 20,000 ampere-hours per year) facilities would be allowed to reduce hexavalent chromium emissions through use of specified chemical fume suppressants to lower surface tension of the plating or anodizing bath. This has been determined to be BACT for these facilities. Using specified chemical fume suppressants to lower surface tension reduces hexavalent chromium emissions to 0.01 milligrams/ampere-hour. Remaining cancer risk for these facilities would be no more than one per million exposed people.

Application of BACT for all other facilities would require use of control technologies rated at 99.97 percent efficient for collecting particles of 0.3 micrometers in diameter. This is the control efficiency achieved through installation of a HEPA filter add-on air pollution control device. The emission limitation equivalent to this level of control would be 0.0015 milligrams/ampere-hour.

Intermediate-sized facilities (greater than 20,000 but less than 200,000 ampere-hours per year) would have five years to comply with the emission limitation if the facility is located more than 100 meters from a sensitive receptor. This would allow some small businesses more time to secure the necessary capital to purchase the needed equipment. To provide earlier protection for sensitive receptors, other intermediate-sized facilities located at or within 100 meters of a sensitive receptor would be required to meet the emission limitation in two years.

Industry representatives have indicated that combinations of in-tank controls such as chemical fume suppressants and polyballs may, in some cases, be able to reduce emissions to no more than 0.0015 milligrams/ampere-hour. Therefore, all intermediate-sized facilities would be given the option to demonstrate compliance with the emission limitation without installation of add-on air pollution control devices. This proposal could reduce compliance costs for some small businesses. However, performance testing would be required to demonstrate compliance. After full implementation, all intermediate-sized facilities would have remaining cancer risk of no more than two per million exposed people.

The largest facilities (more than 200,000 ampere-hours per year) would be required to comply with the emission limitation of 0.0015 milligrams/ampere-hour within two years using an add-on air pollution control device(s). Remaining cancer risk for these facilities would range from ten to no more than 61 per million exposed people. However, facilities with remaining cancer risk over 25 per million exposed people, would be required to conduct a refined assessment of their facility's risk to determine if further risk reduction measures would be necessary.

Table VIII-1 below shows how excess cancer risk would be reduced beyond the risk reduction achieved by implementation of the current ATCM and air district rules.

Table VIII-1. Adoption of Staff's Proposal Significantly Reduces the Estimated Cancer Risk from Hexavalent Chromium Emissions

Number of Facilities by Cancer Risk

	≤1 per million	>1 ≤10 per million	>10 ≤100 per million	>100 per million
Staff Proposal	162	41	17	0
Baseline	90	67	57	6

As shown in Table VIII-1, by adopting the staff's proposal about 162 facilities (74 percent) would have remaining cancer risk of no more than one per million exposed persons. This represents an additional 72 facilities compared to the baseline. Only 17 facilities (about 8 percent) would have estimated cancer risk of over ten per million exposed people. No facilities would have cancer risk exceeding 100 per million exposed people. Under the staff's proposal each facility with residual cancer risk over 25 per million exposed people would need to do a site specific analysis to determine if further control measures are needed. Total hexavalent chromium emissions from all chromium plating and chromic acid anodizing facilities would decrease, by 55 percent, to 1.8 pounds per year.

Off-site worker cancer risks were also evaluated. Table VIII-2 shows the remaining cancer risk for exposed off-site workers if the staff's proposal were to be adopted.

Table VIII-2. Adoption of Staff's Proposal Significantly Reduces the Estimated Cancer Risk from Hexavalent Chromium Emissions for Off-Site Workers

Number of Facilities by Cancer Risk

	≤1 per million	>1 ≤10 per million	>10 ≤100 per million	>100 per million
Staff Proposal	203	14	3	0
Baseline	113	70	36	1

In addition to reducing cancer risk for everyone living near hexavalent chromium and chromic acid anodizing facilities, as shown in Table VIII-2, the proposal would also provide health benefits for off-site workers. As shown, 92 percent or 203 facilities would have cancer risk of no more than one per million exposed off-site workers. This is an additional 90 facilities compared to the 2005 baseline.

These estimates of cancer risk remaining after implementation of the staff's proposal could be either higher or lower. Factors such as meteorology and release characteristics of a facility could change the outcome. Additionally, the cancer risk estimates are based on a fixed distance, and a facility may or may not have a receptor at that location. If a receptor were located less than 20 meters from a facility, their cancer risk could be higher. If a receptor were located more than 20 meters from a facility, their cancer risk could be lower. Twenty meters is the minimum air dispersion modeling distance used by the ARB in the Air Toxics Program.

C. Other Aspects of the Staff's Proposal

Another goal of the amendments is to ensure that new facilities are isolated from sensitive receptors. As discussed previously, we have learned that emissions of hexavalent chromium have the greatest impact on people living near chromium plating and chromic acid anodizing facilities. Our data show that 43 percent of the chromium plating and chromic acid anodizing facilities are located within 100 meters of a sensitive receptor. To prevent future situations such as this, staff is proposing that any new chromium plating or chromic acid anodizing facility not be allowed to operate in an area zoned residential or mixed use or within 150 meters of an area zoned residential or mixed use. At this distance, 150 meters, (~500 feet), modeling for point sources shows that the hexavalent chromium concentration has dropped off by about 80 percent.

Nevertheless, staff is also proposing that facilities would have to conduct a site specific health risk assessment to ensure that public exposure to emissions from the new source, will be below the air districts' levels of significance contained in health risk rules and policies. This proposal provides a margin of safety and accounts for situations where receptors may move in closer to a facility.

While they cannot be quantified because of variation from facility to facility, fugitive dust emissions also likely impact people residing near chromium plating and chromic acid anodizing facilities. Information on fugitive dust emissions is contained in Chapter V. Therefore, staff is proposing that all facilities would need to implement housekeeping measures to reduce dust emissions. We have found that fugitive emissions related to poor housekeeping can be an additional source of hexavalent chromium emissions.

Training explaining the Chromium Plating ATCM and the requirements, conducted by ARB staff, would be required every two years for employees responsible for compliance at chromium plating and chromic acid anodizing facilities. An exception to this requirement would be personnel that had attended the SCAQMD's training class for Rule 1469.

The proposal would also prohibit the sale or use of chromium plating or chromic acid anodizing materials unless sold or used by individuals or businesses under air district permit to conduct such operations.

All of these proposals, as well as the provisions necessary to implement them, are described further in Chapter IX.

IX. Proposed Amendments and Alternatives

Staff is proposing to amend the Chromium Plating ATCM (title 17, California Code of Regulations, section 93102). As described below, the amended ATCM will now be contained in sections 93102 through 93102.16. The amendments are being proposed to further reduce the public's exposure to emissions of hexavalent chromium. If adopted, the staff's proposal would reduce the estimated cancer risk by up to 85 percent. This Chapter is provided to describe, in "plain English," the changes being proposed. The rationale for the proposal is also described. The text of the proposed amendments to the ATCM can be found in Appendix A to this staff report. This Chapter also discusses alternative emission reduction approaches that were evaluated.

A. Summary of the Existing Airborne Toxic Control Measure

Chromium plating and chromic acid anodizing facilities have been regulated to control hexavalent chromium emissions since 1988 when the ATCM was first adopted. The regulation established different limits based on facility throughput and type of operation. Hard chromium plating and chromic acid anodizing facilities, except for small hard chromium plating facilities, were required to control hexavalent chromium emissions by meeting emission limitations using add-on air pollution control devices. The stringency of the limits depended on throughput, with the highest volume facilities meeting the most restrictive limit. Decorative chromium plating facilities, on the other hand, were required to control hexavalent chromium emissions, but to a lesser extent than hard chromium plating facilities. Most decorative chromium plating facilities chose to comply by using chemical fume suppressants.

The regulation was amended in 1998 to incorporate changes necessary for equivalency with the federal Chromium Plating NESHAP. This included changing the requirements for chromic acid anodizing facilities to harmonize them with the requirements for decorative chromium plating facilities, and requiring control of emissions from trivalent chromium plating facilities.

B. Summary of the Proposed Amendments

The staff is proposing a complete renumbering of the Chromium Plating ATCM. Rather than having alphabetized subsections to section 93102, staff is proposing to number sections consecutively in order to make the regulation easier to read. For example, previous subsection (a) would be renumbered to section 93102.1. This convention would be followed throughout the ATCM.

Section 93102 would set forth the organization of the regulation and clarify where requirements pertaining to a specific facility could be found. The reorganized ATCM would be contained in sections 93102 through 93102.16.

1. Section 93102.1--Applicability

Applicability requirements were previously contained in subsection (a). We are proposing a modification to the Applicability section. Originally the regulation's applicability was to "each chromium electroplating or chromic acid anodizing tank at a facility." Staff is proposing that the regulation applies to any owner or operator of a facility performing hard chromium electroplating, decorative chromium electroplating, or chromic acid anodizing. We are proposing this change to clarify that the requirements apply facility-wide. Ultimately, compliance responsibility is placed upon the owner or operator, therefore, this change would provide clarification.

Other changes are proposed to section 93102.1. We are also proposing to extend the applicability of the ATCM to manufacturers or distributors of chromium plating or chromic acid anodizing kits. This is necessary to implement other provisions of the proposal.

Staff is proposing a provision that would allow the ATCM to remain in effect if an individual part of the ATCM is found to be invalid. This severability provision is contained in many ARB regulations and is designed to insure that the control of hexavalent chromium emissions will continue even if a particular provision of the ATCM is held to be invalid by a court.

2. Section 93102.2--Exemptions

Exemptions were previously contained in subsection (a). We are not proposing any new exemptions within the ATCM. The proposal would move the existing exemptions to their own section. Generally, the exemptions exclude process tanks where chromium plating or chromic acid anodizing does not occur. The exemptions also clarify that the provisions for inspection and maintenance do not apply during breakdown conditions.

3. Section 93102.3--Definitions

Definitions were previously contained in subsection (b). Staff is proposing to modify a number of definitions, and is also proposing several new definitions necessary to implement other proposals in the regulation. The modified definitions are intended to further clarify the existing definitions. The proposed amended definitions are shown in Table IX-1 below.

Table IX-1. Definitions Proposed for Modification

Base metal	Modification
Chromic acid anodizing	Foam blanket
Chromium electroplating or chromic acid anodizing tank	Hard chromium electroplating or industrial chromium electroplating
Composite mesh-pad system	High Efficiency Particulate Arrestor (HEPA) filter
Decorative chromium electroplating	Mechanical fume suppressant
Emission limitation	Packed-bed scrubber
Facility	Stalagmometer
Fiber-bed mist eliminator	Tensiometer

One definition proposed for amendment, "Modification," warrants a further explanation. The definition for "Modification" is intended to describe changes to a facility that would trigger additional requirements. Presently, a facility is not considered "Modified" if throughput increases, as long as the maximum design capacity of the equipment is not exceeded. One amendment proposed by staff would define a modification as a change in throughput that would cause a facility to be subject to a different emission limitation. We are also proposing that changes to a permit unit or addition of a permit unit that does not increase hexavalent chromium emissions would not be considered a modification. These changes are necessary to implement the emission limit requirements in section 93102.4.

Several new definitions are proposed to implement other proposals in the Chromium Plating ATCM. Other definitions are proposed to further clarify the ATCM. The proposed new definitions to be added are shown in Table IX-2.

Table IX-2. New Definitions Proposed for Addition

Annual Permitted Ampere-hour	Modified Facility
Dragout	New Facility
Enclosed storage area	Owner or Operator
Enclosed hexavalent chromium electroplating tank	Permitting Agency
Existing Facility	Person
Fugitive dust	Sensitive receptor
Initial start-up	Tank

Most of these proposed new definitions are necessary to implement housekeeping requirements and other measures designed to reduce emissions of hexavalent chromium laden fugitive dust. Other proposed definitions are designed to clarify what constitutes an existing, new or modified facility, and others define those responsible for compliance or oversight.

One new definition proposed, "Sensitive receptor," warrants further explanation. A sensitive receptor is proposed to be defined as "any residence including private homes, condominiums, apartments, and living quarters; education resources such as preschools and kindergarten through grade twelve (K-12) schools; daycare centers; and health care facilities such as hospitals or retirement and nursing homes. A sensitive receptor includes long term care hospitals, hospices, prisons, and dormitories or similar live-in housing." This is the same definition used in the ATCM to Reduce Emissions of Hexavalent Chromium and Nickel from Thermal Spraying (title 17, CCR, section 93102.5), which was adopted by the Board in 2005. The definition is necessary to implement the proposed hexavalent chromium emission limit requirements in subsection 93102.4. As will be explained below, the requirements to control hexavalent chromium emissions will be phased in on different dates depending on a facility's distance to a sensitive receptor. Data show that sensitive receptors located in close proximity to hexavalent chromium plating or chromic anodizing facilities are at greater risk of exposure to elevated levels of hexavalent chromium. Note that as proposed, a residence would be considered a sensitive receptor. This is because children, the elderly, and other health-compromised individuals are often located in residences.

4. Section 93102.4--Emission Limits

Emission limitations for hexavalent chromium were previously contained in subsection (c) and would now be contained in section 93102.4. A number of organizational changes are proposed including renaming the section to "Requirements for Existing, Modified, and New Hexavalent Chromium Plating and Chromic Acid Anodizing Facilities." Other organizational changes are necessary to clarify that the existing limits would remain in effect until the proposed new limits would become effective. The section would be divided into requirements that continue to apply until the new requirements become effective.

a. Proposed subsection (a), Existing Hexavalent Chromium Limits

In section 93102.4, clarifying language is proposed to help the owner or operator to understand when the existing limits would no longer be effective and when compliance with the newly proposed limits would be required. As proposed, subsection 93102.4(a) would contain the current limits for existing hexavalent chromium facilities, and the limits for new or modified facilities up until the effective date of the new limits. Subsection (a)(1) applies to hard chromium plating facilities while subsection (a)(2) applies to decorative chromium plating and chromic acid anodizing facilities. Language is also proposed to specifically list all of the sections that contain other requirements that must be complied with, in addition to the limits set forth in section 93102.4.

b. Proposed subsection (b), New Hexavalent Chromium Limits

Proposed subsection (b) would contain the proposed new requirements for existing hexavalent chromium facilities to reduce emissions. Rather than continued bifurcation of requirements, staff is proposing that all facilities using the hexavalent chromium process, whether they perform decorative plating, hard plating, or chromic acid anodizing, would be subject to the same requirements. Based on emissions testing results, staff believes that uncontrolled emissions from these sources are similar and that each source of hexavalent chromium emissions should be controlled in the same manner and to the same degree. Also, based on our analysis of health risks in Chapter VIII, staff is also proposing that limits be phased in based on throughput, cancer risk, and proximity to sensitive receptors.

The proposed amendments to the ATCM would require best available control technology (BACT) to further reduce the public's exposure to hexavalent chromium from chromium plating and chromic acid anodizing facilities. BACT would apply to all facilities over time. For very small facilities BACT is use of specific chemical fume suppressants. BACT for all other facilities is a HEPA filtration system, or equivalent control. The requirements that would apply to each class of facility are specified in Table 93102.4, and are described below.

Very low throughput ($\leq$ 20,000 ampere-hours per year) facilities would be allowed to reduce hexavalent chromium emissions through use of specified chemical fume suppressants to lower surface tension of the plating or anodizing bath. This represents BACT for these facilities. Using specified chemical fume suppressants to lower surface tension reduces hexavalent chromium emissions to 0.01 milligrams/ampere-hour. Alternatively, these facilities may choose to comply by installing add-on air pollution control devices. Staff estimates that using specified chemical fume suppressants would result in a remaining cancer risk of no more than one per million people exposed. The chemical fume suppressants to be used for compliance are displayed in Table 93102.8 of section 93102.8.

Application of BACT for all other facilities would require use of control technologies rated at 99.97 percent efficient for collecting particles of 0.3 micrometers in diameter. This is the control efficiency achieved through installation of a HEPA filter add-on air pollution control device. The emission limitation equivalent to this level of control would be 0.0015 milligrams/ampere-hour. Staff is also proposing that intermediate-sized facilities be allowed to control emissions with devices other than HEPA filters, as long as a performance test demonstrates hexavalent chromium emissions to be no more than 0.0015 milligrams/ampere-hour. The timing for requiring compliance would be based on annual ampere-hours, health risk, and proximity to sensitive receptors.

Intermediate-sized facilities (> 20,000 and $\leq$ 200,000 ampere-hours per year) would have five years to comply with the emission limitation if the facility is located more than 100 meters from a sensitive receptor. To protect sensitive receptors, other intermediate-sized facilities located at or within 100 meters of a sensitive receptor would be required to meet the emission limitation in two years. All intermediate-sized facilities would be given the option to demonstrate compliance with the emission limitation without installation of add-on air pollution control devices. These proposals are designed to potentially reduce compliance costs for smaller businesses. Staff estimates that meeting the emission limit of 0.0015 milligrams/ampere-hour would result in a remaining cancer risk of no more than one per million people exposed.

The largest facilities (> 200,000 ampere-hours per year) would be required to comply with the emission limitation of 0.0015 milligrams/ampere-hour within two years using an add-on air pollution control device(s). After meeting the emission rate, we estimate that

e. Proposed subsection (e), Notification Requirements for New and Modified Sources

The requirements of proposed subsection 93102.4(e) have been moved from former subsection (j). Minor modifications to the language were also made to improve clarity. These requirements, relating to new and modified facilities, specify other requirements that must be met prior to a facility undergoing modification or prior to a new facility beginning operation.

5. Proposed Section 93102.5--Additional Requirements

Within new section 93102.5, requirements are proposed that apply to all hexavalent chromium plating and chromic acid anodizing facilities (*i.e.*, all existing, modified, and new facilities).

Staff is proposing, in subsection (a), that any facility with an add-on air pollution control device(s) could not remove the device, unless it is replaced with an add-on air pollution control device(s) meeting an emission rate of 0.0015 milligrams/ampere-hour. Requiring that the add-on air pollution control device remain in place provides an extra margin of safety.

ARB staff recognizes that the ATCM has many requirements that may be difficult to understand or carry out correctly without training. Staff also knows that following the requirements are necessary to control hexavalent chromium emissions effectively. Therefore, in subsection (b), we are proposing that every two years personnel designated by the owner or operator as responsible for environmental compliance must attend an ARB training class explaining how to comply. An exception to this requirement would be personnel that had attended the SCAQMD's training class for Rule 1469, which is also required every two years.

Fugitive emissions, essentially dust containing hexavalent chromium, can be an important contributor a facility's overall emission impact. While these emissions are difficult to quantify, we nevertheless believe measures are necessary to minimize these fugitive emissions. We are therefore proposing housekeeping measures in subsection (c) to reduce the mechanisms by which hexavalent chromium may be accidentally splashed or spilled, and are also proposing housekeeping measures to reduce dust that may become re-entrained into the ambient air.

To limit the generation of hexavalent chromium dust, staff's proposal includes:

- Storing chemicals such as chromic acid in closed containers in enclosed storage areas;
- Transporting chemicals to the plating or anodizing bath in closed containers;
- Cleaning up or containing liquid or solid spills that may contain hexavalent chromium within an hour of the spill occurring;
- Minimizing dragout by:
    - For automated lines: requiring drip trays between tanks;

   - For manual lines: requiring that dragout be minimized. When parts are sprayed off over the tank with fresh water, a splash guard would be required to ensure water from the part rinsing is returned to the tank;
- Cleaning of surfaces, such as floors, walkways around tanks, and storage areas that potentially are contaminated with hexavalent chromium at least once every seven days;
- Installing a barrier, such as plastic strip curtains, to separate buffing and grinding areas from the plating tank area; and
- Requiring that all waste/dust from housekeeping practices be disposed of properly as hazardous waste.

6. <u>Proposed Section 93102.6--Requirements for Trivalent Chromium Baths and Enclosed Hexavalent Chromium Electroplating Facilities</u>

The requirements for trivalent chromium plating facilities were previously contained in subsection (c). Proposed new section 93102.6 would specify the requirements for facilities electroplating with the trivalent chromium process and for facilities employing an enclosure around the plating tank to control hexavalent chromium emissions.

Generally, the requirements for facilities plating with trivalent chromium would be unchanged (subsection (a)). However, even though trivalent chromium is not considered a carcinogen, its use is not without some health impacts. Therefore, we are proposing that the separation requirements (in section 93102.4(d)(1)) for new hexavalent chromium facilities also apply to new trivalent chromium plating facilities.

Like the provision for new hexavalent chromium plating or chromic acid anodizing facilities, no new trivalent chromium facility could operate if it were located within an area zoned residential or mixed use, or if it were to be located within 150 meters from the boundary of any area zoned residential or mixed use.

Subsection 93102.6(a) also specifies which requirements of the ATCM an owner or operator of a trivalent chromium plating facility does not need to comply with.

The requirements in subsection (b) relating to enclosed hexavalent chromium tanks are being proposed to incorporate changes to the federal Chromium Plating NESHAP. As described by U.S. EPA, ventilation rates for enclosed tanks are considerably lower than ventilation rates for conventional ventilated facilities. Because of this, some facilities with enclosed tanks had difficulty meeting the chromium emission concentration limit specified in the Chromium Plating NESHAP, even when emissions from those tanks are well controlled. To rectify the situation, U.S. EPA adopted a separate alternative mass emission rate limit for chromium electroplating tanks equipped with enclosing hoods (U.S. EPA, 2004). We are proposing to add these provisions to the Chromium Plating ATCM.

Alternatively, these facilities may opt to comply with an emission rate of 0.0015 milligrams per dry standard cubic meter of air as measured after the add-on air pollution control device, or use a specified chemical fume suppressant.

New enclosed hexavalent chromium plating facilities would also be subject to the separation requirements described above for new trivalent chromium plating facilities.

7. Proposed Section 93102.7--Performance Testing and Test Methods

Performance testing and test methods were previously contained in subsection (d). Many of the proposed new regulatory requirements require facilities to determine the actual hexavalent chromium emission rate after the add-on air pollution control device(s). In this subsection, we are specifying the facilities that would have to conduct a performance (source) test to demonstrate compliance. As proposed, the following types of facilities would need to conduct a source test:

- Existing facilities demonstrating compliance with the 0.0015 milligrams/ampere-hour hexavalent chromium emission limitation;
- Facilities that undergo modification;
- Any new facility; and
- Trivalent chromium plating facilities meeting the emission rate in subsection 93102.6(a)(1).

All of these types of facilities would have to conduct the performance test within 60 days of initial start-up using an approved test method.

Facilities would be able to use an existing source test if it was conducted after January 1, 2000, and the test demonstrated an emission rate of 0.0015 milligrams/ampere-hour, or less. The test would need to have been approved by the permitting agency using an approved test method. The test results would also need to be representative of the air pollution control device(s) currently in use.

Minor modifications are proposed to subsections (c) and (d). One modification to the Approved Test Methods in subsection (c) would clarify that any performance test must include three test runs. Under another proposal, to measure surface tension with a tensiometer continued use of U.S. EPA Method 306-B would be required. When measuring surface tension with a stalagmometer, the method in new proposed Appendix 8, or a method approved by the permitting agency would need to be used. Identifying a specific procedure will provide more accurate and uniform results. In subsection (d), clarifying language is proposed to identify that the pre-test protocol is to be submitted to the permitting agency.

8. Proposed Section 93102.8--Chemical Fume Suppressants Used for Compliance

Results of our emissions testing program, along with results from the SCAQMD certification program, demonstrated that certain chemical fume suppressants were more efficient than others at reducing hexavalent chromium emissions. To ensure maximum reduction of hexavalent chromium from facilities using chemical fume suppressants, staff is proposing to specify the types of chemical fume suppressants that could be used to reduce surface tension. The chemical fume suppressants that could be used are listed below in Table IX-4, along with the surface tension at which they must be used. Based on our emissions testing program and analysis of results from the SCAQMD Fume Suppressant Certification Program (SCAQMD, 2004), staff has determined that the chemical fume suppressants listed in Table IX-4 are most efficient for preventing emissions of hexavalent chromium. In the regulation, Table IX-4 is labeled "Table 93102.8" and is set forth in section 93102.8(a).

Table IX-4. Chemical Fume Suppressants Approved for Use at Specified Surface Tensions

Chemical Fume Suppressant and Manufacturer	Stalagmometer Measured Surface Tension (dynes/centimeter)	Tensiometer Measured Surface Tension (dynes/centimeter)
Benchbrite CR 1800® Benchmark Products	< 40	< 35
Clepo Chrome® MacDermid	< 40	< 35
Fumetrol 140® Atotech U.S.A.	< 40	< 35

Staff is also proposing that additional chemical fume suppressants may be used upon approval by the ARB Executive Officer, if specified criteria are met. A provision to revoke use of a specified chemical fume suppressant, if it is found to no longer meet an emission rate of 0.01 milligrams/ampere-hour or less, is also proposed. This provision is necessary to protect public health.

9. Proposed Section 93102.9--Parameter Monitoring

Parameter monitoring requirements were previously contained in subsection (e). Minor changes are proposed to section 93102.9, Parameter Monitoring, to clarify existing provisions.

10. Proposed Section 93102.10--Inspection and Maintenance Requirements

Inspection and maintenance requirements were previously contained in subsection (f). Changes are proposed to section 93102.10, Inspection and Maintenance Requirements, to consolidate the requirements where appropriate. A new provision is proposed for facilities that have custom designed add-on air pollution control devices. The owner or operator of such a facility would be required to develop operation and maintenance requirements for review and approval by the permitting agency.

11. Proposed section 93102.11--Operation and Maintenance Plan Requirements

Operation and maintenance plan requirements were previously contained in subsection (g). Minor modifications are proposed to section 93102.11. The proposed changes are necessary to update citations for other subsections which have been reorganized.

12. Proposed section 93102.12--Recordkeeping

Recordkeeping requirements were previously contained in subsection (h). Minor modifications are proposed to section 93102.12, Recordkeeping. Most of the modifications clarify the provisions or update citations within the ATCM. Also, as proposed, section 93102.12, would be modified to specify additional records that must be kept. Facilities would be required to maintain monthly records of total ampere-hour usage per calendar year to verify compliance with the emission limit that corresponds to the ampere-hour thresholds. In addition, facilities would be required to keep records documenting that the proposed housekeeping requirements are met.

13. Proposed section 93102.13--Reporting

Reporting requirements were previously contained in subsection (i). Minor changes are proposed to subsections (a) through (d) of section 93102.13, Reporting. These changes would clarify the information to be reported or specify when reports are to be submitted to the permitting agency. The staff is proposing to modify subsection (e) to identify the information that must be submitted to the permitting agency for existing facilities using trivalent chromium and for new facilities using the trivalent chromium process.

14. Proposed section 93102.14--Procedure for Establishing Alternative Requirements

Procedures for establishing alternative requirements were previously contained in subsection (k). Minor modifications are proposed in subsections (a) through (e) of section 93102.14, Procedure for Establishing Alternative Requirements. In subsection (f), we are proposing that waivers obtained from U.S. EPA for alternative compliance with the emission limits will no longer be valid after the date of the requirements in section 93102.4(b) become effective for a particular facility. This modification is necessary to ensure all facilities meet the new requirements. We are also proposing that ARB would have to concur on any waivers associated with alternatives to compliance with section 93102.4, Requirements for Existing, Modified, and New Hexavalent Chromium Plating and Chromic Acid Anodizing Facilities.

15. Proposed section 93102.15--Requirements Related to Chromium Plating or Chromic Acid Anodizing Kits

Staff is proposing requirements related to chromium plating kits. We are aware that these kits are currently offered for sale over the Internet. Because no restrictions exist on who may buy these kits, they may be sold or supplied to a person that is not trained or aware of the hazards associated with chromium plating or chromic acid anodizing. These kits also could be a source of uncontrolled hexavalent chromium emissions. This could lead to unacceptable exposures for the individual performing the chromium plating or chromic acid anodizing, or for near-by sensitive receptors.

Because of these hazards, staff is proposing that these chromium plating or chromic acid anodizing kits could not be sold, supplied, offered for sale, or manufactured for sale in California. However, this provision would not apply if the kit was sold to the owner or operator of a permitted chromium plating or chromic acid anodizing facility.

These kits also could not be used unless the kit is used at a permitted chromium plating or chromic acid anodizing facility that is in full compliance with the ATCM.

We are also proposing that for the purposes of these provisions a "chromium electroplating or chromic acid anodizing kit" means chemicals and associated equipment for conducting chromium electroplating or chromic acid anodizing, including, but not limited to, internal and external tank components.

16. Proposed section 93102.16--Appendices

Staff is proposing that the Appendices to the Chromium Plating ATCM be contained within a new section, 93102.16. There are eight appendices. Most of these have been part of the Chromium Plating ATCM since 1998. Only the Appendices proposed for modification or addition are described. Appendix 1, Content of Performance Test Reports, is proposed for modification to indicate that test results must be provided in milligrams/ampere-hour.

Appendices 2 and 3, Content of Initial Compliance Status Reports, and Content of Ongoing Compliance Status Reports, respectively, are being modified to ensure that the permitting agency has all of the necessary information to ensure facilities are complying with all of the newly proposed provisions and requirements.

We are proposing to add a requirement to Appendix 4, Notification of Construction Reports, to ensure that any new facility is complying with the provisions for new facilities in section 93102.4(d), such as the separation requirements.

We are proposing to add Appendix 7, Alternative Requirements for Enclosed Hexavalent Chromium Electroplating Facilities- Mass Emission Rate Calculation Procedure. The calculation method shown in the appendix is used to demonstrate compliance with the alternative emission limit for enclosed tanks specified in subsection 93102.6(b)(1)(C).

We are also proposing to add Appendix 8, Surface Tension Procedure for a Stalagmometer. This appendix outlines a method to be followed to ensure accurate and consistent measurement of surface tension with a stalagmometer.

17. When the Proposed Amendments Become Legally Effective

In addition, we would like to clarify that the proposed amendments to the ATCM do not impose retroactive requirements on chromium plating and anodizing facilities. California law is clear that the proposed amendments to the ATCM cannot become legally effective until it is adopted by the ARB and is approved by the Office of Administrative Law. Until then, chromium plating and chromic acid anodizing facilities are not required to comply with any requirement specified in the amended ATCM, unless an air district independently imposes the same or similar requirement pursuant to its own local rules or permitting authority.

C. Basis for the Proposed Amendments

The proposed amendments to the Chromium Plating ATCM are based on our reevaluation of BACT for reducing hexavalent chromium emissions from chromium plating and chromic acid anodizing facilities, in consideration of health risk and cost. In reevaluating BACT, we analyzed information from ARB's 2003 chromium plating and chromic acid anodizing facility survey, available source test data, and data from the emissions testing program.

As a basis for the proposal, staff conducted the HRA to determine estimated cancer risks in a manner which is very health protective in estimating cancer risks for a range of reasonably foreseeable exposure scenarios. Staff believes this health protective approach is necessary due to the very high potency and resultant serious health hazards associated with exposure to hexavalent chromium emissions.

Based on the information collected, the health protective analyses conducted, and discussions with air districts, industry, and control equipment manufacturers, we determined that reliable control devices are readily available and widely used. Further, the application of BACT, as proposed by staff, will result in potential cancer risk levels being reduced to no more than one per one million people for 162 facilities (about 75 percent). An additional 41 facilities (about 20 percent), would have estimated cancer risk of no more than ten per million exposed people. Moreover, only six facilities would have a remaining cancer risk greater than 25 per million exposed people. Staff's proposal to require a site specific analysis, for review by the air districts, could result in further cancer risk reduction from these facilities. Overall 92 percent of the facilities would have cancer risk of no more than ten per million exposed people. In addition, the proposed amendments would ensure that the chronic hazard indices for all facilities would not exceed one.

D. Alternatives to the Proposed Amendments

California Government Code section 11346.2 requires the ARB to consider and evaluate reasonable alternatives to the proposed amendments to the ATCM and to provide reasons for rejecting these alternatives. Staff considered the following alternatives to the proposed amendments to the ATCM:

1. Alternative 1: Require Decorative Chromium Plating Facilities to Use the Trivalent Chromium Plating Process

One alternative to the staff's proposal would be to require the use of the trivalent chromium plating process for all decorative chromium plating facilities. The process is already in use successfully in ten businesses (six facilities only conduct trivalent chromium plating and four facilities conduct both trivalent and hexavalent chromium plating) in California. Requiring all decorative chromium facilities to use the trivalent chromium process would eliminate the remaining cancer risk from the hexavalent chromium emissions from decorative chromium plating facilities. In fact, the switch to the trivalent chromium process could be more cost effective than the staff's proposal, which would require installation of BACT (HEPA add-on air pollution control device). As estimated, installation and annual operating costs for a HEPA system are estimated at about $89,000 and $33,500 respectively. Our cost estimate for converting to trivalent chromium includes a one-time cost of about $41,500 and ongoing costs of $23,000. Under the staff's proposal, there will be residual cancer risk. However, 162 facilities would have estimated cancer risks of one or less per million exposed people after adoption of the staff's proposal. Overall, 92 percent of facilities would have cancer risk of less than ten per million exposed people.

Staff has evaluated the trivalent chromium process and has determined that it is not a universal replacement for all decorative chromium plating applications. Also, use of the trivalent chromium process would create business competitiveness issues between California businesses and those in other States, and between California businesses and those off-shore. Therefore, staff has determined this is not a technologically feasible alternative.

Nevertheless, businesses may make the decision to convert to the trivalent chromium process, if it is a viable option for their application.

2. Alternative 2: Require HEPA, or the Equivalent, Add-On Air Pollution Control Device for All Facilities

Another alternative would be to require installation of HEPA, or equivalent, add-on air pollution control devices for all facilities. This technology is the most effective option. Implementation of this proposal would reduce the remaining cancer risk from about 48 facilities that presently have throughput below 20,000 annual ampere-hours. Staff chose not to pursue this alternative. The staff's proposal represents a balance between health risk and cost. For these facilities, chemical fume suppressants represent BACT. Adoption of the staff's proposal will result in these facilities having estimated cancer risks below one per million people. This alternative would result in no appreciable additional benefit and would add additional equipment costs of over $4.0 million. Individual businesses would have annual costs of about $46,000. About half of these facilities are small businesses with annual revenue of less than $1,000,000.

3. Alternative 3: Adopt the Provisions of Rule 1469 Statewide

Industry representatives have asked staff to evaluate the adoption of SCAQMD Rule 1469 statewide. Rule 1469, Control of Hexavalent Chromium Emissions from Chrome Plating and Chromic Acid Anodizing Operations, is now in full effect in the SCAQMD. Rule 1469 requires hexavalent chromium facilities located within 25 meters from a sensitive receptor or within 100 meters from a school to reduce hexavalent chromium emissions such that the residential cancer risk will be no more than ten chances per million people. The rule also requires facilities located greater than 25 meters from a sensitive receptor or 100 meters from a school to reduce emissions such that off-site worker cancer risk would be no more than 25 chances per million people.

Staff has evaluated this alternative and has found it does not provide the level of protection that would be achieved through adoption of the staff's proposal. This is because BACT is not required for all facilities. By using off-site worker scenarios to calculate cancer risk, rather than residential, the risk to people and children living near the facility is underestimated by one-third. This means that estimated cancer risk for residents is 33 per million people exposed, rather than 25 per million people exposed. ARB could not use this scenario because it does not follow standard risk assessment methodologies developed by OEHHA and employed by ARB.

If Rule 1469 were implemented statewide, 75 percent of facilities would have estimated cancer risk of less than ten per million exposed people. This offers very little benefit over the baseline in which 71 percent of facilities were found to have estimated cancer risk of ten per million exposed people. The staff's proposal would result in 92 percent of facilities having estimated cancer risk of less than ten per million exposed people. In addition, if Rule 1469 were adopted statewide, eight percent of facilities would have cancer risk of over 25 per million exposed people. Two facilities' risk would exceed 100 per million exposed people. This is not health protective given the availability of BACT. If the staff's proposal were adopted, no facilities would have cancer risks over 100 per million exposed people. A comparison of the benefits of adopting Rule 1469 statewide and the benefits of the staff's proposal as shown in Figure IX-1.

Adoption of Rule 1469 statewide would, however, result in cost savings over the staff's proposal. Equipment costs would be about $600,000 because only seven additional facilities would need to install add-on air pollution control devices.

4. Alternative 4: Require No Further Control

Alternative 4 would be to require no additional control beyond what the existing ATCM, in combination with implementation of Rule 1469 in the SCAQMD, has achieved. This would be equivalent to the 2005 baseline cancer risk. This would result in allowing the maximum incremental cancer risks from some facilities to exceed 100 per million people and for 29 percent of facilities to have cancer risk in excess of ten per million people. Only 41 percent of facilities would have estimated cancer risk below one per million exposed people. Requiring no further control would, of course, result in cost savings because the staff's proposal is estimated to cost $14.2 million dollars. Of this amount, about $9.6 million would be related to purchasing HEPA filtering add-on air pollution control devices.

Staff does not believe the *status quo* is protective of public health especially considering that 43 percent of facilities are located within 100 meters of a sensitive receptor. Our goal is to achieve the maximum feasible health protection using the most effective controls. This is especially important when people are living, learning, working, or playing near chromium plating and chromic acid anodizing facilities. Thus, staff did not choose Alternative 4.

5. Summary

Table IX-5 compares alternatives three and four with the staff's proposal. Alternatives one and two are not presented. Alternative one is not technologically feasible. Alternative two essentially offers no benefit beyond the staff's proposal.

Table IX-5. Adoption of Staff's Proposal Offers the Greatest Reduction in Significant Community Cancer Risk

Number of Facilities by Cancer Risk

	≤1 per million	>1 ≤10 per million	>10 ≤100 per million	>100 per million
Staff Proposal	162	41	17	0
Rule 1469 Statewide	98	67	53	2
Baseline	90	67	57	6

Table IX-5 shows that the staff's proposal offers the best health protection. As shown, adopting the provisions of SCAQMD Rule 1469 statewide would result in 98 facilities (about 45 percent) with remaining cancer risk of no more than one per million exposed persons. This represents an additional 8 facilities compared to the baseline. Adoption of the staff's proposal would reduce the estimated cancer risk for 162 facilities (about 74 percent) to no more than one per million exposed persons.

6. Conclusion

We evaluated each of the alternatives and determined that the alternatives did not meet the objective of Health and Safety Code section 39666 to reduce emissions to the lowest level achievable through the application of BACT, or a more effective control method, in consideration of cost, health risk, and environmental impacts.

E. Recommendation

Based on the forgoing, staff recommends that the Board adopt the proposed amendments to the Chromium Plating ATCM (Appendix A). Requiring BACT for all facilities provides the greatest reductions in significant community cancer risk. The staff's proposal, compared to the 2005 baseline, would result in up to an 85 percent reduction in estimated cancer risk for individual facilities. Staff predicts the proposal would reduce 162 facilities' (about 74 percent) cancer risk to no more than one per million exposed people, and reduce cancer risk to no more than ten per million for over 92 percent of facilities. The proposal would also directly benefit low income and ethnically diverse communities that have been disproportionately impacted by emissions from chromium plating and chromic acid anodizing facilities.

REFERENCES:

SCAQMD, 2004. South Coast Air Quality Management District. Certified List of Fume Suppressants for Facilities Performing Chrome Plating and Chromic Acid Anodizing Operations. 2004 (http://www.aqmd.gov/prdas/ChromePlating/ChromePlating.htm)

U.S. EPA, 2004. U.S. Environmental Protection Agency. 40 CFR Part 63: "National Emission Standards for Chromium Emissions From Hard and Decorative Chromium Electroplating and Chromium Anodizing Tanks". 2004.

X. Economic Impacts

ARB staff has evaluated the estimated costs and economic impacts associated with implementation of the proposed amendments to the Chromium Plating ATCM. This Chapter summarizes the results of our findings. The expected first year estimated costs, capital costs and annual recurring costs that would be expended to comply with the proposed amendments are described. Staff has conducted a conservative analysis of potential costs to be incurred. We have estimated that all facilities needing to demonstrate compliance with the 0.0015 milligrams/ampere-hour limit would install a HEPA add-on air pollution control device. This may not be the case. Some facilities may be able to demonstrate compliance with alternative, cheaper methods. The costs and associated economic impacts are given for private companies and California governmental agencies.

A. Summary of the Economic Impacts

The proposed amendments to the Chromium Plating ATCM are not expected to have a significant adverse impact on the profitability of most owners or operators of chromium plating and chromic acid anodizing facilities in California. However, staff has determined that costs for some individual businesses are expected to be significant and would adversely impact their profitability. The effect of compliance costs on profitability impacts were estimated by calculating the decline in the return on owner's equity (ROE). A decline in ROE of 10 percent or more indicates a significant adverse impact. The proposed amendments to the ATCM are expected to result in an average ROE decline of nine percent which is not considered to be a significant impact on the profitability of most affected businesses. However, the ROE for some individual businesses exceeds ten percent. We estimate that businesses' profitability impacts range from less than one percent to 41 percent.

When considering the entire industry, we expect the proposed amendments to have no significant impact on employment; business creation, elimination or expansion; or business competitiveness in California. However, some individual businesses, including small businesses, could be significantly impacted, which could result in business closures and lost jobs. We expect no significant adverse fiscal impacts on any local or State agencies.

Of the 226 facilities affected by the proposed amendments to the ATCM, up to 89 facility owners would be required to expend significant capital to meet the requirements. Some of these operators may have difficulty securing the required capital to finance the cost of the add-on air pollution control devices that would be required for compliance with the proposed amendments to the ATCM. However, in 2005, the Governor signed legislation to establish a loan guarantee program for decorative chromium plating operations to purchase pollution control equipment. The program is administered by the Business, Transportation, and Housing Agency. The program provides loan guarantees of up to $100,000 to owners of decorative chromium plating small businesses that may not be able to qualify for a conventional loan. In July of this year, the Governor signed into law amendments to the loan guarantee program. The loan guarantee program is now available for all metal plating facilities.

During the first year, all facilities would have compliance costs. Costs would vary depending on the extent an individual business was already in compliance with the proposed amendments. About 40 percent of facilities are already controlled with HEPA filtration systems, or equivalent; they would incur no capital costs. Another 20 percent of facilities would use chemical fume suppressants as sole control. Therefore, these facilities compliance costs will be low, as well. Compliance costs for trivalent chromium plating facilities would also be low. The proposed amendments would only require these facilities to file an initial compliance status report.

We estimate that costs in the first year would range from $450 to $217,000 with an average cost of $23,000. Median cost would be $8,500. In subsequent years, costs would range from essentially no cost to $217,000 with an average cost of $53,000. Median cost in subsequent years would be $46,000. After the first year, 60 percent of the facilities would have no additional compliance costs. Costs for all facilities include completion of an initial compliance status report. Other costs incurred by some, but not all facilities, include permit fees, performance testing, site specific analyses, housekeeping costs, capital equipment costs (amortized), and ongoing (recurring) costs. The assumptions from which these costs are estimated as described below.

B. Economic Impact Analysis

1. Legal Requirements

Section 11346.3 of the Government Code requires State agencies to assess the potential for adverse economic impacts on California business enterprises and individuals when proposing to adopt or amend any administrative regulation. The assessment must include a consideration of the impact of the proposed regulation on California's jobs, business expansion, elimination or creation, and the ability of California businesses to compete with businesses in other states.

In addition, State agencies are required to estimate the cost or savings to any State or local agency and school district in accordance with instructions adopted by the Department of Finance. The estimate shall include any non-discretionary cost or savings to local agencies and the cost or savings in federal funding to the State.

Health and Safety Code section 57005 requires the ARB to perform an economic impact analysis of submitted alternatives to a proposed regulation before adopting any major regulation. The proposed amendments to the Chromium Plating ATCM are considered to be a "major regulation", because the estimated cost to California business enterprises exceeds $10 million in the first year.

2. Affected Businesses

Any business conducting chromium plating, chromic acid anodizing, or business selling chromium plating kits to non-permitted facilities would be affected by the proposed amendments to the ATCM. Also potentially affected are businesses that are customers of chromium plating or chromic acid anodizing facilities, such as the aerospace and automotive industries. The focus of this analysis, however, will be chromium plating and chromic acid anodizing facilities because these businesses would be most affected by the proposed amendments to the ATCM.

The affected businesses generally fall under a Standard Industrial Classification (SIC) code of 34, Fabricated Metal Industry, and more specifically, SIC 3471, Plating and Polishing, or North American Industry Classification System (NAICS) 332813.

3. Potential Impacts on Profitability for Affected Businesses

The approach used in evaluating the potential economic impact of the proposed amendments to the ATCM on California businesses is as follows:

- All affected facilities are identified from responses to the ARB's 2003 Chromium Plating and Anodizing Facility Survey.
- Financial data and net profit data are obtained for a typical business engaged in plating and polishing businesses from Dun's Financial Profile; SIC 3471 Industry Profiles (D&B, 2005) and Dun and Bradstreet Business Information Report. (D&B, 2006)
- The annual cost of compliance is estimated for the businesses that are affected by the proposed amendments to the ATCM.
- The annual cost of compliance for each business is adjusted for both federal and state taxes. It is assumed affected businesses are subject to federal and State tax rates of 35 percent and 9.3 percent, respectively.
- These adjusted costs are subtracted from net profit data and the results are used to recalculate the ROE.
- The resulting ROE is then compared with the ROE before the subtraction of the adjusted costs to determine the impact on the profitability of the businesses. A reduction of more than 10 percent in profitability is considered to indicate a potential for significant adverse economic impacts. This threshold is consistent with the thresholds used by the U.S. EPA and ARB in previous regulations.
- Affected businesses absorb the costs of the proposed amendments to the ATCM instead of increasing the prices of their products or lowering their costs of doing business through cost-cutting measures.

All of the chromium plating and chromic acid anodizing businesses affected by these proposed amendments are California businesses. These businesses are affected to the extent that implementation of the proposed amendments reduces their profitability. Using ROE to measure profitability, we estimate the decline in ROE for most affected businesses would be less than ten percent based on 2002-2004 financial data. This is based on an average compliance cost for all facilities of $23,000. This does not represent a noticeable decline in the profitability of most affected businesses.

However, for the 89 businesses that would likely need to install or upgrade add-on air pollution control devices, the estimated decline in profitability ranges from 3 to 41 percent. The average estimated compliance costs for these facilities is $53,000.

Of the 89 facilities, 28 small businesses may need to install add-on air pollution control devices. This could result in a potential significant adverse cost impact. These businesses' profitability could decline by 33 percent in order to comply with the proposed amendments. Some marginal businesses would likely face a difficult business decision as to whether to continue operating the chromium plating portion of their operation. However, this cost analysis is based on the assumption that these small businesses would have to install add-on air pollution control devices. Some of these businesses may be able to demonstrate compliance without the use of an add-on air pollution control device. Others may decide to cease chromium plating, but retain other aspects of their operations and remain viable. In these instances, the ROE estimated here would be much lower. Some of these businesses may also qualify for a loan guarantees of up to $100,000 to purchase pollution control equipment.

The remaining 137 businesses would have average compliance costs of about $4,000. The decline in profitability for these businesses is not considered to be significant. The change in ROE ranges from less than one percent to nine percent.

4. Assumptions for Facility Cost Estimates

Seventy-five percent of the facilities are located in the SCAQMD. These facilities have already complied with Rule 1469 and are familiar with how the air district estimated costs for compliance with that rule. To allow for a comparison ARB staff generally used the SCAQMD's cost methodology, except that costs were grown from 2003 to 2006 dollars at a rate of 5 percent (factor of 1.158). Using this factor provides for a 'worst case' cost estimate because the inflation rate has been about three percent over this period of time (CPI, 2006). The costs estimated for each compliance requirement are summarized below in Tables X-1 and X-2. In addition, chemical fume suppressant cost was estimated at $185/gallon at a use rate of 1.98×10^{-6} gallons/ampere-hour.

Table X-1. Estimated Compliance Costs (Other than Those for Add-On Air Pollution Control Devices)**

Initial Compliance Plan	Drip Trays	Plastic Strip Curtains	Permit fee *	Source Test	Site Specific Analysis
$450	2@ $350	$1,138	$700/$2,232	$7,335	$11,500

* Permit fee of $2,232 for initial HEPA permit (cost estimate from ARB's Thermal Spraying Report).

** Costs are rounded.

Table X-2 displays the cost estimates used to estimate costs associated with hexavalent chromium add-on air pollution control devices.

Table X-2. Costs for HEPA Add-on Air Pollution Control Devices

System size Based on Fan Size	Freight	Equipment	Installation	Recurring
Small (5,000 Cubic Feet per Minute (CFM))	$1,580	$33,047	$54,129	$33,513
Medium (10,000 CFM)	$2,328	$48,705	$79,313	$39,850
Large (20,000 CFM)	$3,843	$80,396	$129,882	$57,570

For consistency, ARB staff calculated the cost of add-on air pollution controls as per the SCAQMD method. It was assumed that each tank at a facility is 36 square feet and is ventilated at 150 CFM per square foot. One tank, would require 5,400 CFM to be properly ventilated. The number of tanks at a facility was then multiplied by 5,400 to arrive at the total amount of ventilation required (SCAQMD, 2003a and SCAQMD, 2003b).

For example: 6 tanks @ 36 square feet X 5,400 CFM = 32,400 total CFM

In this example, it is assumed the facility would need to purchase one 5,000 CFM system @ $88,756, one 10,000, system @ $130,346, and one 20,000 CFM system @ $214,121. The total cost would be $433,223. In like fashion, recurring costs would be $130,933.

When actual tank numbers were known, this information was used to estimate cost. When this information was not available, staff estimated the number of tanks needing ventilation based on facilities with similar ampere-hours where the number of tanks was known. The size of the system does not necessarily relate to throughput. An intermediate-sized facility (no more than 200,000 ampere-hours) may have multiple tanks requiring ventilation, such that a larger system 10,000 CFM system is needed. Other very large throughput facilities may only have one tank requiring ventilation. In this case, the larger facility would have cheaper compliance costs as only a 5,000 CFM system may be needed. However, staff has estimated that of the 89 facilities required to install HEPA systems, 80 out of 89 would be 5,000 CFM systems.

We annualized non-recurring fixed costs using the Capital Recovery Method. Using this method, we multiplied the non-recurring fixed costs by the Capital Recovery Factor (CRF) to convert these costs into equal annual payments over a ten year project horizon at a discount rate of five percent. The Capital Recovery Method for annualizing fixed costs is recommended by the California Environmental Protection Agency (Cal/EPA) (Cal/EPA, 1996), and is consistent with the methodology used in previous cost analyses for ARB regulations (ARB, 2000).

The CRF is calculated as follows:

$$CRF = \frac{i(1+i)^n}{(1+i)^n - 1}$$

where,

CRF = *Capital Recovery Factor*
i = *discount interest rate (assumed to be 5 percent)*
n = *project horizon or useful life of equipment*

All costs of the add-on air pollution control devices were annualized over 10 years. These values are based on a conservative estimate of the expected lifetime of the equipment. The total annualized cost was obtained by adding the annual recurring costs to the annualized fixed costs derived by the Capital Recovery Method.

Capital costs include the cost of the add-on air pollution control device, installation, freight, source test, and instrumentation.

Recurring costs include replacement filters, disposal of filters as hazardous waste, electrical usage, labor, property tax, insurance, and reporting costs.

5. Potential Economic Impacts for Individual Chromium Plating and Anodizing Facilities

From our industry survey we have identified 226 chromium plating and chromic acid anodizing facilities in California. Of these businesses, two are federal government facilities, the U.S. Naval Aviation Depot, in the SDCAPCD, and the United States Mint in the BAAQMD.

We estimate that 71 of the affected businesses are small businesses with gross annual revenue of less than $1.0 million (U.S. EPA, 1995a). Of these, 28 businesses would likely incur costs associated with purchase and operation of add-on air pollution control devices.

In terms of estimating compliance costs, facilities can be divided into 4 groups: trivalent chromium plating facilities; hexavalent chromium plating and chromic acid anodizing facilities with throughput of less than or equal to 20,000 annual ampere-hours; hexavalent chromium plating and chromic acid anodizing facilities with throughput of more than 20,000 but less than or equal to 200,000 annual ampere-hours; and hexavalent chromium plating and chromic acid anodizing facilities with throughput of more than 200,000 annual ampere-hours. There are also hexavalent chromium plating and chromic acid anodizing facilities with throughput of more than 20,000 that are already in substantial compliance with the proposal. Costs for these facilities will be estimated separately from those needing to expend significant capital to comply.

a. Trivalent Chromium Plating Facilities

Six facilities conduct only trivalent chromium plating. These facilities would incur costs associated with submitting an initial compliance status report. This cost has been estimated at $450 per facility. Beyond this one-time cost, compliance with the proposed amendments would result in no additional cost for these facilities.

b. Hexavalent Chromium Plating and Chromic Acid Anodizing Facilities with Throughput of Less Than or Equal to 20,000 Annual Ampere-Hours

Forty-eight facilities have been identified with throughput of less than or equal to 20,000 annual ampere-hours. Under the proposed amendments these facilities would be allowed to control hexavalent chromium emissions by reducing surface tension of the plating/anodizing bath by using specified chemical fume suppressants. Compliance costs for these facilities are estimated to average about $2,000. The costs were estimated as described below.

Based on 2003 calendar year data, only ten of these 48 facilities were not using the specified chemical fume suppressants. Costs for these ten facilities to begin using specified chemical fume suppressants would result in no significant cost increase. All 48 of these facilities however, would need to complete an initial compliance status report estimated to cost $450. It is also assumed that these facilities would have permit renewal fees of $700. For facilities with buffing, grinding or polishing operations we estimated costs associated with purchase of plastic strip curtains at $1,100. Costs for purchase of drip trays for facilities with automated lines were estimated to cost $700. Thus, costs for these facilities range from $1,150 to $2,600, with average compliance costs of $2,000. After the first year, 38 of these facilities would have no additional compliance costs beyond housekeeping and recordkeeping. Ten facilities would have annual recurring costs, but they are near zero.

c. Hexavalent Chromium Plating and Chromic Acid Anodizing Facilities with Throughput of More Than 20,000 but Less Than or Equal to 200,000 Annual Ampere-Hours

Sixty facilities have been identified with more than 20,000 but less than or equal to 200,000 annual ampere-hours. Of these, 45 facilities would need to take actions to demonstrate compliance with the emission limit of 0.0015 milligrams/ampere-hour; the other 15 facilities are already in substantial compliance. Generally, to meet the 0.0015 milligrams/ampere-hour limit requires use of a HEPA add-on air pollution control device. However, the requirement would be phased in based on throughput and proximity to sensitive receptors. [The other 15 facilities' costs are estimated as described in part e., below.] Total capital costs for these facilities are estimated to be about $4.0 million. Total annualized costs (amortized plus recurring costs) are estimated to be $2.1 million. The costs were estimated as described below.

Twenty-eight of these facilities are located within 100 meters of a sensitive receptor and would be required to demonstrate compliance within two years. The other 17 facilities would have five years to demonstrate compliance with the emission limit because they do not have sensitive receptors located within 100 meters. Some of these 45 facilities may be able to demonstrate compliance with the emission limit without installation of a HEPA add-on air pollution control device. However, most are expected to need to install a HEPA add-on air pollution control device to meet the 0.0015 milligrams/ampere-hour limit. Costs were estimated based on installation of a HEPA add-on air pollution control device for all of these facilities.

All of these facilities would need to complete an initial compliance status report estimated to cost $450. It is also assumed that these facilities would have permit fees associated with installation a HEPA add-on air pollution control device. This cost is estimated to be $2,200. Ongoing permit renewal fees are estimated at $700. For facilities with buffing, grinding or polishing operations we estimated costs associated with purchase of plastic strip curtains at $1,100. Costs for purchase of drip trays for facilities with automated lines were estimated to cost $700. Performance tests would be required of all facilities, which is included in the cost of purchasing and installing a HEPA add-on air pollution control device.

The cost to purchase an add-on air pollution control device is estimated to be $89,000 in initial capital costs (including installation, source testing, and freight). For these facilities, we amortized the costs of purchasing the add-on air pollution control devices over ten years. We also amortized the costs for permit fees, and purchase of plastic strip curtains and/or drip trays when required. Total costs to be amortized are estimated to be $92,000. This equates to an annualized capital cost of about $12,000 (in 2006 dollars) over the life of the equipment.

Annual recurring costs associated with equipment maintenance and ongoing permit fee renewals are estimated at $34,000. Combining these annual costs with amortized costs results in an annual cost of about $46,000 for purchase, installation, reports, fees, analyses, and maintenance of the equipment.

d. Hexavalent Chromium Plating and Chromic Acid Anodizing Facilities with Throughput of More Than 200,000 Annual Ampere-Hours

One hundred twelve facilities have been identified with more than 200,000 annual ampere-hours. Of these, 44 facilities would need to take actions to demonstrate compliance with the emission limit of 0.0015 milligrams/ampere-hour, as measured after an add-on air pollution control device. Generally, this requires use of a HEPA add-on air pollution control device. Costs were estimated for these facilities based on installation of a HEPA add-on air pollution control device. These facilities would be required to demonstrate compliance within two years. [The other 68 facilities' costs are estimated as described in part e., below.] Total capital costs for 44 facilities are estimated to be $5.6 million. Total annualized costs (amortized plus recurring costs) are estimated to be $2.7 million. The costs were estimated as described below.

All of these facilities would need to complete an initial compliance status report estimated to cost $450. It is also assumed that these facilities would have permit fees associated with installation a HEPA add-on air pollution control device. This cost is estimated to be $2,200. Ongoing permit renewal fees are estimated at $700. For facilities with buffing, grinding or polishing operations we estimated costs associated with purchase of plastic strip curtains at $1,100. Costs for purchase of drip trays for facilities with automated lines were estimated to cost $700. Performance tests would be required of all facilities, which is included in the cost of purchasing and installing a HEPA add-on air pollution control device. After meeting the 0.0015 milligrams/ampere-hour limits, one facility would be required to conduct an additional assessment to determine if further risk reduction was needed. Cost for site specific analysis is estimated to cost $11,500.

The costs to purchase add-on air pollution control devices are estimated to range from $89,000 to about $500,000 in initial capital costs (including installation, source testing, and freight). Average capital cost is about $130,000. For these facilities, we amortized the costs of purchasing the add-on air pollution control devices over ten years. We also amortized the costs for permit fees, and purchase of plastic strip curtains and/or drip trays when required. Total costs to be amortized range from about $90,000 to $500,000. This equates to an annualized capital cost of about $12,000 to $68,000 (in 2006 dollars) over the life of the equipment.

Annual recurring costs associated with equipment maintenance and ongoing permit fee renewals are estimated to range from $34,000 to $150,000, with an average of about $43,000. Combining these annual costs with amortized costs results in an annual cost of about $46,000 to $217,000 for purchase, installation, reports, fees, analyses, and maintenance of the equipment. The mean cost would be about $61,000.

e. <u>Hexavalent Chromium Plating and Chromic Acid Anodizing Facilities with Throughput of More Than 20,000 Annual Ampere-Hours Already in Substantial Compliance with the Proposal</u>

Eighty-three facilities have been identified with throughput of more than 20,000 annual ampere-hours that already meet the emission limit. These facilities would incur compliance costs in the first year only. The average compliance cost for these facilities is about $5,500. The costs for these facilities were estimated as described below.

All of these facilities would need to complete an initial compliance status report estimated to cost $450. It is also assumed that these facilities would have permit renewal fees of $700. For facilities with buffing, grinding or polishing operations we estimated costs associated with purchase of plastic strip curtains at $1,100. Costs for purchase of drip trays for facilities with automated lines were estimated to cost $700. Performance tests would be required of 31 facilities with an estimated cost of $7,500 each. Based on 2003 data, five facilities would be required to conduct an additional assessment to determine if further risk reduction was needed. Cost for this site specific analysis is estimated to cost $11,500. Thus, costs for these facilities range from $1,150 to $21,000, with average compliance costs of about $5,000. Beyond the first year, these facilities would have no additional compliance costs beyond housekeeping and recordkeeping.

6. Potential Impact on Manufacturers and Suppliers of Chromium Plating and Chromic Acid Anodizing Equipment and Chemicals

We do not expect manufacturers of chromium plating and chromic acid anodizing materials to incur any costs. However, the staff's proposal to prohibit sales of chromium plating kits to non-permitted facilities may result in lost revenue for these businesses. The proposed amendments would potentially impact the chemical manufacturers in a positive way through increased sale of chemical fume suppressants. Add-on air pollution control device manufacturers, as well as the metal fabricating industry, would also benefit from the proposed amendments as controls and ductwork for ventilation systems are purchased.

7. Potential Impact on Consumers

The potential impact of the proposed amendments to the ATCM on consumers depends upon the extent to which affected businesses are able to pass on the increased cost to consumers in terms of higher prices for their goods and services. If all costs are passed onto the consumers, we expect the cost per ampere-hour to increase by between $0.01 to $2.21 per ampere-hour. These costs are estimated based on facilities that would have to install add-on air pollution control devices. The lower end of this cost would represent a large facility, while the upper end cost would represent a small facility.

To put these costs into perspective consider that chromium plating an automobile bumper (a decorative chromium application) requires 10 to 12 ampere-hours (Walker, 2006). Using the cost per ampere-hour above, this would mean the increased cost of a bumper would be between $0.12 to $26.52. A larger automobile bumper would require 50 ampere-hours to chromium plate (Walker, 2006). This would mean the increased cost to plate a larger bumper would be under a dollar to as much as $110 more. One current cost estimate to re-plate a bumper is $400. Because the majority of plating is done at larger facilities we anticipate the net impact on consumers to be negligible to minor.

8. Potential Impact on Employment

Of the 226 affected businesses, 86 percent responded to our survey and provided calendar year 2003 employee data. Fifty percent reported employing 25 or fewer people. Another 30 percent reported employing between 26 to 100 people. Four businesses reported employing 1,000 or more employees. Generally, facilities with large numbers of employees have a chromium plating or anodizing process as part of the overall facility's operation. It is likely only a small number of these employees would be dedicated to conducting plating or anodizing. An example of this situation would be an aerospace company. About 25 facilities that would have substantial compliance costs employ ten or fewer people.

We expect the proposed amendments to the ATCM to adversely impact some employees.

9. Potential Impact on Business Creation, Elimination or Expansion

The proposed amendments to the ATCM would have an impact on the status of some California businesses. The compliance costs of the proposed amendments to the ATCM are expected to be significant for marginal chromium plating and chromic acid anodizing facilities as shown by the estimated impacts on the profitability of some affected businesses. The businesses subject to control requirements are expected to pass the compliance costs on to their customers, or make a business decision as to whether or not to continue operations.

10. Potential Impact on Business Competitiveness

The proposed amendments to the ATCM will not have a significant, statewide adverse impact on the ability of California businesses to compete with businesses in other states, although the competitiveness of some individual business would be adversely impacted. No other state controls emissions of hexavalent chromium from chromium plating and chromic acid anodizing businesses as stringently as does California. Most other states' requirements are limited to those of the federal Chromium Plating NESHAP, which is less stringent than the existing ATCM. Therefore, the existing ATCM creates a competitive disadvantage for some California businesses because they generally do not have compliance costs as high as out-of-state businesses.

The proposed amendments would make this existing competitive disadvantage worse for some individual businesses (i.e., those chromium plating and chromic acid anodizing businesses that would have to spend significant amounts of money to comply with the amended ATCM). However, approximately 60 percent of the existing businesses are in substantial compliance with the requirements that would be established by the proposed amendments, and would have to spend very little additional money to comply. The proposed amendments would not have a significant adverse impact on the existing competitive position of these businesses. In addition, many chromium plating and chromic acid anodizing businesses in California compete only with other California businesses. The competitive position of these businesses would also not be significantly impacted by the proposed amendments.

11. Costs to Public Agencies

Health and Safety Code section 39666 requires that, once the Board adopts the proposed amendments, the air districts implement and enforce the ATCM or adopt an equally effective or more stringent regulation. Because the air districts will have primary responsibility for implementing and enforcing the proposed amendments to the ATCM, we evaluated the potential cost to the air districts. We also evaluated the potential cost to local and State agencies. This section provides the conclusions we reached and the basis for those conclusions.

The chromium plating and anodizing facilities affected by the proposed amendments to the ATCM are located in eight air districts, as shown in Table X-3.

Table X-3. Number of Affected Hexavalent Chromium Plating and Chromic Acid Anodizing Facilities by Air District

Location	# Affected Facilities	# Facilities Installing or Upgrading Controls	Percent of Facilities
Bay Area AQMD	18	12	8
Feather River AQMD	1	0	<1
Sacramento Metro AQMD	5	3	<1
South Coast AQMD	173	60	76
San Diego APCD	9	2	4
San Joaquin Valley APCD	17	12	8
Shasta County APCD	2	0	<1
Ventura County APCD	1	0	<1
Total	**226**	**89**	

New costs the air districts would incur as a result of the proposed amendments would be reviewing initial compliance status reports; reviewing permit modifications for facilities adding or upgrading to HEPA, or an equivalent level of control; reviewing source test protocols and results; and reviewing site specific analyses, if necessary. The air districts already review ongoing compliance status reports and permit renewals. Facilities are also regularly inspected. Therefore, we do not expect any additional costs to be incurred for performing these functions. We estimate the new costs to air districts resulting from the proposed amendments to the ATCM to be approximately $685,000.

However, air districts can recover these costs through fees charged to the facilities. The costs to the air districts can be recovered under the fee provisions authorized by Health and Safety Code sections 42311 and 40510. Therefore, the proposed amendments to the ATCM would impose no costs on the air districts that would require the State to reimburse them pursuant to Section 6 of Article XIIIB of the California Constitution and Part 7 (commencing with section 17500), division 4, title 2 of the Government Code. We are also aware that some air districts may assess costs differently than how costs were estimated for this rulemaking. However, any additional costs are also recoverable from fees assessed on facilities within their air district.

The proposed amendments to the Chromium Plating ATCM would not affect any State agency or program other than ARB. Although the air districts will have primary responsibility for enforcing the proposed amendments to the ATCM, the ARB may, at the request of an air district, provide assistance in the form of technical expertise, legal support, or other enforcement support. We estimate that providing assistance to air districts as they adopt the proposed amendments to the ATCM would require about one-quarter person year or $25,000 over the next three fiscal years. Review and approval of chemical fume suppressants data to affirm the chemicals meet the 0.01 milligram/ampere-hour limit would require about two person months each, or $17,000. We expect the number of reviews to be small. These costs are absorbable within the existing ARB budget.

We also anticipate no fiscal effect on federal funding of State programs.

12. Total Cost of the Proposed Amendments to the Airborne Toxic Control Measure

Based on information provided in the ARB's 2003 Chromium Plating and Chromic Acid Anodizing Facility Survey, and applying similar compliance costs to those estimated for compliance with SCAQMD Rule 1469 (2003 dollars grown to 2006 dollars at a rate of 5 percent per year), we estimated the total cost of compliance with the proposed amendments to the ATCM. Total capital costs for purchase of add-on air pollution control devices are estimated at $9.6 million. Total recurring costs are estimated at $3.6 million. An additional $1.0 million in costs are estimated for reports, source testing, permit fees, and site specific analyses. In total, costs are estimated to be $14.2 million.

During the first year, all facilities would have compliance costs. Costs would vary depending on the extent an individual business was already in compliance with the proposed amendments. We estimate that costs in the first year would range from $450 to about $217,000 with an average cost of about $23,000. In subsequent years, costs would range from near zero to $217,000, with an average cost of $53,000. Nine facilities would have ongoing costs over $50,000. After the first year, 60 percent of the facilities would have no additional compliance costs.

REFERENCES

ARB, 2000. Air Resources Board. "Staff Report: Initial Statement of Reasons for Proposed Amendments to the Vapor Recovery Certification and Test Procedures for Gasoline Loading and Motor Vehicle Gasoline Refueling at Service Stations." 2000.

Cal/EPA, 1996. California Environmental Protection Agency. Memorandum from Peter M. Rooney, Undersecretary, to Cal/EPA Executive Officers and Directors. "Economic Analysis Requirements for the Adoption of Administrative Regulations." Appendix C ("Cal/EPA Guidelines for Evaluation Alternatives to Proposed Major Regulations"). 1996.

CPI, 2006. InflationData.com. Current Consumer Price Index. 2006 (http://www.inflationdata.com/inflation/consumer_price_index/currentCPI.asp)

D&B, 2005. Dun and Bradstreet. Duns Financial Profile - Industry Profile; SIC 3471. 2005

D&B, 2006. Dun and Bradstreet. D&B's Business Information Report – Various Businesses. 2006

SCAQMD, 2003b. South Coast Air Quality Management District. "Draft Socioeconomic Assessment for Proposed Amendments to Rule 1469-Hexavalent Chromium Emissions from Chrome Plating and Chromic Acid Anodizing Operations and Proposed Rule 1426-Emissions from Metal Finishing Operations". 2003

SCAQMD, 2003a. South Coast Air Quality Management District. "Draft Staff Report for Proposed Amended Rule 1469-- Hexavalent Chromium Emissions from Chrome Plating and Chromic Acid Anodizing Operations and Proposed Rule 1426- Emissions from Metal Finishing Operations." 2003

U.S. EPA, 1995a. U.S. Environmental Protection Agency, "EPA Office of Compliance Sector Notebook Project – Profile of the Fabricated Metal Products Industry". 1995

Walker, 2006. Air Resources Board staff telephone conversation with Howard Walker, Walker's Custom Chrome. 2006

XI. Environmental Impacts

The main goal of these proposed amendments is to reduce the public's exposure to hexavalent chromium by achieving the maximum reduction in emissions. This is done by proposing a phase-in of HEPA filters, or equivalent for the intermediate and large size facilities, and use of chemical fume suppressants for very small facilities. The proposed amendments are especially designed to reduce exposures when chromium plating and chromic acid anodizing facilities are located near where children and people live, learn, work, and play. The proposal is also designed to have direct benefit for low income and non-white communities that have been disproportionately impacted by hexavalent chromium emissions from chromium plating and chromic acid anodizing operations. A further goal is to isolate people from any new chromium plating or chromic acid anodizing facility.

The primary benefit from the proposed amendments is a large reduction in excess cancer risk from emissions of hexavalent chromium. We estimate cancer risk would be reduced by up to 85 percent. Almost 75 percent of facilities would have cancer risk of less than one per million people exposed. About 92 percent of facilities would have cancer risk of less than ten per million people exposed.

While the reduction in cancer risk is substantial, the overall air quality benefit, in terms of mass, is negligible. Moreover, reducing the cancer risk through adoption of the proposed amendments may have an affect on other environmental factors. As described below, while there may be some potential adverse impacts, ARB staff has determined that they are not significant.

The legal requirements imposed on ARB to assess environmental impacts and our overall evaluation of the environmental impacts of the proposal are summarized below. We evaluated the potential impacts that the proposed amendments to the ATCM may have on air quality, wastewater treatment, and hazardous waste disposal.

A. Legal Requirements

The California Environmental Quality Act (CEQA) and ARB policy require an analysis to determine the potential environmental impacts of proposed regulations. ARB's program for adopting regulations has been certified by the Secretary of Resources, pursuant to Public Resources Code section 21080.5. Consequently, the CEQA environmental analysis requirements may be included in the ISOR for this rulemaking. In the ISOR, the ARB must include a functionally equivalent document, rather than adhering to the format described in CEQA of an Initial Study, a Negative Declaration, and an Environmental Impact Report. In addition, staff will respond in the Final Statement of Reasons for the proposed amendments to the ATCM to all significant environmental issues raised by the public during the 45-day public review period or at the Board hearing.

Public Resources Code section 21159 requires that the environmental impact analysis conducted by ARB include the following:

- An analysis of reasonably foreseeable environmental impacts of the methods of compliance;
- An analysis of reasonably foreseeable feasible mitigation measures; and
- An analysis of reasonably foreseeable alternative means of compliance with the proposed amendments to the ATCM.

Compliance with the proposed amendments to the Chromium Plating ATCM is expected to directly affect air quality and potentially affect other environmental media as well. Our analysis of the reasonably foreseeable environmental impacts of the methods of compliance is presented below.

B. Analysis of Reasonably Foreseeable Environmental Impacts

The proposed amendments reduce the public's exposure to hexavalent chromium emissions from chromium plating and chromic acid anodizing facilities. The methods used to reduce the public's exposure, however, will impact the environment. Our analysis of how the environment would be impacted follows.

1. <u>Potential Air Quality Impacts</u>

As previously discussed, hexavalent chromium is found in the particulate emissions from chromium plating and chromic acid anodizing facilities. However, the small reduction in hexavalent chromium emissions achieved from this proposal would have a negligible effect on ambient particulate levels. While the proposed amendments reduce emissions of hexavalent chromium by about 55 percent, the actual reduction in mass is about 2.2 pounds per year. Remaining emissions are estimated to be 1.8 pounds per year. However, by reducing 2.2 pounds per year of hexavalent chromium, near source cancer risk impacts would be reduced by up to about 85 percent. These reductions will occur in eight air districts, with the greatest benefits occurring in the SCAQMD.

The proposed amendments to the Chromium Plating ATCM are based on our reevaluation of BACT for reducing hexavalent chromium emissions from chromium plating and chromic acid anodizing facilities, in consideration of health risk and cost. The staff's proposal would phase-in BACT over time. The timing for application of BACT would be related to throughput and proximity to sensitive receptors.

By requiring BACT for all facilities, remaining cancer risks would be reduced by up to 85 percent. We also estimate that adoption of the staff's proposal will reduce the estimated cancer risk for 92 percent of facilities to less than or equal to ten per million exposed persons. The proposal would also isolate any new chromium plating or chromic acid anodizing facility from residential or mixed use zones by not allowing new facilities to operate in these areas. The new facility also could not operate within 150 meters of an area so zoned.

Additional indirect air quality impacts will result from the implementation of the proposed amendment to the ATCM. It is anticipated that there will be a temporary increase in emissions of criteria pollutants due to construction related activity involved in the installation of new add-on air pollution controls and the possible dismantling of current controls. Staff finds that this short-term impact will not be significant.

2. Potential Water and Wastewater Impacts

Many of the add-on air pollution control devices required by the proposed amendments require periodic water washdown to clean and maintain the integrity of the system. Implementation of housekeeping measures would likely require fresh water usage as well. This will increase the amount of freshwater used at these facilities. The increased water usage is difficult to quantify, however, we do not expect the increased use to be significant. A total of 89 facilities may increase water usage by installing add-on air pollution control devices. All of this freshwater becomes hazardous wastewater. However, water used to washdown control devices is often returned to the plating tank to reduce generation of hazardous waste.

The State Water Resources Control Board (SWRCB) regulates wastewater in California. It is illegal to dispose into the sewer system, wastewater containing hazardous substances such as hexavalent chromium. Chromium plating and chromic acid anodizing facilities are subject to these regulations. While we expect the amount of wastewater to increase due to the proposed amendments related to housekeeping and equipment maintenance, by compliance with SWRCB regulations, we do not expect this hexavalent chromium to be discharged to lakes, rivers, bays, or oceans.

Some facilities 'treat' their wastewater on site to precipitate the chromium from the water. This sludge, is also hazardous waste, but may be reused in the manufacture of stainless steel, thus further reducing the hazardous waste stream.

3. Potential Hazardous Waste Impacts

Hazardous waste is regulated in California by federal and State laws. In California, all hazardous waste must be disposed of at a facility that is registered with the Department of Toxic Substances Control (DTSC). Chromium plating and chromic acid anodizing facility wastes are classified as hazardous waste because they contain hexavalent chromium.

The proposed amendments, through housekeeping measures and disposal of HEPA filters and other pre-filters from the add-on air pollution control devices that capture hexavalent chromium, would increase the hazardous waste stream.

The use of HEPA systems is already in wide use in the chromium plating and chromic acid anodizing industry in California. These filters, as well as pre-filters designed to increase the useful life of HEPA filters, are considered hazardous waste to be disposed of in Class A landfills. The proposed amendments would require an additional 89 facilities to begin using add-on air pollution control devices with the final collection mechanism likely to be HEPA filters. HEPA filters are usually replaced at least annually, but replacement schedules depend upon the individual operation. Pre-filters are replaced more often.

We have estimated the impact of the incremental increase in the disposal of used filters due to the implementation of the proposed ATCM as follows: For our analysis, we assumed that each of the 89 affected facilities will be disposing of three filters per year, or 89 x 3 = 267 filters per year. Assuming a typical filter volume of 4 cubic feet each, the resulting volume of hazardous waste generated will be 1,068 cubic feet per year (SCAQMD, 2003c). This corresponds to 2.9 cubic feet per day. We do not consider this to be a significant increase in the amount of hazardous waste to be landfilled. Moreover, staff has determined that the expected reduction in cancer risk from the proposed amendments overrides this increase in hazardous waste.

4. Potential Effect on the Environment due to Use of Persistent and Bioaccumulative Perfluorooctyl Sulfonates (PFOS)

One of the hexavalent chromium control technologies in use today employs the use of chemical fume suppressants. The most common types of surfactants used in chromium electroplating and chromic acid anodizing are fluorinated or perfluorinated compounds, or simply, fluorosurfactants (U.S. EPA, 1998).

The fluorosurfactants used as active ingredients in chemical fume suppressants are often referred to as perfluorooctyl sulfonates (PFOS). While these products are highly effective at reducing hexavalent chromium emissions by reducing plating bath surface tension the compounds have been shown to be persistent, bioaccumulative, and toxic to mammals (U.S. EPA, 2006).

Studies indicate that PFOS may have potential developmental, reproductive, and systemic toxicity. PFOS compounds have been shown to be readily absorbed orally and distribute primarily to the serum and liver. Epidemiologic studies have also shown a link between exposure and the incidence of bladder cancer. PFOS compounds have also been shown to exhibit moderate toxicity in fish, aquatic plants, invertebrates, amphibians and birds (U.S. EPA, 2006).

For these reasons, on March 10, 2006, U.S. EPA published at 40 CFR Part 721.9582, a proposal to add certain PFOS into their Significant New Use Rule for perfluoroalkyl sulfonates (PFAS). The PFOS proposed for addition include the PFOS commonly used in chemical fume suppressants.

Our survey of the industry for calendar year 2003 indicated that 190 operations were using chemical fume suppressants as a mechanism to control hexavalent chromium emissions. Almost all of these facilities are using a chemical fume suppressant using PFOS as the active ingredient. We estimate that annually, over 800 gallons of chemical fume suppressant are currently used. The staff's proposal does not require use of chemical fume suppressants except for very small operations. It is also possible that some facilities would cease to use chemical fume suppressants as a result of the staff's proposal. However, when applications allow use of chemical fume suppressants, we expect facilities to continue using them to aid in emission reduction and to lengthen the useful life of HEPA filters.

The proposed amendments would require an additional ten facilities with throughput below 20,000 ampere-hours to either begin using chemical fume suppressants or increase use of chemical fume suppressant to reduce surface tension to below 40 dynes/centimeter. In total, we estimate the initial amount of chemical fume suppressant required to be 0.15 gallons. This is based on total ampere-hours (77,000) and the estimated use of 1.98×10^{-6} gallons of chemical fume suppressant per ampere-hour (SCAQMD, 2003b). Up to eight additional intermediate-sized facilities may begin using chemical fume suppressants if they choose to demonstrate compliance without use of an add-on air pollution control device. At most, the additional amount of chemical fume suppressant used would be three gallons. The chemical fume suppressant is usually supplied at concentrations of 5 to 10 percent PFOS. Typically, in plating/anodizing operations the concentration of PFOS in the plating/anodizing bath is 100 ppm (Atotech, 2006a).

Staff believes this estimate of additional chemical fume suppressant use to be negligible, and expect no significant impact to result from the staff's proposal.

The PFOS chemicals are not present on the finished plated part. Chemical fume suppressants are also known to break down in the plating/anodizing bath (Atotech, 2006a), although the major loss of fume suppressant is due to dragout. Dragout can be reduced by part rinsing over the tank. It has been estimated that about ten percent of the chemical fume suppressant is discharged with wastewater (Atotech, 2006a). Thus, the potential of the general public's exposure to PFOS compounds in the environment from plating and anodizing activities is low.

Staff is not aware of any product other than PFOS that would be as effective at reducing hexavalent chromium while not damaging the plated part. To eliminate the potential of PFOS from chromium plating and chromic acid anodizing activities would require use of add-on air pollution control devices for all facilities, which we have concluded is not appropriate due to costs. Therefore, staff believes that the benefit from the reduction in excess cancers through the use of chemical fume suppressants containing PFOS outweighs the potential adverse impact to the environment due to use of PFOS.

C. Reasonably Foreseeable Mitigation Measures

The California Environmental Quality Act requires an agency to identify and adopt feasible mitigation measures that would minimize any significant adverse environmental impacts described in the environmental analysis. The ARB staff has concluded that no significant adverse environmental impacts should occur from adoption of and compliance with the proposed amendments to the ATCM. Because no significant adverse impacts have been identified, no specific mitigation measures would be necessary.

D. Reasonably Foreseeable Alternative Means of Compliance

Alternatives to the proposed amendments to the Chromium Plating ATCM are discussed in Chapter IX of this report. ARB staff has concluded that the proposed amendments to the ATCM provide the most effective and least burdensome approach to reducing the public's exposure to hexavalent chromium emitted from chromium plating and chromic acid anodizing facilities.

E. Community Health and Environmental Justice

Environmental Justice is defined as the fair treatment of people of all races, cultures, and incomes with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies. The ARB is committed to integrating environmental justice into all of our activities. ARB's "Policies and Actions for Environmental Justice," (Policies) establish our framework for incorporating Environmental Justice into the ARB's programs, consistent with the directive of California state law (ARB, 2001b). These Policies apply to all communities in California. However, environmental justice issues have been raised specifically in the context of low-income areas and non-white communities.

The Policies are intended to promote the fair treatment of all Californians and cover the full spectrum of the ARB's activities. Underlying these Policies is a recognition that the agency needs to engage community members in a meaningful way as it carries out its activities. People should have the best possible information about the air they breathe and what is being done to reduce unhealthful air pollution in their communities. The ARB recognizes its obligation to work closely with all communities, environmental and public health organizations, industry, business owners, other agencies, and all other interested parties to successfully implement these Policies.

During the development of the proposed amendments, ARB staff proactively identified and contacted chromium plating and chromic acid anodizing facility owners, environmental organizations, and other parties interested in chromium plating and chromic acid anodizing. These individuals participated by providing data, reviewing draft regulations, and attending public meetings in which staff directly addressed their concerns.

Staff has found, through modeling analyses, that the health risks from hexavalent chromium emissions from chromium plating and chromic acid anodizing operations tend to be localized, and have the greatest impact on near-source receptors. For these reasons, staff has proposed amendments to reduce exposures to people and children by requiring highly effective controls, and phasing in these controls most quickly at larger facilities and those located nearer to sensitive receptors. Only very small operations (less than 20,000 ampere-hours) would not be required to meet an emission rate of 0.0015 milligrams/ampere-hour. BACT for these facilities is specific chemical fume suppressants capable of reducing emissions to 0.01 milligrams/ampere-hour. However, these small facilities would pose a cancer risk of no more than one per million exposed people. All other facilities would need to demonstrate compliance with the 0.0015 milligram/ampere-hour limit.

For facilities when application of BACT does not reduce cancer risk to below 25 per million exposed people, staff has proposed additional measures to require facilities to conduct a site specific analysis of emissions and health risk. The air districts will use this information to determine if further reductions are necessary. We estimate cancer risk would be reduced by up to 85 percent if the staff's proposal were adopted.

The proposed amendments to the ATCM are consistent with our Policies to reduce health risks from toxic air pollutants in all communities, including those with low-income and non-white populations, regardless of location. Potential health risks from hexavalent chromium emissions from chromium plating and chromic acid anodizing operations can affect both urban and rural communities. Therefore, reducing hexavalent chromium emissions from chromium plating and chromic acid anodizing operations will provide air quality benefits to urban and rural communities in the State, including low-income areas and non-white communities.

We have identified several communities that may be disproportionately impacted from hexavalent chromium emissions from chromium plating and chromic acid anodizing operations. As an example, Appendix I, Chart 1 depicts chromium plating and chromic acid anodizing facilities in the Los Angeles/Orange County area. About 160 facilities are depicted on this Chart. The area shown within the box is magnified in Chart 2. Twenty-four facilities are located within this small area. This is almost 15 percent of all facilities represented in Chart 1. In Chart 2 we have identified those areas where over 30 percent of the residents have incomes below the poverty level (hatched areas). Six facilities are located within this area. Table XI-1 shows the number of facilities located in non-white areas and in areas with a high poverty rate.

Table XI-1. Distribution of Chromium Plating and Chromic Acid Anodizing Facilities in the Los Angeles and Orange County Areas

Location	Total Number of Facilities	30 to 100% Below Poverty	Over 90% Non-white*	Combined 30 to 100% Below Poverty and Over 90% Non-white
Los Angeles and Orange Counties	160	38	80	38
Compton Area	24	6	20	6

* Non-white is defined as the sum of all other races that are not included in the "white-alone" one race category in the 2000 census data prepared by the U.S. Census Bureau.

Table XI-1 shows that half of the facilities in the Los Angeles and Orange County areas are located in areas where over 90 percent of the population is non-white. In our analysis of 2000 U.S. census data, we created the category percent non-white to serve as measure of ethnic diversity on a census tract. The percent non-white value is calculated from the sum of all other races that are not included in the "white-alone" one-race category in the 2000 census data prepared by the U.S. Census Bureau. Of these, 38 facilities (almost 25 percent) are located in areas where the poverty level is 30 percent or more. Similarly for the Compton area, 20 facilities (about 80 percent of the facilities shown in Chart 2) are located in non-white areas, with six of these facilities located in areas where the poverty level exceeds 30 percent. Staff believes this concentration of plating/anodizing operations in low-income and non-white communities has created disproportionate impacts from hexavalent chromium emissions from chromium plating and chromic acid anodizing facilities. Because the proposed amendments to the ATCM would greatly reduce these emissions in residential areas, these communities would realize a major portion of the benefits from the proposal.

To further address environmental justice and the public's concern about developing cancer from exposure to hexavalent chromium emissions at all locations, including currently heavily impacted communities, the proposed amendments to the ATCM establish criteria for the operation of new chromium plating and anodizing facilities. Staff is proposing that any new facility would not be able to operate in any area zoned as residential or mixed use, or within 150 meters of a residential or mixed use zone. Also, new chromium plating and chromic acid anodizing facilities would be required to install add-on air pollution control devices that provide the maximum hexavalent chromium reduction and undergo a site-specific analysis to ensure adequate protection of public health. These criteria will help ensure that new chromium plating and chromic acid anodizing facilities are not operated in areas where people live.

We believe these criteria are necessary to protect people from exposures to hexavalent chromium, an extremely potent, known human carcinogen. While we believe these precautions are necessary in this case, similar requirements may not be appropriate for sources of other TACs. Each TAC should be evaluated on a case by case basis to determine the appropriate methods to protect public health and reduce exposure.

REFERENCES

ARB, 2001b. Air Resources Board. "Policies and Actions for Environmental Justice". 2001

Atotech, 2006a. Atotech USA Inc, GW Walker. Draft Letter to US EPA regarding proposed amendments to the Significant New Use Rule (SNUR) for perfluoroalkyl sulfonates (Docket ID: EPA-HQ-OPPT-2005-0015). 2006.

SCAQMD, 2003b. South Coast Air Quality Management District. "Draft Socioeconomic Assessment for Proposed Amendments to Rule 1469-Hexavalent Chromium Emissions from Chrome Plating and Chromic Acid Anodizing Operations and Proposed Rule 1426-Emissions from Metal Finishing Operations". 2003

SCAQMD, 2003c. South Coast Air Quality Management District, "Final Environmental Assessment: Proposed Rule 1426 – Emissions from Metal Finishing Operations; and, Proposed Amended Rule 1469 – Hexavalent Chromium Emissions from Chrome Plating and Chromic Acid Anodizing Operations." 2003

U.S. EPA, 1998. U.S. Environmental Protection Agency. EPA/625/R-98/002: "Capsule Report Hard Chrome Fume Suppressants and Control Technologies". 1998.

U.S. EPA, 2006. U.S. Environmental Protection Agency. 40 CFR Part 721: "Perfluoroalkyl Sulfonates; Proposed Significant New Use Rule." 2006.

Appendix A

Proposed Regulation Order for the Proposed Amendments to the Chromium Plating ATCM

Hexavalent Chromium Airborne Toxic Control Measure (ATCM) for Chrome Plating and Chromic Acid Anodizing Operations

[Note: The proposed amendments are shown in ~~strikeout~~ to indicate proposed deletions and underline to indicate proposed additions. New quotation marks have been added to the definitions in section 93102.3; these quotation marks have not been underlined to make the regulations easier to read. In addition, explanatory notes are included after or before some provisions of the regulations. They are not part of the regulations; they are included for clarity and are shown in brackets and italics: *[Note......]*

Amend title 17, California Code of Regulations, Section 93102, to read as follows; the amendments include a reorganization of section 93102 so that its provisions are now contained in sections 93102-93102.16:

Section 93102. *~~Hexavalent Chromium~~ Airborne Toxic Control Measure for ~~Chrome~~ Chromium Plating and Chromic Acid Anodizing ~~Operations~~ Facilities.*

The Airborne Toxic Control Measure for Chromium Plating and Chromic Acid Anodizing Facilities (ATCM) is contained in sections 93102 through 93102.16. The ATCM is organized as follows:

Sections 93102 through 93102.3 specify the applicability of the ATCM, exemptions, and definitions. Section 93102.4 sets forth requirements that differ depending on whether a facility is an existing facility, a modified facility, or a new facility. Section 93102.5 sets forth various new requirements that apply to all facilities beginning [Effective Date] (i.e., all existing, modified, and new facilities). Section 93102.6 contains special provisions that apply only to enclosed hexavalent chromium electroplating facilities and facilities that perform electroplating using a trivalent chromium bath. Sections 93102.7 through 93102.14 contain additional requirements that apply to all facilities. Most of the requirements in sections 93102.7 through 93102.14 have been in effect since 1998. Section 93102.15 sets forth requirements that apply to the manufacture, sale, supply, offer for sale, and use of chromium plating and chromic acid anodizing kits in California. There are eight appendices to the ATCM; these appendices are contained in section 93102.6.

93102.1~~(a)~~ *Applicability.*

(a) This regulation shall apply to:

(1) The owner or operator of ~~each chromium electroplating or chromic acid anodizing tank at facilities~~ any facility performing hard chromium electroplating, decorative chromium electroplating, or chromic acid anodizing.

(2) Any person who sells, supplies, offers for sale, uses, or manufactures for sale in California a chromium plating or chromic acid anodizing kit.

(b)~~(5)~~ *Title V Permits.*

The owner or operator of a major source subject to the requirements of this section is required to obtain a title V permit (See 42 U.S.C. 7401, et seq.) from the permitting authority of the district in which the major source is located.

(c) *Severability.*

Each part of this ATCM shall be deemed severable, and in the event that any part of this ATCM is held to be invalid, the remainder of this ATCM shall continue in full force and effect.

93102.2 ~~(2)~~ *Exemptions.*

(a) This regulation shall not apply to process tanks associated with a chromium electroplating or chromic acid anodizing process, but in which neither chromium electroplating nor chromic acid anodizing is taking place. Examples of such tanks include, but are not limited to, rinse tanks, etching tanks, electro stripping tanks and cleaning tanks. Tanks that contain a chromium solution, but in which no electrolytic process occurs, are not subject to this regulation. An example of such a tank is a chrome conversion coating tank where no electrical current is applied.

~~(3) The requirements of subsections (e), (f), and (g) do not apply to decorative chromium electroplating tanks using a trivalent chromium bath with a wetting agent.~~

(b)~~(4)~~ The requirements of subsections 93102.4 ~~(e)~~ and ~~(g)~~ 93102.11 do not apply during periods of equipment breakdown, provided the provisions of the permitting agency's breakdown rule are met (see Appendix 6).

93102.3 ~~(b)~~ *Definitions.*

(a) For the purposes of this regulation, the following definitions shall apply:

(1) *"Add-on air pollution control device"* means equipment installed in the ventilation system of chromium electroplating and anodizing tanks for the purposes of collecting and containing chromium emissions from the tank(s).

(2) *"Air pollution control technique"* means any method, such as an add-on air pollution control device, mechanical fume suppressant or a chemical fume suppressant, that is used to reduce chromium emissions from chromium electroplating and chromic acid anodizing tanks.

(3) *"Ampere-hours"* means the integral of electrical current applied to a plating tank (amperes) over a period of time (hours).

(4) *"Annual Permitted Ampere-hour"* means the maximum allowable chromium plating or anodizing rectifier production in ampere-hours, on an annual basis as specified in the permitting agency's Permit to Operate for the facility.

(5)~~(4)~~ *"Area source"* means any stationary source of hazardous air pollutants that is not a major source as defined in this part.

(6)~~(5)~~ *"Base material"* ~~metal~~ means the metal or metal alloy, or plastic that comprises the workpiece.

(7)~~(6)~~ *"Bath component"* means the trade or brand name of each component(s) in trivalent chromium plating baths. For trivalent chromium baths, the bath composition is proprietary in most cases. Therefore, the trade or brand name for each component(s) can be used; however, the chemical name of the wetting agent contained in that component must be identified.

(8)~~(7)~~ *"Breakdown"* means an unforeseeable impairment of an air pollution control equipment or related operating equipment which causes a violation of any emission limitation or restriction prescribed by a permitting agency's rule or by State law and which: is not the result of neglect or disregard of any air pollution control law, rule, or regulation; is not intentional or the result of negligence, or improper maintenance; is not a recurrent breakdown of the same equipment; and, does not constitute a nuisance pursuant to section 41700 of the California Health and Safety Code, with the burden of proving the criteria of this section placed upon the person seeking to come under the provisions of this law.

(9)~~(8)~~ *"Chemical fume suppressant"* means any chemical agent that reduces or suppresses fumes or mists at the surface of an electroplating or anodizing bath; another term for fume suppressant is mist suppressant.

(10)~~(9)~~ *"Chromic acid"* means the common name for chromium anhydride (CrO3).

(11)~~(10)~~ *"Chromic acid anodizing"* means the electrolytic process by which an oxide layer is produced on the surface of a base ~~metal~~ material for functional purposes (e.g., corrosion resistance or electrical insulation) using a chromic acid solution. In chromic acid anodizing, the part to be anodized acts as the anode in the electrical circuit, and the chromic acid solution, with a concentration typically ranging from 50 to 100 grams per liter (g/L), serves as the electrolyte.

(12)~~(11)~~ *"Chromium electroplating or chromic acid anodizing tank"* means the receptacle or container in which hard or decorative chromium electroplating or chromic acid anodizing occurs~~.~~, along with the following accompanying internal and external tank components needed for chromium electroplating or chromic acid anodizing. These tank components include, but are not limited to, rectifiers fitted with controls to allow for voltage adjustments, heat exchanger equipment, and circulation pumps.

(13)~~(12)~~ *"Composite mesh-pad system"* means an add-on air pollution control device typically consisting of several mesh-pad stages to remove particles. ~~The purpose of the first stage is to remove large particles. Smaller particles are removed in the second stage, which consists of the composite mesh pad. A final stage may remove any reentrained particles not collected by the composite mesh pad.~~

(14)~~(13)~~ *"Decorative chromium electroplating"* means the process by which a thin layer of chromium (typically 0.003 to 2.5 micron~~s~~meters) is electrodeposited on a base metal, plastic, or undercoating material to provide a bright surface with wear and tarnish resistance. In this process, the part(s) serves as the cathode in the electrolytic cell and the solution serves as the electrolyte. Typical current density applied during this process ranges from 540 to 2,400 Amperes per square meter (A/m^2) for total plating times ranging between 0.5 to 5 minutes.

(15) *"Dragout"* means fluid containing hexavalent chromium that adheres to parts when they are removed from a tank.

(16)(14) *"Electroplating or anodizing bath"* means the electrolytic solution used as the conducting medium in which the flow of current is accompanied by movement of metal ions for the purpose of electroplating metal out of the solution onto a workpiece or for oxidizing the base material.

(17)(15) *"Emission limitation"* means, for the purposes of this section trivalent chromium plating, the concentration of total chromium allowed to be emitted expressed in milligrams per dry standard cubic meter (mg/dscm),. For hexavalent chromium plating or anodizing, or the allowable surface tension expressed in dynes per centimeter (dynes/cm) for decorative chromium electroplating and chromic acid anodizing tanks; or and the milligrams of hexavalent chromium per ampere-hour (mg/amp-hr) of electrical charge applied to the chromium electroplating or anodizing tank, or the concentration of chromium allowed to be emitted expressed in milligrams per dry standard cubic meter (mg/dscm). for hard chromium electroplating tanks.

(18) *"Enclosed storage area"* means any space or structure used to contain material that prevents its contents from being emitted into the atmosphere. This includes cabinets, closets or sheds designated for storage.

(19) *"Enclosed hexavalent chromium electroplating tank"* means a hard, decorative or chromic acid anodizing tank using a hexavalent chromium solution that is equipped with an enclosing hood and ventilated at half the rate or less that of an ventilated open surface tank of the same surface area.

(20) *"Existing Facility"* means a facility that is in operation before [Effective Date].

(21)(16) *"Facility"* means the major or area source at which chromium electroplating or chromic acid anodizing is performed. and/or any source or group of sources or other contaminant-emitting activities which are located on one or more contiguous properties within the District, in actual physical contact or separated solely by a public roadway or other public right-of way, and are owned or operated by the same person (or by persons under common control), or an outer continental shelf (OCS) source as determined in 40 CFR Section 55.2.

(22)~~(17)~~ *"Fiber-bed mist eliminator"* means an add-on air pollution control device that removes ~~contaminants~~ particles from a gas stream through the mechanisms of inertial impaction and Brownian diffusion. ~~These devices are typically installed downstream of another control device, which serves to prevent plugging, and consist of one or more fiber beds. Each bed consists of a hollow cylinder formed from two concentric screens; the fiber between the screens may be fabricated from glass, ceramic, plastic, or metal.~~

(23)~~(18)~~ *"Foam blanket"* means the type of chemical fume suppressant that generates a layer of foam across the surface of a solution when current is applied to that solution. A foam blanket does not lower surface tension of a liquid.

(24)~~(19)~~ *"Fresh water"* means water, such as tap water, that has not been previously used in a process operation or, if the water has been recycled from a process operation, it has been treated and meets the effluent guidelines for chromium wastewater.

(25) *"Fugitive dust"* means any solid particulate matter that may contain hexavalent chromium that has the potential to become airborne by natural or man-made activities. "Fugitive dust" does not include particulate matter emitted from an exhaust stack.

(26)~~(20)~~ *"Hard chromium electroplating or industrial chromium electroplating"* means a process by which a thick layer of chromium (typically greater than 1.0 micrometers~~ns~~) is electrodeposited on a base material to provide a surface with functional properties such as wear resistance, a low coefficient of friction, hardness, and corrosion resistance. In this process, the part serves as the cathode in the electrolytic cell and the solution serves as the electrolyte. The ~~H~~hard chromium electroplating process is performed at current densities typically ranging from 1,600 to 6,500 A/m^2 for total plating times ranging from 20 minutes to 36 hours depending upon the desired plate thickness.

<u>(27)</u>~~(21)~~ *"Hexavalent chromium"* means the form of chromium in a valence state of +6.

<u>(28)</u>~~(22)~~ *"High Efficiency Particulate ~~Air~~* <u>Arrestor</u> *(HEPA) filter"* means filter(s) rated at 99.97 percent or more efficient in collecting particle sizes 0.3 micro<u>meters</u>~~ns~~ or larger.

<u>(29)</u> <u>*"Initial Startup"* means the first time a new facility begins production or the first time a modified chromium plating or anodizing tank begins operating at a modified facility. If such production or operation occurs prior to [Effective date], the date of "Initial Startup" is [Effective date]. "Initial Startup" does not include operation solely for testing of equipment or subsequent startup of permit units following malfunction or shutdown.</u>

<u>(30)</u>~~(23)~~ *"Large, hard chromium electroplating facility"* means a facility that performs hard chromium electroplating and emits greater than or equal to 10 pounds per year (lbs/yr) controlled emissions of hexavalent chromium.

<u>(31)</u>~~(24)~~ *"Leak"* means the release of chromium emissions from any opening in the emission collection system prior to exiting the emission control device.

<u>(32)</u>~~(25)~~ *"Major source"* means any stationary source or group of stationary sources located within a contiguous area and under common control that emits or has the potential to emit considering controls, in the aggregate, 10 tons per year or more of any hazardous air pollutant or 25 tons per year or more of any combination of hazardous air pollutants.

<u>(33)</u>~~(26)~~ *"Maximum cumulative potential rectifier capacity"* means the summation of the total installed rectifier capacity associated with the hard chromium electroplating tanks at a facility, expressed in amperes, multiplied by the maximum potential operating schedule of 8,400 hours per year and 0.7, which assumes that electrodes are energized 70 percent of the total operating time. The maximum potential operating schedule is based on operating 24 hours per day, 7 days per week, 50 weeks per year.

<u>(34)</u>~~(27)~~ *"Mechanical fume suppressant"* means any device<u>, including but not limited to polyballs,</u> that reduces fumes or mist at the surfaces of an electroplating or anodizing bath by direct

contact with the surface of the bath. ~~Polyballs are the most commonly used mechanical fume suppressant.~~

(35)~~(28)~~ *"Medium, hard chromium electroplating facility"* means a facility that performs hard chromium electroplating and emits greater than 2 pounds per year (lbs/yr) controlled emissions but less than 10 pounds per year (lbs/yr) controlled emissions of hexavalent chromium.

(36)~~(29)~~ *"Modification"* means either:

(A) any physical change in, change in method of operation of, or addition to an existing permit unit that requires an application for a permit to construct and/or operate and results in an increase in hexavalent chromium emissions. Routine maintenance and/or repair shall not be considered a physical change. A change in the method of operation of equipment, unless previously limited by an enforceable permit condition, shall not include:

~~1.~~ ~~an increase in the production rate, unless such increases will cause the maximum design capacity of the equipment to be exceeded; or~~

1. ~~2.~~ an increase in the hours of operation; or

2. ~~3.~~ a change in ownership of a facility ~~source~~; or

3. an increase in the annual ampere-hours, unless such increase will cause a facility to move from a lower tier to a higher tier in Table 93102.4 of section 93102.4.

(B) The ~~the~~ addition of any new chromium plating or anodizing tank ~~permit unit~~ at an existing facility ~~source~~ which increases hexavalent chromium emissions; or

(C) the fixed capital cost of the replacement of components exceeding 50 percent of the fixed capital cost that would be required to construct a comparable new facility ~~source~~.

(37) *"Modified Facility"* means any facility which has undergone a modification.

(38) *"New Facility"* means any facility that begins initial operations on or after [Effective Date]. "New Facility" does not include

the installation of a new chromium plating or anodizing tank at an existing facility or the modification of an existing facility.

(39)~~(30)~~ *"Operating parameter value"* means a minimum or maximum value established for a control device or process parameter which, if achieved by itself or in combination with one or more other operating parameter values, determines that an owner or operator is in continual compliance with the applicable emission limitation or standard.

(40) *"Owner or Operator"* means a person who is the owner or the operator of a facility performing hard chromium electroplating, decorative chromium electroplating, or chromic acid anodizing.

(41)~~(31)~~ *"Packed-bed scrubber"* means an add-on air pollution control device consisting of a single or double packed-bed that contains packing media on which the chromic acid droplets impinge. ~~The packed-bed section of the scrubber is followed by a mist eliminator to remove any water entrained from the packed-bed section.~~

(42) *"Permitting Agency"* means the local air pollution control or air quality management district.

(43) *"Person"* shall have the same meaning as defined in Health and Safety Code section 39047.

(44)~~(32)~~ *"Responsible official"* means one of the following:

(A) For a corporation: A president, secretary, treasurer, or vice president of the corporation in charge of a principal business function, or any other person who performs similar policy or decision-making functions for the corporation, or a duly authorized representative of such person if the representative is responsible for the overall operation of one or more manufacturing, production, or operating facilities and either:

1. The facilities employ more than 250 persons or have gross annual sales or expenditures exceeding $25 million (in second quarter 1980 dollars); or

2. The delegation of authority to such representative is approved in advance by the Administrator.

(B) For a partnership or sole proprietorship: a general partner or the proprietor, respectively.

(C) For a municipality, state, Federal, or other public agency: either a principal executive officer or ranking elected official. For the purposes of this part, a principal executive officer of a Federal agency includes the chief executive officer having responsibility for the overall operations of a principal geographic unit of the agency (e.g., a Regional Administrator of the U.S. EPA).

(D) For sources (as defined in this part) applying for or subject to a title V permit: "responsible official" shall have the same meaning as defined in 40 CFR Part 70 or federal title V regulations in this chapter (42 U.S.C. 7401, et seq.), whichever is applicable.

(45)~~(33)~~ *"Small, hard chromium electroplating facility"* means a facility that performs hard chromium electroplating and emits less than or equal to 2 pounds per year (lbs/yr) controlled emissions of hexavalent chromium.

(46) *"Sensitive receptor"* means any residence including private homes, condominiums, apartments, and living quarters; education resources such as preschools and kindergarten through grade twelve (k-12) schools; daycare centers; and health care facilities such as hospitals or retirement and nursing homes. A sensitive receptor includes long term care hospitals, hospices, prisons, and dormitories or similar live-in housing.

(47)~~(34)~~ *"Source"* means any chromium electroplating or chromic acid anodizing operation and any equipment or materials associated with the selected associated air pollution control technique.

(48)~~(35)~~ *"Stalagmometer"* means ~~a device used to measure the surface tension of a solution.~~ an instrument used to measure the surface tension of a solution by determining the mass of a drop of liquid by weighing a known number of drops or by counting the number of drops obtained from a given volume of liquid.

(49)~~(36)~~ *"Surface tension"* means the property, due to molecular forces, that exists in the surface film of all liquids and tends to prevent liquid from spreading.

(50) *"Tank"* means the structure or receptacle containing the electroplating or anodizing bath.

(51)~~(37)~~ *"Tank operation"* means the time in which current and/or voltage is being applied to a chromium electroplating tank or a chromic acid anodizing tank.

(52)~~(38)~~ *"Tensiometer"* means ~~a device used to measure the surface tension of a solution.~~ an instrument used to measure the surface tension of a solution by determining the amount of force needed to pull a ring from the liquid surface. The amount of force is proportional to the surface tension.

(53)~~(39)~~ *"Trivalent chromium"* means the form of chromium in a valence state of +3.

(54)~~(40)~~ *"Trivalent chromium process"* means the process used for electrodeposition of a thin layer of chromium onto a base material using a trivalent chromium solution instead of a chromic acid solution.

(55)~~(41)~~ *"Weekly"* means at least once every seven calendar days.

(56)~~(42)~~ *"Wetting agent"* means the type of chemical fume suppressant that reduces the surface tension of a liquid.

93102.4 ~~(c)~~ ~~*Standards*~~ *Requirements for Existing, Modified, and New Hexavalent Chromium Plating and Chromic Acid Anodizing Facilities*.

This section 93102.4 sets forth requirements that apply to all hexavalent chromium hard and decorative chromium electroplating and chromic acid anodizing facilities, except for facilities subject to section 93102.6 (i.e., facilities that perform electroplating using a trivalent chromium bath and are enclosed hexavalent chromium electroplating facilities). The requirements differ depending on whether a facility is an existing facility, a modified facility or a new facility. Additional requirements that apply to all facilities (*i.e.*, all existing, modified, and new facilities) are contained in section 93102.5 and sections 93102.7 through 93102.14.

Subsection (a) contains the requirements to reduce hexavalent chromium emissions that were in effect before [Effective Date]. The limits in subsection (a) shall remain in effect for a facility until the limits in subsection (b) become effective. Once the limits in subsection (b) become effective for an individual facility the limits in subsection (a) no longer apply.

The limits in subsection (b) are phased in depending on the amount of annual permitted ampere-hours and the distance to the nearest sensitive receptor. Depending on the facility, limits in subsection (b) become effective on [Six Months after Effective Date], [Two Years after Effective Date], or [Five Years after Effective Date].

(a)~~(1)~~ *Requirements that Apply to Existing Hexavalent Chromium Electroplating and Chromic Acid Anodizing Facilities.*

An existing facility is a facility that is in operation before [Effective Date].

In addition to the limits specified in this subsection (a) all facilities (*i.e.*, all existing, modified, and new facilities) must comply with the applicable provisions contained in section 93102.5 and sections 93102.7 through 93102.14.

(1) *Limits that Apply to Existing Hard Chromium Electroplating Facilities Until the Limits in subsection (b) Become Effective.* ~~Hard Chrome Electroplating Operations.~~

During tank operation, each owner or operator of an existing~~,~~ ~~modified, or new~~ ~~source~~ facility shall control hexavalent chromium emissions discharged to the atmosphere from that facility ~~source~~ by reducing the hexavalent chromium emissions from the add-on air pollution control device(s) serving the electroplating tank(s) as identified below.

(A) *Limits that Apply Until the Limits in subsection (b) Become Effective for* Existing ~~Operations (on or before 12/16/93)~~ *Hard Chromium Electroplating Facilities that Began Operations on or before December 16, 1993.*

Facility Size	Controlled emissions[1] (lbs/yr)	Requirement		
		≤ 60 million amp-hrs[2]	> 60 million amp-hrs[2]	
			Option 1	Option 2[3]
Large	≥ 10 lbs/yr	≤ 0.006 mg/amp-hr	≤ 0.006 mg/amp-hr	≤ 0.006 mg/amp-hr
Medium	< 10 lbs/yr but > 2 lbs/yr	≤ 0.03 mg/amp-hr	≤ 0.006 mg/amp-hr	≤ 0.03 mg/amp-hr and 0.015 mg/dscm
Small	≤ 2 lbs/yr	≤ 0.15 mg/amp-hr	≤ 0.03 mg/amp-hr	≤ 0.15 mg/amp-hr and 0.015 mg/dscm

(B) ~~New and/or Modified Operations (after 12/16/93)~~ *Limits that Apply Until the Limits in subsection (b) Become Effective for Existing Hard Chromium Electroplating Facilities that Began Operations after December 16, 1993, and Before [Effective Date].*

Facility Size	Controlled Emissions[1] (lbs/yr)	Requirement	
		≤ 60 million amp-hrs[2]	> 60 million amp-hrs[2]
Large	≥ 10 lbs/yr	≤ 0.006 mg/amp-hr	≤ 0.006 mg/amp-hr
Medium/ Small	< 10 lbs/yr	≤ 0.03 mg/amp-hr	≤ 0.006 mg/amp-hr

[1] combined hexavalent or total ~~chrome~~ chromium emissions from hard ~~chrome~~ chromium plating operations.

[2] maximum cumulative potential rectifier capacity or usage limit.

[3] "Option 2" is an alternative emission limitation for small and medium facilities that elect to demonstrate compliance with both a mg/amp-hr and a mg/dscm requirement.

(C) *Special Provisions that Apply for some Hard Chromium Electroplating Facilities Using Less than or Equal to 500,000 Ampere-hours per Year Until the Limits in subsection (b) Become Effective.* ~~*Very small operations using less than or equal to 500,000 ampere-hours per year.*~~

The permitting agency may approve, on a case-by-case basis, alternative standards for ~~small~~ hard ~~chrome plating operations~~ chromium electroplating facilities using less than or equal to 500,000 ampere-hours per year. The operation must have been constructed on or before December 16, 1993. At a minimum, the ~~source~~ facility must use a chemical fume suppressant containing a wetting agent to lower the surface tension of the plating bath to at least 45 dynes per centimeter (dynes/cm) (3.1×10^{-3} pound-force per foot [lbF/ft]). The permitting agency may require additional emission reduction techniques as necessary to reduce the public health impact of emissions from the operation. The owner or operator must comply with the applicable monitoring [subsection ~~(e)~~ 93102.9], recordkeeping [subsection ~~(h)~~ 93102.12], and reporting [subsection ~~(i)~~ 93102.13] requirements. The owner or operator must submit a plan to the permitting agency describing the alternative technique and identifying appropriate monitoring, recordkeeping, and reporting requirements. The permitting agency, with U.S. EPA concurrence, shall approve this plan if equivalent results are obtained. Upon approval, the requirements identified in the plan shall be the applicable requirements under this regulation.

(2) *Requirements that Apply to Existing Hexavalent Decorative Chrom~~e~~ium Electroplating and Chromic Acid Anodizing Facilities Until the Limits in subsection (b) Become Effective.*

During tank operation, each owner or operator of an existing~~,~~ ~~modified, or new source~~ decorative hexavalent chromium electroplating or chromic acid anodizing facility shall control hexavalent chromium emissions discharged to the atmosphere by meeting either of the requirements identified below.

Method of compliance	Requirement
1. add-on air pollution control equipment, or chemical fume suppressants, or mechanical fume suppressants (i.e. polyballs)	0.01 milligrams per dry standard cubic meter of air (mg/dscm) (4.4×10^{-6} gr/dscf)
2. chemical fume suppressants containing a wetting agent	45 dynes per centimeter (dynes/cm) (3.1×10^{-3} pound-force per foot [lbF/ft])

(b) *Limits that Apply to All Existing Hexavalent Hard and Decorative Chromium Electroplating and Chromic Acid Anodizing Facilities After [Effective Date].*

(1) During tank(s) operation, each owner or operator of an existing hexavalent chromium facility shall control hexavalent chromium emissions discharged to the atmosphere by meeting the requirements identified below.

[*Table 93102.4 is a newly proposed table. It is not shown in* underline *for clarity*]

Table 93102.4: Hexavalent Chromium Emission Limits for Existing Facilities

Tiers of Annual Permitted Ampere-Hours	Sensitive Receptor Distance [1]	Emission Limitation	Effective Date
Tier 1 ≤ 20,000	Any	Use Chemical Fume Suppressant as specified in section 93102.8 [2]	[Six Months after Effective Date]
Tier 2 > 20,000 and ≤ 200,000	≤ 100 Meters	0.0015 milligrams/ampere-hour [3]	[Two Years after Effective Date]
Tier 3 > 20,000 and ≤ 200,000	> 100 Meters	0.0015 milligrams/ampere-hour [3]	[Five Years after Effective Date]
Tier 4 > 200,000	Any	0.0015 milligrams/ampere-hour [4, 5]	[Two Years after Effective Date]

1 Distance shall be evaluated by the permitting agency.
2 Alternatively, [Two Years after Effective Date] facility shall comply with the requirement for facilities with > 20,000 and ≤ 200,000 annual permitted ampere-hours.
3 Emission limit compliance may be demonstrated without using add-on air pollution control device(s). If an add-on air pollution control device has been installed, the emission limitation shall be measured after the add-on air pollution control device.
4 Measured after add-on air pollution control device(s).
5 When actual annual emissions exceed 15 grams a site specific analysis must be conducted in accordance with the permitting agency's procedures.

(2) *Demonstrating Compliance with the Emission Limitation in Table 93102.4*

(A) Facilities complying with Tier 2 or Tier 3 requirements in Table 93102.4 may demonstrate compliance with the emission limitation of 0.0015 milligrams/ampere-hour without the use of an add-on air pollution control device(s). At a minimum, if the facility is demonstrating compliance with the Tier 2 or Tier 3 requirements in Table 93102.4 without an add-on air pollution control device(s), the facility must use a chemical fume suppressant as specified in section 93102.8.

(B) Facilities complying with Tier 4 requirements in Table 93102.4 must use an add-on air pollution control device(s) to control hexavalent chromium emissions and demonstrate compliance with the emission limitation of 0.0015 milligrams/ampere-hour as measured after the add-on air pollution control device.

(c) *Requirements for Modified Hexavalent Chromium Electroplating or Chromic Acid Anodizing Facilities.*

(1) During tank operation, each owner or operator of a modified facility shall upon initial start-up control hexavalent chromium emissions discharged to the atmosphere from that facility by reducing the hexavalent chromium emissions from the electroplating or anodizing tank(s) by:

(A) Using an add-on air pollution device(s) to control hexavalent chromium emissions, and

(B) Meeting an emission limit of 0.0015 milligrams per ampere-hour or less as measured after add-on controls.

(2) Prior to initial start-up of a modified facility, with actual annual emissions of hexavalent chromium exceeding 15 grams per year, the owner or operator shall conduct a site specific analysis in accordance with the permitting agency's procedures.

(d) *Requirements for New Hexavalent Chromium Electroplating and Chromic Acid Anodizing Facilities Beginning [Effective Date].*

(1) No person shall operate a new facility unless it is located outside of an area that is zoned for residential or mixed use and is located at least 150 meters from the boundary of any area that is zoned for residential or mixed use as determined by the permitting agency.

(A) A new facility shall be deemed to meet the requirements specified in this subsection (d)(1) if one of the following criteria is met, even if the facility does not meet the requirement at the time of initial startup (e.g., because of a zoning change that occurs after the authority to construct is issued):

1. The requirements specified in this subsection (d)(1) are met at the time it is issued an authority to construct by the permitting agency, and substantial use of the authority to construct takes place within one year after it is issued; or

2. The requirements specified in this subsection (d)(1) are met at the time it is issued an authority to construct by the permitting agency, and substantial use of the authority to construct takes place before any zoning change occurs that affects the operation's ability to meet the requirement at the time of initial startup.

(2) During tank operation, each owner or operator of a new facility shall control hexavalent chromium emissions discharged to the atmosphere from that facility by reducing the hexavalent chromium emissions from the electroplating or anodizing tank(s) by installing a HEPA add-on air pollution control device. The measured emission rate of hexavalent chromium shall be no more than 0.0015 milligrams per ampere-hour as measured after the HEPA add-on air pollution control device.

(3) Prior to initial start-up each new facility shall conduct a site specific analysis in accordance with the permitting agency's procedures.

(4) Prior to initial startup, each new facility shall demonstrate to the permitting agency that the new facility meets the requirements specified in this subsection (d).

~~*(3) Decorative Chromium Electroplating Tanks Using a Trivalent Chromium Bath.*~~

[Note: This subsection has been modified and moved to section 93102.6 of this regulation]

~~During tank operation, each owner or operator of an existing, modified, or new source shall control chromium emissions discharged to the atmosphere by meeting either of the requirements identified below.~~

~~Method of compliance~~	~~Requirement~~
~~add-on air pollution control equipment, or chemical fume suppressants, or mechanical fume suppressants (i.e. polyballs)~~	~~< 0.01 mg/dscm (4.4x10^{-6} gr/dscf)~~
~~chemical fume suppressants containing a wetting agent~~	~~use wetting agent as bath ingredient and comply with recordkeeping and reporting provisions of subsections (h)(9) and (i)(5).~~

(e) *Notification Requirements for New and Modified Facilities.*

[Note: This subsection has been moved from section 93102.13 ~~(j)~~ to this section 93102.4~~(c)~~. It has also been modified.]

(1) *Notification of Construction Reports.*

(A) No person may construct or modify a facility, such that it becomes a facility subject to this section 93102, without submitting a notification of construction or modification to the permitting agency and receiving approval in advance to construct or modify the facility.

(B) The contents of the Notification of Construction Report shall include the information contained in Appendix 4.

(2) *Alternative Notification Requirements:* Instead of complying with the requirements in subpart ~~paragraph~~ (e)(1)(A) of this subsection, a facility may fulfill these requirements by complying with the permitting agency's "New Source Review" requirements, provided similar information is obtained.

93102.5 *Requirements that Apply to Existing, Modified, and New Hexavalent Chromium Plating or Chromic Acid Anodizing Facilities Beginning [Effective Date].*

Each owner or operator of a hexavalent chromium plating or chromic acid anodizing facility shall comply with the following requirements on or after the dates specified below:

(a) *Removal of Add-on Pollution Control Device(s).* No add-on air pollution control device(s) installed before [Effective Date] shall be removed or rendered inoperable unless it is replaced by an add-on air pollution control device(s) meeting an emission rate of 0.0015 mg/amp-hr or less as measured after the add-on air pollution control device.

(b) *Environmental Compliance Training.* No later than [Two Years After Effective Date] and within every two years thereafter, the owner or operator of a facility, or personnel designated by the owner or operator that are responsible for maintaining environmental compliance, shall complete an Air Resources Board (ARB) Compliance Assistance Training Course.

(1) On or after [Two Years After the Effective Date] environmental compliance and recordkeeping required by this section 93102 shall be conducted only by persons who completed an ARB Compliance Assistance Training Course.

(2) In the event that all persons who have completed the ARB training class are no longer associated with a facility, the owner or operator may be responsible for environmental compliance and recordkeeping required by this section for a period of time not to exceed two years. The owner or operator shall ensure that as soon as practicable, but not longer than two years, personnel complete the training specified in subsection 91302.5(b).

(3) Environmental compliance training conducted by the South Coast Air Quality Management District pursuant to Rule 1469 shall fulfill the requirements of this subpart.

(4) Nothing in this subsection 91302.5(b) shall absolve an owner or operator from complying with this section 93102.

(c) *Housekeeping Requirements.* Effective [Six Months After Effective Date], housekeeping practices shall be implemented to reduce potential fugitive emissions of hexavalent chromium. At a minimum, the following practices shall be implemented:

(1) Chromic acid powder or flakes, or other substances that may contain hexavalent chromium, shall be stored in a closed container in an enclosed storage area;

(2) Chromic acid powder or flakes shall be transported from an enclosed storage area to the electroplating or anodizing bath(s) in a closed container;

(3) Any liquid or solid material that may contain hexavalent chromium that is spilled shall be cleaned up or contained within one hour after being spilled.

(4)~~(D)~~ Dragout from the tank(s) shall be minimized by implementing the following practices:

(A) Facilities with automated lines. Drip trays shall be installed between tanks so that the liquid does not fall through the space between tanks. Trays shall be placed such that the liquid is returned to the tank(s).

(B) *Facilities without automated lines.*

1. Each electroplated or anodized part must be handled so that excess chromic acid is not dripped outside the electroplating tank.

2. Each facility spraying down parts over the electroplating or anodizing tank(s) to remove excess chromic acid shall have a splash guard installed around the tank to minimize overspray and to ensure that any hexavalent chromium laden liquid is returned to the electroplating or anodizing tank.

(5) Surfaces within the enclosed storage area, open floor area, walkways around the electroplating or anodizing tank(s), or any surface potentially contaminated with hexavalent chromium, that accumulates or potentially accumulates dust shall be HEPA vacuumed, hand wiped with a damp cloth, or wet mopped, or shall be maintained with the use of non-toxic chemical dust suppressants at least once every seven days.

(6) Buffing, grinding, or polishing areas within a facility shall be separated from the facility by installing a physical barrier. The barrier may take the form of plastic strip curtains.

(7) Chromium or chromium-containing wastes generated from housekeeping activities shall be stored, disposed of, recovered, or recycled using practices that do not lead to fugitive dust and in accordance with hazardous waste requirements.

93102.6 *Special Provisions that Apply Only to Facilities that Perform Electroplating Using a Trivalent Chromium Bath and Enclosed Hexavalent Chromium Electroplating Facilities.*

(a) *Provisions that Apply to All Facilities that Perform Electroplating Using a Trivalent Chromium Bath.*

(1) During tank operation, each owner or operator of an existing, modified, or new facility shall control chromium emissions discharged to the atmosphere by meeting either of the requirements identified below.

[Note: This is an existing table that has been moved from section (c)(3) of the existing regulation. It has not been underlined in order to make it easier to read.]

Method of compliance	Requirement
add-on air pollution control equipment, or chemical fume suppressants, or mechanical fume suppressants (i.e. polyballs)	$\leq$ 0.01 mg/dscm (4.4x10^{-6} gr/dscf)
chemical fume suppressants containing a wetting agent	use wetting agent as bath ingredient and comply with recordkeeping and reporting provisions of ~~sub~~sections ~~(h)(9)~~ 93102.12 (i) and ~~(i)(5)~~ 93102.13 (e).

(2) New facilities that perform electroplating using a trivalent chromium bath must comply with the requirements specified in section 93102.4 (d)(1).

(3) An owner or operator that performs electroplating using a trivalent chromium bath and complying through use of a chemical fume suppressant containing a wetting agent shall not be required to comply with the requirements of sections 93102.4 (except for section 93102.4(d)(1)), 93102.7, 93102.8,

93102.9 (b) through (f), 93102.10, 93102.11, 93102.12 (a) through (f), and 93102.12 (h).

(b)~~(2)~~ *Requirements for Enclosed Hexavalent Chromium Electroplating Tanks.*

(1) The owner or operator of a hexavalent chromium electroplating facility with enclosed hexavalent chromium plating tank(s) shall control hexavalent chromium emissions from the electroplating tank(s) by:

(A) Achieving a hexavalent chromium emission limitation of 0.015 mg/dscm as measured after the add-on air pollution control device(s); or

(B) Using a chemical fume suppressant specified in section 93102.8, and maintaining the surface tension of the plating bath solution at a value specified in section 93102.8; or

(C) Not allowing the mass rate of the total chromium to exceed the maximum allowable mass emission rate determined by using the calculation procedure specified in Appendix 7.

(2) The owner or operator of a facility with enclosed hexavalent chromium plating tank(s) must also comply with all requirements of this ATCM except for the requirements set forth in section 93102.4(b) and (c).

93102.7 ~~(d)~~ *Performance Test Requirements and Test Methods.*

(a)~~(1)~~ *Performance test requirements.*

~~Any source subject to the emission standards in subsection (c)(1)(A) or (B), or any source electing to comply with the mg/dscm emission standard in subsections (c)(2) or (c)(3) shall conduct a performance test to demonstrate compliance with the applicable emission standards within 180 days after initial startup.~~

(1) The following facilities must conduct a performance test to demonstrate compliance with the hexavalent chromium emission rate as specified in section 93102.4:

(A) Existing facilities demonstrating compliance with the 0.0015 milligrams per ampere-hour emission limitation specified in Table 93102.4.

(B) Facilities that undergo a modification after [Effective Date].

(C) New facilities.

(D) Trivalent chromium plating facilities meeting the emission rate specified in section 93102.6 (a)(1).

(2) Facilities must conduct the performance test required by this section 93102.7 no later than 60 days after initial start-up.

(3) The performance test must be conducted using one of the approved test methods specified in subsection 93102.7(c). The hexavalent chromium emission rate shall be multiplied by the facility annual permitted ampere-hour usage to determine the annual emissions of hexavalent chromium for the facility.

(b)~~(2)~~ *Use of ~~existing~~ previously conducted performance test.*

~~A performance test conducted prior to July 24, 1997 may be used to demonstrate compliance provided the existing source test is approved by the permitting agency and the U.S. EPA.~~

A performance test conducted after January 1, 2000 may be used to satisfy the requirements of this section 93102.7 so long as all of the following criteria are met:

(1) The add-on air pollution control device tested demonstrated a hexavalent chromium emission rate of 0.0015 mg/amp-hr or less for hexavalent chromium plating or chromic acid anodizing facilities, or 0.01mg/dscm or less for trivalent chromium plating facilities, and

(2) The performance test was approved by the permitting agency, and

(3) The test is representative of the add-on air pollution control device currently in use as of [Effective Date], and

(4) The performance test was conducted using one of the approved test methods specified in subsection 93102.7(c).

(c)~~(3)~~ *Approved test methods.*

(1)~~(A)~~ Emissions testing for hexavalent and total chromium shall be conducted with a minimum of three test runs in accordance with one of the following test methods:

(A)~~1.~~ California Air Resources Board ~~CARB~~Test Method 425, last amended July 28, 1997, (section 94135, Title 17, California Code of Regulations (CCR); or

(B)~~2.~~ U.S. EPA Method 306, (40 CFR 63 Appendix A) ~~with a minimum of three test runs~~ with hexavalent chromium option (Method 306, Section 2.2.3); or

(C)~~3.~~ South Coast Air Quality Management District Method 205.1~~, for results reported as total chromium~~.

(2)~~(B)~~ Smoke Test to Verify the Seal Integrity of Covers Designed to Reduce Chromium Emissions from Electroplating and Anodizing Tanks (See Appendix 5).

(3)~~(C)~~ Surface tension using a tensiometer shall be measured in accordance with U.S. EPA Method 306B (40 CFR 63 Appendix A). Surface tension using a stalagmometer shall be measured using the procedure set forth in Appendix 8, or an alternative procedure approved by the permitting agency.

(d)~~(4)~~ *Pre-Test protocol.* Facilities ~~Sources~~ subject to the provisions of ~~sub~~section ~~(d)(1), above,~~ 93102.7 (a) must submit a pre-test protocol to the permitting agency at least 60 days prior to conducting a performance test. The pre-test protocol shall include the performance test criteria of the end user and all assumptions, required data, and calculated targets for testing the source target chromium concentration, the preliminary chromium analytical data, and the planned sampling parameters. In addition, the pre-test protocol shall include information on equipment, logistics, personnel, and other resources necessary for an efficient and coordinated test.

(e)~~(5)~~ *Test all emission points.* Each emission point subject to the requirements of this regulation must be tested unless a waiver is granted by U.S. EPA and approved by the permitting agency.

93102.8 *Chemical Fume Suppressants.*

Chemical fume suppressants used to comply with sections 93102.4 and 93102.6 shall meet the criteria specified in this section 93102.8.

(a) One or more of the chemical fume suppressants listed in Table 93102.8 shall be used to reduce the surface tension of the electroplating or anodizing bath(s) below the surface tension value listed in Table 93102.8. The surface tension value may be measured using either a stalagmometer or a tensiometer.

[Table 93102.8 is a new table. For clarity it is not shown in underline/strikeout]

Table 93102.8: Chemical Fume Suppressants Approved for Use at Specified Surface Tensions

Chemical Fume Suppressant and Manufacturer	Stalagmometer Measured Surface Tension (dynes/centimeter)	Tensiometer Measured Surface Tension (dynes/centimeter)
Benchbrite CR 1800® Benchmark Products	< 40	< 35
Clepo Chrome® MacDermid	< 40	< 35
Fumetrol 140® Atotech U.S.A.	< 40	< 35

(b) *Alternative chemical fume suppressants.* Chemical fume suppressants not listed in Table 93102.8 may be used upon approval by the Executive Officer. The Executive Officer shall approve the use of an alternative chemical fume suppressant if the following criteria are met:

(1) The chemical fume suppressant has been performance tested in a hexavalent chromium electroplating or anodizing bath and demonstrated to reduce the hexavalent chromium emissions below 0.01 milligrams per ampere hour; and

(2) In the performance testing, the hexavalent chromium emission rate of 0.01 milligrams per ampere-hour was achieved under conditions in which the surface tension did not exceed 45 dynes/cm, as measured by a stalagmometer or 35 dynes/cm, as measured by a tensiometer.

(c) A chemical fume suppressant that is listed in subsection 93102.8(a) or that has been approved under subsection 93102.8(b) may no longer be used if the Executive Officer determines that the chemical fume suppressant is no longer able to reduce the hexavalent chromium emission rate below 0.01 milligrams per ampere-hour under conditions in which the surface tension does not exceed 45 dynes/cm, as measured by a stalagmometer or 35 dynes/cm, as measured by a tensiometer.

93102.9 ~~(e)~~ *Parameter Monitoring Requirements*.

(a)~~(1)~~ *Ampere-hours.* Each electroplating or anodizing tank or group of electroplating or anodizing tanks shall have installed a continuous recording, non resettable, ampere-hour meter that operates on the electrical power lines connected to the tank or group of tanks. A separate meter shall be hard-wired for each rectifier.

(b)~~(2)~~ *Pressure drop.* The owner or operator shall continuously monitor the pressure drop across an add-on control device such as a composite mesh-pad (CMP), packed-bed scrubber (PBS), a CMP/PBS, fiber-bed mist eliminator, and a High Efficiency Particulate ~~Air~~ Arrestor (HEPA) filter with a mechanical gauge. The gauge shall be located so that it can be easily visible and in clear sight of the operation or maintenance personnel. The pressure drop shall be maintained within ~~±1~~ +2 inches of water of the value established during the performance test to demonstrate compliance with the emission limitation for CMP, PBS, a CMP/PBS, and a fiber-bed mist eliminator. The pressure drop shall be maintained within - ½ times to +2 times the inches of water of the value established during the performance test to demonstrate compliance with the emission limitation for HEPA filters.

(c)~~(3)~~ *Inlet velocity pressure.* The owner or operator shall continuously monitor the inlet velocity pressure of a packed-bed scrubber with a mechanical gauge. The gauge shall be located so that it can be easily visible and in clear sight of the operation or maintenance personnel. The inlet velocity pressure shall be maintained within ± 10 percent of the value established during the performance test to demonstrate compliance with the emission limitation.

(d)~~(4)~~ *Surface tension.* The owner or operator shall measure and monitor the surface tension of the ~~chrome~~ electroplating or ~~chromic acid~~ anodizing ~~tank~~ bath(s) ~~that contains a wetting agent~~ with either a stalagmometer using the procedure in Appendix 8 of this section 93102 or a procedure approved by the permitting agency, or with a tensiometer using U.S. EPA Method 306B (40 CFR part 63, Appendix A). The surface tension shall be maintained ~~at or~~ below the value required by ~~sub~~section ~~(c)(2)~~ 93102.8. Surface tension shall be measured daily for 20 operating days, and weekly thereafter as long as there is no violation of the surface tension requirement. If a violation occurs, the measurement frequency shall return to daily for 20 operating days, and weekly thereafter.

(e)~~(5)~~ *Foam blanket thickness.* The owner or operator shall monitor the foam blanket thickness across the surface of the ~~chrome~~ electroplating or ~~chromic acid~~ anodizing bath ~~tank~~. The foam blanket thickness shall be maintained consistent with the requirements established during the performance test to demonstrate compliance with the emission limitation. Foam thickness shall be measured hourly for 15 operating days, and daily thereafter as long as there is no violation of the foam thickness requirement. If a violation occurs, the measurement frequency shall return to hourly for 15 operating days, and daily thereafter.

(f)~~(6)~~ ~~*Polyballs or similar m*~~ *Mechanical fume suppressants.* The owner or operator shall visually inspect the ~~chrome~~ electroplating or ~~chromic acid~~ anodizing ~~tank~~ bath for coverage comparable to the coverage during the performance test daily.

91302.10 ~~(f)~~ *Inspection and Maintenance Requirements.*

(a)~~(1)~~ ~~Hard and decorative chrome~~ Hexavalent chromium electroplating~~,~~ and chromic acid anodizing ~~operations~~ facilities ~~using add-on air pollution control equipment~~ shall comply with the applicable inspection and maintenance requirements listed in Table 93102.10 ~~(f)(1)~~.

Table 93102.10 ~~(f)(1)~~ -- Summary of Inspection and Maintenance Requirements ~~for Sources Using Add-on Air Pollution Control Devices~~

Control Technique/Equipment	Inspection and Maintenance Requirements	Frequency
Composite mesh-pad (CMP) system~~.~~, Packed-bed scrubber (PBS), or PBS/CMP	1. Visually inspect device to ensure that there is proper drainage, no unusual chromic acid buildup on the pads, and / or packed beds and no evidence of chemical attack that affects the structural integrity of the device.	1. 1/quarter.

	2. Visually inspect back portion of the mesh pad closest to the fan to ensure there is no breakthrough of chromic acid mist and/or back portion of the chevron mist eliminator to ensure it is dry and there is no breakthrough of chromic acid mist.	2. 1/quarter.
	3. Visually inspect ductwork from tank to the control device to ensure there are no leaks.	3. 1/quarter.
	4. Perform washdown ~~of the composite mesh pads in accordance with manufacturer's recommendations~~ and/or add fresh makeup water to the packed bed when it is needed.	4. Per manufacturer.
~~Packed-bed scrubber (PBS)~~	~~1. Visually inspect device to ensure there is proper drainage, no unusual chromic acid buildup on the packed beds, and no evidence of chemical attack that affects the structural integrity of the device.~~	~~1. 1/quarter.~~
	~~2. Visually inspect back portion of the chevron blade mist eliminator to ensure that it is dry and there is no breakthrough of chromic acid mist.~~	~~2. 1/quarter.~~
	~~3. Same as number 3 above for CMP system.~~	~~3. 1/quarter.~~
	~~4. Add fresh makeup water to the packed bed~~[A]	~~4. Whenever makeup is needed.~~
~~PBS/CMP system~~	~~1. Same as for CMP system~~	~~1. 1/quarter.~~
	~~2. Same as for CMP system~~	~~2. 1/quarter.~~
	~~3. Same as for CMP system~~	~~3. 1/quarter.~~
	~~4. Same as for CMP system~~	~~4. Per manufacturer.~~
Fiber-bed mist eliminator[A-B]	1. ~~Visually inspect fiber-bed unit and prefiltering device to ensure there is proper drainage, no unusual chromic acid buildup in the units, and no evidence of chemical attack that affects the structural integrity of the devices.~~ Same as number 1 for CMP/PBS.	1. 1/quarter.
	2. ~~Visually inspect ductwork from tank or tanks to the control device to ensure there are no leaks.~~ Same as number 3 for CMP/PBS.	2. 1/quarter.

	3. ~~Perform washdown of fiber elements in accordance with manufacturer's recommendations.~~ Same as number 4 for CMP/PBS.	3. Per manufacturer.
High Efficiency Particulate ~~Air~~ Arrestor (HEPA) filter	1. Look for changes in the pressure drop.	1. 1/week.
	2. Replace HEPA filter.	2. Per manufacturer's specifications or permitting agency's requirement.
Chromium Tank Covers [facilities complying with subsection 93102.6(b)	1. Drain the air-inlet (purge air) valves at the end of each day that the tank is in operation.	1. 1/day.
	2. Visually inspect access door seals and membranes for integrity.	2. 1/week.
	3. Drain the evacuation unit directly into the plating tank or into the rinse tanks (for recycle into the plating tank).	3. 1/week.
	4. Visually inspect membranes for perforations using a light source that adequately illuminates the membrane (e.g., Grainger model No. 6X971 Fluorescent Hand Lamp).	4. 1/month.
	5. Visually inspect all clamps for proper operation; replace as needed.	5. 1/month.
	6. Clean or replace filters on evacuation unit.	6. 1/month.
	7. Visually inspect piping to, piping from, and body of evacuation unit to ensure there are no leaks and no evidence of chemical attack.	7. 1/quarter.
	8. Replace access door seals, membrane evacuation unit filter, and purge air inlet check valves in accordance with the manufacturer's recommendations.	8. Per manufacturer.

Pitot tube	Backflush with water, or remove from the duct and rinse with fresh water. Replace in the duct and rotate 180 degrees to ensure that the same zero reading is obtained. Check pitot tube ends for damage. Replace pitot tube if cracked or fatigued.	1/quarter.
Ampere-hour meter	Install and maintain per manufacturer's specifications.	Per manufacturer.
Stalagmometer/ Tensiometer	Calibrate and maintain per manufacturer's specifications.	Per manufacturer.

~~A Horizontal packed-bed scrubbers without continuous recirculation must add make-up water to the top of the packed bed.~~

AB Inspection and maintenance requirements for the control device installed upstream of the fiber-bed mist eliminator to prevent plugging do not apply as long as the inspection and maintenance requirements for the fiber-bed unit are followed.

~~(2) Hard and decorative chrome electroplating, and chromic acid anodizing operations using chemical fume suppressants (i.e. wetting agent, foam) or mechanical fume suppressants (i.e. polyballs) shall comply with the applicable inspection and maintenance requirements in Table (f)(2).~~

Note: Table (f)(2) is proposed for deletion

~~Table (f)(2) – Summary of Inspection and Maintenance Requirements for Sources Using Chemical or Mechanical Fume Suppressants~~

~~**Equipment**~~	~~**Inspection and Maintenance Requirement for Monitoring Equipment**~~	~~**Frequency**~~
~~Ampere-hour meter~~	~~Install and maintain per manufacturer's specifications~~	~~Per manufacturer~~
~~Stalagmometer/ Tensiometer~~	~~Calibrate and maintain per manufacturer's specifications~~	~~Per manufacturer~~

(b) Add-on air pollution control device(s) that is custom designed for a specific operation shall develop operating and maintenance requirements. The requirements shall be submitted to the permitting agency for review and approval. The requirements and frequency of inspection must be sufficient to ensure compliance.

93102.11 ~~(g)~~ *Operation and Maintenance Plan (O & M plan) Requirements.*

(a)~~(1)~~ *Prepare the O & M plan.* The owner or operator subject to the inspection and maintenance requirements of subsections 93102.10(a) and (b) ~~(f)(1)~~ shall prepare an operation and maintenance plan. For major sources, the plan shall be incorporated by reference into the source's title V permit. The plan shall incorporate the inspection and maintenance requirements for that device or monitoring equipment, as identified in Table 93102.10 ~~(f)(1)~~ or subsection 93102.10 (b) of this section and include the following elements:

(1)~~(A)~~ A standardized checklist to document the operation and maintenance of the facility ~~source~~, the add-on air pollution control device, and the process and control system monitoring equipment; and

(2)~~(B)~~ Procedures to be followed to ensure that equipment is properly maintained. [To satisfy the inspection and maintenance~~s~~ requirements of this subsection, the owner or operator may use applicable standard operating procedure (SOP) manuals, Occupational Safety and Health Administration (OSHA) plans, or other existing plans, provided the alternative plans meet the requirements of this subsection.]

(b)~~(2)~~ *Retain the O & M plan.* The owner or operator shall keep the written operation and maintenance plan on record after it is developed to be made available for inspection, upon request, during normal working hours.

(c)~~(3)~~ *Changes to the O & M plan.* Any changes made by the owner or operator should be documented in an addendum to the plan. In addition, the owner or operator shall keep previous (i.e., superseded) versions of the operation and maintenance plan on record to be made available for inspection, upon request, during normal working hours, for a period of 5 years after each revision to the plan.

(d)~~(4)~~ *Revisions to the O & M plan to address breakdowns.* The operation and maintenance plan shall be revised as necessary to minimize breakdowns.

93102.12 ~~(h)~~ *Recordkeeping Requirements.*

(a)~~(1)~~ Inspection records~~ for sources using add-on control air pollution control devices~~. The owner or operator shall maintain inspection records to document that the inspection and maintenance requirements of ~~sub~~section ~~(f)~~ 93102.10 and Table ~~(f)(1)~~ 93102.10, and the provisions of the operation and maintenance plan required by ~~sub~~section ~~(g)~~ 93102.11 have been met. The record can take the form of a checklist and shall identify:

(1)~~(A)~~ the device inspected,

(2)~~(B)~~ the date and time of inspection,

(3)~~(C)~~ a brief description of the working condition of the device during the inspection,

(4)~~(D)~~ maintenance activities performed on the components of the air pollution control system (i.e. duct work replacement, filter pad replacement, fan replacement, etc), and

(5)~~(E)~~ actions taken to correct deficiencies found during the inspection.

~~(2) Inspection records for sources using chemical fume suppressants (i.e. wetting agent, foam) or mechanical fume suppressants (i.e. polyballs). The owner or operator shall maintain inspection records to document that the inspection and maintenance requirement of subsection (f)(2) and Table (f)(2) have been met. The record can take the form of a checklist.~~

(b)~~(3)~~ *Performance test records.* The owner or operator shall maintain test reports documenting the conditions and results of all performance tests.

(c)~~(4)~~ *Monitoring data records.* The owner or operator shall maintain records of monitoring data required by ~~sub~~section 93102.9 ~~(e)~~ that are used to demonstrate compliance~~ with the standard~~ including the date and time the data are collected.

(1)~~(A)~~ *Cumulative rectifier usage records.* Record the actual cumulative rectifier usage expended during each month of the reporting period, and the total usage expended to date.

(2)~~(B)~~ *Pressure drop.* The owner or operator shall record the pressure drop once a week.

(3)~~(C)~~ *Inlet Velocity Pressure.* The owner or operator shall record the inlet velocity pressure weekly.

(4)~~(D)~~ *Surface tension.* The owner or operator shall record the surface tension daily for 20 operating days, and weekly thereafter as long as there is no violation of the surface tension requirement. If the surface tension exceeds ~~45 dynes/cm~~ levels specified in section 93102.8, the owner or operator shall again record the surface tension daily for 20 operating days, and weekly thereafter.

(5)~~(E)~~ *Foam thickness.* The owner or operator shall record the foam thickness hourly for 15 operating days, and daily thereafter as long as there is no violation of the foam thickness requirement. If a violation occurs, the measurement frequency shall return to hourly for 15 operating days, and daily thereafter.

(d)~~(5)~~ *Breakdown records.* The owner or operator shall maintain records of the occurrence, duration, and cause (if known) and action taken on each breakdown.

(e)~~(6)~~ *Records of excesses.* The owner or operator shall maintain records of exceedances of~~:~~ the emission limitations in ~~sub~~section 93102.4 ~~(c)~~, the monitoring parameter values established under ~~sub~~section ~~(e)~~ 93102.9, or any site-specific operating parameters established for alternative equipment. The records shall include the date of the occurrence, the duration, cause (if known), and, where possible, the magnitude of any excess emissions.

(f)~~(7)~~ *Records demonstrating facility size.* Facility size for determining the applicable emission limitation in subsection 93102.4 (a) is determined by the maximum cumulative potential rectifier capacity. However, a facility with a maximum cumulative potential rectifier capacity of 60 million amp-hr/yr or more may, at the option of the owner or operator, be considered small or medium if the actual cumulative rectifier usage is less than 60 million amp-hr/yr as demonstrated by using either of the following procedures:

(1)~~(A)~~ *Annual actual cumulative rectifier capacity.* Show by records that the facility's previous annual actual cumulative rectifier capacity was less than 60 million amp-hr/yr, by using nonresettable ampere-hour meters and keeping monthly records of actual ampere-hour capacity for each 12-month rolling period following the compliance date. The actual cumulative rectifier capacity for the previous 12-month rolling period shall be tabulated monthly by adding the capacity for the current month to the capacities for the previous 11 months; or

(2)(B) *Maximum cumulative potential rectifier usage limit.* By accepting a limit on the maximum cumulative potential rectifier usage of a hard chromium electroplating facility through a title V permit condition or a permitting agency operating permit condition and by maintaining monthly records in accordance with subsection 93102.12(c)(1) (h)(4)(A) to demonstrate that the limit has not been exceeded.

(g) *Records of annual ampere-hour use.* Facilities shall maintain monthly records of total ampere-hour use per calendar year. The record shall be submitted to the permitting agency as part of their Initial and Ongoing Compliance Status Reports as specified in Appendix 2 and 3.

(h)(8) *Records of chemical fume suppressant additions.* For facilities sources using chemical fume suppressants to comply with the standards or requirements, the owner or operator shall maintain records of the date, time, approximate volume, and product identification of the chemical fume suppressants that are is added to the electroplating or anodizing bath.

(i)(9) *Records of trivalent chromium process bath components.* For facilities sources complying with subsection 93102.6(a) (c)(3) using the trivalent chromiume baths process, the owner or operator shall maintain records of the bath components purchased, with the wetting agent clearly identified as a bath constituent contained in one of the components.

(j)(10) *New/modified source review information.* The owner or operator shall maintain records supporting the notifications and reports required by the permitting agency's new source review provisions and/or subsection 93102.4(e) (j).

(k) *Housekeeping records.* The owner or operator shall maintain records demonstrating compliance with housekeeping requirements, as required by section 93102.5, including the dates on which specific activities were completed, and records showing that chromium or chromium-containing wastes have been stored, disposed of, recovered, or recycled using practices that do not lead to fugitive dust emissions.

(l)(11) *Records retention.* All records shall be maintained for five years, at least two years on site.

93102.13 ~~(i)~~ *Reporting Requirements.*

(a)~~(1)~~ *Performance test documentation.*

(1)~~(A)~~ *Notification of performance test.*

(A)~~1.~~ The owner or operator of a facility ~~source~~ shall notify the permitting agency of his or her intention to conduct a performance test at least 60 calendar days before the performance test is scheduled.

(B)~~2~~. The provisions in subsection 93102.13(a)(1)(A) ~~(i)(1)(A)1.~~, above, do not apply if the performance test was conducted prior to July 24, 1997, was used to demonstrate compliance with 93102.4(a) or 93102.6(a), and was approved by the permitting agency and the U.S. EPA.

(2)~~(B)~~ *Reports of performance test results.* The owner or operator shall report performance test results to the permitting agency. Reports of performance test results shall be submitted no later than 90 days following the completion of the required performance test, and shall be submitted as part of the notification of compliance status required by subpart (b) ~~paragraph (2)~~ of this subsection.

(3)~~(C)~~ The content of performance test reports shall contain the information ~~is~~ identified in Appendix 1.

(b)~~(2)~~ *Initial compliance status report.* An initial compliance status report is required each time that a facility ~~source~~ becomes subject to the requirements of this section. The owner or operator shall submit to the permitting agency an initial compliance status report, signed by the responsible official who shall certify its accuracy, attesting to whether the facility ~~source~~ has complied with this rule.

(1)~~(A)~~ Initial compliance status report ~~due date.~~

~~1.~~ ~~For sources required to conduct a performance test, the initial compliance status report shall be submitted to the permitting agency no later than 90 calendar days following completion of the compliance demonstration.~~

~~2.~~ ~~For sources that are not required to complete a performance test, the initial compliance status report~~ shall be submitted to the permitting agency no later than 30 days after the effective date of this rule for existing facilities ~~sources~~, or at start-up for new facilities ~~sources~~.

(2)~~(B)~~ The content of the initial compliance status report shall contain the information ~~is~~ identified in Appendix 2.

(c)~~(3)~~ *Ongoing compliance status reports.* The owner or operator shall submit a summary report to the permitting agency to document the ongoing compliance status.

(1)~~(A)~~ *~~Frequency of o~~ Ongoing compliance status reports~~.~~*

~~1.~~ ~~The report~~ shall be submitted to the permitting agency on or before February 1 annually for ~~major~~ all facilities ~~sources~~ and shall include information for the preceding calendar year (January 1 through December 31).

~~2.~~ ~~The report shall be prepared annually and made available to the permitting agency upon request for area sources.~~

(2)~~(B)~~ The content of ongoing compliance status reports shall include the information ~~is~~ identified in Appendix 3.

(d)~~(4)~~ *Reports of breakdowns.* The owner or operator shall report breakdowns as required by the permitting agency's breakdown rule.

(e)~~(5)~~ *Reports associated with the trivalent chromium process ~~baths~~ ~~using a wetting agent~~.*

(1) *Facilities currently using the trivalent chromium process.*

(A) Owners or operators electroplating with the trivalent chromium process ~~baths~~ using a wetting agent are not subject to subsections (a), (b), and (c) ~~paragraphs (1) through (3)~~ of this subsection 93102.13, but ~~must instead~~ shall submit to the permitting agency the following information ~~reports:~~

~~(A)~~ ~~Sources currently using trivalent chromium. N~~ no later than 30 days after the effective date of this rule: ~~, the owner or operator shall submit a notification of compliance status that contains:~~

1. The name and address of each facility ~~source~~ subject to this paragraph;

2. A statement that a trivalent chromium process that incorporates a wetting agent will be used to comply with these requirements; and

3. The list of bath components that comprise the trivalent chromium bath, with the wetting agent clearly identified.

(B) An owner or operator electroplating with the trivalent chromium process and complying with the emission limitation option in subsection 93102.6 (a) shall submit the information contained in subsections (a), (b), and (c) of this section 93102.13. The report shall be submitted in accordance with the schedules identified in those paragraphs.

(2)~~(B)~~ Facilities ~~sources~~ changing to the trivalent chromiume process. Within 30 days of a change to the trivalent chromium ~~electroplating~~ process, the owner or operator shall submit to the permitting agency a report that includes:

(A) Facilities electroplating with the trivalent chromium process using a wetting agent shall submit the following information:

1. The name and address of each facility subject to this paragraph; and

2. A statement that a trivalent chromium process that incorporates a wetting agent will be used to comply with these requirements; and

3. The list of bath components that comprise the trivalent chromium bath, with the wetting agent clearly identified; and

4.~~1.~~ A description of the manner in which the process has been changed. ~~and the emission limitation, if any, now applicable to the source; and~~

(B) Facilities electroplating with the trivalent chromium process and complying with the emission limitation option in 93102.6 (a) shall submit the information contained in subsections (a), (b), and (c) of this subsection 93102.13. The report shall be submitted in accordance with the schedules identified in those paragraphs.

~~2.~~ ~~The notification and reporting requirements of paragraphs (1), (2), and (3) of this subsection, if the source complies with the emission limitation option, or paragraph (5) of this subsection, if the source uses a wetting agent to comply. The report shall be submitted in accordance with the schedules identified in those paragraphs.~~

(f)~~(6)~~ *Adjustments to the timeline for submittal and format of reports.* A permitting agency may adjust the timeline for submittal of periodic reports, allow consolidation of multiple reports into a single report, establish a common schedule for submittal or reports, or accept reports prepared to comply with other State or local requirements. Prior to allowing an adjustment, the permitting agency must find that the adjustment will provide the same information and will not alter the overall frequency of reporting.

~~*(j)*~~ ~~*New and Modified Sources.*~~

[Note: this subsection has been moved to section 93102.4 and has been modified.]

~~(1) Notification of Construction Reports. After the effective date of this rule no person may construct or modify a source, such that it becomes a source subject to this section, without submitting a notification of construction or modification to the permitting agency and receiving approval in advance to construct or modify the source. The contents of the Notification of Construction Report is contained in Appendix 4.~~

~~(2) New Source Review Rules. In lieu of complying with the requirements in paragraph (j)(1) of this subsection, a facility may fulfill these requirements by complying with the permitting agency's new source review rule or policy, provided similar information is obtained.~~

93102.14 ~~(k)~~ *Procedure for Establishing Alternative Requirements.*

(a)~~(1)~~ *Request Approval of an Alternative Requirement.* Any person may request approval of an alternative requirement. The person seeking such approval shall submit the proposed alternative requirement to the permitting agency for approval. The request must include the proposed alternative requirement, the reason for requesting the alternative requirement, and information demonstrating that the criteria for approval identified in Table 93102.14 ~~(k)(1)~~ ~~is~~ are met.

(b)~~(2)~~ *Approval of an Alternative Requirement.* A permitting agency may approve an alternative requirement if it determines that application of the alternative requirement meets the criteria for approval identified in

Table 93102.14 ~~(k)(1)~~, and the permitting agency has received concurrence by the ARB and U.S. EPA where concurrence is required.

(c)~~(3)~~ *Concurrence for an Alternative Requirement.* For those requirements identified in Table 93102.14 ~~(k)(1)~~ as requiring concurrence by the U.S. EPA and ARB, the permitting agency shall submit the alternative requirement to the concurring agency prior to final action by the permitting agency.

(d)~~(4)~~ *Reports of Approved Alternative Requirements to U.S. EPA.* The permitting agency shall provide the U.S. EPA and ARB with copies of all approved alternative requirements. The information shall be provided at a mutually agreed upon frequency.

(e)~~(5)~~ *Approval Criteria.* Nothing in this section prohibits the permitting agency from establishing approval criteria more stringent than that required in Table 93102.14 ~~(k)(1)~~.

(f)~~(6)~~ *Alternatives Approved by U.S. EPA.* Waivers obtained from U.S. EPA prior to ~~the effective date~~ [Effective Date] of this regulation shall remain in effect until the effective dates of the requirements in subsection 93102.4(b) become effective.

Table 93102.14 ~~(k)(1)~~ -- Requirements for Approval of Alternatives

Subsection	**Requirement**	**Criteria for Approval**	**Approving Agency**	**Concurring Agency** ~~(4)~~ (1)
~~(a)~~ 93102.1	~~a~~Applicability	equivalent type and size of facility ~~source~~ regulated	District	U. S. EPA
~~(c)~~ 93102.4	~~standards~~ Limits and requirements	equivalent emission reductions	District	U. S. EPA, ARB
~~(d)(1)~~ 93102.7(a)	~~p~~Performance test requirements	equivalent means of determining compliance	District	U. S. EPA
~~(d)(2)~~ 93102.7(b)	~~u~~Use of previously conducted ~~existing~~ performance ~~source~~ tests	~~O~~overall existing tests provide a similar level of compliance assurance	District	U. S. EPA
~~(d)(3)~~ 93102.7(c)	~~a~~Alternative test method	provides a similar level of accuracy and precision	District	U. S. EPA ARB
~~(d)(4)~~ 93102.7(d)	~~a~~Amendments to the pre-test	equivalent means of determining	District	U. S. EPA

	protocol	compliance		
~~(d)(5)~~ 93102.7(e)	~~t~~Test all emission points	equivalent means of determining compliance	District	U. S. EPA
~~(e)~~ 93102.9	~~p~~Parameter monitoring	equivalent means of determining and assuring compliance	District	U. S. EPA
~~(f)~~ 93102.10	~~i~~Inspection maintenance requirements	equivalent means of assuring compliance	District	U. S. EPA
~~(g)~~ 93102.11	~~o~~Operation and maintenance plans	equivalent means of assuring compliance	District	U. S. EPA
~~(h)(1)(10)~~ 93102.12 (a) through (f) and (h) through (j)	~~r~~Record-keeping	equivalent means of assuring compliance	District	U. S. EPA
~~(h)(11)~~ 93102.12(l)	~~r~~Retention of records	assure historical records available for up to 5 years	District	U. S. EPA
~~(i)~~ 93102.13	~~r~~Reporting	equivalent means of assuring compliance	District	U. S. EPA

~~1. combined hexavalent or total chrome emissions from hard chrome plating operations~~

~~2. maximum cumulative potential rectifier capacity or usage limit~~

~~3. "Option 2" is an alternative emission limitation for small and medium facilities that elect to demonstrate compliance with both a mg/amp-hr and a mg/dscm requirement~~

~~4.~~ 1. U.S. EPA or the implementing agency in accordance with any delegation of authority to approve alternatives from the U.S. EPA.

93102.15 *Requirements Relating to Chromium Plating Kits.*

(a) Except as provided in subsection (b), no person shall sell, supply, offer for sale, or manufacture for sale in California, any chromium plating or chromic acid anodizing kit.

(b) The provisions of subsection (a) do not apply to any person that sells, supplies, offers for sale, or manufactures for sale in California a chromium plating or chromic acid anodizing kit to the owner or operator of a permitted facility at which chromium plating or chromic acid anodizing is performed.

(c) No person shall use a chromium plating or chromic acid anodizing kit to perform chromium electroplating or chromic acid anodizing unless these activities are performed at a permitted facility that complies with the requirements of this ATCM.

(d) For the purposes of this section, "chromium electroplating or chromic acid anodizing kit" means chemicals and associated equipment for conducting chromium electroplating or chromic acid anodizing including, but not limited to, internal and external tank components.

93102.16 This section 93102.16 contains Appendices 1 through 8 to the ATCM for Chromium Plating and Chromic Acid Anodizing Facilities.

Appendix 1 - Content of Performance Test Reports

Performance test reports required by section 93102.13 shall contain the following information:

1. A brief process description;
2. Sampling location description(s);
3. A description of sampling and analytical procedures and any modifications to standard procedures;
4. Test results in mg/amp-hr;
5. Quality assurance procedures and results;
6. Records of operating conditions during the test, preparation of standards, and calibration procedures;
7. Original data for field sampling and field and laboratory analyses;
8. Documentation of calculations; and
9. Any other information required by the test method.

Note: Test reports consistent with the provisions of California Air Resources Board ~~ARB~~ Method 425 will fulfill the above performance test report content requirement.

Appendix 2 - Content of Initial Compliance Status Reports

Initial compliance status reports required by subsection 93102.13(b) shall contain the following information:

1. ~~The applicable emission limitation and the methods that were used to determine compliance with this limitation;~~
2. ~~If a performance test is required, the test report documenting the results of the performance test, which contains the elements listed in Appendix 1;~~
3. ~~The type and quantity of hazardous air pollutants emitted by the source reported in mg/dscm or mg/hr for decorative and anodizing operations. (If the owner or operator is subject to the construction and modification provisions of subsection (j) and had previously submitted emission estimates, the owner or operator shall state that this report corrects or verifies the previous estimate.) For sources not required to conduct a performance test, the surface tension measurement may fulfill this requirement;~~
4. ~~For each monitored parameter for which a compliant value is to be established under subsection (e) the specific operating parameter value, or range of values, that corresponds to compliance with the applicable emission limit;~~
5. ~~The methods that will be used to determine continuous compliance, including a description of monitoring and reporting requirements, if methods differ from those identified in this section;~~
6. ~~A description of the air pollution control technique for each emission point;~~
7. ~~A statement that the owner or operator has completed and has on file the operation and maintenance plan as required by subsection (g);~~

1. Company Information: Facility name, address, owner/operator name, telephone number, the measured distance from the edge of the facility that is nearest to the sensitive receptor to the property boundary of the sensitive receptor that is within 150 meters;

2. The applicable requirements from section 93102.4 and the methods that were used to determine compliance. A description of the air pollution control technique for each emission point;

3. If a facility is using add-on controls to comply provide the following:

   a) Description of add-on controls and a performance test report documenting the results of the performance test, which contains the elements listed in Appendix 1;

b) The actual hexavalent chromium emissions of the facility in pounds per year calculated by multiplying the emission rate with the actual ampere-hours for the preceding calendar year.

c) For monitored parameters 93102.9 (b) and (c), the specific operating parameter value, or range of values, that corresponds to compliance with the applicable emission limit;

d) A statement that the owner or operator has completed and has on file the operation and maintenance plan as required by subdivision (j);

4. If a facility is using in-tank controls to comply, provide the following:

a) Description of in-tank controls including name of in tank controls, name of chemical fume suppressant, surface tension of the electroplating or anodizing bath;

b) For monitored parameters 93102.9 (d), (e), and (f) the specific operating parameter value where applicable, or range of values, that corresponds to compliance;

5. The actual cumulative ampere-hour usage expended during the preceding calendar year.

6.~~8.~~ If the owner or operator is determining facility size based on actual cumulative rectifier usage, records to support that the facility is small or medium. For existing facilities ~~sources~~, records from any 12-month period preceding the compliance date shall be used or a description of how operations will change to meet a small or medium designation shall be provided. For new facilities ~~sources~~, records of projected rectifier usage for the first 12-month period of tank operation shall be used;

7. A statement that the owner or operator, or personnel designated by the owner or operator, has completed Environmental Compliance Training pursuant to 93102.5 (b).

8.~~9.~~ A statement by the owner or operator as to whether the facilities ~~source~~ has complied with the provisions of ~~this~~ sections 93102 through 93102.16.

Appendix 3 - Content of Ongoing Compliance Status Reports

Ongoing compliance status reports required by section 93102.13(c) shall contain the following information:

~~1. The company name and address of the source~~; 1. Company Information: facility name, address, owner/operator name, telephone number, the measured distance from the edge of the facility that is nearest to the sensitive receptor to the property boundary of the sensitive receptor that is within 150 meters

~~2. An identification of the operating parameter that is monitored for compliance determination, as required by subsection (e);~~

~~3.~~ 2. The relevant ~~emission limitation~~ requirements for the facility ~~source~~, and the operating parameter value, or range of values, that correspond to compliance ~~with this emission limitation~~ as specified in the notification of initial compliance status required by Appendix 2;

~~4. The beginning and ending dates of the reporting period;~~

~~5. A description of the type of process performed in the source;~~

~~6.~~ 3. The actual cumulative ~~rectifier~~ ampere-hour usage expended during the reporting period, on a month-by-month basis, for the reporting period January 1 through December 31;~~- if the source is a hard chromium electroplating tank~~;

4. The actual hexavalent chromium emissions of the facility during the reporting period in pounds per year calculated by multiplying the emission rate with the actual ampere-hour usage for the reporting period;

~~7.~~ 5. A summary of any excess emissions or exceeded monitoring parameters as identified in the records required by subsection ~~(h)(6)~~ 93102.12(e) ;

~~8.~~ 6. A certification by a responsible official that the inspection and maintenance requirements in ~~sub~~section 93102.10 ~~(f)~~ were followed in accordance with the operation and maintenance plan for the facility ~~source~~;

~~9.~~ 7. If the operation and maintenance plan required by ~~sub~~section 93102.11 ~~(g)~~ was not followed, an explanation of the reasons for not following the provisions, an assessment of whether any excess emissions and/or monitoring parameter excesses are believed to have occurred, and a copy of the record(s) required by subsection 93102.12(a) ~~(h)(1)~~ documenting that the operation and maintenance plan was not followed;

~~10.~~ 8. A description of any changes in monitoring, processes, or controls since the last reporting period;

9. A statement that the owner or operator, or personnel designated by the owner or operator, has, within the last 2 years, completed Environmental Compliance Training pursuant to 93102.5(b)

~~11.~~10. The name, title, and signature of the responsible official who is certifying the accuracy of the report; and
~~12.~~11. The date of the report.

Appendix 4 - Notification of Construction Reports

Notification of Construction Reports required by subsection 93102.4(e) shall contain the following information:

1.~~A.~~ The owner or operator's name, title, and address;
2.~~B.~~ The address (i.e., physical location) or proposed address of the facility ~~source~~ if different from the owner's or operator's;
3.~~C.~~ A notification of intention to construct a new facility ~~source~~ and certification that all of the criteria specified in subsection 93102.4 (d) are met.
4. A notification of intention to ~~or~~ make any physical or operational changes to a facility ~~source~~ that may meet or has been determined to meet the criteria for a modification;
5.~~D.~~ The expected commencement and completion dates of the construction or modification;
6.~~E.~~ The anticipated date of (initial) startup of the facility ~~source~~;
7.~~F.~~ The type of process operation to be performed (hard or decorative chromium electroplating, or chromic acid anodizing);
8.~~G.~~ A description of the air pollution control technique to be used to control emissions, such as preliminary design drawings and design capacity if an add-on air pollution control device is used; and
9.~~H.~~ An estimate of emissions from the facility ~~source~~ based on engineering calculations and vendor information on control device efficiency, expressed in units consistent with the emission limits of this subpart. Calculations of emission estimates should be in sufficient detail to permit assessment of the validity of the calculations.

Note: A facility can fulfill these report content requirements by complying with the permitting agency's new source review rule or policy, provided similar information is obtained.

Appendix 5 - Smoke Test for Chromium Tank Covers

SMOKE TEST TO VERIFY THE SEAL INTEGRITY OF COVERS DESIGNED TO REDUCE CHROMIUM EMISSIONS FROM ELECTROPLATING AND ANODIZING TANKS

1. Applicability and Principle

2.~~1.1~~ Applicability. This alternative method is applicable to all hard chromium electroplating and anodizing operations where a chromium tank cover is used on the tank for reducing chromium emissions.

3.~~1.2~~ Principle. During chromium electroplating or anodizing operations, bubbles of hydrogen and oxygen gas generated during the process rise to the surface of the tank liquid and burst. Upon bursting, tiny droplets of chromic acid (chromium mist) become entrained in the air above the tank. Because the chromium tank cover completely encloses the air above the tank, the chromium mist either falls back into the solution because of gravity or collects on the inside walls of the chromium tank cover and runs back into the solution. A semi-permeable membrane allows passage of the hydrogen and oxygen out of the chromium tank cover. A lit smoke device is placed inside the chromium tank cover to detect leaks at the membrane, joints, or seals.

3.~~2.~~ Apparatus

4.~~2.1~~ Smoke device. Adequate to generate 500 to 1000 ft^3 of smoke/20 ft^2 of tank surface area (e.g., Model #1A=15 SECONDS from Superior Signal, New York).

5.~~2.2~~ Small container. To hold the smoke device.

6.~~3.~~ Procedure

Place the small container on a stable and flat area at center of the chromium tank cover (you can use a board and place it on the buss bars). Place the smoke device inside the container. After lighting the smoke device, quickly close the access door to avoid smoke from escaping. Let smoke device completely burn; entire space under the chromium tank cover will now be filled with the smoke. Observe for leaks of smoke from each seal, joint, and membrane of the chromium tank cover. Record these observations including the locations and a qualitative assessment of any leaks of smoke.

When all seals, joints, and membranes have been observed, evacuate the unit to remove the smoke from the chromium tank cover.

Appendix 6 - Air Pollution Control or Air Quality Management District Breakdown Rules.

DISTRICT	RULE #	RULE NAME
Amador	516	Upset and Breakdown Conditions
Antelope	430	Breakdown Provisions
Bay Area	1	General Provisions and Definitions
Butte	275	Reporting Procedures for Excess Emissions
Calaveras	516	Upset and Breakdown Conditions
Colusa	1.13	Equipment Breakdown
El Dorado	516	Upset and Breakdown Conditions
Feather River	9.6	Equipment Breakdown
Glenn	95.2	Malfunction of Equipment
Great Basin	403	Breakdown
Imperial	111	Equipment Breakdown
Kern	111	Equipment Breakdown
Lake	Chapter III, Article II	Malfunction
Lassen	2:15	Equipment Breakdown
Mariposa	516	Upset and Breakdown Conditions
Mendocino	R1-5-540	Equipment Breakdown
Modoc	2.12	Equipment Breakdown
Mojave	430	Breakdown Provisions
Monterey Bay	214	Breakdown Condition
North Coast	3-4-540	Breakdown and Violation Reporting
North Coast	1-5-540	Equipment Breakdown
Northern Sierra	516	Upset and Breakdown Conditions
Northern Sonoma	1-5-540	Equipment Breakdown
Placer	404	Upset Conditions Breakdown. Scheduled Maintenance
Sacramento	602	Breakdown Conditions: Emergency Variance
San Diego	98	Breakdown Conditions: Emergency Variance
San Joaquin	110	Equipment Breakdown
San Luis Obispo	107	Breakdown or Upset Conditions and Emergency Variances

Santa Barbara	505	Breakdown Conditions
Santa Barbara	506	Emergency Variances for Breakdowns
Shasta	3:10	Excess Emissions
Siskiyou	2.12	Equipment Breakdown (Siskiyou)
South Coast	430	Breakdown Provisions
Tehama	4:17	Upset or Breakdown Conditions
Tuolumne	516	Upset and Breakdown Conditions
Ventura	32	Breakdown conditions; Emergency Variances
Yolo Solano	5.2	Upset/Breakdown Conditions: Emergency Variance

Appendix 7 – Alternative Requirements for Enclosed Hexavalent Chromium Electroplating Facilities – Mass Emission Rate Calculation Procedure

Mass Emission Rate Should be calculated using the following equation:

MAMER = ETSA x K x 0.015 mg/dscm

Where:

MAMER = the alternative emission rate for enclosed hexavalent chromium electroplating tanks in mg/hr.

ETSA = the hexavalent chromium electroplating tank surface area in square feet(ft^2).

K = a conversion factor, 425 dscm/(ft^2x hr).

Appendix 8 – Surface Tension Procedure for a Stalagmometer

The stalagmometer must first be properly cleaned before being used for the first time and after a period of storage. Properly clean the stalagmometer using the following procedure:

1. Set up stalagmometer in stand in a fume hood.

2. Place a clean 150 mL beaker underneath the stalagmometer then fill with reagent grade concentrated nitric acid. Immerse bottom tip (approximately ½ ") of stalagmometer into the beaker.

3. Squeeze rubber bulb and pinch at the arrow up (1) position to collapse. Place bulb end securely on top end of stalagmometer. Carefully draw the nitric acid by pinching the arrow up (1) position until the level is above the top etched line.

4. Allow nitric acid to remain in stalagmometer for 5 minutes and then carefully remove the bulb allowing the acid to completely drain.

5. Fill a clean 150 mL beaker with distilled or deionized water. Using the rubber bulb per the instructions in Step #3, rinse and drain stalagmometer with deionized or distilled water until the inside is "water break" free.

6. Fill a clean 150 mL beaker with alcohol. Again using the rubber bulb per Step #3, rinse and drain stalagmometer twice with alcohol and allow the stalagmometer to dry completely.

7. Take a sample of the solution to be tested and adjust the solution to room temperature. Measure the specific gravity and record reading.

8. Fill a clean 150 mL beaker with solution to be tested. Immerse bottom end of stalagmometer into the beaker. Fill the stag per instructions in Step #3, making sure that the solution level is above the top etched line.

9. Raise the stalagmometer so that the bottom end is completely out of solution. Remove bulb and immediately place a finger on the top end of the stalagmometer. Carefully use the finger to bring the solution level down to the top etched line. Do not release finger at this time.

10. "Wipe" the excess solution on the lower tip by touching it against the side of the beaker.

11. Release fingertip to allow solution to drain and count number of drops until the level reaches the bottom etched line.

Calculations for Surface Tension

$$\text{Surface tension (dynes/cm)} = \frac{Sw * Nw * D}{N * Dw}$$

Sw = Surface tension of water at 25°C or 77°F (72.75 dynes/cm)
Nw = water drop number etched on instrument
D = measured specific gravity (g/ml)
N = # of solution drops
Dw = water density (1.0 g/mL)

PRECAUTIONS:

1. Make sure they stalagmometer is clean (no sludge or film)
2. No chips, cracks, etc
3. Vertical placement
4. No vibration
5. 20 drops per minute rate (10 dynes/cm)
6. Performance checked with water
7. Sample at room temperature

NOTE: Authority cited: sections 39600, 39601, 39650, 39658, 39659, 39666, and 41511, Health and Safety Code. Reference: sections 39650, 39658, 39659, 39665, 39666, and 41511, Health and Safety Code; and 40 CFR Part 63 Subpart N.

Appendix B

Chronology of Meetings

Appendix B
Chronology of Meetings

Date	Meeting
January 29, 2002	Diamond Bar Stakeholder Workgroup
July 2, 2002	Conference call with California Air Districts
October 8, 2002	Conference call with California Air Districts
October 16, 2002	Meeting with Chemical Manufacturer
November 22, 2002	El Monte Stakeholder Workgroup
November 25, 2002	San Francisco Stakeholder Workgroup
December 17, 2002	Fresno Stakeholder Workgroup
October, 28, 2003	Conference call with Metal Finishing Association of Southern California
November 13, 2003	Conference call with the Northern California Metal Finishing Association
November 18, 2003	Conference call with California Air Districts
December 9, 2003	Fresno Stakeholder Workgroup
December 10, 2003	San Francisco Stakeholder Workgroup
December 11, 2003	El Monte Stakeholder Workgroup
January 12, 2004	Conference call with California Air Districts
November, 7, 2005	Meeting with SCAQMD staff in Diamond Bar
November 16, 2005	Conference call with California Air Districts
January, 2006	Conference calls with Chemical Manufacturers
April 13, 2006	Conference call with California Air Districts
May 3, 2006	Conference call with Metal Finishing Association of Southern California
May 10, 2006	Northern California Chrome Stakeholder Workgroup
May 12, 2006	El Monte Stakeholder Workgroup
June 8, 2006	Environmental Stakeholder Teleconference
June 22, 2006	California Air Districts Teleconference
June 26, 2006	Chrome-plating Industry Teleconference
June 27, 2006	Diamond Bar Public Workshop
June 30, 2006	Northern California Chrome Public Workshop

Appendix C

Industry Survey Form

Terry Tamminen
Agency Secretary

Air Resources Board

Alan C. Lloyd, Ph.D.
Chairman
1001 I Street • P.O. Box 2815
Sacramento, California 95812 • www.arb.ca.gov

Arnold Schwarzenegger
Governor

April 12, 2004

Dear Sir or Madam:

This letter is to notify you that the California Air Resources Board (CARB) will be conducting a telephone survey of chromium plating and chromic acid anodizing operations to develop an emissions inventory for calendar year 2003. The emissions data and other information about your operation will help us in the evaluation of the Airborne Toxic Control Measure (ATCM) for Chromium Plating and Chromic Acid Anodizing operations.

We are aware that you have reported some information about your operation to your air pollution control district *via* your initial and ongoing compliance reports. We have evaluated those reports and have gathered some of the information we need. However, to complete our data set, some additional information is needed. We would like your cooperation in answering a short questionnaire by telephone. To facilitate the telephone survey, and allow you time to compile the information, I have enclosed a copy of the questions we will be asking. We intend to begin making calls to collect the information beginning April 26.

We are requesting this information in accordance with California Health and Safety Code sections 39607, 39701, 41511, and 42303; and title 17, California Code of Regulations section 91100. These sections of State law require owners and operators of sources of air pollution to submit information needed to help CARB estimate atmospheric emissions and carry out other responsibilities.

Thank you in advance for your assistance in this effort. If you have any questions, please contact Ms. Shobna Sahni at (626) 575-7039 or e-mail spandhoh@arb.ca.gov.

Sincerely,

/S/

Janette Brooks, Chief
Air Quality Measures Branch
Stationary Source Division

Enclosure

cc: See next page

cc:

Mr. Randy Frazier
Bay Area Air Quality Management District
939 Ellis Street
San Francisco, California 94109

Mr. David Jones
South Coast Air Quality Management District
21865 Copley Drive
Diamond Bar, California 91765

Ms. Loni Adams
Sacramento Metropolitan Air Quality Management District
777 12th Street 3rd Floor
Sacramento, California 95814

Mr. Archie de la Cruz
San Diego Air Pollution Control District
9150 Chesapeake Drive
San Diego, California 92123

Mr. Martin Keast
San Joaquin Valley Unified Air Pollution Control District
1990 E. Gettysburg Avenue
Fresno, California 93726

Mr. Junio Donal
County of Shasta Air Quality Management District
1855 Placer Street
Redding, California 96001

Ms. Terri Thomas
Ventura County Air Pollution Control District
669 County Square Drive
Ventura, California 93003

Ms. Shobna Sahni
Technical Evaluation Section
Air Quality Measures Branch

ENCLOSURE

Chromium Plating Questionnaire

Type of business: (check all that apply)

- ☐ Hard
- ☐ Decorative
- ☐ Trivalent Chromium plating
- ☐ Chromic Acid Anodizing

Total Ampere-hour usage for calendar year 2003:

- ☐ Hard: ________________ Amp-hrs
- ☐ Decorative: ____________ Amp-hrs
- ☐ Trivalent: _____________ Amp-hrs
- ☐ Anodizing: _____________ Amp-hrs

Range of current applied (amperes) when plating:

- ☐ 0 – 500
- ☐ 0 - 1,000
- ☐ 0 – 5,000 or above

Do you have any in tank controls for your chrome plating or anodizing tank?

Polyballs?
- ☐ No
- ☐ Yes

Chemical fume suppressants?
- ☐ No
- ☐ Yes
  - Name: ______________
  - Manufacturer: _________
  - Annual usage: _______lbs

Do you have any add-on pollution control equipment or forced ventilation for your chrome plating or anodizing tank?

- ☐ No
- ☐ Yes
  - ➢ Please describe (example, HEPA filter, mesh pad, mist eliminator)____________
  - ➢ What month and year was the source test done? _____________
  - ➢ What was the average results in mg/amp-hr? ______________

What kind of plating line do you have?

- ☐ Manual – no hoist
- ☐ Automatic / hoist line

Do you perform any grinding and polishing work at your facility?____________

How do you store your chemicals?____________________________________

Terry Tamminen
Agency Secretary

Air Resources Board

Alan C. Lloyd, Ph.D.
Chairman
1001 I Street • P.O. Box 2815
Sacramento, California 95812 • www.arb.ca.gov

Arnold Schwarzenegger
Governor

November 29, 2004

Dear Sir or Madam:

Through this letter I am transmitting a brief questionnaire to help us better understand services provided by your company for the hexavalent chromium plating and chromic acid anodizing industry in California. The California Air Resources Board (ARB) is gathering information on chemical fume suppressants, as well as information on plating bath maintenance, as part of our evaluation of the State's Airborne Toxic Control Measure (ATCM) for Chromium Plating and Chromic Acid Anodizing operations. We are asking for: 1) information on fume suppressants sold in California, including formulation data, mechanism of reducing hexavalent chromium emissions, and cost; and 2) information on acceptable contaminant levels in decorative hexavalent chromium plating baths.

We are requesting this information in accordance with California Health and Safety Code sections 39607, 39701, and 41511, and title 17, California Code of Regulations (CCR) section 91100. These sections authorize ARB to ***require*** the submission of information needed to estimate atmospheric emissions and to carry out its other statutory responsibilities. Associated laws and regulations may be found at the following website: www.arb.ca.gov/html/lawsregs.htm.

Enclosure A to this letter is the questionnaire to be completed. If your company manufactures or sells more than one chemical fume suppressant for use in chromium plating and/or anodizing operations, please copy Enclosure A and fill out one form for each product. The address to mail your completed forms is provided in Enclosure A and data are due no later than January 17, 2005.

State law protects the confidentiality of trade secrets (title 17, CCR, sections 91000-91022). The Confidentiality Information Form (Enclosure B) provides a summary of the regulations and must be filled out if you wish to designate information as confidential. ARB has many years of experience in handling confidential information and takes its responsibility very seriously. All confidential information will be kept in specifically designated, locked file cabinets and will only be accessible to authorized ARB staff on an "as needed" basis. All information that is designated as confidential will be handled in strict accordance with ARB confidentiality regulations and policies.

Sir or Madam
November 29, 2004
Page 2

Thank you in advance for your assistance in this effort. If you have any questions, please contact Ms. Shobna Sahni at (626) 575-7039 or via email at spandhoh@arb.ca.gov or Ms. Carla Takemoto at (916) 324-8028 or via email at ctakemot@arb.ca.gov.

Sincerely,

Janette Brooks

Janette Brooks, Chief
Air Quality Measures Branch
Stationary Source Division

Enclosure A: Chemical Fume Suppressant Manufacturer Questionnaire
Enclosure B: Confidential Information Submittal Form

cc: Ms. Shobna Sahni
Technical Evaluation Section
Air Quality Measures Branch

Ms. Carla Takemoto
Technical Evaluation Section
Air Quality Measures Branch

ENCLOSURE A

Chemical Fume Suppressant Questionnaire

Please provide required data by January 17, 2005

Mail to:
California Air Resources Board
Stationary Source Division
Attn: Shobna Sahni
P.O. Box 2815
Sacramento, CA 95812

Questions:
Contact: Shobna Sahni or Carla Takemoto
(626) 575-7039 (916) 324-8028
(626) 575-7012 (fax) (916) 327-5634
spandhoh@arb.ca.gov ctakemot@arb.ca.gov

Step 1. Company Name and Contact Information

Company Name: ______________________
Company Address: ______________________
____
Contact Name: ______________________
Contact Phone #: ______________________

Number of chemical fume suppressant products sold in California for use by hexavalent chromium plating and/or anodizing operations? __________

Please make copies, as needed, and complete Steps 2-4 for each product

Step 2a. Fume Suppressant – General Information

Product Name: ______________________
Product Form (liquid/powder/tablet/other): ______________________
California sales for calendar year 2003 (gallons/lbs): __________

Step 2b. Fume Suppressant – Formula Information

Please report all ingredients that comprise more than 1% by weight in your formula. The total weight should equal 100%:

Formulation Data:

Ingredient Name	*Weight percentage (%)*

ENCLOSURE A

Step 3. Fume Suppressant – Mechanism of Reducing Emissions

Product Name ____________________ Company Name________________

Does the fume suppressant reduce surface tension as the method for controlling emissions? (Yes/No) ______________

If yes, what is the optimum surface tension (at which successful plating can still be conducted) for emission reduction? (dynes/cm)

____

Does the fume suppressant create a foam blanket as the method for controlling emissions? (Yes/No) _______________

If yes, how thick must the foam blanket be to maximize emission reduction? (inches):

____

How long does it take to form the foam blanket? (minutes): _____

Is this product a concentrate? (Yes/No) ____

If yes, what is the dilution ratio? ______________

Does the company have any emissions data for when this product is used? (Yes/No)? ___________________ (If Yes, please provide a copy with your submittal)

Other Comments: ____

____

Step 4. Fume Suppressant – Cost Information

Please provide cost per gallon or pound for each fume suppressant: ___________

ENCLOSURE A

Step 5. Bath Maintenance - Decorative Hexavalent Chromium Plating Baths

Contaminants:

For decorative hexavalent chromium plating baths, record the level of each bath contaminant that you consider acceptable before clean-up would be recommended.

Contaminant	**Acceptable Level**
Trivalent Chromium (oz/gal)	________
Iron (ppm)	________
Nickel (ppm)	________
Copper (ppm)	________
Chloride (ppm)	________
Other__________	________
Other__________	________

Comments:

____

____

____

ENCLOSURE B

CONFIDENTIAL INFORMATION SUBMITTAL FORM

If you wish to designate any information contained in your survey data as **CONFIDENTIAL INFORMATION**, please provide the data requested below and return it with your completed survey forms.

In accordance with Title 17, California Code of Regulations (CCR), sections 91000 to 91022, and the California Public Records Act (Government Code section 6250 et seq.), the information that a company provides to the Air Resources Board (ARB) may be released: (1) to the public upon request, except trade secrets which are not emissions data or other information which is exempt from disclosure or the disclosure of which is prohibited by law; (2) to the U.S. Environmental Protection Agency (EPA), which protects trade secrets as provided in section 114(c) of the Clean Air Act and amendments thereto (42 USC 7401 et seq.) and in federal regulation; and (3) to other public agencies provided that those agencies preserve the protections afforded information which is identified as a trade secret, or otherwise exempt from disclosure by law (section 39660(e)).

Trade secrets as defined in Government Code section 6254.7 are not public records and therefore will not be released to the public. However, the California Public Records Act provides that air pollution emission data are always public records, even if the data comes within the definition of trade secrets. On the other hand, the information used to calculate emissions is a trade secret.

If any company believes that any of the information it may provide is a trade secret or otherwise exempt from disclosure under any other provision of law, **it must identify the confidential information as such at the time of submission to the ARB and must provide the name, address, and telephone number of the individual to be consulted**, if the ARB receives a request for disclosure or seeks to disclose the data claimed to be confidential. The ARB may ask the company to provide documentation of its claim of trade secret or exemption at a later date. Data identified as confidential will not be disclosed unless the ARB determines, in accordance with the above referenced regulations, that the data do not qualify for a legal exemption from disclosure. The regulations establish substantial safeguards before any such disclosure.

In accordance with the provisions of Title 17, California Code of Regulations, sections 91000 to 91022, and the California Public Records Act (Government Code sections 6250 et seq.),

Company Name:

____ declares that only those portions specifically identified and submitted in response to the California Air Resources Board's information request on the survey are confidential "**trade secret**" information, and requests that it be protected as such from public disclosure. All inquiries pertaining to the confidentiality of this information should be directed to the following person:

Name (please print): ____________________________________
Signature: ____
Title: ____
Telephone #: ____
Company Address: ____________________________________
____

Appendix E

Economic Survey Forms

Alan C. Lloyd, Ph.D.
Agency Secretary

Air Resources Board

1001 I Street • P.O. Box 2815
Sacramento, California 95812 • www.arb.ca.gov

Arnold Schwarzenegger
Governor

February 7, 2005

Dear Sir or Madam:

I am writing to notify you that the California Air Resources Board (ARB) will be telephoning you to obtain economic data for calendar year 2003. The brief questions, (shown in the box below) regarding your annual revenue and employee information, will provide data for the economic impact assessment we will conduct as we evaluate changes to the Airborne Toxic Control Measure (ATCM) for Chromium Plating and Chromic Acid Anodizing operations.

I appreciate that you have already provided emissions data and other information from our previous chrome plating questionnaire. We would like your cooperation again in answering these three questions by telephone. It would be helpful if you could fill in the requested information prior to receiving our call. We intend to start making calls to collect the information beginning February 21.

---

1. Gross Annual Revenue for 2003:

- ❑ Less than $1,000,000
- ❑ $1,000,001 to $5,000,000
- ❑ $5,000,001 to 10,000,000
- ❑ Greater than $10,000,000

2. Total number of employees: __________

3. Number of employees working in the chrome plating line: __________

We are requesting this information in accordance with California Health and Safety Code sections 39607, 39701, 41511, and 42303; and title 17, California Code of Regulations section 91100. These sections of State law require owners and operators of sources of air pollution to submit information needed to help ARB estimate atmospheric emissions and carry out other responsibilities.

I want to assure you that the information you provide will be kept confidential. ARB has many years of experience in handling confidential information and takes its responsibilities very seriously. All confidential information will be kept in locked file cabinets and will only be accessible to authorized staff.

Thank you in advance for your assistance in this effort. If you have any questions, please contact Ms. Zuzana Vona at (916) 323-9688, or e-mail zvona@arb.ca.gov.

Sincerely,

Janette Brooks, Chief
Air Quality Measures Branch
Stationary Source Division

cc: See next page

cc: Mr. Randy Frazier
Bay Area Air Quality Management District
939 Ellis Street
San Francisco, California 94109

Mr. David Jones
South Coast Air Quality Management District
21865 Copley Drive
Diamond Bar, California 91765

Ms. Loni Adams
Sacramento Metropolitan Air Quality Management District
777 12th Street, 3rd Floor
Sacramento, California 95814

Mr. Archie de la Cruz
San Diego Air Pollution Control District
9150 Chesapeake Drive
San Diego, California 92123

Mr. Martin Keast
San Joaquin Valley Unified Air Pollution Control District
1990 East Gettysburg Avenue
Fresno, California 93726

Mr. Junio Donal
Shasta County Air Quality Management District
1855 Placer Street
Redding, California 96001

Ms. Terri Thomas
Ventura County Air Pollution Control District
669 County Square Drive
Ventura, California 93003

Ms. Zuzana Vona
Technical Evaluation Section
Air Quality Measures Branch

Appendix F

Results of Emission Testing Program

Table VI-1
Sigma Plating Company, Inc. Hoist Line Decorative Chromium Plating Tank
Sampling Dates – January 9, 10, & 17, 2003

Sampling Location	**Plating Tank Exhaust**					
Sample Number	SI-02	SI-03	SI-07			
Sampling Date	1/9/2003	1/10/2003	1/17/2003			
Plating Tank Data						
Totalizer (amp-hours)	12,468	9,080	4,634			
Production Rate (amp-hrs/hr)	2,078	1,892	1,655			
Stack Data						
Temperature (^{0}F)	69	63	67			
Velocity (ft/sec)	57	53	58			
Static Pressure ("$H_2$0)	-4.4	-4.4	-4.4			
Stack Area (sq. ft.)	0.994	0.994	0.994			
Flow Rate (DSCFM)	3300	3100	3400			
Moisture (% of v/v)	0.7	0.9	0.1			
Sampling Data						
Sampling Time (minutes)	360	288	168			
Sample Volume (DSCF)	428.10	326.64	191.63			
Chromium Data (ng/sample)						
Total Chromium	3.5E+6	2.8E+6	1.9E+5			
Hexavalent Chromium	1.4E+6	6.8E+5	7.8E+4			
Isokinetic Rate (%)	104	106	98			
EMISSIONS						
Concentration (ng/dscf)						
Total Chromium	8.2E+3	8.6E+3	1.0E+3			
Hexavalent Chromium	3.3E+3	2.1E+3	4.1E+3			
Emission Rate (mg/hr)						
Total Chromium	1600	1600	210			
Hexavalent Chromium	660	390	83			
Emissions Factors (mg/amp-hr)[1]						
Total Chromium	**0.77**	**0.85**	**0.13**			
Hexavalent Chromium	**0.32**	**0.21**	**0.05**			

DSCF means dry standard cubic feet. Standard conditions are 68 F and 29.92 inches Hg.
DSCFM means dry standard cubic feet per minute.
[1] **Emissions Factors** (mg/amp-hr) = Emission Rate (mg/hr) / Plating Tank Production Rate (amp-hrs/hr)

Table VI-2
Sigma Plating Company, Inc. Hoist Line Decorative Chromium Plating Tank Mist Eliminator
Sampling Dates – January 14, 15, & 16, 2003

Sampling Location	Upstream of Mist Eliminator	Downstream of Mist Eliminator	Upstream of Mist Eliminator	Downstream of Mist Eliminator	Upstream of Mist Eliminator	Downstream of Mist Eliminator
Test Number	SI-04[1]	SO-04[3]	SI-05	SO-05	SI-06	SO-06
Sampling Date	1/14/2003		1/15/2003		1/16/2003	
Plating Tank Data						
Totalizer (amp-hrs)	6,059[3]		8,874		9,002	
Production Rate (amp-hrs/hr)	1,010		1,479		1,500	
Stack Data						
Temperature (^{0}F)	69	67	72	72	76	72
Velocity (ft/sec)	59	66	59	65	59	61
Static Pressure ("H_20)	-4.4	-7.4	-4.4	-7.4	-4.4	-7.4
Stack Area (sq. ft.)	0.994	0.994	0.994	0.994	0.994	0.994
Flow Rate (DSCFM)	3400	3800	3400	3700	3400	3500
Moisture (% of v/v)	1.0	1.0	0.6	0.8	0.2	0.5
Sampling Data						
Sampling Time (minutes)	360	360	360	360	360	360
Sample Volume (DSCF)	238.39	280.24	253.58	273.84	249.54	257.45
Chromuim Data (ng/sample)						
Total Chromium	2.1E+6	2.4E+3	4.2E+4	7.0E+3	5.9E+3	5.5E+3
Hexavalent Chromium	9.5E+5	2.5+E3	2.9E+4	5.6E+3	3.2E+3	4.2E+3
Isokinetic Rate (%)	100.1	106.4	106.1	105.3	105.3	105.0
EMISSIONS						
Concentration (ng/dscf)						
Total Chromium	8600	8.7	170	26	24	21
Hexavalent Chromium	4000	9.1	120	20	13	16
Emission Rate (mg/hr)						
Total Chromium	1800	2.0	34	5.7	4.8	4.5
Hexavalent Chromium	820	2.1	24	4.6	2.6	3.5
Mist Eliminator Control Efficiency (%)[2]						
Total Chromium	**99.9**		**83.2**		**6.3**	
Hexavalent Chromium	**99.7**		**80.8**		--[3]	
Emission Factor (mg/amp-hr)[4]						
Total Chromium	**1.78**	**2.0E-3**	**2.3E-2**	**3.9E-3**	**3.2E-3**	**3.0E-3**
Hexavalent Chromium	**0.81**	**2.1E-3**	**1.6E-2**	**3.1E-3**	**1.7E-3**	**2.3E-3**

DSCF means dry standard cubic feet. Standard conditions are 68 F and 29.92 inches Hg.
DSCFM means dry standard cubic feet per minute.
1 Hoist line operations were suspended for ~4 hours during Run 04. Emissions sampling runs were suspended for 2 of the 4 hours.
2 **Efficiency** = [(Inlet, SI – Outlet, SO) / Inlet, SI] * 100
3 Efficiency could not be calculated
4 **Emissions Factors** (mg/amp-hr) = Emission Rate (mg/hr) / Plating Tank Production Rate (amp-hrs/hr)

Table VI-4
Freeboard Space, Chromic Acid Concentration and Average Temperature for the Decorative Chromium Plating Tank During Testing

Date	Run	Freeboard (inches)	Chromic Acid Concentration (oz/gal)	Temperature (°F)
1/09/03	SI-O2	3.0 – 3.0	34.4	112-113
1/10/03	SI-O3	3.0 - 2.75	33.96	112
1/17/03	SI-O7	5.0 - 4.9	33.07	109
1/14/03	SI-O4 & SO-O4	5.0 - 5.2	34.18	110
1/15/03	SI-O5 & SO-O5	4.2 – 4.5	32.85	109
1/16/03	SI-O6 & SO-O6	4.5 – 4.5	32.63	109-110

Note:
- Freeboard space was measured at the beginning and end of the day.
- Chromic acid concentration samples were taken once a day.
- Temperature was measured throughout the day.

Table VI-5
Average Amperes & Volts During Plating and Total Ampere-Hours for the Decorative Chromium Plating Tank Tested

Date	Run	Amperes	Volts	Ampere-Hours
1/09/03	SI-O2	5,200 – 6,600	6.75 – 7.5	12,468
1/10/03	SI-O3	5,000 – 6,200	6.5 – 7.5	9,080
1/17/03	SI-O7	2,800 – 6,700	5.4 – 6.8	4,634
1/14/03	SI-O4 & SO-O4	3,400 – 6,200	5.2 – 7.2	6,059
1/15/03	SI-O5 & SO-O5	4,000 – 5,800	6.0 – 6.6	8,874
1/16/03	SI-O6 & SO-O6	3,500 – 6,200	5.8 – 6.2	9,002

Note: Plating amperes varied at the beginning and end of plating as well as with plating of different parts.

Table VI-6
Surface Tension (dynes/cm) Readings at the Beginning and End of Each Day

Date	Sample	Operator Stalagmometer Reading	SCAQMD Stalagmometer Reading	SCAQMD Tensiometer Reading
1/09/03	SI-O2	34.7 - 41.5	40.0 – 43.2	28.4 – 29.5
1/10/03	SI-O3	30.7 - 31.3	29.0 – 32.6	23.6 – 24.9
1/17/03	SI-O7	41.5 - 35.5	40.1 – 40.2	28.5 – 27.6
1/14/03	SI-O4 & SO-O4	32.4 - 35.5	34.8 – 35.5	25.3 – 26.0
1/15/03	SI-O5 & SO-O5	38.7 - 37.8	39.9 – 40.2	27.9 – 28.7
1/16/03	SI-O6 & SO-O6	42.6 - 43.7	43.5 – 44.6	29.7 – 29.0

Table VI-3
Sigma Plating Company, Inc. Hoist Line Indoor Ambient Metals
Sampling Dates – January 8 - 10 & 14 – 16, 2003

Sampling Dates	1/8/2003*	1/9/2003	1/10/2003	1/14/2003	1/15/2003	1/16/2003
Metals (ng/m^3)						
Total Chromium	**1,836**	**131**	**391**	**346**	**285**	**157**
Manganese	68	19	52	71	110	45
Iron	10,430	2,153	4,164	7,099	15,127	3,134
Nickel	3,090	271	695	1,010	1,243	430
Cobalt	1.8	<1	1.6	2	1.9	1.2
Copper	253	55	155	268	192	125
Zinc	472	80	231	395	320	146
Arsenic	1.1	<1	<1	2.2	1.9	<1
Strontium	23	5.3	19	22	23	14
Molybdenum	1.8	<1	2.1	3.9	25	3.2
Tin	44	5.3	11	16	11	30
Antimony	7.2	1.8	7.5	11	15	8
Lead	811	42	122	126	67	47

* January 8 was windy and dusty which may account for the higher concentrations.

Table VI-1
ARB METHOD 425 TEST RESULTS
Excello Plating Company, Inc. Decorative Chrome Plating Tank

Sampling Location	Plating Tank Exhaust			
Sample Number	E-1	E-2	E-3	
Sampling date	03/05/03	03/06/03	03/07/03	
Plating Tank Data				
Totalizer, amp-hours	786	1515	1452	
Production Rate (amp-hrs/hr)	151	252	242	
Stack Data				
Temperature (deg.F)	70.0	70.5	71.3	
Velocity (ft/sec)	23.1	23.1	23.1	
Static Pressure ("H2O)	0.05	0.05	0.05	
Stack Area (sq.ft.)	0.785	0.785	0.785	
Flow Rate (DSCFM)	1064	1068	1064	
Moisture (% of v/v)	0.46	0.23	0.43	
Sampling Data				
Sampling Time (minutes)	312	360	360	
Sample Volume (DSCF)	298.79	356.31	356.11	
Isokinetic Rate (%)	89.8	92.4	92.8	
Chromium Data (ng/sample)				
Total Chromium	4062	6366	3504	
Hexavalent Chromium	3508	6701	2740	
EMISSIONS				Average of Runs E-2 and E-3 *
Concentration (ng/DSCF)				
Total Chromium	13.59	17.866	9.840	**13.85**
Hexavalent Chromium	11.74	18.808	7.693	**13.25**
Emission Rate (mg/hr)				
Total Chromium	0.868	1.145	0.628	**0.887**
Hexavalent Chromium	0.750	1.205	0.491	**0.848**
Emission Factors (mg/amp-hr)				
Total Chromium	**5.74E-03**	**4.54E-03**	**2.60E-03**	**3.57E-03**
Hexavalent Chromium	**4.96E-03**	**4.77E-03**	**2.03E-03**	**3.40E-03**

* Notes: Isokinetic rate for run E-1 was less than 90%.
DSCF = Dry Standard Cubic Feet: DSCFM = DSCF per Minute.

Table VI-2 Excello Plating Company, Inc. Indoor, Ambient Hexavalent Chromium Levels			
Sample Number	E-1-A	E-2-A	E-3-A
Sample Date	3/5/2003	3/6/2003	3/7/2003
Sampling Time (minutes)	405	400	396
Volume Collected (Liters)	4042.2	4012.1	3972.0
Cr (VI) collected (nanograms)	888.6	790.7	421.0
Concentration (ng/m³)	219.8	197.1	106.0

Table VI-3 Parameters Measured During Testing				
	Date	3/05/03	3/06/03	3/07/03
	Run	E1	E2	E3
Freeboard (inches)		3.75 - 4.25	3.75 - 3.50	4.0 – 4.0
Chromic Acid Concentration (oz/gal)		43.0	45.9	45.3
Temperature (°F)		111.2	110.6	112
Amperes		150	250	250
Volts		3	3	3
Ampere-Hours		786	1,515	1,452

Note:

- Freeboard space was measured at the beginning and end of the day.
- Chromic acid concentration samples were taken once a day.
- Temperature was measured throughout the day.
- Plating amperes varied at the beginning and end of plating as well as with plating of different parts.

Table VI-4 Surface Tension (dynes/cm) Readings Beginning and End of Each Day				
Date	Run	Anachem Lab Reading	SCAQMD Stalagmometer Reading	SCAQMD Tensiometer Reading
3/05/03	E1	26.6	31.5 – 33.8	23.5 – 24.0
3/06/03	E2	26.8	31.3 – 34.9	23.1 – 24.2
3/07/03	E3	25.7	33.9 – 34.0	23.9 – 24.5

Table VI-1
ARB METHOD 425 TEST RESULTS
Van Nuys Plating Company - Decorative Chrome Plating Tank

Sampling Location	[redacted]			
Sample Number	V-1	V-2	V-3	
Sampling date	04/09/03	04/10/03	04/11/03	
Plating Tank Data				
Totalizer, amp-hours	669	819	781	
Production Rate (amp-hrs/hr)	112	123	130	
Stack Data				
Temperature (deg.F)	77.8	74.0	70.9	
Velocity (ft/sec)	16.3	16.5	16.5	
Static Pressure ("H2O)	-0.98	-0.98	-0.98	
Stack Area (sq.ft.)	0.785	0.785	0.785	
Flow Rate (DSCFM)	728	743	756	
Moisture (% of v/v)	0.69	1.05	1.42	
Sampling Data				
Sampling Time (minutes)	360	400	360	
Sample Volume (DSCF)	260.94	293.17	279.10	
Isokinetic Rate (%)	99.3	98.5	102.3	
Chromium Data (ng/sample)				
Total Chromium	1.10E+05	1.68E+05	1.30E+05	
Hexavalent Chromium	1.05E+05	1.46E+05	1.11E+05	
EMISSIONS				Averages
Concentration (ng/DSCF)				
Total Chromium	421.1	573.2	464.7	**486.3**
Hexavalent Chromium	402.2	497.0	397.4	**432.2**
Emission Rate (mg/hr)				
Total Chromium	18.40	25.54	21.08	**21.67**
Hexavalent Chromium	17.57	22.14	18.03	**19.25**
Emission Factors (mg/amp-hr)				
Total Chromium	**0.165**	**0.208**	**0.162**	**0.178**
Hexavalent Chromium	**0.158**	**0.180**	**0.139**	**0.159**

DSCF = Dry Standard Cubic Feet: DSCFM = DSCF per Minute.

Table VI-II
Van Nuys Plating Company, Inc.
Indoor, Ambient Hexavalent Chromium Levels

Sample Number	V-2A	V-3A	V-4A	V-5A	V-6A
Sample Date	4/9/2003	4/9/2003	4/10/2003	4/10/2003	4/11/2003
Sampling Time (minutes)	77	123	400	396	328
Volume Collected (Liters)	791.4	1264.1	4130.7	4128.6	3387.2
Cr (VI) collected (nanograms)	3.0	9.4	15.2	0.7	13.7
Concentration (ng/m^3)	3.8	7.4	3.7	0.7	4.1
Daily averages	5.6		2.2		4.1

Table VI-1
Alta Plating Decorative Chromium Plating Tank
Sampling Dates – January 27-29 & February 2-4, 2004

Sampling Location	**40 dynes/cm Surface Tension**			**30 dynes/cm Surface Tension**		
Sample Number	A-11	A-12	A-13	A-21	A-22	A-23
Sampling Date	1/27/2004	1/28/2004	1/29/2004	2/2/2004	2/3/2004	2/4/2004
Plating Tank Data						
Totalizer (amp-hours)	183	537	393	390	382	383
Production Rate (amp-hrs/hr)	30.5	67.1	65.5	65.0	63.7	63.8
Freeboard (inches to overflow)*	5.8 -.4.5	4.0 - 4.2	4.0 - 4.0	4.75 - 5.0	4.0 - 4.5	4.5 - 4.9
Surface Tension (dynes/cm)*	39.3 – 39.9	40.7 – 39.3	40.1 – 39.7	30.8 – 28.9	30.5 – 28.9	29.2 – 28.4
Chromic Acid Conc. (oz/gal)	37.7	34.3	35.9	35.1	34.5	34.6
Bath Temperature (^oF)	110	110	109	104	109	109
Stack Data						
Stack Temperature (^0F)	63	62	61	62	62	61
Velocity (ft/sec)	23	21	21	21	20	21
Static Pressure ("H_20)	-0.28	-0.25	-0.25	-0.27	-0.25	-0.26
Stack Area (sq. ft.)	0.785	0.785	0.785	0.785	0.785	0.785
Flow Rate (DSCFM)	1102	983	984	972	958	982
Moisture (% of v/v)	1.0	1.0	0.9	1.0	1.2	1.0
Sampling Data						
Sampling Time (minutes)	360	480	360	360	360	360
Sample Volume (DSCF)	390.14	485.60	378.17	353.49	349.45	359.83
Chromium Data (ng/sample)						
Total Chromium	3110	4810	5220	1450	2860	1520
Hexavalent Chromium	2250	3330	3840	1113	2462	980
Isokinetic Rate (%)	101	105	109	103	104	104
EMISSIONS						
Concentration (ng/dscf)						
Total Chromium	7.97	9.90	13.8	4.10	8.18	4.23
Hexavalent Chromium	5.77	6.86	10.2	3.15	7.05	2.72
Emission Rate (mg/hr)						
Total Chromium	0.53	0.58	0.82	0.24	0.47	0.25
Hexavalent Chromium	0.38	0.41	0.60	0.18	0.41	0.16
Emissions Factors (mg/amp-hr)**						
Total Chromium	**0.017**	**0.009**	**0.012**	**0.004**	**0.007**	**0.004**
Hexavalent Chromium	**0.012**	**0.006**	**0.009**	**0.003**	**0.006**	**0.003**

DSCF & DSCFM means dry standard cubic feet and dry standard cubic feet per minute at 68 F and 29.92 inches Hg.

* Paired numbers show "start " - "end" of sample run results (i.e. Run A-11 started at 5.8 in. & 39.3 dyne/cm).

**** Emissions Factors** (mg/amp-hr) = Emission Rate (mg/hr) / Plating Tank Production Rate (amp-hrs/hr)

Table VI-2a
Alta Plating Company
Indoor Ambient Hexavalent Chromium

40 dyne/cm Surface Tension

Sample Number:	A-11-A	A-12-A	A-13-A
Sample Date:	1/27/2004	1/28/2004	1/29/2004
Sampling Time (minutes)	226	422	310
Volume Collected (liters)	2260	4220	3100
Cr (VI) collected (nanograms)	160	120	32
Indoor Ambient Concentration (ng/m^3)	**70**	**28**	**10**

Table VI-2b
Alta Plating Company
Indoor Ambient Hexavalent Chromium

30 dyne/cm Surface Tension

Sample Number:	A-21-A	A-22-A	A-23-A
Sample Date:	2/2/2004	2/3/2004	2/4/2004
Sampling Time (minutes)	353	313	350
Volume Collected (liters)	3530	3130	3500
Cr (VI) collected (nanograms)	63	50	33
Indoor Ambient Concentration (ng/m^3)	**18**	**16**	**9.3**

Background Indoor Ambient Sampling Results: Facility 4

Table VI-2c
Alta Plating Company
Indoor Ambient Hexavalent Chromium

. Ambient Results with Plating Tank Capture Hood Removed*

Sample Number:	A-33-A	A-32-A	A-31-A**	A-30-A
Sample Date:	2/5/2004	2/6/2004	2/8/2004	2/9/2004
Sampling Time (minutes)	339	450	1747**	368
Volume Collected (liters)	3390	4500	17470	3680
Cr (VI) collected (nanograms)	270	190	69	210
Totalizer, amp-hours	130	182	**	172
Indoor Ambient Concentration (ng/m^3)	**79**	**41**	**3.9**	**57**

* - These indoor ambient samples were collected after emissions sampling of the plating tank was completed and the plating tank capture hood removed.

** - Sample A-31-A was collected on a Sunday when Alta was not plating. However, the sampler failed to shut off automatically. It was shut down manually at 8:00 am Monday - after Alta began plating.

Table VI-1 Sherm's Custom Plating Decorative Chromium Plating Tank Results Sampling Dates--March 9, 10, & 11, 2004			
Sampling Location	Chromium Plating tank	Chromium Plating tank	Chromium Plating tank
Sample Date	March 9, 2004	March 10, 2004	March 11, 2004
Sample Number	S-1	S-2	S-3
Plating Tank Data			
Totalizer (amp-hours)	415	459	425
Production Rate (amp-hrs/hr)	69.2	76.5	81.7
Freeboard (inches to overflow)*	5.0-4.9	3.0-3.5	4.0-4.0
Chromic Acid Conc. (oz/gal)	34.2	32.6	Not Done
Temperature (°F)	109.5	109.8	109.8
Surface Tension (dynes/cm)*	35.6-35.9	37.5-35.9	37.8-37.9
Stack Data			
Stack Temp. (°F)	75	75	72
Velocity (ft/sec)	19.49	22.19	20.33
Static Pressure ("H_2O)	-0.23	-0.29	-0.19
Stack Area (sq. ft.)	0.785	0.785	0.785
Flow Rate (DSCFM)	904	1030	943
Moisture (% of v/v)	1.1	0.6	1.0
Sampling Data			
Sampling Time (minutes)	360	360	312
Sampling Volume (DSCF)	330.08	360.50	295.40
Chromium Data (ng/sample)			
Total Chromium	19,440	22,600	22,730
Hexavalent Chromium	19,413	21,490	23,693
Isokinetic Ratio(%)	103.9	99.6	102.9
EMISSIONS			
Concentration (ng/DSCF)			
Total Chromium	58.89	62.69	76.95
Hexavalent Chromium	58.81	59.61	80.21
Emission Rate (mg/hr)			
Total Chromium	3.19	3.87	4.35
Hexavalent Chromium	3.19	3.68	4.54
Emission Factors (mg/amp-hr)**			
Total Chromium	**0.046**	**0.051**	**0.053**
Hexavalent Chromium	**0.046**	**0.048**	**0.056**

DSCF means dry standard cubic feet at 68°F and 29.92" Hg. DSCFM means dry standard cubic feet per minute.
*Paired values separated by a hyphen are "start-end" of day measurements.
**Emission Factor = Emission rate/Production rate.

Table VI-2a
Sherm's Custom Plating
Indoor (PQ-100) Ambient Hexavalent Chromium Sampling Results

Ambient sampling during source testing with the hood in place

Sample Number:	S1-A	S2-A	S3-A
Sample Date:	03/09/2004	03/10/2004	03/11/2004
Sampling Time (minutes)	300	335	300*
Volume Collected (liters)	3000	3350	3000
Cr (VI) Collected (nanograms)	200	130	190
Indoor Ambient Concentration (ng/m^3)	**67**	**39**	**65**

* Note: Difference between the annotated start and stop time does not equal 300 minutes. It is assumed the start time was written incorrectly since the sampling interval is read directly from the PQ-100.

Background Indoor Ambient Sampling Results: Facility 5

Table VI-2b
Sherm's Custom Plating
Indoor (PQ-100) Ambient Hexavalent Chromium Sampling Results

Ambient sampling after source testing with the hood removed

Sample Number:	S11-A	S12-A	S13-A
Sample Date:	03/19/2004	03/20/2004	03/21/2004
Sampling Time (minutes)	393	417	340
Volume Collected (liters)	3930	4170	3400
Cr (VI) Collected (nanograms)	390	870	410
Indoor Ambient Concentration (ng/m^3)	**100**	**210**	**120**

Table VI-2
Clovis Specialty Decorative Chromium Plating Tank Test Week 2 (Clovis2)
Sampling Dates – October 19-21, 2004

Sampling Location			
Sample Number	C21	C22	C23
Sampling Date	10/19/04	10/20/04	10/21/04
Plating Tank Data			
Totalizer (amp-hours)	331	382	360
Production Rate (amp-hrs/hr)	159	191	180
Freeboard (inches to overflow)*	4.375	4.875	4.375
Surface Tension (dynes/cm)	44.1	41.6	42.2
Chromic Acid Conc. (oz/gal)	30.2	30.2	30.2
Bath Temperature (°F)	106	110	112
Stack Data			
Stack Temperature (°F)	68	67	63
Velocity (ft/sec)	20.68	20.40	19.84
Static Pressure ("H_20)	-0.22	-0.22	-0.24
Stack Area (sq. ft.)	0.785	0.785	0.785
Flow Rate (DSCFM)	945	931	922
Moisture (% of v/v)	1.3	1.3	1.1
Sampling Data			
Sampling Time (minutes)	125	120	120
Sample Volume (DSCF)	118.65	111.03	111.23
Chromium Data (ng/sample)			
Total Chromium	20,990	12,960	18,670
Hexavalent Chromium	21,800	11,280	20,570
Isokinetic Rate (%)	102.9	101.9	103.1
EMISSIONS			
Concentration (ng/dscf)			
Total Chromium	177	117	168
Hexavalent Chromium	184	102	185
Emission Rate (mg/hr)			
Total Chromium	10.0	6.5	9.3
Hexavalent Chromium	10.4	5.7	10.2
Emissions Factors (mg/amp-hr)**			
Total Chromium	**0.063**	**0.034**	**0.052**
Hexavalent Chromium	**0.065**	**0.030**	**0.057**

DSCF & DSCFM means dry standard cubic feet and dry standard cubic feet per minute at 68 F and 29.92 inches Hg.
* Measured at the start of the plating day.
** **Emissions Factors** (mg/amp-hr) = Emission Rate (mg/hr) / Plating Tank Production Rate (amp-hrs/hr)

Background Indoor Ambient Sampling Results: Facility 6

Table A1-1b
Clovis Specialty
Indoor Ambient Hexavalent Chromium

(without Capture Hood)

Sample Number:	C4-A	C5-A	C6-A	C7-A
Sample Date:	6/1/2004	6/2/2004	6/3/2004	6/4/2004
Sampling Time (minutes)	1,403	1,317	1,115	470
Volume Collected (liters)	14,030	13,068	11,150	4,653
Plating Tank Amp-hours	1	72	22	51
Cr (VI) collected (nanograms)	1700	3600	1500	2100
Indoor Ambient Concentration (ng/m^3)	**120**	**280**	**130**	**460**

Table A2-1a
Clovis Specialty Plating – Test Week 2
Indoor (PQ-100) Ambient Hexavalent Chromium Sampling Results

(Ambient sampling on rectifier during source testing ***with*** *capture hood in place.)*

Sample Number:	C20-RA	C21-RA	C22-RA	C23-RA
Sample Date:	10/18/04	10/19/04	10/20/04	10/21/04
Sampling Time (minutes)	196	308	143	132
Volume Sampled (liters)	1960	3080	1430	1320
Cr (VI) Collected (ng/sample)	300	5000	470	1800
Indoor Ambient Concentration (ng/m^3)	150	1600	330	1300

This rectifier is next to the plating tank, but outside the source test capture hood.

Table A2-1b
Clovis Specialty Plating – Test Week 2
Indoor (PQ-100) Ambient Hexavalent Chromium Sampling Results

(2nd parallel ambient sampling during source testing ***with*** *capture hood in place.)*

Sample Number:	C20-CA	C21-CA	C22-CA	C23-CA
Sample Date:	10/18/04	10/19/04	10/20/04	10/21/04
Sampling Time (minutes)	188	308	139	**
Volume Sampled (liters)	1880	3050	1380	**
Cr (VI) Collected (ng/sample)	270	1700	700	810
Indoor Ambient Concentration (ng/m^3)	150	560	510	**

CA samples parallel RA samples above - away from the tank and rectifier, but in the same room. RA samples were collected at the same location as Week 1 indoor samples.
** Air Volume data not recorded. Indoor concentration can not be calculated.

Table VI-3
Clovis Specialty Decorative Chromium Plating Tank Test Week 3 (Clovis 3)
Sampling Dates – May 24-25, 2005

Sampling Location			
Sample Number	C31	C32	C33
Sampling Date	5/24/05	5/25/05 AM	5/25/05 PM
Plating Tank Data			
Totalizer (amp-hours)	385	309	316
Production Rate (amp-hrs/hr)	192.5	154.5	158
Freeboard (inches to overflow)*	5 5/8	5 5/8	5 5/8
Surface Tension (dynes/cm)	36.6	32.7	22.1 (fume suppressant added before sampling)
Chromic Acid Conc. (oz/gal)	25.0	25.0	25.0
Bath Temperature (°F)	108	110	110
Stack Data			
Stack Temperature (°F)	91	86	92
Velocity (ft/sec)	19.8	18.6	18.9
Static Pressure ("$H_2$0)	-0.20	-0.21	-0.20
Stack Area (sq. ft.)	0.785	0.785	0.785
Flow Rate (DSCFM)	871	828	836
Moisture (% of v/v)	1.2	1.0	0.7
Sampling Data			
Sampling Time (minutes)	120	120	120
Sample Volume (DSCF)	103	96.9	97.8
Chromium Data (ng/sample)			
Total Chromium	19,800	14,284	18,390
Hexavalent Chromium	19,690	13,284	18,100
Isokinetic Rate (%)	101.2	100.0	99.8
EMISSIONS			
Concentration (ng/dscf)			
Total Chromium	192	147	188
Hexavalent Chromium	191	137	185
Emission Rate (mg/hr)			
Total Chromium	10	7.3	9.4
Hexavalent Chromium	10	6.8	9.3
Emissions Factors (mg/amp-hr)**			
Total Chromium	**0.052**	**0.047**	**0.059**
Hexavalent Chromium	**0.052**	**0.044**	**0.059**

DSCF & DSCFM means dry standard cubic feet and dry standard cubic feet per minute at 68 F and 29.92 inches Hg.
* Measured at the start of the plating day.
** **Emissions Factors** (mg/amp-hr) = Emission Rate (mg/hr) / Plating Tank Production Rate (amp-hrs/hr)

Table A3-1a
Clovis Specialty Plating – Test Week 3
Indoor (PQ-100) Ambient Hexavalent Chromium Sampling Results

*(Ambient indoor sampling on rectifier during source testing **with** capture hood in place.)*

Sample Number:	C30-RA	C31-RA	C32-RA	C33-RA
Sample Date:	5/24/05	5/24/05	5/25/05	5/25/05
Sampling Time (minutes)	264	122	128	125
Volume Sampled (liters)	2640	1220	1280	1250
Cr (VI) Collected (ng/sample)	5837	1964	646	1069
Indoor Ambient Concentration (ng/m^3)	**2,200**	**1,600**	**510**	**860**

This rectifier is next to the plating tank, but outside the source test capture hood.

Table A3-1b
Clovis Specialty Plating – Test Week 3
Indoor (PQ-100) Ambient Hexavalent Chromium Sampling Results

*(Ambient indoor sampling during source testing **with** capture hood in place.)*

Sample Number:		C31-CA	C32-CA	C33-CA
Sample Date:		5/24/05	5/25/05	5/25/05
Sampling Time (minutes)		132	129	121
Volume Sampled (liters)		1320	1290	1210
Cr (VI) Collected (ng/sample)		1425	978	1067
Indoor Ambient Concentration (ng/m^3)		1,100	760	880

CA samples parallel RA samples above - away from the tank and rectifier, but in the same room. RA samples were collected at the same location as Clovis 1 indoor samples.

Table VI-4
Clovis Specialty Decorative Chromium Plating Tank Test Week 4 (Clovis 4)
Sampling Dates – June 29-30, 2005

Sampling Location			
Sample Number	C41	C42	C43
Sampling Date	6/29/05	6/30/05	6/30/05
Plating Tank Data			
Totalizer (amp-hours)	356	299	345
Production Rate (amp-hrs/hr)	178	149.5	172,5
Freeboard (inches to overflow)*	4.5	4.0	4.0
Surface Tension (dynes/cm)	31.5	31.5	31.5
Chromic Acid Conc. (oz/gal)	28.2	28.2	28.2
Bath Temperature (°F)	105.6	108.6	107.6
Stack Data			
Stack Temperature (°F)	87.5	87.5	95
Velocity (ft/sec)	21.6	19.0	19.8
Static Pressure ("H_20)	-0.24	-0.17	-0.20
Stack Area (sq. ft.)	0.785	0.785	0.785
Flow Rate (DSCFM)	955	837	864
Moisture (% of v/v)	1.3	1.6	1.3
Sampling Data			
Sampling Time (minutes)	120	120	120
Sample Volume (DSCF)	111	100	102
Chromium Data (ng/sample)			
Total Chromium	40,860	14,900	29,290
Hexavalent Chromium	29,910	9,890	25,020
Isokinetic Rate (%)	99.3	102	101
EMISSIONS			
Concentration (ng/dscf)			
Total Chromium	368	149	287
Hexavalent Chromium	269	99	245
Emission Rate (mg/hr)			
Total Chromium	21	7.5	15
Hexavalent Chromium	15	5.0	13
Emissions Factors (mg/amp-hr)**			
Total Chromium	**0.12**	**0.050**	**0.086**
Hexavalent Chromium	**0.087**	**0.033**	**0.074**

DSCF & DSCFM means dry standard cubic feet and dry standard cubic feet per minute at 68 F and 29.92 inches Hg.
* Measured at the start of the plating day.
** **Emissions Factors** (mg/amp-hr) = Emission Rate (mg/hr) / Plating Tank Production Rate (amp-hrs/hr)

Table A4-1
Clovis Specialty Plating (Clovis 4) Test
Indoor Ambient Hexavalent Chromium Results

(with Capture Hood over Plating Tank)

Sample Collection: JUNE 2005

Filter ID	Air Volume liters	Cr(VI) ng/ml	Cr(VI) ng recovered	Cr(VI) ng/liter	Cr(VI) ng/m^3	Plating Tank Total amp-hrs
C41-RA	1,330	98.68	1480	1.113	**1113**	356
C41-CA	1,320	206.81	3102	2.350	**2350**	"
C41-CAC	136	21.67	325	2.390	**2390**	"
C42-RA	1,570	46.91	704	0.448	**448**	299
C42-CA	1,540	122.14	1832	1.190	**1190**	"
42-CAC	171					"
C43-RA	1,200	63.13	947	0.789	**789**	345
C43-CA	1,190	101.59	1524	1.281	**1281**	"
C43-CAC	131	12.91	194	1.481	**1481**	"

extraction volume = ~15 ml.

-RA sampler was located on the plating tank rectifier and next to the sampling hood.
-CA sampler was located behind and on the opposite side of the sampling hood.
-CAC sampler was located ~1 meter from CA sampler but sampled at 1 lpm instead of 10 lpm.

Table VI Walker's Custom Chrome Chromium Plating Tank Sampling Dates – February 15-23, 2006			
Sampling Location			
Sample Number	W-11	W-12	W-13
Sampling Date	2/15/06	2/16/06	2/17/06
Plating Tank Data			
Totalizer (amp-hours)	331	300	300
Production Rate (amp-hrs/hr)	165.5	75	75
Freeboard (inches to overflow)	4.75	4.5	5
Surface Tension (dynes/cm)	35.1	35.4	35.4
Chromic Acid Conc. (oz/gal)	34.8	34.8	34.8
Bath Temperature (°F)	90-100	92-105	98-107
Stack Data			
Stack Temperature (°F)	65	61	61
Velocity (ft/sec)	19.2	20.2	21.6
Static Pressure ("H_20)	-0.26	-0.24	-0.25
Stack Area (sq. ft.)	0.785	0.785	0.785
Flow Rate (DSCFM)	899	958	1000
Moisture (% of v/v)	0.7	0.5	0.9
Sampling Data			
Sampling Time (minutes)	120	240	240
Sample Volume (DSCF)	110.56	233.10	235.72
Chromium Data (ng/sample)			
Total Chromium	1700	5090	4680
Hexavalent Chromium	1262	3232	3610
Isokinetic Rate (%)	105	104	101
EMISSIONS			
Concentration (ng/dscm)			
Total Chromium	543	771	701
Hexavalent Chromium	403	490	541
Emission Rate (mg/hr)			
Total Chromium	0.83	1.25	1.19
Hexavalent Chromium	0.62	0.80	0.92
Emissions Factors (mg/amp-hr)			
Total Chromium	**0.0050**	**0.017**	**0.016**
Hexavalent Chromium	**0.0037**	**0.011**	**0.012**

Standard Conditions = 68° F and 29.92 in. Hg. DSCF = dry standard cubic feet. DSCM = dry standard cubic meter. DSCFM = dry standard cubic feet per minute.

Appendix G

Results of SDCAPCD Dust Samples Collected from Hexavalent Chromium Plating Facilities

Appendix G: Hexavalent Chromium Content Contained in Dust Samples Collected from Chromium Plating Shops in San Diego County, 2002

Date Sampled	Location	% of Total that is Hex	Hex Cr	Total Cr
			mg/kg	
8/20/2002	within 2 feet from the side of the chrome plating tank near the emission collection vent ducts	16%	**4,990**	30,400
8/20/2002	the corners of the back doors (entry and roll up garage doors)	2%	3.6	224
5/23/2002	on top of tank, within 1 foot in front of tank.	37%	**33,000**	88,300
5/23/2002	near back north east door.	N/A	< 0.8	1,920
5/23/2002	near back north west door.	N/A	< 0.8	4,920
5/23/2002	in adjacent alley north of the facility.	N/A	< 0.8	23
7/25/2002	within 5 feet in front of tank near rectifier. Note: sample taken underneath the wooden operating flooring	31%	**30,800**	98,800
7/26/2002	on tank, within 3 feet in front of tank.	67%	**89,800**	135,000
7/26/2002	near roll up garage door in back of facility.	N/A	< 0.8	772
6/28/2002	within 2 feet in front of tank, on top of 5 foot high DI? cylinder.	25%	**39,200**	156,000

Appendix G: Hexavalent Chromium Content Contained in Dust Samples Collected from Chromium Plating Shops in San Diego County, 2002

6/28/2002	within 2 feet behind tank. Note: no "outlet" sample was taken since smoke indicated changing air currents.	34%	**23,900**	69,900
6/18/2002	on lip of tank, within 1 foot in front of tank, within 2 feet in front of tank (near activator tank).	52%	**30,000**	58,000
6/18/2002	near back door of facility.	N/A	< 20	6,830
6/25/2002	within 3 feet to the right side of tank P7-4 (on cement floor inside paneling), within 3 feet in front right side of Tank P7-8.	11%	407	3,790
6/25/2002	near (east?) door next to composite mesh pad.	7%	172	2,410
6/25/2002	on surface within 2 feet of tank P7-13. Note: surface is two feet higher tank top of tank P7-13.	0.1%	81	69,800
7/9/2002	within 6 feet in front of tank (near rinse tank), within 2 feet in the side of tank, within 10 feet behind tank. Note: sample taken on lower cement flooring which is lower than the wooden operating flooring.	30%	**9,560**	31,400

Appendix G: Hexavalent Chromium Content Contained in Dust Samples Collected from Chromium Plating Shops in San Diego County, 2002

7/9/2002	near roll up garage door on side of facility.	N/A	< 0.8	195
7/17/2002	within 1 foot to the left of the tank on cement floor of secondary containment. Note: no elevated wooden operating floor at facility.	22%	**8,160**	37,500
7/10/2002	within 1 foot in front of tank, within 5 feet in front of tank, within 1 foot behind tank.	13%	**1,320**	10,100
7/10/2002	near front windows of facility, along south east wall of polishing room.	N/A	< 0.8	182
7/16/2002	on tank, within 2 feet in front of tank.	31%	**28,700**	93,300
7/16/2002	near front door of facility.	N/A	< 0.8	348

Appendix H

Air Quality Modeling Parameters and Results

Air Quality Modeling of Emissions from Shops with Chromium Plating Services

Prepared by: Tony Servin, P.E.,
Planning and Technical Support Division,
California Air Resources Board,
California Environmental Protection Agency

Date: November 14, 2004

Summary

It has been requested to evaluate the air quality impacts of emissions from shops with chromium plating services. The shops in this analysis vent emissions through forced ventilation (stacks) or natural ventilation (fugitive). The facilities with forced ventilation are grouped into four categories directly related to expected plume rise and amp-hour usage (low, medium, high, or horizontal). The facilities with natural ventilation are grouped into three categories dependent on the physical size of the shop (small, medium, or large). The dispersion of emissions is simulated with the latest version of the U.S. EPA air dispersion model ISCST3 (02035). The meteorological data used in the dispersion are collected from four locations throughout the state (Oakland, Fresno, San Diego, and Pasadena). In addition, a worst-case analysis is also simulated with screening meteorological conditions.

The analysis is based on a unit emission rate (1 g/s). Therefore, to obtain the estimated annual average concentration of hexavalent chromium in the air, the model results should be multiplied by the pollutant emission rate. Table S-1 shows a summary of the maximum chi/q[1] for the different shop types and screening meteorological conditions. The maximum chi/q is 1500 ($\mu g/m^3$)/(g/s) for shops with horizontal stacks or small shops with fugitive ventilation. Details of the analysis, example calculations, and additional results with historical meteorological data are described below.

[1] Chi/q is the predicted concentration based on an emission rate of 1 g/s. The chi/q is multiplied by the actual emission rate (g/s) to obtain the downwind concentration ($\mu g/m^3$). This is possible because the downwind concentration is directly proportional to the emission rate as described in the ISCST3 air quality model.

Table S.1 – Maximum (Screening) Annual Average Chi/Q (µg/m³)/(g/s) from Shops with Chromium Plating									
Shop		Distance Downwind							
Type	Size	20 m	30 m	40 m	50 m	100 m	200 m	500 m	1000 m
Stack	Low		310	340	300	190	64	12	4
	Medium		140	140	130	84	47	12	4
	High		72	89	88	69	43	11	3
	Horizontal	1500	1300	1000	780	250	70	12	4
Fugitive	Small	1500	990	710	530	210	61	12	3
	Medium	1000	700	520	430	190	59	12	3
	Large	620	470	370	300	160	54	11	3

- Multiply by hourly emissions [annual inventory (g) / (3285 hrs/yr) / (3600 s/hr)] to obtain annual average concentration.
- A blank cell indicates no calculation because the plume is in the building wake or is still aloft.

Approach

Facilities (shops) that provide decorative and hard chromium plating services have the potential to emit hexavalent chromium. It has been requested by ARB's Stationary Source Division to analyze the downwind dispersion of emissions from various shop configurations for chrome plating facilities. Data for 26 different shops with forced ventilation (stacks) and shops with natural ventilation (fugitive) in three sizes are provided by ARB's Stationary Source Division (Appendix H-1). The data for the shops with stacks are summarized into four categories based on the potential for plume rise and amp-hour consumption (further details below).

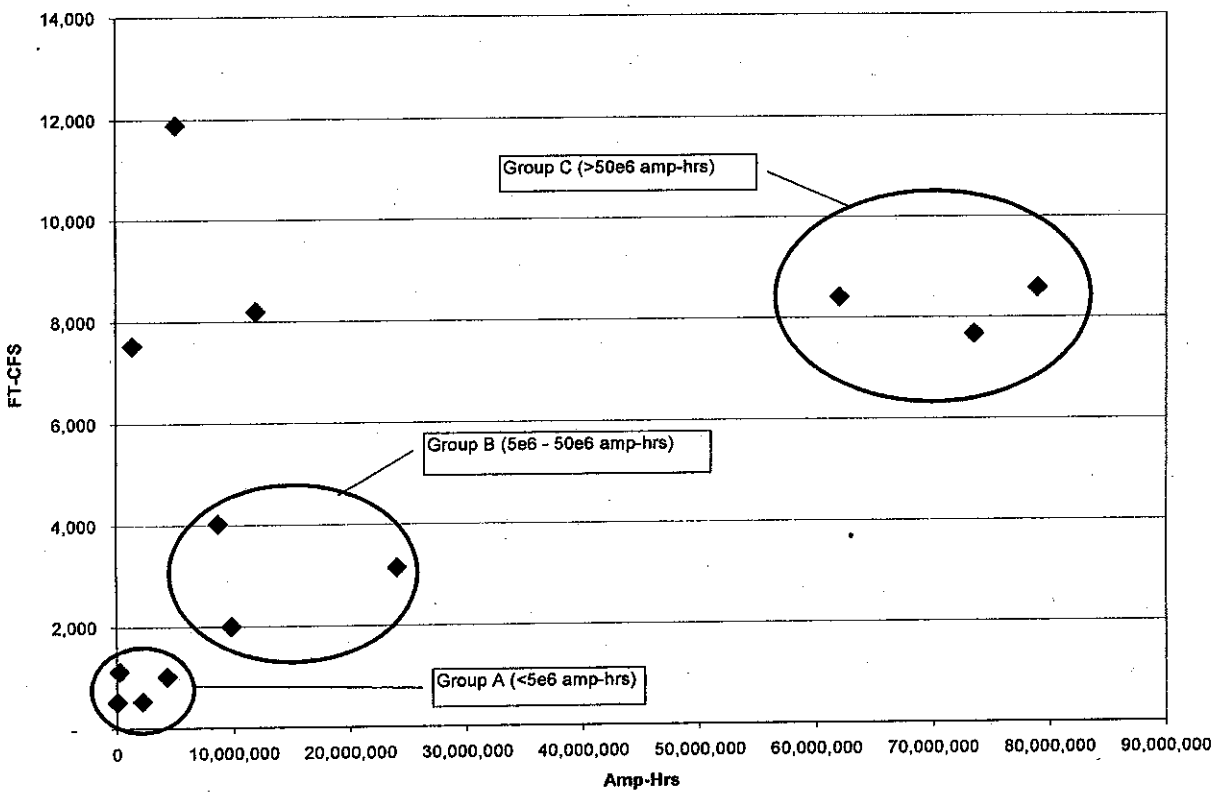
The stack parameters and fugitive building parameters are input to the latest version of the U.S. EPA ISCST3 (Version 02035) air quality model to estimate downwind impacts. Urban dispersion coefficients are used in ISCST3. Receptor heights are set at 1.2 meters above ground level. Terrain is assumed to be flat. The meteorological data used in the dispersion are collected from four locations throughout the state (Oakland, Fresno, San Diego, and Pasadena). In addition, a worst-case analysis is also simulated with screening meteorological conditions.

The model results are presented as annual average chi/q, which are concentrations based on a unit emission rate (1 g/s). In this way, the model results may be scaled to represent annual average concentrations from any facility by multiplying the chi/q with the facility emission rate.

Release Parameters - Stack Emissions

Stack data for shops with forced ventilation provided by SSD (Appendix H-1). These stack data are grouped in order to reduce the number of air dispersion model runs. Since all stacks essentially emit at approximately ambient conditions, temperature is not considered for stratifying the data. Of the stack parameters with vertical stack releases, we calculate the stack height (feet) multiplied by the gas flow (cubic feet per second). These two parameters are directly used to estimate final plume rise in the air dispersion model and are related to estimating downwind concentration. Figure 1 shows the stratified data as a function of facility amp-hours.

Figure 1 – Height * Stack Flow vs Amp - Hours



The data shown in Figure 1 are stratified into four groups. Table 1 shows the four stratified groups.

Table 1 – Stack Data Stratified		
Shop Group	Plume Rise Potential	Amp Hours
A	Low	< 5,000,000 amp-hrs
B	Medium	5,000,000 – 50,000,000 amp-hrs
C	High	> 50,000,000 amp-hrs
D	Horizontal	any amp-hrs with horizontal stack or raincap

Group D is for all stacks with horizontal releases or raincaps regardless of amp-hours. Plume rise is canceled when the stacks are horizontal or in the presence of a raincap for ambient temperature plumes.

Mean stack conditions for the vertical stacks, groups A-C, are used for each group in Table 1 as inputs to the air dispersion model. Figure 1 also shows data that lie outside of the groups. These data are not used in the mean. As a result, the predicted downwind concentrations for groups A and B will be biased towards overestimation of the mean. Table 2 shows the mean stack parameters for the four groupings. The stack data for the 26 shops (Appendix H-1) are incomplete for all necessary parameters to estimate plume rise. Therefore the mean conditions calculated in Table 2 is based on data from the shops where all parameters are available.

Table 2 – Stack Parameters

Parameter	Group A	Group B	Group C	Group D
Number of Facilities	4	3	3	4
Flow (cfs)	28	111	200	na
Diameter (m)	0.32	0.66	0.92	0.81
Velocity (m/s)	10.4	12.2	8.5	0.001
Temperature (C)	24	24	24	24
Stack Height (m)	9.1	9.1	12.8	5.6
Building Height (m)	8.8	8.8	12.5	5.3
Building Length (m)	10	10	10	10

Note 1: Building length, width and height are used for building downwash. We assume all stacks are impacted by building downwash. Therefore, building height is one foot (0.3 m) below stack height and building length and width is assumed to be ten meters.

Note 2: Raincaps and horizontal stacks (group D) are treated differently by setting the exit velocity to 0.001 m/s, turning stacktip downwash off, and reducing the stack height by three times the stack diameter (OEHHA Air Toxics Hot Spots Program Risk Assessment Guidelines, Part IV, 2000).

Release Parameters - Fugitive Emissions

Data for the shops with natural ventilation are provided by SSD (Appendix H-1). Table 3 shows a summary of the assumed release parameters for volume source releases in the dispersion model. The release parameters summarized in Table 3 reflect the lower range of the building dimensions in order to bias the predicted concentrations towards overestimation.

Table 3 – Volume (Fugitive) Source Parameters

Parameter	Group A-Vol (Small)	Group B-Vol (Medium)	Group C-Vol (Large)
Number of Facilities	14	42	11
Area Size (m^2)	<279	279 – 929	929 – 2787
Modeled Length (m)	10	17	30
Release Height (m), H/2	2.5	2.5	2.5
Syo (m), L/4.3	2.3	4.0	7.0
Szo(m), H/2.15	2.3	2.3	2.3
20 m receptor distance (m)	25	28	35

Meteorological Data

Meteorological data for this analysis are from four representative locations plus a screening analysis. Table 4 shows the latest consecutive five years of processed meteorological data, as recommended by the U.S. EPA Guideline on Air Quality Models. Shorter periods are used where longer periods are not available. The operating period for the chrome platers is 6 am to 3 pm. Therefore, Table 4 also includes a summary of meteorological conditions during normal operating hours. Appendix H-2 is the wind rose companion for Table 4.

Table 4 – Meteorological Data Summary

		Oakland	Fresno	San Diego (Miramar)	Pasadena	screening
Period	Winds	1960-1964	1985-1989	1967-1971	1981	Screening meteorological data are restricted to P-G stabilities A-D (daytime conditions only).
24 hours	Avg. Speed	4.5 m/s	3.1 m/s	2.8 m/s	1.6 m/s	
	Calms	11%	14%	17%	22%	
6 am – 3 pm	Avg. Speed	4.5 m/s	2.9 m/s	3.1 m/s	1.6 m/s	
	Calms	9%	13%	14%	16%	

Screening meteorological data represents inputs used in the U.S. EPA SCREEN3 air dispersion model. Our application is limited to daytime hours, Pasquill-Gifford stabilities A through D, since it is assumed emissions occur within the time period of 6 am to 3 pm. To estimate annual averages from the screening 1-hour averages, we multiply by the scaling factors of 0.5 to obtain an eight hour average and then we multiply by 9/24 to obtain the annual average as described in the HARP User Guide, December 2003.

Receptors

Receptors are placed at a minimum distance of 20 meters from the edge of building or stack. Polar receptors are used to plot the maximum downwind annual average concentration regardless of wind direction. Flagpole receptors set at 1.2 meters (4 ft.) above ground.

Results

Table 5 shows the annual average chi/q for screening conditions. As a result the chi/q in Table 5 are biased towards overprediction. Additional tables are provided below that show results with actual meteorological conditions for four locations in the state. The average emission rate (grams/second) should be multiplied by the chi/q to obtain the annual average concentration (µg/m^3). The average emission rate (grams/second) is based on nine hour days and 365 days per year. This is lower than the actual hourly emission rate during plating activity. However, since emissions may be distributed at any time throughout 6 am to 3 pm, we assumed the emissions are uniformly distributed over nine hours for modeling purposes.

Table 5 – Maximum (Screening) Annual Average Chi/Q (µg/m^3)/(g/s) from Shops with Chromium Plating

Shop		Distance Downwind							
Type	Size	20 m	30 m	40 m	50 m	100 m	200 m	500 m	1000 m
Stack	Low		310	340	300	190	64	12	4
	Medium		140	140	130	84	47	12	4
	High		72	89	88	69	43	11	3
	Horizontal	1500	1300	1000	780	250	70	12	4
Fugitive	Small	1500	990	710	530	210	61	12	3
	Medium	1000	700	520	430	190	59	12	3
	Large	620	470	370	300	160	54	11	3

- Multiply by hourly emissions [annual inventory (g) / (3285 hrs/yr) / (3600 s/hr)] to obtain annual average concentration.
- A blank cell indicates no calculation because the plume is in the building wake or is still aloft.

As an example for using Table 5, if the annual hexavalent chromium inventory for a shop is 0.1 lbs/yr, the maximum annual average concentration is estimated as follows:

$$AnnualAverage = 0.0058\frac{\mu g}{m^3} = \underbrace{1500\frac{(ug/m^3)}{(g/s)}}_{\text{chi/q}} \times \underbrace{0.1(lbs/yr)}_{\text{inventory}} \times \underbrace{\frac{454(g/lb)}{3285(hrs/yr)\times 3600(s/hr)}}_{\text{conversion factors}}$$

The chi/q results based on meteorological data from Oakland, Fresno, San Diego, and Pasadena are shown in Tables 6 through 9, respectively. The example calculation shown above should be used to convert the chi/q in Tables 6-9 to annual average concentrations. The results based on Pasadena meteorology, Table 9, show the highest chi/q.

**Table 6 – Maximum (Oakland)
Annual Average Chi/Q (µg/m³)/(g/s)
from Shops with Chromium Plating**

Shop		Distance Downwind							
Type	Size	20 m	30 m	40 m	50 m	100 m	200 m	500 m	1000 m
Stack	Low		58	51	43	17	4.9	0.8	0.2
	Medium		46	44	39	16	4.8	0.8	0.2
	High		17	22	22	13	4.4	0.8	0.2
	Horizontal	170	120	86	63	19	5.0	0.8	0.2
Fugitive	Small	180	110	70	50	17	4.7	0.8	0.2
	Medium	140	83	58	45	17	4.7	0.8	0.2
	Large	97	66	48	36	17	4.7	0.8	0.2

- Multiply by hourly emissions [annual inventory (g) / (3285 hrs/yr) / (3600 s/hr)] to obtain annual average concentration.
- A blank cell indicates no calculation because the plume is in the building wake or is still aloft.

**Table 7 – Maximum (Fresno)
Annual Average Chi/Q (µg/m³)/(g/s)
from Shops with Chromium Plating**

Shop		Distance Downwind							
Type	Size	20 m	30 m	40 m	50 m	100 m	200 m	500 m	1000 m
Stack	Low		61	54	44	16	4.7	0.8	0.2
	Medium		43	41	36	15	4.4	0.8	0.2
	High		17	23	23	13	4.1	0.7	0.2
	Horizontal	180	130	87	63	19	4.9	0.8	0.2
Fugitive	Small	180	110	70	50	17	4.7	0.8	0.2
	Medium	140	83	58	45	17	4.7	0.8	0.2
	Large	95	65	47	36	17	4.6	0.8	0.2

- Multiply by hourly emissions [annual inventory (g) / (3285 hrs/yr) / (3600 s/hr)] to obtain annual average concentration.
- A blank cell indicates no calculation because the plume is in the building wake or is still aloft.

Table 8 – Maximum (San Diego, Inland) Annual Average Chi/Q (µg/m³)/(g/s) from Shops with Chromium Plating									
Shop		Distance Downwind							
Type	Size	20 m	30 m	40 m	50 m	100 m	200 m	500 m	1000 m
Stack	Low		71	64	53	20	5.4	0.9	0.2
	Medium		49	47	41	17	5.2	0.9	0.2
	High		20	27	27	15	4.8	0.8	0.2
	Horizontal	220	150	110	75	22	5.6	0.9	0.2
Fugitive	Small	220	130	85	60	20	5.3	0.9	0.2
	Medium	220	100	71	54	20	5.3	0.9	0.2
	Large	120	83	59	44	20	5.3	0.9	0.2

- Multiply by hourly emissions [annual inventory (g) / (3285 hrs/yr) / (3600 s/hr)] to obtain annual average concentration.
- A blank cell indicates no calculation because the plume is in the building wake or is still aloft.

Table 9 – Maximum (Pasadena) Annual Average Chi/Q (µg/m³)/(g/s) from Shops with Chromium Plating									
Shop		Distance Downwind							
Type	Size	20 m	30 m	40 m	50 m	100 m	200 m	500 m	1000 m
Stack	Low		130	120	100	38	11	1.7	0.4
	Medium		52	53	50	28	9.6	1.7	0.4
	High		25	38	39	25	9.0	1.6	0.4
	Horizontal	470	320	220	150	43	11	1.8	0.4
Fugitive	Small	420	250	160	120	39	10	1.7	0.4
	Medium	340	190	130	100	38	10	1.7	0.4
	Large	230	150	110	81	38	10	1.7	0.4

- Multiply by hourly emissions [annual inventory (g) / (3285 hrs/yr) / (3600 s/hr)] to obtain annual average concentration.
- A blank cell indicates no calculation because the plume is in the building wake or is still aloft.

Appendix H-1

Chromium Plating Shop Physical Descriptions for Emission Release Parameters Provided by ARB's Stationary Source Division

Chromium Plating & Anodizing Facilities Dispersion Modeling Parameters

There are two types of facilities that need to be modeled. Facilities with ventilation systems (49%), and facilities without ventilation systems (51%).

Ventilated facilities with stacks:

Amp-hr distribution:	Range	Median	Mean
	500 – 83,000,000	1,000,000	8,000,000

Operating Parameter vary from continuous operation to the minimum of 4 hrs/day, 5 days/week

Facility Amp-hrs	Stack height (ft)	Stack diameter (in)	Exit Velocity (ft/sec)	Temperature (°F)
10,000	building height	10 X 15	26.56	78.5
35,000	25	11.5 X 14.5	18.1	82
200,000	25-Hor	34	21.5	78
225,000	26	13.5	43.2	73
1,100,000	building height	15 X 7.5	28.9	70
1,300,000	building height	19 1/2 X 26	13	85
1,400,000	30	28	58.7	69
2,200,000	?	12	50.4	75
2,200,000	32	8	47.3	70
4,300,000	34	14	28	69
5,100,000	55	26	58.6	77
8,700,000	25	30.75	31.2	75
9,800,000	30	13.5	67	94
10,700,000		48	35	55
12,000,000	45	32	32.6	91
17,800,000	building+185"	32	56.8	81
18,500,000	25-Hor	26 X 22	17.5	70
24,000,000	30	30	21.3	78
28,700,000	30-horizontal	27.75 X 39.75	23.75	78
30,500,000	25-Hor	26.75 X 21.75	21	60
34,000,000	Building +11'	24	16	84
62,000,000	40.5	34	32.9	75
	39	39	40.83	78
73,500,000	50	39	18.5	64
	50	39	13.5	64
79,000,000	36	36	33.7	70

South Coast Data: on stack height (64):
28 with 4.3 – 7.3m stack 30 with 7.3 – 15 m stack 5 with > 15m stack

Unventilated Facilities:

Volume source we need building dimensions. The source has usually one tank.

Amp-hr distribution:	Range	Median	Mean
	120 – 10,000,000	70,000	470,000

Operating Parameter vary from 12 hrs/day, 7days/week to the minimum of 2 hrs/day, 5 days/week

SCAQMD building dimensions for 68 volume sources

14 with < 279 m^2
42 with 279 – 929 m^2
11 with 929 – 2,787 m^2

Appendix H-2

Wind Roses and Modeling Outputs

Figure B1 – Oakland Wind Rose (6 am – 3 pm)

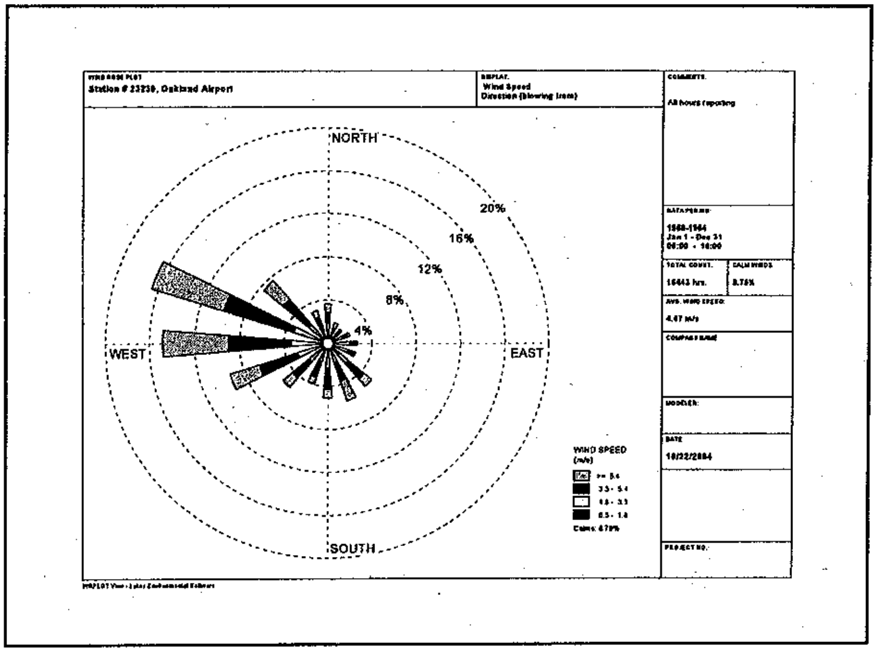


Figure B2 – Oakland Wind Rose (All Hours)

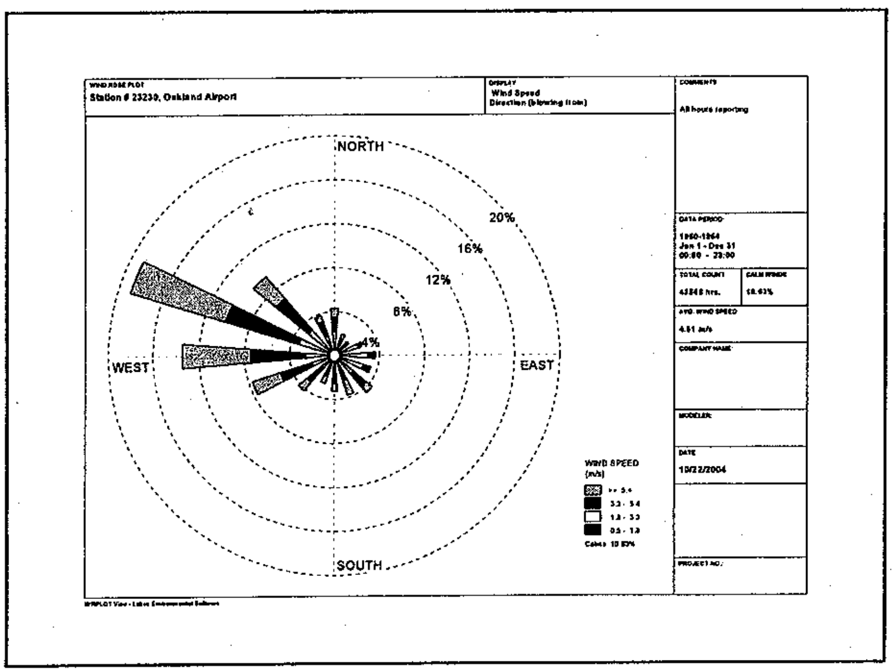


Figure B3 – Fresno Wind Rose (6am – 3pm)

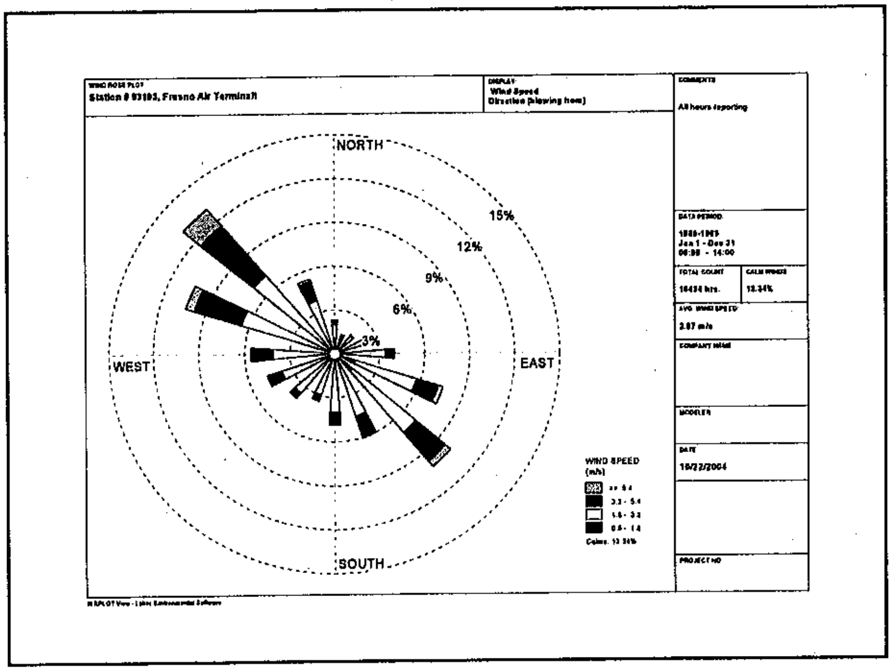


Figure B4 – Fresno Wind Rose (All Hours)

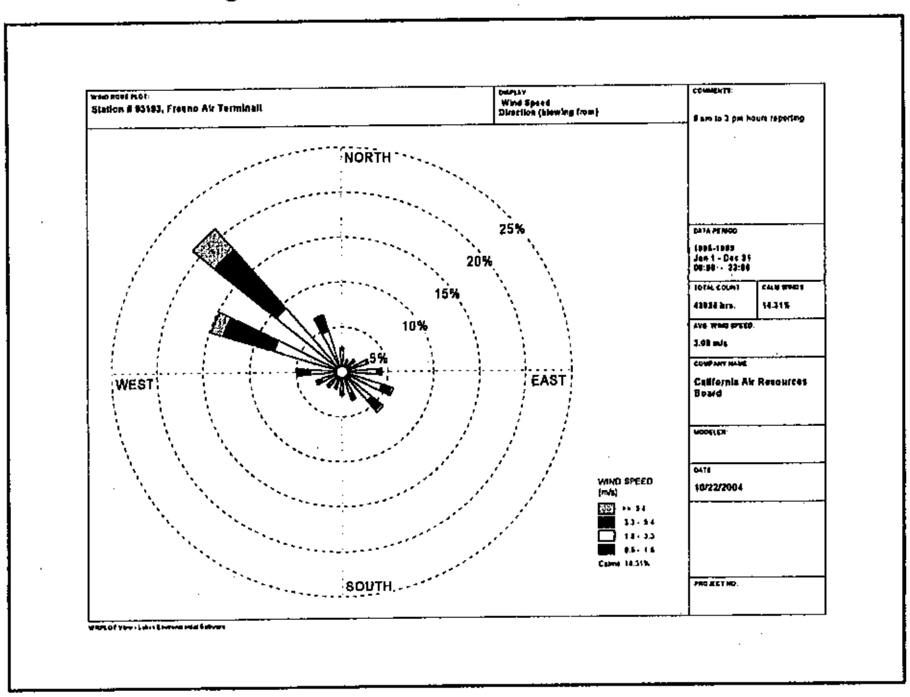


Figure B5 – San Diego (Miramar) Wind Rose (6am – 3pm)

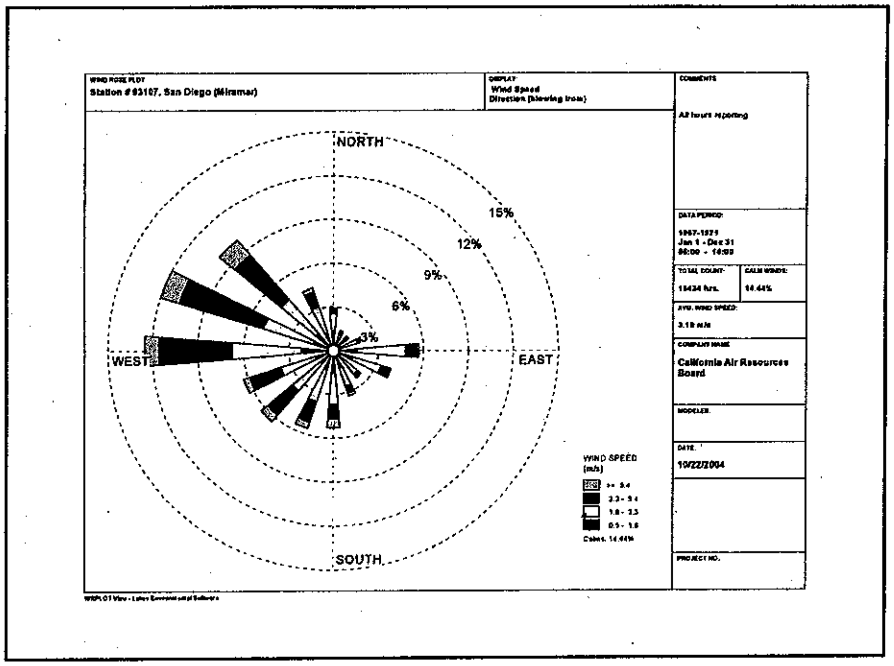


Figure B6 – San Diego (Miramar) Wind Rose (All Hours)

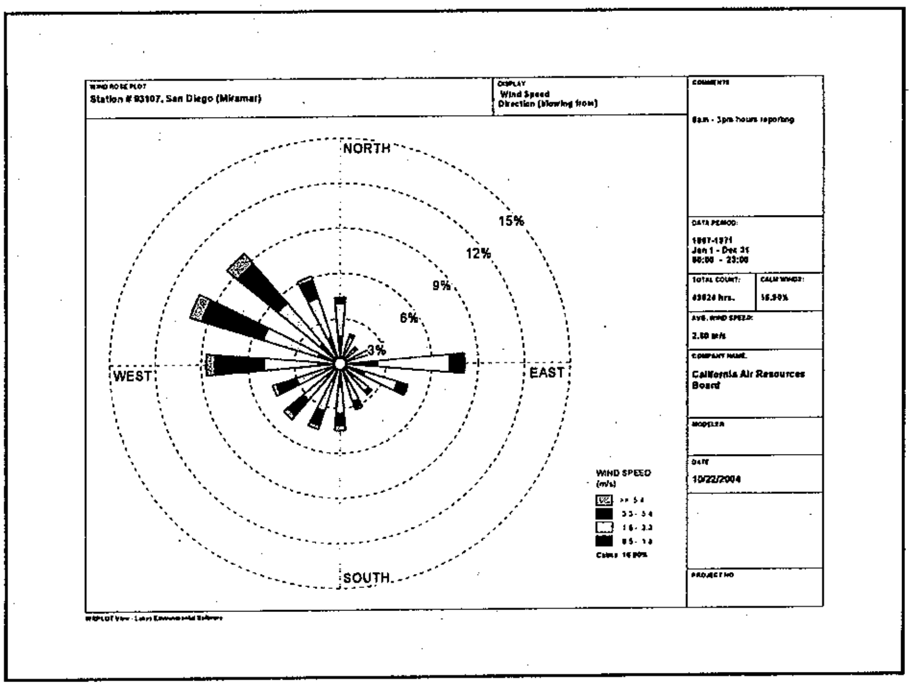


Figure B7 – Pasadena Wind Rose (6am – 3pm)

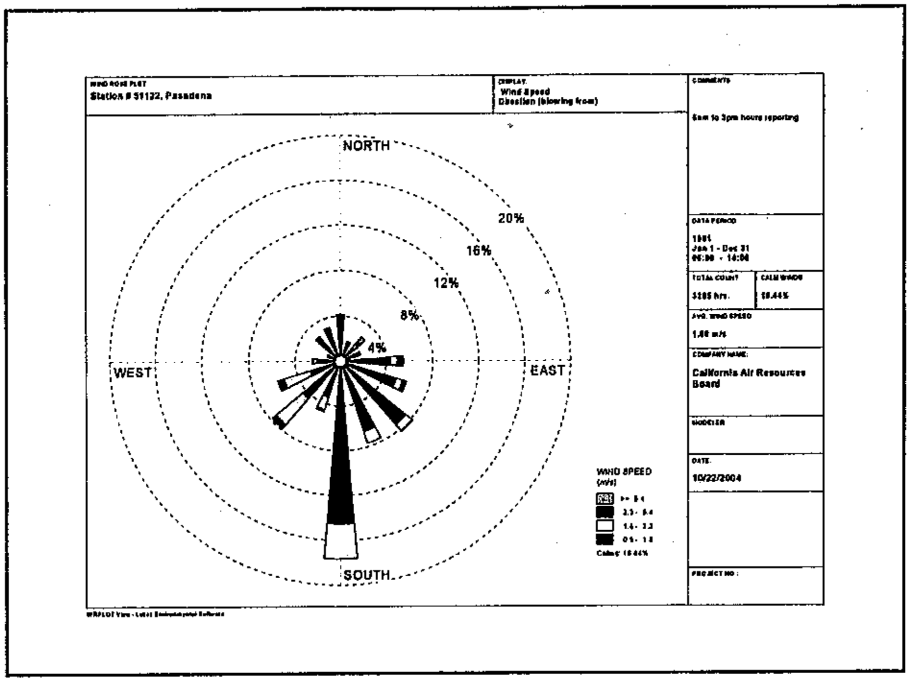
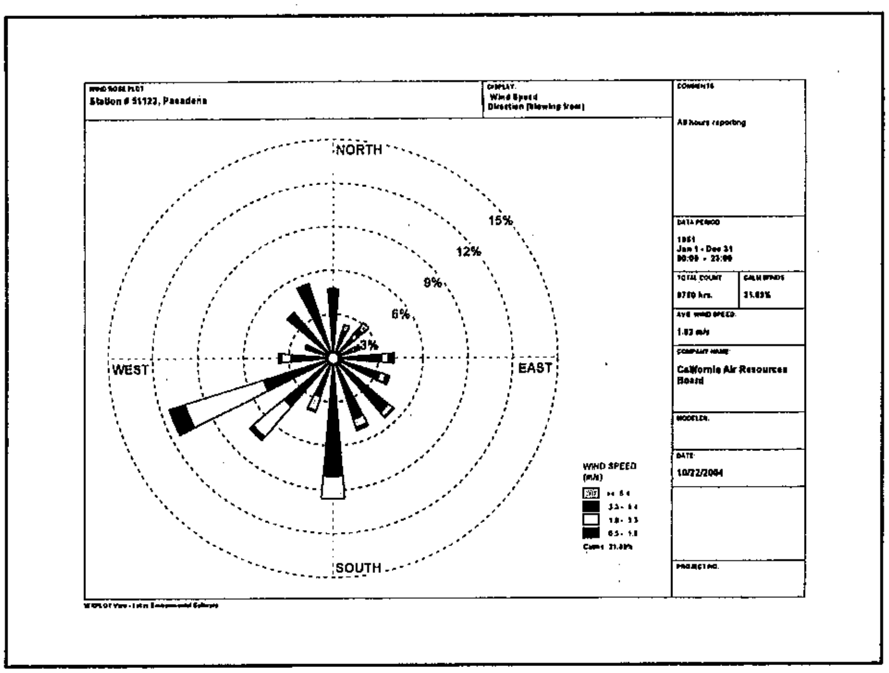


Figure B8 – Pasadena Wind Rose (All Hours)



Modeling

Chrome Plating with a stack source, unit emission rate

q (g/s)	days/week	**q (g/yr)**	**q (lb/yr)**
1	7	**11,793,600**	**26,000**
(m)	(ug/m3)	(ug/m3)	(ug/m3)
Distance from edge of facility	Fresno	San Diego, Inland	Pasadena
20			
Low	n/a	n/a	n/a
Medium	n/a	n/a	n/a
High	n/a	n/a	n/a
Horizontal	180.00	220.00	470.00
30			
Low	61.00	71.00	130.00
Medium	43.00	49.00	52.00
High	17.00	20.00	25.00
Horizontal	130.00	150.00	320.00
40			
Low	54.00	64.00	120.00
Medium	41.00	47.00	53.00
High	23.00	27.00	38.00
Horizontal	87.00	110.00	220.00
50			
Low	44.00	53.00	100.00
Medium	36.00	41.00	50.00
High	23.00	27.00	39.00
Horizontal	63.00	75.00	150.00
100			
Low	16.00	20.00	38.00
Medium	15.00	17.00	28.00
High	13.00	15.00	25.00
Horizontal	19.00	22.00	43.00
200			
Low	4.70	5.40	11.00
Medium	4.40	5.20	9.60
High	4.10	4.80	9.00
Horizontal	4.90	5.60	11.00
500			
Low	0.80	0.90	1.70
Medium	0.80	0.90	1.70
High	0.70	0.80	1.60
Horizontal	0.80	0.90	1.80
1000			
Low	0.20	0.20	0.40
Medium	0.20	0.20	0.40
High	0.20	0.20	0.40
Horizontal	0.20	0.20	0.40

ISCST (Version 02035) Model Results
In addition to the details in the figures, the following met. Data are used to estimate long term (annual) averages)
These data are the latest available processed databases.

Modeling

Chrome Plating with fugitive source, unit emission rate

q (g/s)	hrs/day	days/week	**q (g/yr)**	**q (lb/yr)**
1	9	7	**11,793,600**	**26,000**
	|-------- period (annual) average ---- ------------------------- ---|			
(m)	(ug/m3)	(ug/m3)	(ug/m3)	(ug/m3)
Distance from edge of facility	Oakland	Fresno	San Diego, Inland	Pasadena
20				
small	180.00	180.00	220.00	420.00
medium	140.00	140.00	220.00	340.00
large	97.00	95.00	120.00	230.00
30				
small	110.00	110.00	130.00	250.00
medium	83.00	83.00	100.00	190.00
large	66.00	65.00	83.00	150.00
40				
small	70.00	70.00	85.00	160.00
medium	58.00	58.00	71.00	130.00
large	48.00	47.00	59.00	110.00
50				
small	50.00	50.00	60.00	120.00
medium	45.00	45.00	54.00	100.00
large	36.00	36.00	44.00	81.00
100				
small	17.00	17.00	20.00	39.00
medium	17.00	17.00	20.00	38.00
large	17.00	17.00	20.00	38.00
200				
small	4.70	4.70	5.30	10.00
medium	4.70	4.70	5.30	10.00
large	4.70	4.60	5.30	10.00
500				
small	0.80	0.80	0.90	1.70
medium	0.80	0.80	0.90	1.70
large	0.80	0.80	0.90	1.70
1000				
small	0.20	0.20	0.20	0.40
medium	0.20	0.20	0.20	0.40
large	0.20	0.20	0.20	0.40

ISCST (Version 02035) Model Results
In addition to the details in the figures, the following met. data are used to estimate long term (annual) averages)
These data are the latest available processed databases.

REFERENCE

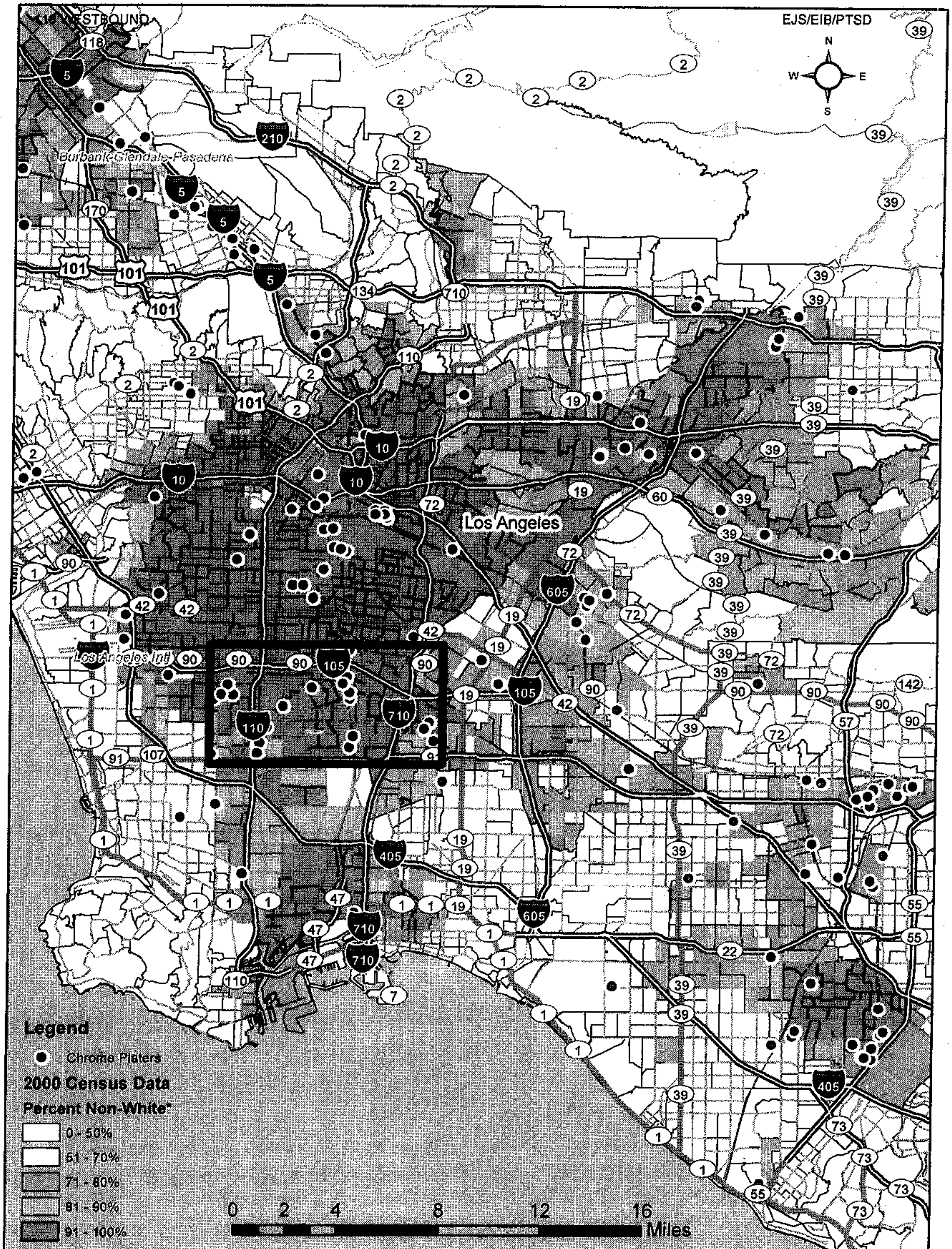
ARB Compilation of Emission Testing Results from Chromium Plating and Chromic Acid Anodizing Facilities

Appendix I

Analysis of Proximity of Chromium Plating and Chromic Acid Anodizing Facilities in Southern California

Appendix I - Chart 1

Los Angeles Area - Percent Non-White

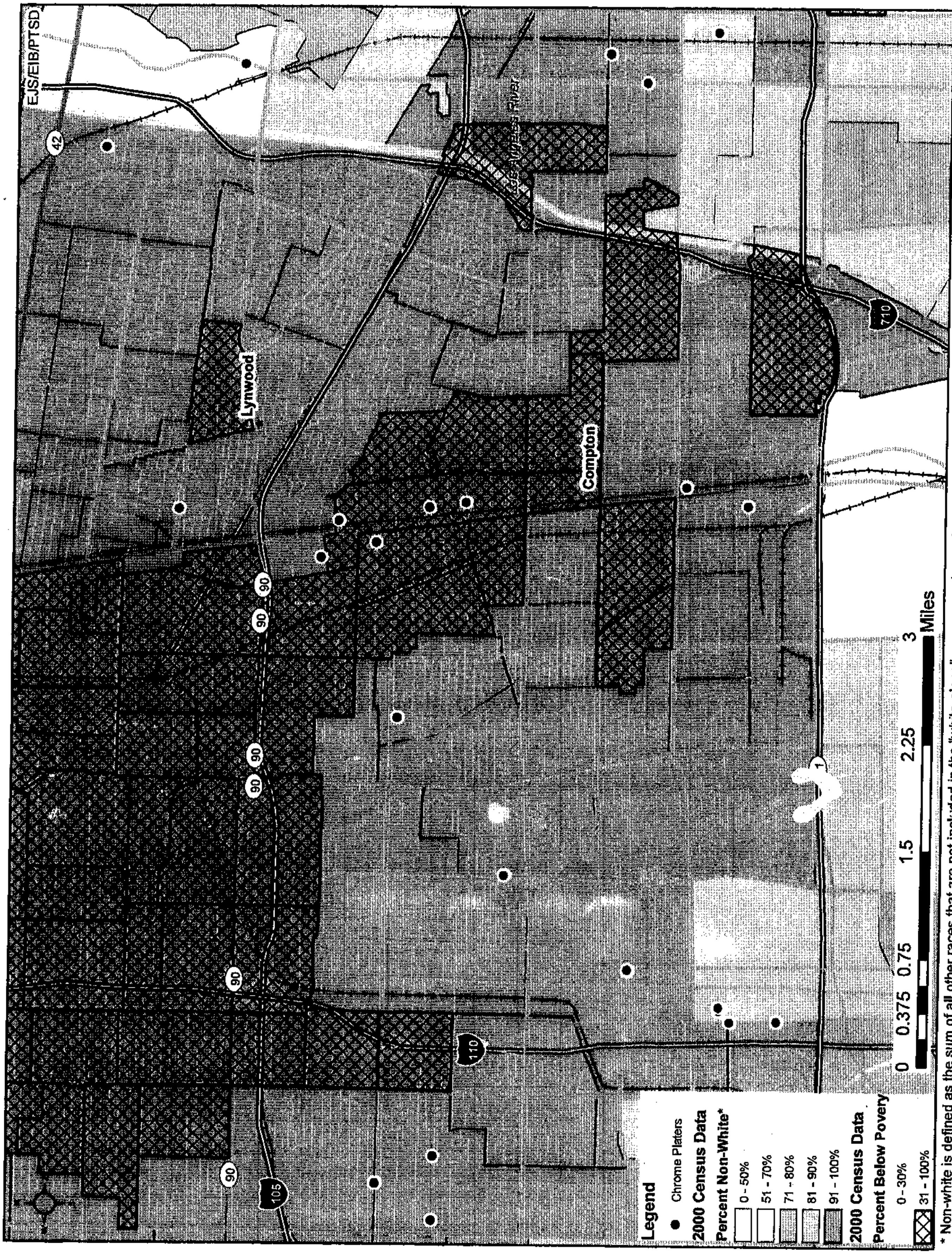


* Non-white is defined as the sum of all other races that are not included in the "white-alone" one-race category in the 2000 census data prepared by the U.S. Census Bureau.

California Environmental Protection Agency

Air Resources Board

Appendix I - Chart 2



Compton Area -- % Non-White and % Below Poverty

Title 13. CALIFORNIA AIR RESOURCES BOARD

NOTICE OF PUBLIC HEARING TO CONSIDER TECHNICAL STATUS AND PROPOSED REVISIONS TO MALFUNCTION AND DIAGNOSTIC SYSTEM REQUIREMENTS AND ASSOCIATED ENFORCEMENT PROVISIONS FOR PASSENGER CARS, LIGHT-DUTY TRUCKS, AND MEDIUM-DUTY VEHICLES AND ENGINES (OBD II) AND EMISSION WARRANTY REGULATIONS

The Air Resources Board (the Board or ARB) will conduct a public hearing at the time and place noted below to review the technical status and implementation of California's OBD II requirements. The Board will consider amendments to the OBD II regulation to update the diesel monitoring requirements to be more consistent with the newly-adopted heavy-duty on-board diagnostic (HD OBD) regulation, to improve incorporation of OBD II into Inspection and Maintenance (I/M) programs, to clarify and improve the regulation where necessary, and to make clarifications to the OBD II enforcement provisions, among other things. The Board will also consider amendments to the emission warranty regulations to update the references to emission-related parts that are presently used in emission control technology and to simplify the requirements where possible.

DATE: September 28, 2006

TIME: 9:00 a.m.

PLACE: California Environmental Protection Agency
Air Resources Board
Byron Sher Auditorium
1001 I Street
Sacramento, California 95814

This item will be considered at a two-day meeting of the Board, which will commence at 9:00 a.m., September 28, 2006, and may continue at 8:30 a.m., September 29, 2006. This item might not be considered until September 29, 2006. Please consult the agenda for the meeting, which will be available at least ten days before September 28, 2006, to determine the day on which this item will be considered.

For individuals with sensory disabilities, this document is available in Braille, large print, audiocassette or computer disk. Please contact ARB's Disability Coordinator at (916) 323-4916 by voice or through the California Relay Services at 711, to place your request for disability services. If you are a person with limited English and would like to request interpreter services, please contact ARB's Bilingual Manager at (916) 323-7053.

INFORMATIVE DIGEST OF PROPOSED ACTION AND POLICY STATEMENT OVERVIEW

<u>Sections Affected</u>: Proposed adoption of amendments to title 13, California Code of Regulations (CCR) sections 1968.2 and 1968.5, which establish OBD II requirements and enforcement provisions for 2004 and subsequent model-year passenger cars, light-duty trucks, and medium-duty vehicles and engines; proposed adoption of amendments to title 13, CCR sections 2035, 2037, and 2038, which establish emission control system warranty requirements for 1990 and subsequent model year passenger cars, light-duty trucks, and medium-duty vehicles and engines.

<u>Documents Incorporated by Reference</u>:

ISO 15765-4:2005 "Road Vehicles-Diagnostics on Controller Area Network (CAN) - Part 4: Requirements for emission-related systems."

SAE J1939 March 2005-"Recommended Practice for a Serial Control and Communications Vehicle Network" and the associated subparts included in SAE HS-1939, "Truck and Bus Control and Communications Network Standards Manual," 2005 Edition.

SAE J1699-3 – "OBD II Compliance Test Cases," May 2006.

SAE J2534 – "Recommended Practice for Pass-Thru Vehicle Programming," April 2004.

<u>Background</u>: The Board originally adopted title 13, CCR section 1968.1 on September 12, 1989, requiring manufacturers to implement OBD II systems on new motor vehicles. The regulation, which was first implemented beginning with the 1994 model year, required that essentially all 1996 and later model year passenger cars, light-duty trucks, and medium-duty vehicles and engines be equipped with OBD II systems. The regulation specifically required monitoring of engine misfire, catalysts, oxygen sensors, evaporative systems, exhaust gas recirculation (EGR), secondary air systems, fuel systems, and all electronic powertrain components that can affect emissions when malfunctioning. The regulation also required OBD II systems to provide specific diagnostic information in a standardized format through a standardized serial data link on-board the vehicles. Pursuant to section 209(b) of the federal Clean Air Act (CAA), ARB obtained a preemption waiver from the U.S. Environmental Protection Agency (U.S. EPA) in October 1996 for the OBD II regulation.

Subsequently, ARB updated the OBD II requirements in 2002 with the adoption of section 1968.2, title 13, CCR, which established OBD II requirements and enforcement requirements for 2004 and subsequent model year passenger cars, light-duty trucks, and medium-duty vehicles and engines. Section 1968.2 essentially updated the requirements of section 1968.1 by improving and clarifying the monitoring requirements where needed, adding new monitoring requirements, improving the availability of service information, addressing issues associated with the implementation of OBD II into I/M programs, and adding testing requirements to ensure compliance with the OBD II regulation. Concurrently, ARB also adopted section 1968.5, title 13, CCR, which established OBD II enforcement provisions for 2004 and subsequent model year vehicles, including provisions that set up specific criteria that identify vehicles with OBD II-related problems that are subject to remedial orders by ARB. A waiver request regarding the 2002 amendments is presently pending before U.S. EPA.

In 1979, pursuant to Health and Safety Code section 43205, ARB adopted sections 2035-2041, title 13, CCR, which contain the warranty requirements for passenger cars, light-duty trucks, and medium-duty vehicles. The regulations established requirements for manufacturers to warrant emission-related parts for both defects and performance for a period of three years and 50,000 miles. Additionally, under the regulation, a subset of "high-cost" emission-related parts was eligible to be warranted for seven years and 70,000 miles if they met specific inflation-adjusted cost numbers. ARB subsequently amended the regulation in 1990, and made minor changes regarding the timing of submittal of information required under these sections in 1999.

Staff Proposal: In 2002, the Board directed the staff to continue to follow manufacturers' progress towards meeting the OBD II requirements and to report back should modifications to the requirements be deemed appropriate. Since then, the staff has identified areas in which modifications to section 1968.2 would provide for improved monitoring system performance. The majority of the proposed modifications are related to the monitoring requirements for diesel vehicles. The staff proposes updating the diesel monitoring requirements to make them more consistent with the monitoring requirements of the HD OBD regulation (title 13, CCR section 1971.1) that was recently adopted in 2005. Specifically, to alleviate manufacturers' concerns about meeting the proposed malfunction emission thresholds, the proposal would amend the regulation to phase-in the final, more stringent malfunction thresholds at which the manufacturers must illuminate the malfunction indicator light and would not require general compliance with final thresholds until the 2013 model year.

For 2007 through 2012 model year light-duty diesel vehicles certified to the higher interim malfunction emission thresholds, the proposal would include an additional step to help protect against possible increased emissions from the higher thresholds and to help ensure that these vehicles are indeed performing as designed. Specifically, the proposal would require manufacturers of these vehicles to perform emission testing on actual production vehicles to verify their compliance with the emission standard. Having the manufacturers perform this testing on all diesel vehicle models (which would be equivalent to the in-use tailpipe compliance testing done by ARB on a limited number of vehicle models each year) would provide some assurance that the vehicles, as a whole, do not have a design defect that causes them to fail to meet the base emission standards.

Among the other amendments being proposed to the OBD II regulation are:

- Adding additional requirements for the storage and erasure of permanent fault codes.
- Allowing manufacturers to use 0.100 as the minimum in-use performance ratio for determining acceptable OBD II monitoring frequency for the first three years that a vehicle model is certified instead of just the first two years.
- Allowing manufacturers to continue to use a malfunction threshold of "3.5 times the NOx standards" for gasoline catalysts for two additional years, through the 2008 model year.
- Requiring manufacturers to detect failures caused by an air-fuel ratio cylinder imbalance under the gasoline fuel system monitoring requirements.
- Revising the gasoline primary and secondary oxygen sensor monitoring requirements to clarify and detail the minimum acceptable amount of monitoring that OBD II systems must perform.
- Revising the comprehensive component monitoring requirements to provide more guidance to manufactures related to monitoring components on hybrid vehicles.
- Adding additional parameters that manufacturers must include in the data stream for gasoline and diesel vehicles.
- Requiring manufacturers to provide additional engine run time tracking requirements for medium-duty diesel vehicles.
- Deleting the service information requirements.
- Extending the deadline under the production vehicle evaluation testing requirements for reporting of in-use monitoring performance data from six months to twelve months after start of normal production.

The staff is also proposing amendments to section 1968.5 to align the enforcement provisions, as necessary, with the proposed changes to section 1968.2. Additionally, the staff is proposing the Board delete reference to the "procedures of the California I/M program" from the mandatory recall provisions related to I/M testing and instead list the specific criteria of OBD II noncompliances related to conducting Smog Check inspections that would result in mandatory recall. The staff is also proposing more appropriate in-use thresholds (i.e., thresholds at which a vehicle would be found to have a nonconforming OBD II system and would be subject to possible enforcement action) for OBD II emission testing of diesel vehicles certified to the higher interim malfunction thresholds required for the 2007 through 2012 model years.

Additionally, the staff is proposing amendments to the ARB emission warranty regulations (specifically title 13, CCR, sections 2035, 2037 and 2038) to update the references to emission-related parts used with current emission control technology and to simplify the requirements where possible. Specifically, the proposed amendments would eliminate the outdated (last updated in 1985) emission-related parts list used today to identify components eligible for the high-cost warranty and instead require high cost warranty coverage for any component that is subject to warranty for 3 years and 50,000 miles and meets the inflation-adjusted cost limit.

<u>Comparable Federal Regulations</u>: In February 1993, U.S. EPA promulgated final on-board diagnostic requirements for federally certified vehicles. (40 CFR Part 86, sections 86.094-2, 86.094-17, 86.094-18(a), 86.094-21(h), 86.094-25(d), 86.094-30(f), 86.094-35(l), 86.095-30(f), 86.095-35(l); see 58 Fed.Reg. 9468-9488 (February 19, 1993).) The requirements were last modified with a final rule signed on November 29, 2005 and published December 20, 2005 (70 Fed.Reg. 75403). A central part of the federal regulation is that, for purposes of federal certification of vehicles, U.S. EPA will deem California-certified OBD II systems to comply with the federal regulations. On October 3, 1996, U.S. EPA formally granted California's request for a waiver regarding the OBD II regulation, as last amended in December 1994,[1] recognizing that the OBD II regulation is at least as stringent in protecting public health and welfare as the federal regulation, and that unique circumstances exist in California necessitating the need for the state's own motor vehicle regulations program.

The federal OBD requirements are comparable in concept and purpose with California's OBD II regulation; however, differences exist with respect to the scope and stringency of the requirements of the two regulations. More specifically, California's current OBD II regulations are generally more stringent than the comparable federal requirements. Under the OBD II requirements, manufacturers must implement monitoring strategies for essentially all emission control systems and emission-related components. Generally, the OBD II regulation requires that components be monitored to indicate malfunctions when component deterioration or failure causes emissions to exceed 1.5 times the applicable tailpipe emission standards of the certified vehicle. The regulation also requires that components be monitored for functional performance even if the failure of such components does not cause emissions to exceed the 1.5 times the standards threshold. The federal requirements, in contrast, require monitoring only of the catalyst, engine misfire, evaporative emission control system, and oxygen sensors. Other emission control systems or components, such as exhaust gas recirculation and secondary air systems, need only be monitored if by malfunctioning, vehicle emissions exceed 1.5 times the applicable tailpipe standards. No functional monitoring is required. This also applies to after-treatment devices on diesel applications, such as catalyst systems and particulate matter traps.

In Health and Safety Code sections 43013, 43018, and 43101, the Legislature has expressly directed ARB to adopt emission standards for new motor vehicles that are necessary and technologically feasible and 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 standards at the earliest practicable date. ARB initially adopted and is proposing to amend the OBD II regulation to meet those legislative directives.

Regarding emission warranties, the federal emission warranty requirements (section 207 of the Federal CCA) are comparable in concept but with significant

[1] *California State Motor Vehicle Pollution Control Standards; Waiver of Federal Preemption; Decision,* dated October 3, 1996, 61 Fed.Reg. 53371-53372.

differences in actual warranty coverage. California's current emission warranty provisions, pursuant to Health and Safety Code section 43205, provide coverage of all emission-related parts for three years and 50,000 miles while the federal emission warranty provides similar coverage only for two years and 24,000 miles. Additionally, California's emission warranty provisions cover specific "high-cost" emission parts for a longer warranty period of seven years and 70,000 miles with the "high-cost" determination based on exceeding an annually CPI-adjusted repair cost limit. Federal warranty provisions, on the other hand, mandate coverage only for the catalyst and the vehicle on-board computer for eight years and 80,000 miles, regardless of the repair cost for either of those items or any other emission related part. While the federal warranty provision does provide for longer coverage on the catalyst and the on-board computer, it does not provide the same level of consumer protection for other high-cost emission parts as the California provisions for seven years and 70,000 miles. Further, the three years and 50,000 miles California warranty provides additional coverage for all emission-related parts beyond the federal two years and 24,000 miles (or the typical vehicle manufacturer "bumper-to-bumper" warranty of three years and 36,000 miles). When taken in total, the California emission warranty provisions are more stringent than the federal requirements given they provide additional coverage for all parts and many high-cost parts.

The differing ARB warranty provisions have been adopted pursuant to the express dictates of Health and Safety Code section 43205. Both the costs amendments to the OBD and warranty regulation are justified by the benefit to human health, public health and safety, and environment.

AVAILABILITY OF DOCUMENTS AND AGENCY CONTACT PERSONS

ARB staff has prepared a Staff Report: Initial Statement of Reasons (ISOR) for the proposed regulatory action that includes a summary of the environmental and economic impacts of the proposal. The report is entitled: Technical Status and Revisions to Malfunction and Diagnostic System Requirements for Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles and Engines (OBD II) and the Emission Warranty Regulations.

Copies of the ISOR and the full text of the proposed regulatory language, in underline and strikeout format to allow for comparison with the existing regulations, may be accessed on the ARB's website listed below, or may be obtained from the Public Information Office, Air Resources Board, 1001 I Street, Visitors and Environmental Services Center, 1st Floor, Sacramento, CA 95814, (916) 322-2990 at least 45 days prior to the scheduled hearing (September 28, 2006).

Upon its completion, the Final Statement of Reasons (FSOR) will be available and copies may be requested from the agency contact persons in this notice, or may be accessed on the ARB's website listed below.

Inquiries concerning the substance of the proposed regulation should be directed to the agency contact persons for this rulemaking: Mike Regenfuss, Staff Air Pollution Specialist, at (626) 575-7004 or email (mregenfu@arb.ca.gov), or Mike McCarthy, Manager, Advanced Engineering Section, Mobile Source Control Division, at (626) 575-6615 or email (mmccarth@arb.ca.gov).

Further, the agency representative and designated back-up contact persons to whom non-substantive inquiries concerning the proposed administrative action may be directed are Artavia Edwards, Manager, Board Administration & Regulatory Coordination Unit, (916) 322-6070, or Alexa Malik, Regulations Coordinator, (916) 322-4011. The Board has compiled a record for this rulemaking action, which includes all the information upon which the proposal is based. This material is available for inspection upon request to the agency contact persons.

If you are a person with a disability and desire to obtain this document in an alternative format, please contact the Air Resources Board ADA Coordinator at (916) 323-4916, or TDD (916) 324-9531, or (800) 700-8326 for TDD calls outside the Sacramento area.

This notice, the ISOR and all subsequent regulatory documents, including the FSOR, when completed, are available on the ARB Internet site for this rulemaking at: http://www.arb.ca.gov/regact/obdii06/obdii06.htm.

COSTS TO PUBLIC AGENCIES AND TO BUSINESSES AND PERSONS AFFECTED

The determinations of the Board's Executive Officer concerning the costs or savings necessarily incurred by public agencies and private persons and businesses in reasonable compliance with the proposed amendments are presented below.

Pursuant to Government Code section 11346.5(a)(5), the Executive Officer has determined that the proposed amendments will not impose a mandate on local agencies or school districts. The Executive Officer has further determined pursuant to Government Code section 11346.5(a)(6) that the proposed regulatory action will result in some additional costs to the ARB and will create negligible costs to all other state agencies that purchase diesel vehicles. In addition, the Executive Officer has determined that the proposed regulatory action will not create costs or savings in federal funding to the state, will not create costs or savings to local agencies or school districts that is required to be reimbursed under Part 7 (commencing with section 17500), Division 4, Title 2 of the Government Code, and will not result in other nondiscretionary savings to state or local agencies.

In developing this regulatory proposal, the ARB staff evaluated the potential economic impacts on representative private persons and businesses, and has determined that any business or individual purchasing a diesel vehicle equipped with an OBD II system would incur additional costs as a result of this regulation. Specifically, retail costs for new medium-duty diesel vehicles equipped with an OBD II system are expected to increase by $153 per vehicle (an increase of approximately 0.4% of the retail cost of the vehicle), while retail costs for new light-duty diesel vehicles equipped with an OBD II system are expected to increase by $140 per vehicle. Further, because OBD II systems are expected to detect emission-system and component malfunctions that would not otherwise be detected, the regulation would be expected to result in owners and operators potentially incurring additional emission-related repairs. However, the increase in repairs from having more components on the vehicle that are subject to OBD II monitoring would be offset by expected increases in component durability as vehicle manufacturers produce more durable vehicles to avoid warranty expense or consumer dissatisfaction. It is expected that these repairs would result in average costs of approximately $22 per diesel vehicle, per year over the 20 year life of the vehicle (all vehicles are expected to incur, on average, 0.6 additional repairs over the first 20 years of operation at an average repair cost of $444).

The Executive Officer has made an initial determination, pursuant to Government Code section 11346.5(a)(8), that the proposed regulatory action would not have a significant statewide adverse economic impact directly affecting businesses, including the ability of California businesses to compete with businesses in other states, or on representative private persons. Support for this determination is set forth in the ISOR. Additionally, in accordance with Government Code section 11346.3, the Executive Officer has determined that the proposed regulatory action would not affect the creation or elimination of jobs within the State of California, the creation of new businesses or elimination of existing businesses within the State of California, or the expansion of businesses currently doing business within the State of California.

For manufacturers of light- and medium-duty gasoline vehicles, the costs to comply with the proposed regulatory action are expected to be negligible. The proposed revisions consist primarily of modifications to existing computer software. Incorporation and verification of the revised OBD II software would be accomplished during the regular design proves at no additional cost. As a result, costs to manufacturers, and therefore consumers, are anticipated to remain virtually unchanged.

For manufacturers of light-duty and medium-duty diesel vehicles, the costs to comply with the proposed regulatory action are expected to be less than the $140 and $153 retail price increases that were calculated for implementation of the requirements. Manufacturers would incur these costs in the form of additional hardware and software installed in the engine and the testing and development costs to implement the requirements. The Executive Officer anticipates that manufacturers would recoup these costs through the anticipated $140 and $153 retail price increase on each vehicle they sell.

Of the 34 domestic and foreign corporations that manufacturer California-certified passenger cars, light-duty trucks, and medium-duty gasoline and diesel vehicles equipped with OBD II systems, only one motor vehicle manufacturing plant, the New United Motor Manufacturing, Inc. (NUMMI), a joint venture between Toyota Motor Corporation and General Motors Corporation, is located in California. As stated, the costs associated with the amendments principally involve research and development costs and do not affect assembly line production. Additionally, all manufacturers that produce diesel vehicles should experience similar, if not identical costs. Thus, the NUMMI facility, which does not produce diesel vehicles, should not be at either an advantage or disadvantage in relation to out-of-state car manufacturing facilities and should not experience an increase or decrease in the number of jobs at the facility.

In developing this regulatory proposal, ARB staff has found that the proposal would impose no significant adverse economic impact on private persons and businesses as consumers. The $153 cost increase, for example, represents less than a 0.4% increase in the retail price of a medium-duty diesel vehicle, and the $22 per vehicle per year in increased maintenance costs is negligible. Accordingly, the Executive Officer has determined that there will be no, or negligible, potential cost impact on representative private persons or businesses as a result of the proposed regulatory action.

The Executive Officer has also determined, pursuant to title 1, CCR, section 4, that the proposed regulatory action will have no significant adverse effect on small businesses because the regulation primarily affects vehicle manufacturers, none of which are small businesses. Further, small businesses which service or repair vehicles should not see any increased cost in equipment or tools or any reduction in the number of vehicles needing repair as a result of these amendments. Small businesses that own or operate vehicles would incur the same costs as individuals or other businesses in an increase in vehicle maintenance costs of $22 per vehicle per year for any 2007 model year or newer medium-duty diesel vehicle purchased.

The amendments to the regulation do not impose any additional reporting requirements of manufacturers. In accordance with Government Code sections 11346.3(c) and 11346.5(a)(11), the ARB's Executive Officer has previously found that the reporting requirements of the regulation which apply to businesses are necessary for the health, safety, and welfare of the people of the State of California.

Before taking final action on the proposed regulatory action, the Board must determine that no reasonable alternative considered by the agency or that has been otherwise identified and brought to the attention of the agency would be more effective in carrying out the purpose for which the action is proposed, or would be as effective and less burdensome to affected private persons than the proposed action.

SUBMITTAL OF COMMENTS

The public may present comments relating to this matter orally or in writing at the hearing, and in writing or by e-mail before the hearing. To be considered by the Board, written submissions must be received by no later than 12:00 noon, **September 28, 2006** and addressed to the following:

Postal Mail is to be sent to:

Clerk of the Board
Air Resources Board
1001 "I" Street, 23rd Floor
Sacramento, California 95814

Electronic submittal : http://www.arb.ca.gov/lispub/comm/bclist.php and received at the ARB no later than 12:00 noon, **September 28, 2006.**

Facsimile submissions are to be transmitted to the Clerk of the Board at (916) 322-3928 and received at the ARB no later than 12:00 noon, **September 28, 2006.**

The Board requests, but does not require, that 30 copies of any written statement be submitted and that all written statements be filed at least 10 days prior to the hearing so that ARB staff and Board Members have time to fully consider each comment. The ARB encourages members of the public to bring to the attention of staff in advance of the hearing any suggestions for modification of the proposed regulatory action.

STATUTORY AUTHORITY AND REFERENCES

This regulatory action is proposed under that authority granted in sections 39600, 39601, 43000.5, 43013, 43016, 43018, 43100, 43101, 43104, 43105, 43105.5, 43106, 43154, 43205, 43211, and 43212 of the Health and Safety Code. This action is proposed to implement, interpret and make specific sections 39002, 39003, 39010-39060, 39515, 39600-39601, 43000, 43000.5, 43004, 43006, 43013, 43016, 43018, 43100, 43101, 43102, 43104, 43105, 43105.5, 43106, 43150-43156, 43204, 43205, 43211, and 43212 of the Health and Safety Code.

HEARING PROCEDURES AND AVAILIBILITY OF MODIFIED TEXT

The public hearing will be conducted in accordance with the California Administrative Procedure Act, Title 2, Division 3, Part 1, Chapter 3.5 (commencing with section 11340) of the Government Code.

Following the public hearing, the Board may adopt the regulatory language as originally proposed, or with non substantial or grammatical modifications. The Board may also adopt the proposed regulatory language with other modifications if the text as modified is sufficiently related to the originally proposed text that the public was adequately placed on notice that the regulatory language as modified could result from the proposed regulatory action; in such event the full regulatory text, with the modifications clearly indicated, will be made available to the public, for written comment, at least 15 days before it is adopted.

The public may request a copy of the modified regulatory text from the ARB's Public Information Office, Air Resources Board, 1001 "I" Street, Visitors and Environmental Services Center, 1st Floor, Sacramento, California 95814, (916) 322-2990.

CALIFORNIA AIR RESOURCES BOARD

Catherine Witherspoon
Executive Officer

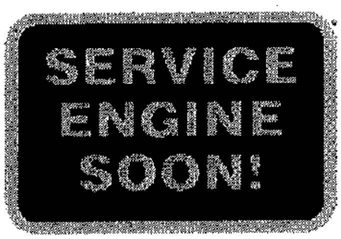
Date: July 31, 2006

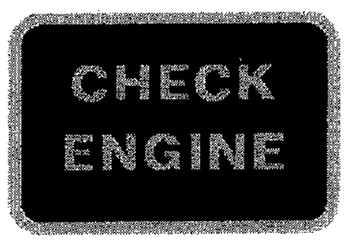
State of California
AIR RESOURCES BOARD

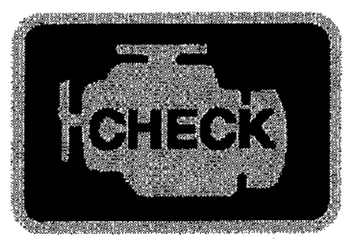
STAFF REPORT: INITIAL STATEMENT OF REASONS FOR PROPOSED RULEMAKING

Technical Status and Revisions to Malfunction and Diagnostic System Requirements for Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles and Engines (OBD II) and the Emission Warranty Regulations

Date of Release:	August 11, 2006
Scheduled for Consideration:	September 28, 2006







This document has been reviewed by the staff of the California Air Resources Board and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies for the Air Resources Board, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

Table of Contents

I. SUMMARY OF STAFF PROPOSAL AND RELATED POLICY ISSUES

Background

Second generation on-board diagnostics (OBD II) systems consist mainly of software designed into motor vehicle on-board computers that detect emission control system malfunctions as they occur. The OBD II system monitors virtually every component and system that can cause increases in emissions. The system generally relies on information from sensors already available on the vehicle and rarely requires an additional sensor just for OBD II monitoring. When an emission-related malfunction is detected, the OBD II system alerts the vehicle operator by illuminating the malfunction indicator light (MIL) on the instrument panel. By alerting the driver of malfunctions as they occur, repairs can be made promptly, which results in fewer emissions from the vehicle. The OBD II system also stores important information that identifies the faulty component or system and the nature of the fault, which allows technicians to quickly diagnose and properly repair the problem. It also results in less expensive repairs and promotes repairs done correctly the first time, resulting in less costs to the vehicle owners.

With OBD II systems having been required on 1996 and newer vehicles, including most vehicles sold nationwide, more than 110 million vehicles are currently equipped with them. Input from manufacturers, service technicians, inspection and maintenance (I/M) programs, and in-use evaluation programs indicate that OBD II systems are very effective in finding emission problems and facilitating repairs. Accordingly, the U.S. EPA issued a final rule indicating its confidence in the performance of OBD II systems by requiring states with I/M programs to perform OBD II checks for these newer cars and allowing them to be used in lieu of current tailpipe tests. The California I/M program (Smog Check) has adopted these provisions.

The Air Resources Board (ARB or the Board) originally adopted OBD II requirements in 1989 and required all passenger cars, light-duty trucks, and medium-duty vehicles and engines to be equipped with the systems by the 1996 model year. The Board has modified the regulation in regular updates since initial adoption to address manufacturers' implementation concerns and, where needed, to strengthen specific monitoring requirements. Most recently, the Board updated the OBD II requirements in 2002 to address several concerns and issues regarding the regulation (section 1968.2, title 13, California Code of Regulations (CCR)) and establish enforcement requirements (section 1968.5, title 13, CCR). The Board also adopted heavy-duty on-board diagnostic system (HD OBD) requirements in July 2005 that will become applicable to 2010 and later heavy-duty engines. This proposal does not amend the HD OBD regulation.

Since 2002, based on its experience and input from industry, ARB staff has identified several areas in the OBD II regulation in which additional modifications would be appropriate to provide for improved emission control monitoring. The proposed changes to section 1968.2 are included herewith as Attachment A, while the proposed changes to section 1968.5 are included herewith as Attachment B. The most significant proposed modifications for gasoline and diesel vehicles are reviewed below.

<u>Gasoline Vehicles</u>

Staff is proposing several revisions to the OBD II requirements for gasoline vehicles. In general, the changes refine existing monitoring requirements to improve the effectiveness of OBD II systems or revise implementation dates to provide manufacturers with additional time to meet the final, more stringent requirements.

Air-Fuel Cylinder Imbalance Monitoring

The key emission control elements of current low emission gasoline vehicles are precise fuel control systems working in conjunction with very capable advanced technology catalyst systems. The fuel system must provide a single specific air-fuel mixture ratio to the catalyst under all engine operating conditions in order to achieve the low emissions required by current emission standards. Recognizing the importance of proper operation of the fuel system, the current OBD II regulation requires malfunctions to be detected when the fuel system cannot maintain emissions below 1.5 times the emission standards.

Recent field testing of vehicles, however, has revealed an in-use fuel system-related malfunction that existing OBD II systems generally cannot identify or detect even when emissions exceed 1.5 times the standards. Moreover, the current OBD II regulation has not identified such a malfunction as a specific failure mode requiring detection. The problem has been traced to cylinder-to-cylinder variations in air-fuel mixture ratio that are not properly corrected by the fuel control system. This type of malfunction or system deterioration can have a significant impact on emissions. The imbalances can be caused by fuel injector variation, unequal airflow into the cylinders, uneven exhaust gas recirculation (EGR) distribution across the engine cylinders, or effects of oxygen sensor placement in the exhaust system. The impact of these variations is that the air-fuel mixture arriving at the catalyst is not at the optimum ratio to achieve maximum efficiency of the catalyst, thereby resulting in higher emissions without detection of a malfunction because the monitors have not been designed to detect such an imbalance. Staff is proposing that manufacturers be required to detect an air-fuel cylinder imbalance in one or more cylinder that causes the fuel delivery system to be unable to maintain emissions below a specified emission level. Staff has outlined one monitoring approach in this report that relies on closer examination of oxygen sensor signals to identify when this anomaly is taking place. Appropriate lead time is being provided to phase in this new monitoring provision.

Oxygen Sensor Monitoring

The OBD II regulation currently contains monitoring requirements for oxygen sensors, which provide critical inputs to the fuel control system in order to achieve lowest emissions. One of the oxygen sensor parameters currently required to be monitored is the response rate, which is the ability of the sensor to respond quickly to changes in air-fuel mixture ratios. While the current regulation requires response rate monitoring, staff is proposing changes to the regulatory language that would more specifically identify the kinds of response rate deterioration that would need to be detected. The changes would ensure that all manufacturers are implementing the monitor uniformly and completely so that all possible means of oxygen sensor deterioration would be detected prior to emissions exceeding 1.5 times the standards. Beginning in the 2009 model year, manufacturers would need to submit data or other documentation demonstrating they have used a calibration method that would ensure that the response rate criteria are satisfied.

Results from in-use testing of vehicles by ARB staff have also reinforced the need for more rigorous monitoring of the secondary oxygen sensors used both to adjust and fine-tune the fuel control over time and to monitor the catalyst for proper operation. For secondary oxygen sensors, the regulation currently requires the diagnostic system to detect a fault, to the extent feasible, when the sensor can no longer reliably monitor the catalyst. Given the location of the sensor downstream of the catalyst, stringent monitoring of the sensor has been difficult to achieve or isolate from other effects. Accordingly staff has been accepting fairly simple "activity" diagnostics that verify minimal operation of the sensor as acceptable monitoring techniques. Unfortunately, in-use vehicles with deteriorated secondary oxygen sensors and deteriorated catalysts have been found to have high emissions and no malfunction indication. Replacement of the secondary oxygen sensor subsequently allowed the diagnostic system to detect the malfunctioning catalyst and illuminate the malfunction light. Ideally, manufacturers' secondary oxygen sensor monitors should be able to detect and illuminate the MIL for this fault. Unfortunately, most current monitors have a "gap" in the degree of sensor deterioration between where the sensor is no longer sufficient for proper catalyst monitoring and where the sensor itself can be detected as malfunctioning. Considering that catalyst fault codes are a significant percentage of the failures found in high-mileage vehicles, the regulation needs to be modified to better inform manufacturers of what is expected of secondary oxygen sensor monitors and to avoid problems like these in the future. Improved monitoring techniques for the rear sensor have been identified as well as improved monitoring techniques for the catalyst monitor that are less sensitive to secondary sensor performance degradation. Manufacturers would be required to implement these improvements on 2009 and later model year vehicles.

Catalyst Monitoring

In the 2002 OBD II update, the Board approved the addition of a requirement to monitor the catalyst for increases in oxides of nitrogen (NOx) emissions, and lead time was provided to develop the monitoring technique. Manufacturers, however, have contended that implementing improvements to meet the final threshold of 1.75 times the NOx standard are taking longer than originally anticipated. While some manufacturers are on track to meet the original phase-in, several have discovered that more significant changes to their monitoring strategies or catalyst formulations and/or configurations are needed. Staff is, therefore, proposing to extend the intermediate malfunction threshold of 3.5 times the NOx standard for an additional two years to allow more development time needed to meet the final threshold for signaling a catalyst malfunction relative to NOx emissions.

Permanent Fault Codes

Based on feedback and experience gained from incorporating OBD II inspections into the Smog Check program and other nationwide I/M programs, staff is proposing a requirement to make it easier to distinguish vehicles that have been properly repaired from vehicles undergoing fraudulent actions aimed at avoiding a proper inspection. Currently, a technician or vehicle owner can erase all fault codes and extinguish the MIL by issuing a command from a generic scan tool plugged into the vehicle or, in many cases, simply by disconnecting the vehicle battery. These actions reset internal flags known as the "readiness status" that determine if a vehicle is ready for a Smog Check inspection. They also remove all traces of previous faults that the OBD II system had detected on the vehicle. With some minimal additional vehicle operation, the internal flags can be partially reset before a fault is re-detected. In some cases, this approach had been used to pass inspections without needed repairs being performed.

For vehicles that have a MIL illuminated for one or more faults, the staff proposal would require manufacturers to store "permanent" fault codes. Vehicle owners and technicians would not be able to clear or erase permanent fault codes by any generic or manufacturer-specific scan tool command (or by disconnecting the battery). Instead, these fault codes would only be allowed to be self-cleared by the OBD II system itself, once the monitor responsible for setting that fault code has run and passed enough times to confirm that the fault was no longer present. Permanent fault codes would allow the Smog Check program to target and reject or fail those vehicles that have recently had the malfunction light illuminated and have not subsequently been driven enough to know if the fault has been repaired correctly. While this change may not seem noteworthy on its face, the problem being addressed is a source of major lost emission reductions in Smog Check.

Light-Duty Diesels

Currently no light-duty diesel vehicles are sold in California, because manufacturers have not been able to comply with current low emission vehicle emission standards. However, progress in reducing diesel engine emissions is occurring, and several manufacturers have expressed a desire to introduce diesel vehicles in California as early as next year.

Current OBD II Requirements for Light-Duty Diesels

In adopting the Low Emission Vehicle II (LEV II) emission standards in 1998, the Board rejected a proposal to establish a less stringent emission standard that could be met by higher emitting light-duty diesel vehicles. This action set the precedent that all light-duty vehicles, regardless of the fuel or technology used, must meet the same emission standards. The LEV II emission standards are based on the capabilities of gasoline engines, which in general are the lowest emitting technology currently available. The current OBD II regulations also embrace this precedent by requiring diesel vehicles to meet the same monitoring requirements as gasoline vehicles.

Since the OBD II requirements were adopted, advances in diesel engine emission control technology have occurred, and vehicle manufacturers believe they can comply with the same emission standards as gasoline engine vehicles. The newly developed emission control technology, such as particulate filters and NOx selective catalytic reduction, differ greatly from the emission controls used on gasoline engines. Thus, new OBD monitoring methods have to be developed for diesels, and these have lagged the development of the emission control technology itself. As a result, light-duty diesel vehicles cannot meet the current, stringent monitoring thresholds, and thus the OBD II requirements would prevent the introduction of light-duty diesel vehicles for some time to come.

Proposed OBD II Requirements for Light-Duty Diesels

Staff believes that the goal of requiring all light-duty vehicles to comply with the same OBD II requirements is appropriate and consistent with the principle that has been applied to light-duty tailpipe emission standards. However, staff also believes that additional time is required to develop monitoring methods for new emission technologies such as those expected to be used on light-duty diesel vehicles. Thus staff has developed a set of interim monitoring thresholds (the multiple of the emission standard at which the MIL is lit) for new technologies used on diesel vehicles. The interim thresholds would end in 2013, the same year full compliance with HD OBD is required. In 2013 and beyond, light-duty diesels would have to meet the same stringent monitoring thresholds as gasoline vehicles.

Staff consulted with vehicle manufacturers regarding the technical challenges and time needed to develop fully capable OBD II monitors for light-duty diesel vehicles. Based on information received, staff has identified several pathways that should allow compliance with the proposed intermediate monitoring thresholds. For the 2007 to 2009 model years, staff is proposing monitoring thresholds that it believes are consistent with the capabilities of the vehicle manufacturers. These include thresholds as high as five times the emission standard for particulate filters and oxidation catalysts, and thresholds around three times the emission standard for many other monitors. Staff is proposing more stringent interim thresholds for 2010. These are based on projected refinement of monitoring methods learned from assessing the capabilities of the heavy-duty engine manufacturers during development of the HD OBD regulation last year and projected capability of sensor technology learned from meetings with suppliers of sensors needed for monitoring (e.g., particulate matter (PM) and NOx sensors). Staff believes that compliance with monitoring thresholds equivalent to those required of gasoline vehicles can be achieved by the 2013 model year, although the vehicle manufacturers believe they cannot be achieved before the 2016 model year. The interim thresholds have been set with an eye towards monitoring technologies that can meet the 2010 model year thresholds and be further developed in the 2010 to 2013 time frame to achieve the more stringent thresholds.

Table 1
Light-Duty Diesel OBD II Thresholds
(multiple of emission standard)

		ARB proposal
Monitor	**Model Year**	**NMHC**
NMHC catalyst	2007-2009	5.0
	2010-2012	3.0
	2013+	1.75
NOx SCR catalyst/adsorber		**NOx**
	2007-2009	3.0
	2010-2012	2.5
	2013+	1.75
PM filter		**PM**
	2007-2009	5.0
	2010-2012	4.0
	2013+	1.75

Recognizing that higher intermediate OBD II thresholds risks the possibility of increased emissions without malfunctions being detected, the amendments would require manufacturers of 2007 through 2012 model year light-duty diesel vehicles to perform emission testing on actual production vehicles to verify their compliance with the emission standard. Having the manufacturers perform this testing on all diesel vehicle models (which would be equivalent to the in-use tailpipe compliance testing done by ARB on a limited number of vehicle models each year) will provide some assurance that the vehicles, as a whole, do not have a design defect that causes them to fail to meet the base emission standards. However, it is important to note that this type of testing is intended to catch systematic failures or design defects that cause the vehicle to fail to meet the tailpipe standards during the first 120,000 miles whereas OBD II systems are intended to identify each and every vehicle in need of an emission repair for the entire life of the vehicle. Accordingly, this testing does not directly offset the reduced capability of the OBD II system. Similarly, ARB will begin to work with the Bureau of Automotive Repair (BAR) to investigate subjecting light-duty diesel vehicles to biennial SmogCheck inspections like their gasoline counterparts. Again, this would not make-up for the interim reduced OBD II system capability but would provide additional assurance that faults eventually detected by the OBD II system would be repaired.

Medium-Duty Diesels

Unlike the light duty vehicle class, there already is an established presence and market demand for diesels in the medium-duty segment of the market, which includes the heavier pick-up trucks and vans up to 14,000 pounds gross vehicle weight. When the OBD II regulation was first adopted in 1989, they contained provisions that all light- and medium-duty diesels would need to meet comprehensive monitoring requirements starting with the 1997 model year. Thus, medium-duty diesels have been subject to OBD II requirements for 10 years. The current OBD II regulation already contains stringent thresholds for medium-duty diesel emission control systems, including aftertreatment components that were in the early stages of development when the regulations were last updated in 2002. Continuing development of medium-duty diesel aftertreatment systems has closely followed similar efforts well underway for heavy-duty vehicle classes since engines used in medium-duty diesels are generally certified under heavy-duty engine certification procedures. Both classes need to meet very stringent emission standards, especially for PM and NOx, that take effect in the 2007 – 2010 timeframe. As stated, the Board adopted HD OBD requirements in July 2005 that are applicable starting with the 2010 model year.

To better harmonize the medium- and heavy-duty requirements, staff is proposing to amend the medium-duty requirements. Following the HD OBD regulation, the staff proposal includes more specificity in the OBD II regulation to ensure robust and uniform monitoring strategies across all manufacturers but also provides, in most cases, a relaxation in the emission malfunction thresholds.

The OBD II requirements for medium-duty diesel vehicles, which began in 1997, generally reflected the same level of stringency as that for gasoline vehicles, although there were significantly fewer emission-related monitors because diesels had fewer emission controls. At the time of the 2002 Board hearing update, relatively little was certain about the emission control technologies that manufacturers would incorporate on diesel engines to meet the newly adopted 2007 emission standards; accordingly, OBD II thresholds continued to be patterned largely after the relative stringency used for gasoline vehicles. In order to set emission thresholds for the 2005 HD OBD rulemaking, staff worked with industry to better understand the technologies that were maturing and becoming more likely to be placed into production to meet the new stringent 2007 heavy-duty tailpipe standards. With the information gained, staff proposed, and the Board adopted, technically feasible emission malfunction thresholds appropriate for the new emission controls and the resources available to industry that ended up being less stringent than those originally projected in 2002 (and currently adopted) for medium-duty diesels. Since the emission control technologies will be similar for diesels in both the medium- and heavy-duty classes, staff concluded that the medium-duty OBD II thresholds should be consistent with those adopted for HD OBD. As a result, staff is proposing less stringent thresholds for medium-duty diesels than were adopted in the 2002 rulemaking. On the other hand, staff is also proposing substantially more detailed and rigorous monitoring requirements. For example, rather than specifying the fuel system to be monitored for faults that could cause emissions to increase beyond 1.5 times the standard, the proposal would require OBD II systems to specifically evaluate fuel injection pressure, timing, and quantity for malfunctions that would cause increases in emissions above specified thresholds to ensure uniform and complete fuel system evaluation among all manufacturers.

While heavy duty manufacturers will first be incorporating OBD systems in 2010, medium-duty diesel manufacturers have been implementing OBD II systems for a decade. As such, the OBD II proposal includes threshold monitoring requirements for the major emission related components starting in the 2007 model year rather than in the 2010 model year. Medium-duty manufacturers argue that these thresholds should be delayed until 2010 to match the HD OBD phase-in. However, the medium-duty manufacturers have had greater experience in developing OBD II systems and should have been working on solutions to monitoring requirements for some time given the existing OBD II regulations and the pending 2007 emission standards that drive new emission control technologies. Therefore, staff is proposing that medium duty engines comply with monitoring requirements for the technologies needed to meet the 2007 standards, but is proposing significantly less stringent thresholds for the 2007 through 2009 model years. Staff expects most manufacturers would be able to meet these less stringent thresholds in the early years based on initial certification information that has been received for the 2007 model year. In 2010, medium-duty diesels would be required to generally meet the same thresholds that are required for the first year phase-in of HD OBD.

<u>Other Diesel Vehicle Issues</u>

Staff's proposed amendments also include two other noteworthy items that apply to both light- and medium-duty diesel vehicles. The first item pertains to adjustment factors that are required for diesel emission testing and the second item involves tracking and reporting of particular engine operating conditions. Both items have been subject to additional discussions with manufacturers and are generally opposed in some form or another by the manufacturers.

Emission Adjustment Factors

A unique feature of several of the new emission controls evolving for diesel vehicles in the 2007 and subsequent model year time frame is the requirement of infrequent, but periodic, activation under specific conditions to regenerate or purge stored emissions. The most common of these is the PM filter which typically requires an active regeneration event every 300 to 500 miles to burn off the accumulated soot. Other examples include NOx aftertreatment emission controls such as NOx adsorbers which periodically require a desulphurization event. When these active events occur, tailpipe emissions can increase dramatically, exceeding the allowable tailpipe standards. However, since these events occur infrequently, the emission test procedures proscribe a method to account for the additional emissions. Essentially, the procedures require a manufacturer to determine the frequency of the events, to measure the incremental emissions from the event, and to add the appropriate fraction of the incremental emissions to all emission tests conducted without the event. For example, an event may happen once every ten emission tests and cause incremental emissions of 1.3 g/bhp-hr NOx. The emission test procedures would require one-tenth of the 1.3 g/bhp-hr increase, or 0.13 g/bhp-hr, to be added to emission test results obtained without the event, and this total would be compared to the tailpipe emission standard.

This method allows the excess emissions generated during the event to be spread out across all emission tests between successive events to provide a representative average emission level from the vehicle.

Under the staff's proposal, vehicle manufacturers would need to also utilize this adjustment procedure when calibrating OBD II monitors that are tied to emission thresholds. This ensures that when a manufacturer calibrates a system to detect a fault at 1.5 times the standard, for example, the actual average emissions from the vehicle at the point it detects the fault would indeed be at or below 1.5 times the standard. If manufacturers did not include the adjustment factor in determining the calibration, the actual average in-use emissions when the fault is detected would be at some unknown level greater than 1.5 times the standard.

As an additional complication, the component for which the manufacturer is developing the calibration (e.g., a malfunctioning fuel system) could cause an appreciable change to the infrequent event (either increasing or decreasing the frequency with which the event occurs or altering the incremental emissions generated during the event). Using the PM filter regeneration event example described above, a manufacturer working on a fuel system pressure malfunction calibration may find that engine-out PM emissions are greatly increased when the failure occurs. Consequently, the PM filter will accumulate soot at a much higher rate, thus triggering the regeneration event to occur more frequently. If the event were to now occur once every five emission tests instead of once every ten, the adjustment factor would increase from one-tenth of 1.3 g/bhp-hr to one-fifth of 1.3g/bhp-hr, or 0.26 g/bhp-hr. Accordingly, the manufacturer would not only have to use the adjustment factors when calibrating OBD II emission threshold monitors but would also have to recalculate the appropriate adjustment factor for the specific component being calibrated.

For some monitors, staff expects that this calibration scenario will not occur and accordingly will have no impact on the infrequent events (and thus, no recalculation of the original adjustment factors). For other monitors, staff expects this may alter the frequency of the event or the incremental emissions generated during the event. In rare cases, it may even affect both the frequency and the incremental emissions. In any case, failure to properly account for the infrequent events would result in the systems being calibrated at unrepresentative emission levels, so actual average in-use emission levels when faults are detected would be unknown. Proper determination of adjustment factors is also necessary to be able to effectively perform enforcement testing. Use of incorrect adjustment factors would lead to incorrect emission measurements and incorrect findings of compliance (or noncompliance).

While manufacturers have agreed that, technically, it is appropriate to account for such events in the manner noted above, manufacturers have argued that the additional testing time and resources to properly determine the adjustment factors are significant and that they do not have any available time or resources to devote to it. Given that the impact of the adjustment factors on the emission results can be very large and that a consistent policy for effective enforcement testing is needed, staff's proposal does require the use of adjustment factors for OBD II thresholds for all 2007 and subsequent model year vehicles. However, to provide manufacturers with interim relief to be able to better utilize available resources, several changes are proposed.

First, for the 2007 model year, manufacturers would be allowed on all emission threshold monitors to utilize the baseline adjustment factors that they were required to calculate for determining compliance with the tailpipe standards. Thus, manufacturers would not incur any additional time or resources in recalculating the adjustment factors and would simply need to add in the adjustment factor when calibrating the OBD II monitors.

Second, starting in the 2008 model year, manufacturers would be able to continue to use the baseline adjustment factors for all monitors except the oxidation catalyst monitor. For this catalyst monitor, manufacturers would be required to recalculate the adjustment factors appropriate for a malfunctioning catalyst. Staff selected this monitor because the catalyst can have an extremely large impact on the incremental emissions generated during a regeneration event and almost no impact on the emission tests between events. Further, most manufacturers are designing this monitor to run and complete during a PM filter regeneration event and, thus, are already focusing their calibration and testing of the catalyst on emission tests with a regeneration event occurring (which are the exact data predominantly needed to be able to properly recalculate the adjustment factors).

Lastly, manufacturers would be required to determine appropriate adjustment factors for all OBD II emission threshold monitors starting with the 2010 model year. As noted before, staff expects some monitors will have no, or a negligible impact on the regeneration events and thus require no recalculation of adjustment factors. Others will require manufacturers to either measure emission during a regeneration event (to determine if the incremental emissions are changed) and to assess engine out emission levels (to determine if regeneration frequency is likely to be impacted). Manufacturers will likely be able to achieve much of this by engineering evaluation with their knowledge of the triggers for the regeneration events and comparison measurements or calculations to the baseline system. This would ensure that, from 2010 on, in-use emission levels when a fault is detected will actually be at the required levels.

Tracking of Engine Run Time

Another item in the proposed amendments requires tracking of various engine operating conditions in the engine computer itself and reporting out of the stored data to a standardized scan tool (used by technicians, inspectors, etc.). Under the current emission standards and certification procedures, manufacturers are allowed to implement auxiliary emission control devices (AECDs) that are typically software strategies that alter the way the engine or its emission controls work when specific conditions are met. Manufacturers are required to seek ARB approval of all of their AECDs and submit details of the strategies during certification including a subset of AECDs which are justified by the manufacturer as necessary to protect the vehicle, engine, or other emission control components from damage. Often times, these protection AECDs deactivate or substantially diminish the effectiveness of the emission controls, leading to large increases in tailpipe emissions when they are activated. To minimize any adverse emission impact in-use, ARB certification staff must thoroughly evaluate the submitted AECDs, understand all the nuances of the strategy, and ensure that activation of the AECDs are limited to only those conditions where it is absolutely necessary. Further, staff must ensure that the system is robustly designed and is not using or relying on protection AECDs to bolster an otherwise under-designed or "frail" system. To aid the certification staff in consistent evaluation and usage of such AECDs especially as new emission controls emerge at such a rapid pace, the proposed amendments would require the OBD II system to keep track of how often the subset of AECDs with the most potential for adverse emission impact are activated.

Specifically, the system would only need to track operation of AECDs that are: (a) justified by the manufacturer as necessary to avoid vehicle, engine, or emission control component damage; (b) that are not activated substantially during the emission test; and (c) that reduce the effectiveness of the emission control system. For each such "emission-increasing" AECD (EI-AECD), the system would keep track of the cumulative engine run time that the strategy has been activated. During inspections or other programs, the data could be read-out from the vehicle's computer and staff would be able to see the actual in-use frequency of operation of these strategies that increase emissions. Strategies that are activated more frequently than originally estimated by the manufacturer (and documented at the time of certification) would warrant further investigation and trigger the need to be re-evaluated prior to approving future model year vehicles using the same strategy. Large differences in activation time between various manufacturers' EI-AECDs would also warrant further investigation to determine if the inequity is a result of a manufacturer using a system that is inadequately designed and is utilizing an EI-AECD to make-up for it.

Manufacturers have voiced considerable objection to this requirement. Manufacturers have stated that the OBD II regulation is an inappropriate regulation to include such a requirement. While staff believes it is the appropriate place for it as it is the only regulation that proscribes information that must be stored and read-out from the on-board computer in a standardized format, staff has also offered to rename the regulation and/or create a unique regulation in title 13 during this rulemaking. Manufacturers have rejected such alternatives as not solving the concern.

Manufacturers have also argued that AECD strategies are highly confidential and this requirement will make it easier for competitors to reverse engineer the strategies. However, the proposed requirement is to keep track of cumulative time when such strategies are active and, at the end of each driving cycle, update the counters. There is no real-time indication during vehicle operation as to when such strategies are or are not active. Accordingly, the most a competitor can do is look at the counters at the end of each trip and determine how much total time during the previous trip an EI-AECD was active—but not any idea of when it actually happened. Further, the tracking will be reported as "EI-AECD #n", giving the competitor no knowledge as to what the system actually sensed or what action it took (e.g., sensed that engine oil temperature exceeded xxx°F and closed the EGR valve as a result). The competitor would be better able to reverse-engineer the system by simply measuring tailpipe emissions (and looking for spikes when they happen in real-time) or by monitoring the emission controls for deactivation (e.g., watching for the EGR valve to close).

Lastly, manufacturers have argued that this is a "data-logging" experiment that is not needed to be installed on every vehicle and could just as effectively be gathered with special equipment on a few vehicles. Staff's experience with the strategies being used and planned for many of the new diesel emission control technologies is that they are very difficult to assess as to expected in-use frequency and can vary greatly based on driver habits, vehicle usage patterns (e.g., trucks used for towing or delivery or as a daily commuter), and even atmospheric conditions (e.g., temperature, elevation, terrain). In fact, the manufacturers themselves have often argued that such wide variances in usage patterns and driver habits have justified the need for less stringent monitoring requirements and/or larger tolerances. Accordingly, the same representative data could not be gathered from a few trucks with data-logging equipment. Further, many of the on-board computers used with diesel engines already keep track of items like total engine run time, engine idle time, and various other subsets of engine run time. Adding additional counters for each EI-AECD is a relatively insignificant additional burden on the engine computer software and hardware.

Other Items

Staff is proposing to amend the OBD II enforcement regulation (section 1968.5, title 13, CCR), which is included herewith as Attachment B, to align the enforcement provisions, as necessary, with the proposed changes to the OBD II regulation (section 1968.2, title 13, CCR). Additionally, the staff is proposing to delete reference to the "procedures of the California I/M program" from the mandatory recall provisions related to I/M testing and instead list the specific criteria of OBD II noncompliances related to conducting Smog Check inspections that would result in mandatory recall. The staff is also proposing more appropriate in-use thresholds (i.e., thresholds at which a vehicle would be found to have a nonconforming OBD II system and would be subject to possible enforcement action) for OBD II emission testing of diesel vehicles certified to the higher interim malfunction thresholds required for the 2007 through the 2012 model years.

Staff is also proposing to revise the emission warranty regulations, which are included herewith as Attachment C, to update references to "emission-related parts" to better account for changing emission control technology over time. Current warranty provisions have both a "performance" and a "defects" provision for warranty coverage. Under the "performance" provision, any vehicle that fails a Smog Check test within 3 years/50,000 miles would receive repairs covered by the vehicle manufacturer. Under the "defects" provision, vehicles that have defects in emission components or that cause the OBD II MIL to illuminate would also be repaired by the manufacturer for 3 years/50,000 miles. Further, under the "defects" provision, any vehicle that has an emission defect before 7 years/70,000 miles would be covered under warranty if the defect meets specific inflation-adjusted cost limits to repair. To be eligible for this "high cost" warranty provision, however, the defective part must be contained on a warranty parts list maintained by the Board staff. Unfortunately, the list is often not up to date and may not include new technologies that should be on the list. Therefore, staff is proposing to eliminate the out-of-date warranty parts list and simply extend the "high cost" warranty to parts that exceed the specific inflation-adjusted cost limits to repair and are covered by the 3 year/50,000 mile "defect" warranty coverage. What this means is essentially any defective part that turns on the OBD II malfunction light and is a "high cost part" would automatically receive warranty coverage for 7 years/70,000 miles. Consumers would benefit from simplifying the eligibility determination since there would be less doubt about what parts are covered under the proposed revision. Additionally, manufacturers could no longer deny warranty coverage on newer technology vehicles such as hybrid vehicles simply because parts that should have been on the parts list were not present or the company name of a part was slightly different than the description of the part contained on the list, etc.

Summary of Impacts

Environmental Impacts and Environmental Justice Issues

Staff anticipates that the proposed amendments to the regulations will help ensure that measurable emission benefits are achieved both statewide and in the South Coast Air Basin. Monitoring of a motor vehicle's emission control system through the use of OBD II systems helps ensure that vehicles initially certified to the very low and near-zero emission standards maintain their performance throughout the entire vehicle life. Since the amendments are designed to reduce emissions statewide, it should not adversely impact any community in the State, including low-income or minority communities.

Cost Impact

Regarding costs, staff does not expect the proposed revisions will result in any adverse economic impacts. Compliance costs for gasoline light- and medium-duty vehicles should not be affected by the proposed amendments as they generally restructure and clarify currently adopted OBD II requirements. Further, several of the proposed amendments might lessen the overall cost impact of the current regulation by providing additional lead time to manufacturers. The compliance costs for light-duty diesel vehicles were not estimated because gasoline engines provide the basic compliance path, and light-duty diesels are an alternative technology that will be used only if the manufacturer finds it cost-effective. Compliance costs for diesel medium-duty engines have been estimated by staff to add $153 to the retail price of a new vehicle, while compliance costs for light-duty diesel vehicles have been estimated to add $140 to the retail price of a new vehicle. Considering the minimal cost per vehicle increase, the proposed amendments are not expected to significantly alter previously calculated emission benefits or findings. Therefore, the combined benefit of the LEV II and OBD II programs that was estimated in 2002 to result in 57 tons per day reduction of reactive organic gases (ROG) + NOx in the South Coast Air Basin and cost $2.18 per pound of ROG + NOx should still apply.

Economic Impact

Overall, the proposed amendments to the regulations are expected to have no noticeable impact on the profitability of automobile manufacturers. These manufacturers are large and are mostly located outside California although some have some operations in California. The proposed changes involve minimal development and verification of software, minimal hardware modifications, and staff has provided adequate lead times to implement the requirements. Staff believes, therefore, that the proposed amendments would cause no noticeable adverse impact in California employment, business status, and competitiveness.

II. TECHNICAL STATUS AND PROPOSED REVISIONS TO MONITORING SYSTEM REQUIREMENTS FOR GASOLINE/SPARK-IGNITED ENGINES

Since its inception on 1996 model year vehicles, OBD II systems on gasoline vehicles have matured greatly and have proven very effective in finding emission problems in-use and facilitating repairs. Accordingly, the staff is proposing minimal revisions to the current gasoline OBD II system requirements. These proposed changes consist primarily of one new monitoring requirement (air-fuel ratio cylinder imbalance), one new feature for I/M testing, extension of leadtimes and phase-in schedules for a few of the current requirements, and enhancements and clarifications of the current language where needed to help manufacturers better understand the requirements and ensure consistency between manufacturers' diagnostic system capability.

A. <u>CATALYST MONITORING</u>

Virtually all OBD II-equipped vehicles use three-way catalysts (i.e., catalyst systems that simultaneously convert hydrocarbons (HC), carbon monoxide (CO), and NOx). The regulation currently requires monitoring of HC and NOx conversion efficiency on all LEV II vehicles. Regarding NOx conversion efficiency monitoring, manufacturers are required to indicate a malfunction before NOx emissions exceed 3.5 times the standard for 2005 and 2006 model year vehicles and before NOx emissions exceed 1.75 times the standard for 2007 and subsequent model year vehicles (except for passenger car/light-duty truck SULEV II vehicles, which have a threshold of 2.5 times the NOx standard). When this requirement was adopted in 2002, ARB had provided industry with what it considered sufficient leadtime to meet this requirement. Manufacturers, however, have contended that implementing improvements to meet the threshold of 1.75 times the NOx standard is taking longer than originally anticipated. While some manufacturers are still on track to meet the original phase-in, several have discovered that more significant changes to their monitor strategies and/or catalyst formulations are necessary than their early development suggested. As such, changes to extend the phase-in have been proposed. Specifically, these changes would allow the higher interim threshold of 3.5 times the NOx standard to be used for an additional two model years (i.e., 2007 and 2008 model years) and to allow carry-over of those calibrations until the 2010 model year. This additional phase-in time should allow all manufacturers to make any further changes needed to comply with the final threshold of 1.75 times the NOx standard in the 2009 and 2010 model years.

B. EVAPORATIVE SYSTEM MONITORING

The OBD II regulation currently requires monitoring of the complete evaporative system for vapor leaks to the atmosphere as well as verification of proper function of the purge valve. Traditionally, vehicles have used a single purge path to purge vapor from the system to the engine. However, some newer engines, especially turbo-charged engines, have implemented two paths to ensure sufficient purge during boost operation. For vehicles that rely on the proper function of both paths to maintain in-use emission levels, the requirement has been clarified to ensure that both purge paths are monitored.

C. SECONDARY AIR SYSTEM MONITORING

Secondary air systems are used on vehicles to reduce cold start exhaust emissions and typically consist of an electric air pump, hoses, and a check valve(s) to deliver outside air to the exhaust system upstream of the catalytic converter(s). The OBD II regulation currently requires manufacturers to monitor the "air flow" delivered by the secondary air system and, in cases where there are more than one delivery hose (e.g., one to each side, or bank, of a V-6 engine), to verify that the proper amount of air is delivered through each hose. Industry, however, questioned the necessity of monitoring the air flow to each bank of the engine in cases where complete blockage of air delivery to one bank does not affect emissions. Thus, the staff is proposing modified language to exempt detection of flow to both banks if the manufacturer can show that complete blockage of air delivery to one bank does not cause a measurable increase in emissions.

D. AIR-FUEL RATIO CYLINDER IMBALANCE MONITORING

An important part of the emission control system on gasoline vehicles is the fuel system. Proper delivery of fuel is essential to maintain stoichiometric operation, maximize catalytic converter efficiency, and minimize tail pipe emissions. As such, the OBD II regulation has always required fuel system malfunctions to be detected when the fuel system cannot maintain emissions below 1.5 times the standards.

Recently, field testing has revealed in-use fuel system-related malfunctions that OBD II systems generally cannot identify but which can cause emissions to exceed 1.5 times the standards with no detection of a malfunction. Additionally, this failure mode is not specifically identified in the current OBD II regulation. Manufacturers investigated this problem and found the cause to be cylinder-to-cylinder differences or imbalances in the air-fuel ratio that are not properly corrected by the fuel control system. As stated, this type of malfunction or system deterioration can have a significant impact on emissions. The imbalances can be caused by fuel injector variation, unequal airflow into the cylinders, or uneven EGR distribution across the cylinders. In many cases, the front oxygen sensor, which is located in the manifold collector and is used for feedback fuel control, does not equally sense all cylinders and may cause the feedback fuel control system to be blind or overly sensitive to specific cylinders. This can result in improper fuel system corrections (i.e., the fuel system under-compensates or overcompensates for the imbalance) and higher emissions without detection of a malfunction.

To address this, the staff is proposing that manufacturers be required to detect an air-fuel cylinder imbalance in one or more cylinders that causes the fuel delivery system to be unable to maintain emissions below a specified emission level. To provide manufacturers sufficient leadtime to comply with the new requirements, staff is proposing a phase-in during the 2011-2013 model years with a malfunction threshold of 3.0 times the standards. For most vehicles, 100 percent of the vehicles would be required to meet the final threshold of 1.5 times the standards in the 2014 model year. However, to allow additional flexibility in phasing in the final malfunction threshold, a manufacturer may continue to use 3.0 times standards for any applications that were certified in the 2011, 2012, or 2013 model year to 3.0 times the applicable FTP standards and carried over to the 2014 model year.

The staff is proposing a different phase-in schedule for vehicles equipped with certain types of EGR systems that have been found to be more prone to causing cylinder imbalance as the system deteriorates. The staff is proposing cylinder imbalance malfunctions be detected on all 2011 and subsequent model year vehicles equipped with EGR systems that have separate flow delivery passageways (internal or external) that deliver EGR flow to individual cylinders (e.g., an EGR system with individual delivery pipes to each cylinder).

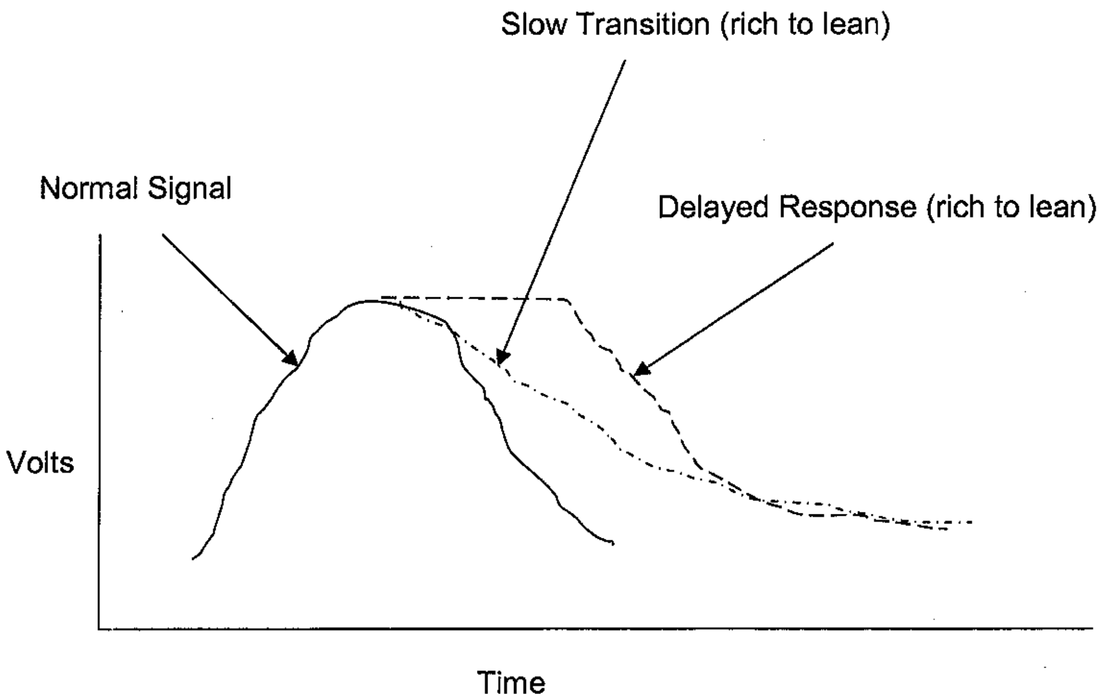
There are a number of monitoring strategies that may be used to detect cylinder imbalances. Monitoring of these types of failures may be accomplished by evaluating the front and/or rear oxygen sensor signals. During in-use testing of vehicles with cylinder imbalance malfunctions by ARB staff, one vehicle had a cylinder imbalance caused by intake valve deposits. The valve deposits caused an EGR effect in that cylinder which resulted in a rich air-fuel ratio relative to the other cylinders. Coincidentally, the oxygen sensor was oversensitive to the malfunctioning cylinder and the fuel system overcompensated by leaning out all the cylinders yielding an overall lean bias for the engine. The lean bias caused NOx emissions to significantly exceed the emission standards. The vehicle manufacturer analyzed the vehicle using special engineering tools to obtain a high-speed signal from the oxygen sensors. With the high speed data, the manufacturer observed that front oxygen sensor signal was noisy (i.e., there were rich spikes in the exhaust signal due the relatively rich air-fuel ratio in the cylinder that had the valve deposits). The noisy signal was an indicator that something was wrong with the system. Fuel system monitors generally use filtered or slower speed oxygen sensor signals to determine the average fuel system error caused by malfunctions that uniformly affect all cylinders. Therefore, typical fuel system monitors would not detect a noisy sensor as malfunctioning fuel system behavior. However, monitoring of the high-speed signal of the front sensor for this kind of behavior could be used to detect a cylinder imbalance fault. Additionally, the rear oxygen sensor signal also could show signs of cylinder imbalance. In the example discussed above, the rear oxygen sensor indicated a lean signal throughout the emission test cycle. However, depending on the fuel control strategy and the catalyst and sensor configuration, analysis of the rear sensor alone may not be sufficient for cylinder imbalance monitoring, nor would analysis of the rear oxygen sensor fuel control values be sufficient to cover all cases. (Monitoring of the downstream fuel control values will therefore remain a separate requirement in the regulation.)

E. OXYGEN SENSOR MONITORING

The OBD II regulation currently details specific monitoring requirements for conventional oxygen sensors, which have traditionally been used as one of the primary emission controls for feedback fuel control systems. Further, manufacturers using other types of exhaust gas sensors are required to submit a monitoring plan for approval to ensure newer technology sensors that may replace oxygen sensors are adequately monitored. Since the last regulatory update in 2002, there has been an increased use of wide-range, or universal, air-fuel (A/F) sensors in lieu of conventional oxygen sensors. With increased usage and gained experience, ARB staff is proposing that the regulation be amended to more specifically detail minimum monitoring requirements for A/F sensors. This would eliminate the need for manufacturers to submit a case-by-case monitoring plan for approval.

The OBD II regulation currently requires oxygen sensors to be monitored for response rate malfunctions. The staff is proposing to clarify what is expected of manufacturers when developing response rate monitors for primary oxygen and A/F sensors. Specifically, manufacturers would be required to detect both asymmetric malfunctions (i.e. faults that affect only the lean-to-rich response rate or only the rich-to-lean response rate) and symmetric malfunctions (i.e., faults that equally affect both the lean-to-rich and rich-to-lean response rates). Further, as has been required since the 1996 model year, manufacturers would continue to be required to detect faults that affect the response either by delaying the initial reaction of sensor to an exhaust gas change (e.g., "delayed" response) or by delaying the transition from a rich reading to a lean reading (or vice-versa) (e.g., "slow transition") (see Fig. 1 below). While all manufacturers are currently capable of detecting each of these types of faults, not all of them have rigorously calibrated the monitors to ensure proper detection of the faults before emissions exceed 1.5 times the standards. Accordingly, the proposed changes would identify the failure modes for response that should be considered by manufacturers in calibrating the response diagnostic. Under the proposal, manufacturers would be required to consider six different response fault conditions when determining the worst case failure mode necessary for calibration: asymmetric lean-to-rich delayed response, asymmetric rich-to-lean delayed response, asymmetric lean-to-rich slow transition, asymmetric rich-to-lean slow transition, symmetric delayed response, and symmetric slow transition. Manufacturers would be expected to determine an appropriate response monitor threshold(s) to ensure that all response failures are detected prior to exceeding 1.5 times the standards. Further, beginning with a phase-in starting in the 2009 model year, manufacturers would be required to submit data and/or documentation demonstrating that they have used a calibration method that ensures that these criteria have been satisfied.

Fig. 1: O2 Sensor Deterioration Sketch



Results from testing in-use vehicles by ARB staff have also reinforced the need for more rigorous monitoring of the secondary sensors used primarily to monitor the catalyst for proper operation. For secondary oxygen sensors, the regulation currently requires the diagnostic system to detect a fault, to the extent feasible, when the secondary oxygen sensor is no longer reliable for monitoring. Given the location of the sensor downstream of the catalyst, stringent monitoring of the sensor has been difficult to achieve or isolate from other effects (e.g., oxygen storage in the catalyst). Accordingly, staff has been accepting fairly simple "activity" diagnostics that verify minimal operation of the sensor as acceptable monitoring techniques. Unfortunately, in-use vehicles with deteriorated secondary oxygen sensors and deteriorated catalysts have been found to have high emissions and no MIL illumination. Staff found that replacement of the secondary oxygen sensor resulted in the diagnostic system being able to detect the malfunctioning catalyst and illuminate the MIL. Ideally, manufacturers' secondary oxygen sensor monitors should be able to detect and illuminate the MIL for this fault (i.e., detect a malfunction for deteriorated sensors that cannot robustly detect a "threshold" catalyst). However, very few manufacturers currently have monitors that meet this ideal situation. Most current monitors have a gap in the degree of sensor deterioration between where the sensor is no longer sufficient for catalyst monitoring and where the sensor itself can be detected as malfunctioning. Considering that catalyst fault codes are a significant percentage of the failures found in high-mileage cars in I/M programs, the staff believes the regulation needs to be modified to make manufacturers better understand what is expected of the secondary oxygen sensor monitors and to avoid problems like these in the future. Further, recent improvements in monitoring techniques for the rear sensor have been identified that enable more stringent monitoring of the sensor as well as improved monitoring techniques for the catalyst monitor that are less sensitive to secondary sensor performance degradation.

Thus, the proposed amendments would require better monitoring of the secondary sensors to ensure "sufficient" sensor performance for other monitors. Specifically, the amendments would require the OBD II system be designed such that the worst-performing acceptable secondary sensor is able to detect the best-performing unacceptable system or component (e.g., catalyst) that uses the secondary sensor for monitoring. In other words, in the case of the catalyst monitor, the worst-performing secondary oxygen sensor that could "pass" the secondary sensor monitor should be able to detect a deteriorated catalyst that just barely "fails" the catalyst monitor (i.e., a catalyst deteriorated right to the threshold). If the OBD II system is technically unable to meet this requirement, manufacturers would be required to submit a plan detailing how they will proposed to ultimately close the gap, and the proposed amendments would prescribe the minimum acceptable level of monitoring required of secondary oxygen sensors in the interim. Specifically, the OBD II system would be required to detect a slow rich-to-lean response malfunction of the sensor during a fuel shut-off event (e.g., deceleration fuel cut event). This monitor would be required to monitor the response time during the following periods: (1) from a rich condition (e.g., 0.7 Volts) at the start of fuel shut-off to a lean condition (e.g., 0.1 Volts) expected during fuel shut-off conditions, and (2) the response time of the sensor in the intermediate sensor range (e.g., from 0.55 Volts to 0.3 Volts). In order to develop a robust monitor, manufacturers would need to isolate the sensor response from catalyst effects and transport time as much as possible. Most manufacturers are already implementing some form of this monitor. However, not all manufacturers use fuel shut-off during deceleration to the degree or frequency that is necessary for the monitoring defined above. Therefore, in developing the proposed diagnostics, some manufacturers will also have to make changes to their fuel control strategies to ensure that fuel shut-off is initiated from a rich condition (i.e., a sensor voltage that is greater than voltages necessary to make the response time measurements defined above) and occurs with sufficient in-use frequency to meet the minimum required monitoring frequency specified in the regulation.

To allow time for manufacturers to make these changes across their product lines, the proposal would phase-in this requirement starting with the 2009 model year, with all 2011 and subsequent model year vehicles required to meet this requirement. The OBD II system would be required to track and report the in-use monitoring frequency of this monitor starting with the 2010 model year. Additionally, prior to certification of 2009 model year vehicles, the manufacturers would be required to submit a comprehensive plan demonstrating the their efforts to minimize any gaps remaining between the worst-performing acceptable sensor and a "sufficient" sensor.

F. COLD START EMISSION REDUCTION STRATEGY MONITORING

In order to meet the LEV standards, manufacturers have to design emission control system and control strategies to minimize emissions during and after a cold engine start. The vast majority of emissions during an FTP emission test are generated during the short period after engine start before the catalytic converter "lights off" (i.e., reaches the operating temperature where it begins to achieve high conversion efficiency). In order to minimize these cold start emissions, manufacturers use special strategies to maximize the heat transferred through the exhaust to the catalytic converter to accelerate light off. The most common elements of cold start strategies are modifications to engine speed and ignition timing. The idle speed is increased over the speed that is normally used, or is necessary, for a start-up. Increased idle speed increases exhaust mass flow. Ignition timing is also retarded from normal timing which makes the engine run less efficiently. Retarded ignition timing increases the exhaust temperature and further increases exhaust mass flow. Combined, the two elements generate hotter exhaust temperatures and more thermal mass that can be used to accelerate the light off of the catalyst.

During the last regulatory update in 2002, ARB adopted requirements for monitoring of the cold start emission reduction strategies to ensure these strategies were properly executed on in-use vehicles. Manufacturers have since implemented cold start monitors strategies beginning with the 2006 model year. The cold start monitoring requirements have been a difficult requirement for staff to administer. It requires a detailed disclosure by the manufacturers on how their cold start strategy works. At the same time, it requires an in depth understanding by both ARB staff and the manufacturers' staff of how malfunctions, drivers' actions, and vehicle operating conditions (e.g., fuel quality) can affect the proper execution of the cold start strategy.

In reviewing the cold start monitoring strategies that manufacturers have implemented, the staff has concluded that, in some cases, the monitors do not sufficiently ensure that the cold start strategies are successfully executed. For example, some monitors evaluate the combined effects of idle speed and ignition timing and only detect a malfunction when both elements (i.e., engine speed and ignition timing) of the emission reduction strategy have failed. The staff believes this is an inappropriate way to design the monitor because the OBD II system will not detect a malfunction until two failures have occurred. Other manufacturers have calibrated their monitors such that a malfunction will not be detected until the performance of the cold start system has deteriorated beyond what is required for normal warmed-up engine operation. For example, most manufacturers require increased idle speed during cold start. Some manufacturers, however, have implemented malfunction thresholds for the cold start monitor that require the engine speed to be less than the normal warmed up idle speed for a malfunction to be detected. While such an approach does indeed verify that the engine starts and idles, it does not verify that some amount of increased idle speed was achieved during the cold start.

To address these issues, the staff is proposing changes to the cold start monitoring requirements to ensure more consistent implementation of the requirements by all manufacturers. Specifically, the staff is proposing more specific malfunction criteria for the elements of the cold start monitoring strategy. Under the proposed changes, the OBD II system would detect a malfunction if either of two malfunction criteria is satisfied.

For the first proposed malfunction criterion, the OBD II system would be required to detect a cold start malfunction if any single commanded element of the cold start strategy does not properly respond to the commanded action while the cold start strategy is active. A cold start strategy element has proper cold start response if the following conditions are satisfied: (i) the element responds by a robustly detectable amount; (ii) the element responds in the direction of the desired command; and (iii) the magnitude of response is above and beyond what the element would achieve on start-up without the cold start strategy active. For example, if the cold start strategy commands a higher idle engine speed, a fault must be detected if there is no detectable amount of engine speed increase above what the system would achieve without the cold start strategy active. For elements involving spark timing (e.g., retarded spark timing), the monitor may verify final *commanded* spark timing in lieu of verifying actual *delivered* spark timing.

For the second proposed malfunction criterion, the OBD II system would detect a cold start malfunction when any failure or deterioration of the cold start emission reduction control strategy causes a vehicle's emissions to be equal to or above 1.5 times the applicable FTP standards. For this requirement, the OBD II system shall either monitor all elements of the system as a whole (e.g., measuring air flow and modeling overall heat into the exhaust) or the individual elements (e.g., increased engine speed, commanded final spark timing) for failures that cause vehicle emissions to exceed 1.5 times the applicable FTP standards.

The staff is proposing implementation of these requirements on 30 percent of 2010, 60 percent of 2011, and 100 percent of 2012 and subsequent model year vehicles. Manufactures will satisfy these proposed requirements by enhancements to their existing cold start strategy monitors.

G. COMPREHENSIVE COMPONENT MONITORING

One of the most important elements of the OBD II system is that it requires comprehensive monitoring of all electronic powertrain components or systems that either can affect vehicle emissions or are used as part of the OBD II diagnostic strategy for another monitored component or system. This includes input components such as sensors and output components or systems such as valves, actuators, and solenoids. Monitoring of all these components is essential since their proper performance can be critical to the monitoring strategies of other components or systems.

However, as vehicles have become increasingly sophisticated, there has been a proliferation of electronic components much beyond the traditional electronic powertrain components that existed when OBD II was started. Many of these components are peripheral components not related to fuel or emission control of the engine. Yet, by the most stringent of interpretations, these ancillary components could be considered subject to OBD II because they are powertrain-related and could affect emissions indirectly by increasing electrical demand or load on the engine when malfunctioning.

In order to keep OBD II systems containable and focused on identifying the powertrain components more directly related to fuel or emission control, the staff is proposing changes to exclude certain types of powertrain components. Specifically, the proposed changes would exclude components that are driven by the engine or can increase emissions only by increasing electrical demand or load on the vehicle and are not related to fuel or emission control. Examples of such excluded components could include electric power steering systems or intelligent vehicle charging systems.

Additionally, while hybrid vehicle powertrain components are subject to monitoring, the current regulation does not have very specific guidelines aimed at hybrid components, and some manufacturers have been unsure as to how to design their hybrid component diagnostics to be acceptable under the regulation. Ideally, the regulation would provide specific performance and diagnostic requirements for each and every hybrid component. Unfortunately, hybrids are still rapidly evolving and neither the staff nor manufacturers have developed sufficient experience to detail monitoring requirements for all hybrid components that would properly comprehend how they are used in all applications. Thus, the staff has proposed the inclusion of general guidelines specifying that monitoring would be required for (1) all components/systems used as part of the diagnostic strategy for other monitored component/systems, (2) all energy input devices to the electrical propulsion system, and (3) battery charging system performance, electric motor performance, and regenerative braking performance, and has added a provision that would require manufacturers to submit a monitoring plan for ARB's review and approval.

H. EXCEPTIONS TO MONITORING REQUIREMENTS

Currently, under the OBD II regulation, malfunction thresholds for gasoline vehicles are set to a multiple of the applicable emission standards for chassis-certified vehicles. However, there is a small segment of medium-duty vehicles that are designed and certified to engine dynamometer emission standards. Given the limited number of vehicles and products in this segment, the staff has included proposed language that would allow manufacturers to submit a plan for approval of how they will establish malfunction criteria on engine dynamometer-certified products that are equivalent to the specified malfunction criteria. In practice, manufacturers have been doing this since the start of OBD II, and the proposed language simply codifies what has become industry practice.

III. TECHNICAL STATUS AND PROPOSED REVISIONS TO MONITORING SYSTEM REQUIREMENTS FOR DIESEL/COMPRESSION-IGNITED ENGINES

The staff recently adopted OBD requirements for heavy-duty gasoline and diesel vehicles and engines (HD OBD). The HD OBD requirements were established in the context of heavy-duty engine manufacturers having to meet significantly more stringent tailpipe emission standards for the 2007 through 2010 model years and having to introduce a significant number of new emission controls to meet those requirements. During the rulemaking process for the HD OBD regulation, the staff gained an increased understanding of emission controls used on diesel engines, the types of malfunctions that could lead to emission increases, and the types of monitors needed to ensure robust effective detection of these faults.

It has always been the intention of staff to revise the OBD II requirements for light-duty and medium-duty diesel vehicles once it had adopted the comprehensive OBD requirements for heavy-duty diesel vehicles. Thus, as part of the ARB's biennial review of the OBD II regulation, the staff is proposing several amendments to the monitoring requirements for diesel/compression-ignited engines. For increased clarity, staff has separated the monitoring requirements for gasoline vehicles and diesel vehicles in the revised regulation.

Summaries of the proposed diesel malfunction thresholds are shown below in Tables 2 and 3. Table 2 summarizes the thresholds for light-duty vehicles and Table 3 summarizes the thresholds for medium-duty engines. While the malfunction thresholds are summarized in the tables, the details of the diesel monitoring requirements are discussed in later sections. Tables 2 and 3, notably, do not include malfunction thresholds for medium-duty diesel vehicles certified to a chassis dynamometer tailpipe emission standard. Staff has not proposed specific thresholds for these vehicles. Rather, as discussed below in section III.M, the monitoring requirements applicable to medium-duty diesel vehicles certified to an engine dynamometer tailpipe emission standard shall apply, and the manufacturer is required to use manufacturer-specified chassis-based thresholds that have been approved by the Executive Officer as equivalent to those proposed for each engine dynamometer-based malfunction criterion.

Table 2: Light-Duty Diesel Emission Thresholds

Monitor	MY	OBDII Thresholds--g/mile NMHC	CO	NOx	PM
NMHC catalyst	2007-2009	5.0x	--	---	---
	2010-2012	3.0x	--	--	--
	2013+	1.75x	---	---	--
NOx SCR cat/Adsorber	2007-2009	3.0x	--	3.0x	--
	2010-2012	2.5x	--	2.5x	--
	2013+	1.75x	--	1.75x	--
fuel system-pressure	2007-2009	3.0x	3.0x	3.0x	3.0x
	2010-2012	2.0x	2.0x	2.0x	2.0x
	2013+	1.5x	1.5x	1.5x	2.0x
fuel system-timing/quantity	2010-2012	3.0x	3.0x	3.0x	3.0x
	2013+	1.5x	1.5x	1.5x	2.0x
A/F sensor-upstream	2007-2009	2.5x	2.5x	2.5x	2.5x
	2010-2012	2.0x	2.0x	2.0x	2.0x
	2013+	1.5x	1.5x	1.5x	2.0x
A/F sensor-downstream	2007-2009	3.5x	3.5x	3.5x	5.0x
	2010-2012	2.5x	2.5x	2.5x	4.0x
	2013+	1.5x	1.5x	1.75x	2.0x
PM/NOx sensor	2007-2009	3.5x	3.5x	3.5x	5.0x
	2010-2012	2.5x	2.5x	2.5x	4.0x
	2013+	1.5x	1.5x	1.75x	2.0x
EGR- flow, response, cooler	2007-2009	3.0x	3.0x	3.0x	3.0x
	2010-2012	2.5x	2.5x	2.5x	2.5x
	2013+	1.5x	1.5x	1.5x	2.0x
Boost pressure- control, cooling	2007-2009	--	---	---	---
	2010-2012	2.0x	2.0x	2.0x	2.0x
	2013+	1.5x	1.5x	1.5x	2.0x
PM filter-efficiency	2004-2009	--	---	---	5.0x
	2010-2012	--	---	---	4.0x
	2013+	--	---	---	1.75x
PM filter-regeneration frequency	2007-2009	functional	--	--	---
	2010-2012	3.0x	3.0x	3.0x	---
	2013+	1.5x	1.5x	1.5x	---
VVT	2007-2009	3.0x	3.0x	3.0x	3.0x
	2010-2012	2.5x	2.5x	2.5x	2.5x
	2013+	1.5x	1.5x	1.5x	2.0x
Cold-start strategy	2007-2009	--	---	---	---
	2010-2012	2.5x	2.5x	2.5x	2.5x
	2013+	1.5x	1.5x	1.5x	2.0x

Table 3: Medium-Duty Diesel Emission Thresholds

			OBDII Thresholds--g/bhp-hr			
Monitor	MY	cert std.	NMHC	CO	NOx	PM
NMHC cat	2007-2012		2.5x	--	---	---
	2013+		2.0x	---	---	--
NOx cat/Adsorber	2007-2009		3.5x	--	+0.5	--
	2010-2012		2.5x	--	+0.3	--
	2013+		2.0x	--	+0.2	--
fuel system-pressure	2007+	> 0.50 NOx	1.5x	1.5x	1.5x	0.03/+0.02
	2007-2012	</= 0.50 NOx	2.5x	2.5x	+0.3	0.03/+0.02
	2013+	</= 0.50 NOx	2.0x	2.0x	+0.2	0.03/+0.02
fuel system-timing/quantity	2010-2012		2.5x	2.5x	+0.3	0.03/+0.02
	2013+		2.0x	2.0x	+0.2	0.03/+0.02
A/F sensor-upstream	2007+	> 0.50 NOx	1.5x	1.5x	1.5x	0.03/+0.02
	2007-2012	</= 0.50 NOx	2.5x	2.5x	+0.3	0.03/+0.02
	2013+	</= 0.50 NOx	2.0x	2.0x	+0.2	0.03/+0.02
A/F sensor-downstream	2007-2009		2.5x	2.5x	+0.5	0.05/+0.04
	2010-2012		2.5x	2.5x	+0.3	0.05/+0.04
	2013+		2.0x	2.0x	+0.2	0.03/+0.02
PM/NOx sensor	2007-2009		2.5x	--	+0.5	0.05/+0.04
	2010-2012		2.5x	--	+0.3	0.05/+0.04
	2013+		2.0x	--	+0.2	0.03/+0.02
EGR- flow & cooler	2004-2006		1.5x	1.5x	1.5x	1.5x
	2007-2012		2.5x	2.5x	+0.3	0.03/+0.02
	2013+		2.0x	2.0x	+0.2	0.03/+0.02
Boost pressure	2010-2012		2.5x	2.5x	+0.3	0.03/+0.02
	2013+		2.0x	2.0x	+0.2	0.03/+0.02
PM filter-efficiency	2004-2009		--	---	---	0.09
	2010-2012		--	---	---	0.05/+0.04
	2013+		--	---	---	0.03/+0.02
PM filter-frequent regen	2007-2009		functional	--	--	---
	2010-2012		2.5x	---	+0.3	---
	2103+		2.0x	---	+0.2	---
VVT	2006-2012		2.5x	2.5x	+0.3	0.03/+0.02
	2013+		2.0x	2.0x	+0.2	0.03/+0.02
Cold-start strategy	2010-2012		functional	--	--	---
	2013+		2.0x	2.0x	+0.2	0.03/+0.02

A. NON-METHANE HYDROCARBON (NMHC) CONVERTING CATALYST MONITORING

Background

Diesel oxidation catalysts have been used on some off-road diesel engines since the 1960s and on some trucks and buses in the U.S. since the early 1990s. Oxidation catalysts are generally used for reducing HC and CO emissions via an oxidation process. Current diesel oxidation catalysts, however, are also optimized to reduce PM emissions. Manufacturers are likely to include oxidation catalysts to enhance the performance of other aftertreatment emission controls while also using them for a small reduction in HC, CO and PM emissions.

With the last amendments adopted in 2002, the OBD II regulation currently requires 2004 and subsequent model year light-duty vehicles and 2007 and subsequent model year medium-duty vehicles to monitor the catalyst for both HC and NOx conversion capability. Manufacturers are required to indicate a catalyst malfunction when the conversion capability of the catalyst system decreases to the point that emissions exceed 1.75 times the applicable HC, NOx, or PM standard. Since adoption of those thresholds, staff has gained considerable experience in expected usage of oxidation catalysts and advancements in monitoring technology through the development of the HD OBD regulation. Monitoring technology has not evolved as well as expected as manufacturers have largely focused on development of emission solutions to meet the tailpipe standards and spent very little time on ensuring diagnostic capability was maturing equivalently.

Accordingly, the staff is proposing to relax the monitoring thresholds for oxidation catalysts and give manufacturers significantly more lead time to incorporate proper monitoring. Manufacturers would still be required to detect a malfunction of the catalyst before emissions exceed specified levels and the specified levels would become increasingly more stringent from the 2007 through 2013 model years. Details of the proposed monitoring thresholds and the phase-ins are provided in Tables 2 and 3 at the beginning of section III. of this report. If a malfunctioning catalyst cannot cause emissions to exceed the applicable emission threshold, a manufacturer would only be required to functionally monitor the system and indicate a malfunction when no NMHC conversion efficiency could be detected. At a minimum, manufacturers would be required to monitor the catalyst once per driving cycle in which the monitoring conditions are met.

The OBD II system would also be required to monitor the oxidation catalyst for other aftertreatment assistance functions. For example, for catalysts used to generate an exotherm to assist PM filter regeneration, the OBD II system would be required to indicate a malfunction when the catalyst is unable to generate a sufficient exotherm to achieve regeneration of the PM filter. Similarly for catalysts used to generate a feedgas constituency to assist selective catalytic reduction (SCR) systems (e.g., to increase NO_2 concentration upstream of an SCR system), the OBD II system would be required to indicate a malfunction when the catalyst is unable to generate the necessary feedgas constituents for proper SCR system operation. Lastly, for catalysts located downstream of a PM filter and used to convert NMHC emissions during PM filter regeneration, the OBD II system would be required to indicate a malfunction when the catalyst has no detectable amount of NMHC conversion capability.

In order to determine the proper OBD II malfunction threshold for the oxidation catalyst, manufacturers would be required to progressively deteriorate or "age" the catalyst(s) to the point where emissions exceed the malfunction threshold (e.g., 1.75 times the standard). The method used to age the catalyst(s) must be representative of real world catalyst deterioration (e.g., thermal and/or poisoning degradation) under normal and malfunctioning operating conditions. For engines with aftertreatment systems that only utilize diesel oxidation catalysts, the catalyst(s) can be aged as a system to the emission threshold for determining the malfunction threshold. However, for engines with aftertreatment systems that utilize multiple catalyst technologies (e.g., an aftertreatment system that includes an oxidation catalyst, catalyzed NOx adsorber, catalyzed PM filter, and lean NOx catalyst), determining the OBD II malfunction threshold for the diesel oxidation catalyst becomes more complex since the aging effects on the catalyst are dependent on many factors, including the location of the oxidation catalyst relative to the other aftertreatment technologies and the synergism between each component in the system. Given that each component in the system is dependent on every other component of the overall catalyst system and deteriorate in-use as a system, it would not be appropriate to treat each component in the system independent of the others.

Since it is uncertain what exhaust configurations and aftertreatment systems manufacturers will use to comply with the future emission standards, it is important for the staff to develop and specify a "one-size-fits-all" aging process that accurately represents every possible future aftertreatment configuration. Once diesel aftertreatment system designs have stabilized to a level similar to gasoline aftertreatment systems (i.e., the variation of aftertreatment systems is limited) defining a generic catalyst aging plan will be more simple and practical. Until then, the staff would require manufacturers to submit a monitoring plan to the Executive Officer for review and approval of the monitoring strategy, malfunction criteria, and monitoring conditions prior to introduction on a production engine. Executive Officer approval would be based on the representativeness of the catalyst system aging to real world catalyst deterioration under normal and malfunctioning operating conditions, the effectiveness of the monitor to pinpoint the likely area of malfunction, and verification that each catalyst component is functioning as designed.

Technical Feasibility of Proposed Monitoring Requirements

To achieve the interim monitoring requirements, or alternatively, if only a functional monitor of the catalyst is required, temperature sensors could be used for monitoring. A functioning oxidation catalyst is expected to provide a significant exotherm when it oxidizes HC and CO. By placing one or more temperature sensors at or near the catalyst, the temperature of the catalyst could be measured during conditions where a large exotherm is expected. This would likely be monitoring during an intrusive event such as PM filter regeneration where fuel is added to the exhaust mixture to create a large exotherm in the catalyst. If the measured exotherm does not exceed a predetermined amount that only a properly-working catalyst can achieve, the diagnostic would fail. With improved temperature sensors, manufacturers may also be able to characterize catalyst light-off characteristics (e.g., after a cold start) and correlate warm-up characteristics with corresponding emission levels.

Monitoring of the oxidation catalysts could also be performed similar to that used on gasoline vehicles for three-way catalysts that use ceria to provide an oxygen storage function. The monitoring concept is based on the principle that the catalyst's oxygen storage capability correlates well with HC and NOx conversion efficiency. Thus, oxygen sensors located upstream and downstream of the catalyst can be used to determine when the oxygen storage capability of the catalyst deteriorates below a predetermined threshold. Determining the oxygen storage capacity would require lean air-fuel (A/F) operation followed by rich A/F operation or vice-versa during catalyst monitoring. Since a diesel engine normally operates lean of stoichiometry, the lean A/F operation portion will be a normal event. However, the rich A/F operation would have to be commanded intrusively when the catalyst monitor is active. The rich A/F operation could be achieved with the engine fuel injectors through late fuel injection or with a dedicated injector in the exhaust upstream of the catalyst. With lean operation, the catalyst will be saturated with stored oxygen. As a result, both the front and rear oxygen sensors should be reading lean. However, when rich A/F operation initiates, the front oxygen sensor would switch immediately to a "rich" indication while the rear oxygen sensor should stay reading "lean" until the stored oxygen in the catalyst is all consumed by the rich fuel mixture in the exhaust. As the catalyst deteriorates, the delay time between the front and rear oxygen sensors reading rich would become progressively smaller. Thus, by comparing the time difference between the responses of the front and rear oxygen sensors to the lean-to-rich or rich-to-lean A/F changes, the performance of the catalyst could be determined. Although conventional oxygen sensors are utilized to illustrate the monitoring method above, these sensors could be replaced with A/F sensors for additional engine control benefits such as EGR trimming and fuel quantity trimming.

For monitoring of the oxidation catalysts capability for other aftertreatment assistance functions (e.g., generating an exotherm for PM regeneration or proper feedgas for subsequent aftertreatment), a functional monitor is all that is required. It is expected that manufacturers would also use the exotherm approach mentioned above to either directly measure the function (e.g., proper exotherm generation) or correlate to the required function (e.g., proper feedgas generation). For catalysts upstream of the PM filter, it is expected that this monitoring would be conducted during an active regeneration event. For catalysts downstream of the PM filter, however, it is likely that manufacturers will have to intrusively add fuel (either in-exhaust or through in-cylinder post-injection) to create a sufficient exotherm to distinguish malfunctioning catalysts.

B. OXIDES OF NITROGEN (NOx) CONVERTING CATALYST MONITORING

Selective Catalytic Reduction (SCR) Catalyst

Background

The SCR catalyst has been used on power plants and stationary engines since the 1970s and is now being developed for use on on-road diesel engines. SCR catalysts are considered one of the most promising exhaust aftertreatment technologies for NOx control. SCR systems use nitrogen-containing compounds such as ammonia or urea, which are injected from a separate reservoir into the exhaust gas stream before the catalyst. Currently the SCR system, with NOx reduction rates of over 80 percent, is one of the more promising catalyst technologies capable of achieving the most stringent NOx emission standards.

SCR catalyst systems require an accurate ammonia control system to inject precise amounts of reductant. An injection rate that is too low may result in lower NOx conversions while an injection that is too high may release unwanted ammonia emissions (referred to as ammonia slip) to the atmosphere. In general, ammonia to NOx ratios of around 1:1 are used to provide the highest NOx conversion rates with minimal ammonia slip. Therefore, it is important to inject just the right amount of ammonia appropriate for the amount of NOx in the exhaust. For stationary source engines, estimating the exhaust NOx levels is fairly easy since the engine usually operates at a constant speed and load and the NOx emission rate is generally stable. However, on-road diesel engines operate over a range of speeds and loads, thereby making NOx exhaust estimates difficult without a dedicated NOx sensor in the exhaust. With an accurate fast response NOx sensor, closed-loop control of the ammonia injection can be used to achieve and maintain the desired ammonia/NOx ratios in the SCR catalyst for high NOx conversion efficiency (i.e., greater than 90 percent) necessary to achieve the stringent NOx emission standards under various engine-operating conditions. Currently, however, such an accurate fast response NOx sensor is not yet available. It has been estimated that achieving the medium-duty 2010 NOx emission standards with SCR systems will require a NOx sensor that can measure NOx levels accurately around the 10 to 20 ppm range with little cross sensitivity to ammonia.[1] Current NOx sensors do not yet meet these specifications, but sensor technology is improving quickly such that zero to 500 ppm resolution sensors have been achieved[2] and zero to 100 ppm sensors are being developed.[3] With further development, sensors are expected to achieve the required NOx sensitivity in time for the 2010 medium-duty emission standards. Regarding cross-sensitivity to ammonia, work has been done that indicates ammonia and NOx measurements can be independently measured by conditioning the output signal.[4] This signal conditioning method resulted in a linear output for both ammonia and NOx from the NOx sensor downstream of the catalyst.

For SCR systems, closed-loop feedback control of the reductant injection could be achieved using one or two NOx sensors. If two are used, the first NOx sensor would be located upstream of the catalyst and the reductant injection point and would be used for measuring the engine-out NOx emissions and determining the amount of reductant injection needed to reduce emissions. The second NOx sensor located downstream of

[1] Song, Q. and Zhu, G., "Model-based Closed-loop Control of Urea SCR Exhaust Aftertreatment System for Diesel Engine," SAE Paper 2002-01-0287.

[2] Kato, N., Kokune, N., Lemire, B., and Walde, T., "Long Term Stable NOx Sensor with Integrated In-Connector Control Electronics," SAE Paper 1999-01-0202.

[3] Kobayashi, N., et al., "Development of Simultaneous NOx/NH3 Sensor in Exhaust Gas," Mitsubishi Heavy Industries, Ltd., Technical Review Vol.38 No.3 (Oct. 2001).

[4] Schaer, C. M., Onder, C. H., Geering, H. P., and Elsener, M., "Control of a Urea SCR Catalytic Converter System for a Mobile Heavy Duty Diesel Engine," SAE Paper 2003-01-0776.

the catalyst would be used for measuring the amount of ammonia and NOx emissions exiting the catalyst and providing feedback to the reductant injection control system. If the downstream NOx sensor detects too much NOx emissions exiting the catalyst, the control system can inject higher quantities of reductant. Conversely, if the downstream NOx sensor detects too much ammonia slip exiting the catalyst, the control system can decrease the amount of reductant injection. With further development, the staff projects that manufacturers will be able to model the upstream NOx levels (based on other engine operating parameters such as engine speed, fuel injection quantity and timing, EGR flow rate), thereby eliminating the need for the front NOx sensor for both control and monitoring purposes.

Recently, some manufacturers have indicated that they believe 2010 emission standards can be met without utilizing a closed-loop feedback system. Instead, an open-loop control system that is based on the "feed-forward" concept could be used. The open-loop system would only require a single NOx sensor that is located upstream of the SCR catalyst to help determine the amount of NOx in the exhaust stream that must be reduced with urea injection. The location of the NOx sensor upstream of the SCR catalyst has a higher NOx concentration and therefore, does not require as accurate a NOx sensor as a downstream NOx sensor would. Although a downstream sensor would still be required for monitoring purposes, the SCR dosing algorithm could be simplified with this approach. However, staff believes this system design is not as robust as a closed-loop system and could allow substantial emission deterioration to occur as the vehicle ages if the downstream sensor is not used for SCR dosing control purposes.

Production SCR catalyst systems may also contain auxiliary catalysts to improve the overall NOx conversion rate of the system. An oxidation catalyst is often positioned downstream of the SCR catalyst to help control ammonia slip on systems without closed-loop control of ammonia injection. The use of a "guard" catalyst could allow higher ammonia injection levels, thereby increasing the NOx conversion efficiency without releasing un-reacted ammonia into the exhaust. The guard catalyst can also reduce HC and CO emission levels and diesel odors. However, increased N_2O emissions may occur and NOx emission levels may actually increase if too much ammonia is oxidized in the catalyst. Some SCR systems may also include an oxidation catalyst upstream of the SCR catalyst and urea injection point to generate NO_2 for reducing the operating temperature range and/or volume of the SCR catalyst. Studies have indicated that increasing the NO_2 content in the exhaust stream can reduce the SCR temperature requirements by about 100 degrees Celsius.[5] This "pre-oxidation" catalyst also has the added benefit of reducing HC emissions. However, additional sulfate PM emissions can occur when high sulfur fuel is used.[6]

---

[5] Walker, A. P., Chandler, G. R., Cooper, B. J., et al., "An Integrated SCR and Continuously Regenerating Trap System to Meet Future NOx and PM Legislation," SAE Paper 2000-01-0188.

[6] "Van Helden, R., van Genderen, M., van Aken, M., et al., "Engine Dynamometer and Vehicle Performance of a Urea SCR-System for Heavy-Duty truck Engines," SAE Paper 2002-01-0286.

Despite its high NOx conversion efficiency, there are several concerns in applying SCR systems to mobile applications. First, proper injection control is difficult under transient conditions. Second, design modifications to accommodate the necessarily large SCR catalysts may be difficult and costly. Further, there are many as yet unresolved issues regarding infrastructure changes that would be necessary to address the storage and refilling of the reductant supply on vehicles. Nonetheless, there is extensive research going on in the development and improvement of applying SCR to diesel vehicles.

Proposed Monitoring Requirements

The currently adopted OBD II regulation requires monitoring of diesel catalysts for malfunctions that would cause NOx emissions to exceed 1.75 times the emission standard. As was stated in the introduction to section III., these requirements were adopted in 2002 with the intent that staff would investigate further into monitoring capability while developing the heavy-duty OBD regulation. In doing so, staff has gained a better understanding of manufacturers' capabilities as they move towards implementation of NOx aftertreatment. With this experience, staff is proposing to relax the monitoring thresholds for catalysts used for NOx conversion to better reflect the technologies, capabilities, and resource constraints of the vehicle manufacturers. Manufacturers would still be required to detect a malfunction of the catalyst before emissions exceed specified levels and the specified levels would become increasingly more stringent from the 2007 through 2013 model years. Details of the proposed monitoring thresholds and the phase-ins are provided in Tables 2 and 3 at the beginning of section III. of this report. As with other monitored components, if a malfunctioning catalyst cannot cause emissions to exceed the applicable malfunction emission threshold, a manufacturer would only be required to functionally monitor the system and indicate a malfunction when no NOx conversion efficiency could be detected. At a minimum, manufacturers would be required to monitor the catalyst once per driving cycle in which the monitoring conditions are met.

Further, the staff is proposing that the mechanism for adding the fuel reductant (e.g., urea) be monitored for proper function. Manufacturers would be required to indicate a malfunction if a failure of the reductant delivery causes the engine's NOx emissions to exceed the malfunction emission thresholds referenced above. If a reductant delivery malfunction cannot cause emissions to exceed the applicable emission threshold, a manufacturer would only be required to functionally monitor the system and indicate a malfunction when the system has reached its control limits such that is it no longer able to deliver the desired quantity of reductant. Additionally, if the reductant tank is separate from the fuel tank, manufacturers would be required to indicate a malfunction when there is no longer sufficient reductant available (i.e., the reductant tank is empty) or when the incorrect reductant is used. Since precise control of reductant addition throughout the engine's operation range is essential for good NOx performance from the system, the reductant delivery performance monitor must be conducted continuously.

<u>Technical Feasibility of Proposed Monitoring Requirements</u>

As mentioned earlier, current NOx sensor technology tends to have a cross-sensitivity to ammonia (i.e., as much as 65 percent of ammonia can be read as NOx). Although this cross-sensitivity can be detrimental to SCR controls (i.e., reductant injection/NOx reduction efficiencies), it is actually beneficial for monitoring purposes. Monitoring of the catalyst can be done by using the same NOx sensors that are used for SCR control. When the SCR catalyst is functioning properly, the upstream sensor should read high (for high NOx levels) while the downstream sensor should read low (for low NOx and low ammonia levels). With a deteriorated SCR catalyst, the downstream sensor should read similar values as the upstream sensor or higher (i.e., high NOx and high ammonia levels) since the NOx reduction capability of the catalyst has diminished. Therefore, a malfunctioning SCR catalyst could be detected when the downstream sensor output is near or greater than the upstream sensor output. A similar monitoring approach can be used if a manufacturer models upstream NOx emissions instead of using an upstream NOx sensor. In this case, the comparison is simply made between the modeled upstream NOx value and the downstream sensor value.

Manufacturers have indicated concerns that NOx sensors will not be of sufficient resolution or accuracy to monitor to stringent thresholds. However, if NOx sensor development does not achieve the desired accuracy by 2010, alternative approaches could be pursued. A simple approach that would likely be feasible to meet the interim threshold levels would be to limit monitoring of the catalyst to conditions where engine out NOx concentrations are the highest and, thus, also the highest after the catalyst. Doing so may raise the concentration levels at the tailpipe to high enough levels that the sensor resolution and accuracy may be sufficient. Another approach that can be taken places the downstream NOx sensor at a location in the SCR catalyst that is more ideally suited for the sensor's NOX sensitivity (i.e., where NOx levels are slightly higher than at the SCR catalyst outlet). This new sensor location may require the SCR catalyst substrate to be separated into a front and rear section with the downstream NOx sensor located between the two substrates. This technique has been utilized by gasoline engine manufacturers since 1994 to allow monitoring of three-way catalysts to more stringent emission standards. By monitoring the capability of the front substrate and inferring the capability of the second, the sensor may be operated in a much higher NOx concentration environment that is better suited to the sensor's resolution and accuracy. However, the SCR monitor may require intrusive urea dosing control to reduce the dosing such that the NOx sensor downstream of the first substrate will not detect any ammonia. In such a case, one would have assurance that the NOx concentrations detected by the sensor consist entirely of NOx and not ammonia. By comparing the NOx concentrations at this location to a threshold that infers the performance of the entire catalyst, a deteriorated catalyst can be determined. At least one manufacturer has indicated that it models urea storage in the catalyst and does not inject urea continuously. For such a urea control strategy, the partial volume monitoring method possibly can be integrated with a portion of the non-continuous urea injection periods to reduce the intrusiveness of the monitor.

Monitoring of the reductant injection functionality could also be done with the NOx sensors that are used for control or catalyst monitoring purposes. With a properly functioning injector, the downstream NOx sensor should see a change from high NOx levels to low NOx levels as reductant injection quantities are varied. In contrast, a lack of reductant injection would result in continuously high NOx levels at the downstream NOx sensor. Therefore, a malfunctioning injector could be found when the downstream NOx sensor continues to measure high NOx after an injection event has been commanded.

Reductant level monitoring can also be conducted by utilizing the existing NOx sensors that are used for control purposes. Specifically, the downstream NOx sensor can be used to determine if the reductant tank no longer has sufficient reductant available. Similar to the fuel reductant injection functionality monitor described previously, when the reductant tank has sufficient reductant quantities and the injection system is working properly, the downstream NOx sensor should see a change from high NOx levels to low NOx levels. If the NOx levels remain constant both before and after reductant injection, then the reductant was not properly delivered and either the injection system is malfunctioning or there is no longer sufficient reductant available for injection in the reservoir. Alternatively, reductant level monitoring can also be conducted by utilizing a dedicated "float" type level sensor similar to the ones used on fuel tanks to determine sufficient reductant levels. Some manufacturers may prefer using a dedicated reductant level sensor in the reductant tank to inform the vehicle operator of current reductant levels with a gauge on the instrument panel. If manufacturers use such a sensor for operator convenience, it could also be used to monitor the reductant level in the tank. The level sensor will provide an output (e.g., voltage) that is dependent upon the reductant level. When the output of the level sensor decreases below a calibrated voltage for an empty tank, there is no longer sufficient reductant available for proper function of the SCR system.

Monitoring for incorrect reductant can also be conducted indirectly by utilizing the existing NOx sensors that are used for control purposes. If an improper reductant is utilized, the SCR system will not function properly. Therefore, NOx emissions downstream from the SCR catalyst will remain high both before and after injection. The downstream NOx sensor will see the high NOx levels after injection and inform the OBD II system of a problem. Other approaches being considered include the use of a reductant quality sensor within the reductant tank or the exhaust stream.

C. MISFIRE MONITORING

Background

Misfire, the lack of combustion in the cylinder, causes increased engine-out HC emissions. On gasoline engines, misfire is due to absence of spark, poor fuel metering, and poor compression. Misfire on gasoline engines can be intermittent (e.g., the misfire only occurs under certain engine speeds or loads). Consequently, the OBD II regulation currently requires continuous monitoring for misfire malfunctions on gasoline engines. However, for diesel engines, manufacturers have maintained that misfire only occurs due to poor compression (e.g., worn valves or piston rings, improper injector or glow plug seating), and when poor compression results in a misfiring cylinder, the cylinder will misfire under all operating conditions. Accordingly, for diesel engines, the OBD II regulation currently requires monitoring for misfire that occurs continuously in one or more cylinders at least once per driving cycle in which monitoring conditions (i.e., idle conditions) are met and does not allow the idle period under which misfire monitoring is to occur to require more than 15 seconds of continuous data collection, nor does it allow more than 1000 continuous engine revolutions of data to make a decision. Also, unlike the requirements for gasoline vehicles, the regulation does not require detection of malfunctions before an emission threshold is exceeded (e.g., 1.5 times the standards) on diesel vehicles.

Proposed Monitoring Requirements

The proposed revisions to the regulation would essentially keep the misfire monitoring requirements the same for conventional diesel engines. However, the staff is proposing amendments that would allow manufacturers to conduct this monitoring under conditions other than the idle conditions stated above so long as the general monitoring condition requirements for all monitors are met. This would allow for future innovations or alternate strategies that may more robustly detect misfire under non-idle conditions.

As stated, the current monitoring requirements were based on engine manufacturers' assertions that a misfiring diesel engine will always misfires. However, contrary to manufacturers' assessment, the staff is concerned that real world malfunctions that cause misfires on diesel engines may occur intermittently or only during off-idle conditions. The staff will continue to investigate the possibility of these misfires but currently does not have sufficient information or data to thoroughly validate these concerns. As additional information becomes available for future Board reviews of the OBD II regulation, the staff may propose a more comprehensive requirement.

Additionally, for 2010 and subsequent model year vehicles equipped with sensors that can detect combustion or combustion quality (e.g., for use in homogeneous charge compression ignition (HCCI) control system), the proposed monitoring requirements would be similar to the current requirements for detection of misfire causing emissions to exceed 1.5 times the standards for gasoline vehicles. For these specific diesel vehicles, the OBD system would be required to detect a misfire malfunction prior to emissions exceeding an emission threshold. For light-duty vehicles and medium-duty passenger vehicles certified to a chassis dynamometer tailpipe emission standard, the threshold would be 1.5 times the applicable standards. For medium-duty vehicles (including medium-duty passenger vehicles) certified to an engine dynamometer tailpipe emission standard, the threshold would be 2.0 times the applicable NMHC, CO, or NOx standards or either 0.03 g/bhp-hr PM as measured on a test cycle or 0.02 g/bhp-hr above the applicable PM standard (whichever is higher for PM). Further, this monitoring would be required to be continuous under all positive torque engine speed and load conditions. For these engines, the premise that a misfiring diesel engine misfires under all speeds and loads is clearly not correct. These engines precisely control the combustion process and require additional sensors to accurately measure combustion characteristics. Given the presence of these additional sensors and the likelihood that these types of engines can experience misfire in very specific speed and load regions, continuous monitoring for misfire is appropriate. Staff expects that combustion sensors would only be used on engines that require precise control of air and fuel metering and mixing to achieve proper combustion and maintain low engine-out emission levels.

Technical Feasibility of Proposed Monitoring Requirements

For diesel engines that use combustion sensors, misfire monitoring is feasible because these sensors provide a direct measurement of combustion and, therefore, lack of combustion (i.e., misfire) can be directly measured as well. These sensors are intended to measure various characteristics of a combustion event for feedback control of the precise air and fuel metering. Accordingly, the resolution of sensors that have this capability is well beyond what would be needed to detect a complete lack of combustion.

D. FUEL SYSTEM MONITORING

Background

An important component in emission control is the fuel system. Proper delivery of fuel (in both quantity and injection timing) plays a crucial role in maintaining low engine-out emissions. The performance of the fuel system is also critical for aftertreatment device control strategies. As such, thorough monitoring of the fuel system is an essential element in an OBD II system. The fuel system is primarily comprised of a fuel pump, fuel pressure control device, and fuel injectors. Additionally, the fuel system generally has sophisticated control strategies that utilize one or more feedback sensors to ensure the proper amount of fuel is being delivered to the cylinders. While gasoline engines have undergone relatively minor hardware changes (but substantial fine-tuning in the control strategy and feedback inputs), diesel engines have more recently undergone substantial changes to the fuel system hardware and now incorporate more refined control strategies and feedback inputs.

For diesel engines, a substantial change has occurred in recent years as manufacturers have transitioned to new high-pressure fuel systems. One of the most widely used is a "common-rail" fuel injection system, which is generally comprised of a high-pressure fuel pump, an electronically-controlled pressure regulator, a fuel rail pressure sensor, a common fuel rail that feeds all the individual fuel injectors that directly inject fuel into each cylinder, and a closed-loop feedback system that uses the fuel rail pressure sensor to achieve the commanded fuel rail pressure. Unlike older style fuel systems where fuel pressure was mechanically linked to engine speed (and thus, varied from low to high as engine speed increased), common-rail systems are capable of controlling to any desired fuel pressure independent of engine speed. Increased fuel pressure control allows greater precision relative to fuel quantity and fuel injection timing, and provides engine manufacturers with tremendous flexibility in optimizing the performance and emission characteristics of the engine. The ability of the system to generate high pressure independent of engine speed also improves fuel delivery at low engine speeds.

While most diesel engine manufacturers use common-rail systems, some use improved unit injector systems. In these systems, fuel pressure is generated within the injector itself rather than via an engine-driven high-pressure fuel pump in a common-rail system. Typically, the injector unit is both electrically and hydraulically-controlled. A high-pressure oil pump is used to deliver oil to the injector, which in turn activates a plunger in the injector to increase the fuel pressure to the desired level. Earlier versions of unit injector systems were able to achieve some of the advantages of common-rail systems (e.g., high fuel pressures) but still had limitations on the pressure that they could build based on engine speed. Further, the fuel pressure was a function of engine speed and could not be modified to a lower or higher pressure at a given engine speed. Newer design iterations have created an injector with extra valves that allow the system to deliver higher or lower pressures at a given engine speed. Thus, while there is still some dependence on engine speed for the fuel pressure, it is largely adjustable and can achieve much of the same fuel pressure range a common-rail system is capable of achieving.

Precise control of the fuel injection timing is crucial for optimal engine and emission performance. As injection timing is advanced (i.e., fuel injection occurs earlier), HC emissions and fuel consumption are minimized but NOx emissions are increased. As injection timing is retarded (i.e., fuel injection occurs later), NOx emissions can be dramatically reduced but HC emissions, PM emissions, and fuel consumption increase. Engine manufacturers must continually optimize the system to deliver the desired fuel quantity precisely at the right time.

The common-rail system or improved unit injector system also provides engine manufacturers with the ability to separate a single fuel injection event into discrete events such as pilot (or pre) injection, main injection, and post injection. A system using a pilot injection and a main injection instead of a single injection event has been shown to generate a 16 percent reduction in NOx emissions[7] in addition to providing a substantial reduction in engine noise. Another study has shown that the use of pilot injection versus no pilot injection can lead to a 20 percent reduction in PM emissions and a five percent reduction in fuel usage at a similar NOx level.[8]

Lastly, the high pressures and near infinite control in a common-rail or improved unit injector system begin to open the door for manufacturers to modify the fuel injection pressure during a fuel injection event which results in different fuel quantity injection rate profiles or "shapes." "Rate-shaping," as it is commonly known, allows manufacturers to

---

[7] Tullis, S., Greeves G., 1996. "Improving NOx Versus BSFC with EUI 200 Using EGR and Pilot Injection for Heavy-Duty Diesel Engines", SAE 960843 (www.dieselnet.com, Diesel Fuel Injection, Common-Rail Fuel Injection).

[8] Greeves, G., Tullis, S., and Barker, B., 2003, "Advanced Two-Actuator EUI and Emission Reduction for Heavy-Duty Diesel Engines", SAE 2003-01-0698.

begin a fuel injection event with a set injection rate and end the injection at a different injection rate. This could be used to progressively increase the fuel quantity during the injection event and has been shown to lower NOx emissions in laboratory settings.[9]

Given these various aspects of common-rail systems and improved unit injector systems, malfunctions that would affect the fuel pressure control, injection timing, pilot/main/post injection timing or quantity, or ability to accurately perform rate-shaping could lead to substantial increases in emissions (primarily NOx or PM), often times with an associated change in fuel consumption.

The OBD II regulation currently contains general language that requires fuel system monitoring of the performance of all electronic fuel system components to the extent feasible that can cause emission to exceed 1.5 times the applicable standards. With the experience gained from the adoption of the heavy-duty OBD regulation, the staff is proposing more specific monitoring requirements that would delineate malfunctions of the different aspects of the fuel system (e.g., fuel pressure, injection quantity).

Proposed Monitoring Requirements

For diesel engines, the staff is proposing several monitoring requirements to verify the overall fuel system's ability to meet the emission standards and to verify that individual aspects or capabilities of the system are properly functioning.

Fuel System Pressure Control Monitoring

The staff is proposing monitoring requirements that continuously verify whether the system is able to control to the desired fuel pressure. The OBD II system would be required to indicate a malfunction when the system can no longer control the fuel system pressure with the consequence that emissions exceed the thresholds specified in Tables 2 and 3. If no failure of the system can cause emissions to exceed the applicable malfunction emission threshold, then the OBD II system would be required to detect a fault when the fuel pressure control system has reached its control authority limits and can no longer increase or decrease the command to the pressure regulator to achieve the desired fuel system pressure. Similar to the current requirements for fuel system and misfire monitoring on gasoline vehicles, staff is proposing that the OBD II system would be required to store similar conditions (i.e., engine speed, load, and temperature status) when a fuel system pressure malfunction is detected in order to improve the detection capability of faults that only happen in specific speed and load regions of the engine.

Fuel Injection Quantity Monitoring

For 2010 and subsequent model year vehicles, the staff is proposing monitoring requirements that verify the fuel system is able to accurately deliver the proper quantity of fuel required for each injection. The OBD II system would be required to indicate a

9 "Advanced Technologies: Fuel Injection and Combustion," www.dieselnet.com.

fault when the system is unable to accurately deliver the desired fuel quantity with the consequence that emissions exceed the thresholds specified in Tables 2 and 3. If no failure can cause emissions to exceed the malfunction emission threshold, then the OBD system would be required to detect a fault when the fuel injection system has reached its control authority limits and can no longer increase or decrease the commanded injection quantity to achieve the desired fuel injection quantity.

Malfunctions or deterioration of the system such as injector deposits or injector wear that restrict flow can result in individual cylinder variations that alter the injection quantity or injection profile and lead to increases in emissions. Unlike gasoline engines, diesel engines have no feedback system that directly verifies the proper fuel quantity. While large decreases in the fuel injection quantity can be noticed by the vehicle operator (e.g., reduction in maximum power output of the engine), small changes go unnoticed and may have a substantial impact on emissions by reducing the ability of the system to accurately deliver fuel (through separate pilot, main, or post injections or timing). As an example, pilot injections typically represent only a few percent (e.g., four to five percent) of the total fuel injected for an individual cylinder fueling event but can have a disproportional impact on increases in NOx emissions (e.g., +16 percent). Deterioration or other malfunctions could affect the ability of the system to accurately deliver the pilot injection yet still achieve acceptable performance to the vehicle operator.

Fuel Injection Timing Monitoring

For 2010 and subsequent model year vehicles, the staff is proposing that manufacturers implement monitoring to verify that fuel injection timing is correct; that is, that fuel is injected at the precise time that it is commanded to happen. Small changes in fuel timing (advance or retard) can have significant impacts on emissions. If the injector were to open too soon (due to a deteriorated needle lift return spring, etc.), fuel would be injected too soon and potentially at a lower than desired fuel pressure. If the injector were to be delayed in opening (due to restrictions in the injector body passages, etc.), fuel would be injected later than desired and potentially at a higher fuel pressure than desired. As such, the OBD II system would be required to verify that the fuel injection occurs within a manufacturer-specified tolerance of the commanded fuel timing point and indicate a malfunction prior to emissions exceeding the thresholds specified in Tables 2 and 3.

Feedback Control Monitoring

Regarding feedback-controlled fuel systems, staff is proposing that manufacturers indicate a malfunction if the fuel system fails to begin feedback control within a manufacturer-specified time interval. Manufacturers would also be required to indicate a malfunction if failure or deterioration of components used as part of the feedback control strategy causes the system to go open-loop (i.e., stops feedback control) or default operation of the fuel system. Lastly, manufacturers would also be required to indicate a malfunction if feedback control has used up all of the adjustment allowed by the manufacturer and cannot achieve the feedback target. Malfunctions that cause delays in starting feedback control and malfunctions that cause open-loop operation could either be detected with a fuel-system specific monitor or with individual component monitors.

Technical Feasibility of Proposed Monitoring Requirements

A few passenger cars and several medium-duty applications utilizing diesel engines have been monitoring the fuel system components since the 1997 model year under the OBD II regulation. Recently, this has included vehicles using common-rail fuel injection and improved unit injector systems, the same new technology that staff expects to be used throughout the heavy-duty industry. For some aspects of these high-pressure fuel systems, however, the monitoring requirement amendments proposed by the staff would extend beyond those presently required for existing medium-duty applications.

Fuel System Pressure Control Monitoring

The first fuel system monitoring requirement proposed by the staff is to identify malfunctions that prevent the fuel system from controlling the fuel pressure to the desired level. Manufacturers control fuel pressure by using a closed-loop feedback algorithm that allows them to increase or decrease fuel pressure until the fuel pressure sensor indicates they have achieved the desired pressure level. For the common-rail systems currently certified on medium-duty vehicles, the manufacturers are indeed continuously monitoring the fuel system pressure by comparing the actual fuel system pressure sensed by a fuel rail pressure sensor to the target fuel system pressure stored in a software table or calculated by an algorithm inside the on-board computer. A fault is indicated if too large of a difference exists between the two. The error limits are established by engine dynamometer emission tests to ensure a malfunction will be detected before emissions exceed 1.5 times the applicable emission standards. In some cases, manufacturers have developed separate strategies that can identify small errors over a long period of time versus large errors over a short period of time. In other cases, one strategy is capable of detecting both types of malfunctions at the appropriate level. In cases where no fuel pressure error can generate a large enough emission increase to exceed 1.5 times any of the applicable standards, manufacturers are required to set the threshold at their control limits (e.g., when they reach a point where they can no longer increase or decrease fuel pressure to achieve the desired fuel pressure). Several medium-duty applications already meet this monitoring requirement. By its nature, a closed-loop system is inherently capable of being monitored because it simply requires analysis of the same closed-loop feedback parameter that is also being used by the system for control purposes.

Fuel Injection Quantity Monitoring

The second diesel fuel system monitoring requirement being proposed is that the monitor verify that the proper quantity of fuel is being injected. Again, manufacturers would be required to establish the malfunction criteria by conducting emission tests to ensure a malfunction will be detected before emissions exceed the malfunction emission threshold (e.g., 2.5 times the applicable emission standards). In cases where no fuel quantity error can generate a large enough emission increase to exceed the malfunction emission threshold, manufacturers would be required to set the threshold at their control limits (e.g., when they reach a point where they can no longer increase or decrease fuel quantity to achieve the desired fuel quantity).

As there is no overall feedback sensor to indicate that the proper mass of fuel has been injected, this monitoring would be more difficult. One manufacturer, however, is currently using a strategy that verifies the injection quantity under very specific engine operating conditions and appears to be capable of determining that the system is accurately delivering the desired fuel quantity. This strategy entails intrusive operation of the fuel injection system during a deceleration event where fuel injection is normally shut off (e.g., coasting or braking from a higher vehicle speed down to a low speed or a stop). During the deceleration, fuel injection to a single cylinder is turned back on to deliver a very small amount of fuel. Typically, the amount of fuel would be smaller than, or perhaps comparable to, the amount of fuel injected during a pilot or pre injection. If the fuel injection system is working correctly, that known injected fuel quantity will generate a known increase in fluctuations (accelerations) of the crankshaft that can be measured by the crankshaft position sensor. If too little fuel is delivered, the measured crankshaft acceleration will be smaller than expected. If too much fuel is delivered, the measured crankshaft acceleration will be larger than expected. This process can even be used to "balance" out each cylinder or correct for system tolerances or deterioration by modifying the commanded injection quantity until it produces the desired crankshaft acceleration and applying a correction or adaptive term to that cylinder to compensate future injections of that cylinder to the desired nominal amount. Each cylinder can, in turn, be cycled through this process and a separate analysis can be made for the performance of the fuel injection system for each cylinder. Even if this procedure requires only one cylinder be tested per revolution (to eliminate any change in engine operation or output that would be noticeable to the driver) and requires each cylinder to be tested on four separate revolutions, this process would only take two seconds for a six-cylinder engine decelerating through 1500 rpm.

The crankshaft position sensor is commonly used to identify the precise position of the piston relative to the intake and exhaust valves to allow for very accurate fuel injection timing control and, as such, has sufficient resolution and data sampling within the on-board computer to be able to measure such crankshaft accelerations. Further, in addition to the current use of this strategy by a medium-duty diesel engine manufacturer, a nearly identical crankshaft fluctuation technique has been commonly used on medium-duty diesel engines during idle conditions to determine if individual cylinders are misfiring since the 1997 model year.

Another technique that may be used to achieve the same monitoring capability is some variation on the current cylinder balance tests used by many manufacturers to improve idle quality. In such strategies, fueling to individual cylinders is increased, decreased, or shut off to determine if the cylinder is contributing an equal share to the output of the engine. This strategy again relies on changes in crankshaft/engine speed to measure the individual cylinder's contribution relative to known good values and/or the other cylinders. Such an approach would be viable to effectively determine the fuel injection quantity is correct for each cylinder but has the disadvantage of not necessarily being able to verify the system is able to deliver small amounts of fuel precisely (such as those commanded during a pilot injection).

The staff expects other monitoring techniques will likely surface as manufacturers begin to develop their systems. One other approach that has been newly mentioned but not investigated very thoroughly is the use of a wide-range air-fuel (A/F) sensor in the exhaust to confirm fuel injection quantity. The monitoring concept is that the A/F sensor output can be compared to the measured air going into the engine and calculated fuel quantity injected to see if the two agree. Differences in the comparison may be able to be used to identify incorrect fuel injection quantity.

Fuel Injection Timing Monitoring

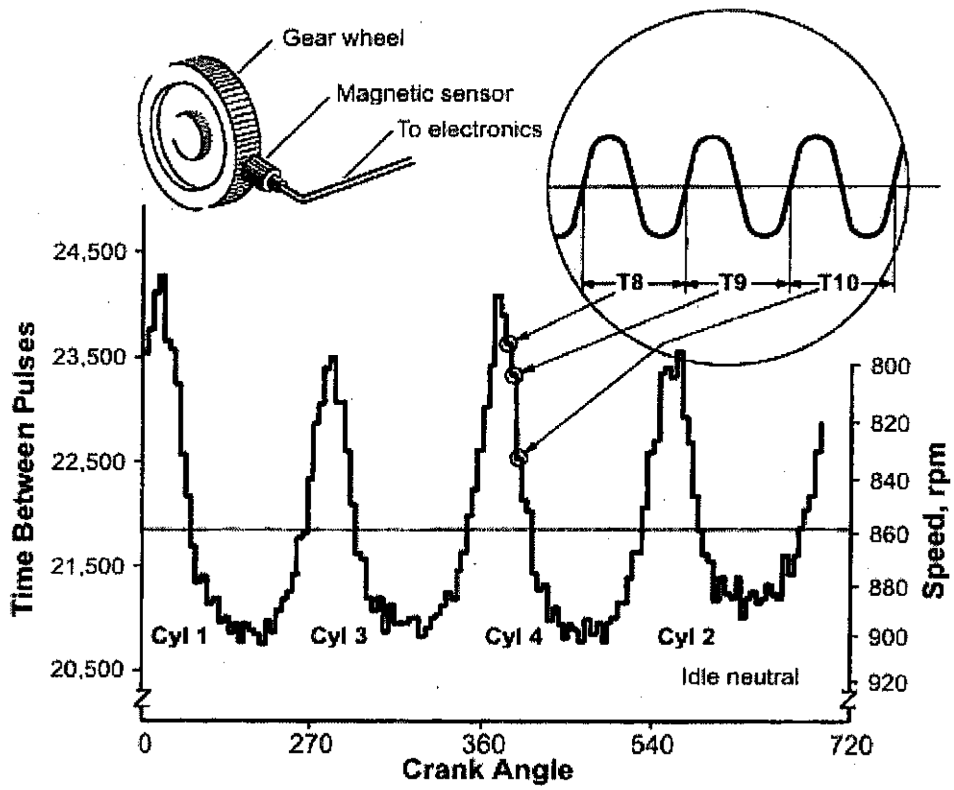
A similar, or even the same, technique could potentially be used to meet this third proposed monitoring requirement. By monitoring the crankshaft speed fluctuation and, most notably, the time at which such fluctuation begins, ends, or reaches a peak, the OBD II system could compare the time to the commanded fuel injection timing point and verify that the fluctuation occurred within an acceptable time delay from the commanded fuel injection. If the system was working improperly and actual fuel injection was delayed relative to when it was commanded, the corresponding crankshaft speed fluctuation would also be delayed and result in a longer than acceptable time period between commanded fuel injection timing and crankshaft speed fluctuation. Mention of this exact method is found in dieselnet.com[10]:

> In fact, some experiments were conducted at the Bendix Diesel Engine Controls in which a signal was obtained and digitized to analyze the impulsive flywheel motion that results from the torque development. Figure 5 shows the results of this experiment which was conducted on a 4-cylinder Volkswagen diesel engine. While the general observation is that in an engine the flywheel is rotating at a steady speed, it is in fact rotating in a pulsating pattern as shown in Figure 5. By referencing the trace in Figure 5, control engineers at Bendix *were able to infer injection timing and fueling for each cylinder.* Analysis of such trace can yield information regarding when the piston began its downward acceleration. From this determination, an injection timing is inferred by referencing the start of piston acceleration to a set top-dead-center reference. Comparative analysis is then conducted by the electronic control unit *to determine the injection timing for each individual cylinder.* In injection systems where individual cylinder control of the fuel injection is available, adjustments can be made to equalize the effective injection timing in all cylinders. *Likewise, the rate and amount of acceleration of each flywheel impulse can be used to infer the fueling in each cylinder.* Once again, the

[10] "Controls for Modern Diesel Engines: Model-Based Control Systems," www.dieselnet.com

electronic control unit is capable to adjust the cylinder-to-cylinder fueling rate for smoother engine operation...[Emphasis added]

Figure 5. Torque Pulses Development in a 4-Cylinder Diesel Engine



Another technique that has been mentioned to the staff but not studied in depth is to confirm fuel injection timing involves an electrical feedback signal from the injector to the computer to confirm when the injection occurred. Such techniques would likely use an inductive signature to identify exactly when an injector opened or closed and verify that it was at the expected timing. The staff expects further investigation would be needed to confirm such a monitoring technique would be sufficient to verify fuel injection timing.

Feedback Control Monitoring

The staff further proposed that the fuel system be monitored for feedback control. The conditions necessary for feedback control (i.e., the feedback enable criteria) are defined as part of the control strategy in the engine computer. The feedback enable criteria are typically based on minimum conditions necessary for reliable and stable feedback control. When the manufacturer is designing and calibrating the OBD II system, the manufacturer would determine how long it takes to satisfy these feedback enable criteria on a properly functioning engine for the range of in-use operating conditions. The OBD II system can evaluate whether it takes too long for these conditions to be satisfied after engine start relative to normal behavior for the system, and a malfunction can be indicated when the time exceeds a specified value (i.e., the malfunction criterion). For example, for fuel pressure feedback control, a manufacturer may wait to begin feedback control until fuel system pressure has reached a minimum specified value. In a properly functioning system, pressure builds in the system as the engine is cranked and shortly after starting, and the pressure enable criterion is reached within a few seconds after engine start. However, a malfunctioning system (e.g., due to a faulty low-pressure fuel pump) may take a significantly longer time to reach the feedback enable pressure. A malfunction would be indicated when the actual time to reach the feedback enable pressure exceeds the malfunction criterion.

Malfunctions that cause open-loop or default operation can be readily detected as well. As discussed above, the feedback enable criteria are clearly defined in the computer and are based on what is necessary for reliable control. After feedback control has begun, the OBD II system can detect when these criteria are no longer being satisfied and indicate a malfunction. For example, one of the enable criteria could be that the pressure sensor has to be within a certain range. The upper pressure limit would be based on the maximum pressure that can be generated in a properly functioning system. A malfunction would be indicated when the pressure exceeds the upper limit and the fuel system stops feedback control and goes open-loop.

The feedback control system has limits on how much adjustment can be made. The limits would likely be based on the ability to maintain acceptable control. Like the feedback enable criteria, the control limits are defined in the computer. The OBD II system would continuously track the actual adjustments made by the control system and indicate a malfunction if the limits are reached.

E. EXHAUST GAS SENSOR MONITORING

Background

Exhaust gas sensors (e.g., oxygen sensors, A/F sensors, NOx sensors, PM sensors) are expected to be used by light- and medium-duty diesel engine manufacturers to optimize their emission control technologies as well as satisfy many of the proposed OBD II monitoring requirements, such as NOx aftertreatment monitoring and EGR system monitoring. Since an exhaust gas sensor will be a critical component of a vehicle's emission control system, the proper performance of this component needs to be assured in order to maintain low emissions.

The OBD II regulation currently requires the diagnostic system to monitor the output voltage, response rate, and any other parameter that can affect emissions or other diagnostics of the primary and secondary oxygen and A/F sensors, including continuous monitoring of circuit continuity and out-of-range values. Manufacturers are required to indicate a fault prior to emissions exceeding 1.5 times the applicable standards. For heated oxygen sensors, the heater must be monitored for circuit continuity faults and for failures where the current or voltage drop within the circuit deteriorates below the manufacturer's specified limits for proper operation. For these other types of exhaust gas sensors, manufacturers are required to submit a monitoring plan for approval demonstrating that the monitors presented would be as reliable and effective as those for conventional sensors, though they are at a minimum required to be monitored for circuit continuity, out-of-range values, and rationality faults.

Proposed Monitoring Requirements

With further experience, staff is now proposing more detailed requirements specific to each type of exhaust gas sensor and its intended usage in the diesel emission control system. Specifically, staff has detailed separate requirements for upstream A/F sensors, downstream A/F sensors, and PM or NOx sensors. Details of the specific malfunction thresholds are provided in Tables 2 and 3 at the beginning of section III.

For all exhaust gas sensors, the proposed regulation would also require the OBD II system to monitor for circuit continuity and out-of-range faults and faults that would cause the sensor to no longer be sufficient for use for other OBD II monitors (e.g., catalyst monitors). Additionally, since emission control system performance is essential in meeting the emission standards and maintaining low emissions, malfunctions where the system is unable to optimize this should be detected. Thus, the staff is also proposing that for all exhaust gas sensors, the OBD II system would be required to indicate a malfunction when a sensor fault occurs such that an emission control system stops using the sensor as a feedback input. Additionally, for heated exhaust gas sensors, manufacturers would be required to monitor the heater for proper performance as well as circuit continuity faults.

Technical Feasibility of Proposed Monitoring Requirements

The OBD II regulation currently has similar monitoring requirements for oxygen and A/F sensors, though the malfunction emission thresholds being proposed by the staff are different. Nevertheless, the technical feasibility has clearly been demonstrated for these packages.

NOx sensors are a recent technology and currently still being developed and improved. Since NOx sensors are projected to only be used for control and monitoring of aftertreatment systems that reduce NOx emissions (e.g., SCR systems), the OBD II system would have to distinguish between deterioration of the aftertreatment system and the NOx sensor itself for the reasons discussed below. As the aftertreatment deteriorates, NOx emissions will increase (i.e., the NOx concentration levels in the exhaust increase), and assuming there is no attendant deterioration in the NOx sensor, the NOx sensor will read these increasing NOx levels. The increased NOx levels can be the basis for determining a malfunction of the aftertreatment system. However, if the NOx sensor experiences deterioration (has an increasingly slower response rate) along with the aftertreatment system, the sensor may not properly read the increased NOx levels from the malfunctioning aftertreatment system, and the aftertreatment monitor would conclude the malfunctioning aftertreatment system is functioning properly. Similarly, the performance of NOx aftertreatment (i.e., level of deterioration of the after treatment system) could affect the results of the sensor monitor. Therefore, to achieve robust monitoring of aftertreatment and sensors, the OBD II system has to distinguish between deterioration of the aftertreatment system and the NOx sensor. To properly monitor the sensor, it is crucial to account for the effects of aftertreatment performance on the results of a sensor monitor. The NOx sensor monitor has to be conducted under conditions where the aftertreatment performance can either be quantified and compensated for in the monitoring results or its effects can be eliminated.

Using an SCR system as an example, the effects of the SCR performance could be eliminated by monitoring under a steady-state operating condition (i.e., a steady-state engine-out NOx condition). Under a relatively steady-state condition, reductant injection could be "frozen," that is, the reductant injection quantity could be held constant, which would also freeze the conversion efficiency of the SCR system. With SCR performance held constant, engine-out NOx emissions could be intrusively increased by a known amount (e.g., by reducing EGR flow or changing fuel injection timing and allowing the engine-out NOx model to determine the increase in emissions). The resulting increase in emissions would pass through the SCR catalyst unconverted, and the sensor response to the known increase in NOx concentrations could be measured and evaluated. This strategy could be used to detect both response malfunctions (i.e., the sensor reads the correct NOx concentration levels but the sensor reading does not change fast enough to changing exhaust NOx concentrations) and rationality malfunctions (i.e., the sensor reads the wrong concentration level). Rationality malfunctions could be detected by making sure the sensor reading changes by the same amount as the intrusive change in emissions. Lastly, the sensor response to decreasing NOx concentrations could be also be evaluated by measuring the response when the intrusive strategy is turned off and engine-out NOx emissions are returned to normal levels. Malfunction criteria could then be determined by correlating sensor response and emission levels from conducting emission tests with sensors having various levels of deterioration.

PM sensors are even less developed than NOx sensors; as such, less is certain about the important characteristics of PM sensors relative to their use in emission control or their proper use as monitoring devices. However, staff has had discussions with sensor suppliers about PM sensor development and is encouraged by the early findings. Further, staff has held discussions with these suppliers about the need for diagnostics, and staff expects that basic diagnostics such as circuit checks, out-of-range values, and heater functionality will be easily implemented. For sensor response or other such characteristics, manufacturers may need to implement strategies similar to those discussed above for NOx sensors and require intrusive operation to verify sensor readings or response during known exhaust concentration conditions.

F. EXHAUST GAS RECIRCULATION (EGR) SYSTEM MONITORING

Background

Exhaust gas recirculation (EGR) systems are currently being used to complement advanced fuel injection and turbocharger systems to meet NOx levels of approximately 2.0 g/hp-hr (the 2004 standard is 2.5 g/hp-hr NMHC+NOx with a 0.5 g/hp-hr NMHC cap). Some systems also use an EGR cooler to further reduce NOx emissions. While NOx control technologies have evolved and been refined on gasoline engines over the last 30 years, they had not been as readily adapted to diesel engines. However, as light- and medium-duty diesel engines have been subject to increasingly more stringent emission standards, EGR systems have become more commonplace and will likely be a key emission control component on future diesel engines.

While in theory the EGR system simply routes some exhaust gas back to the intake, production systems can be complex and involve many components to ensure accurate control of EGR flow and maintain acceptable PM and NOx emissions while minimizing effects on fuel economy. To determine the necessary EGR flow rates and control EGR flow, EGR systems normally use the following components: an EGR valve, valve position sensor, boost pressure sensor, intake temperature sensor, intake (fresh) airflow sensor, and tubing or piping to connect the various components of the system. EGR temperature sensors and exhaust backpressure sensors are also commonly used. Additionally, some systems use a variable geometry turbocharger to provide the backpressure necessary to drive the EGR flow. Therefore, EGR is not a stand alone emission control device. Rather, it is carefully integrated with the air handling system to control NOx while not adversely affecting PM emissions and fuel economy.

The OBD II regulation currently requires manufacturers to indicate a malfunction of the EGR flow rate before emissions exceed 1.5 times the applicable standards. If a malfunction of the system could not cause emissions to exceed 1.5 times the standards, manufacturers are required to detect a malfunction if there is no detectable amount of EGR flow. Individual electronic components (e.g., valves, sensors) used by the EGR system are required to be monitored under the comprehensive component monitoring requirements.

Proposed Monitoring Requirements

With staff's gained experience during the heavy-duty OBD regulation work, staff is proposing revisions that better specify the exact types of EGR system malfunctions that must be detected and appropriate thresholds and leadtime for each component. Given the need to accurately control EGR to maintain acceptable emission levels, the staff is proposing monitoring requirements for flow rate and response rate malfunctions. Additionally, on vehicles equipped with EGR coolers, the OBD II system would be required to monitor the cooler for insufficient cooling malfunctions. Details of the exact emission thresholds and phase-in years are included in Tables 2 and 3 at the beginning of section III.

EGR Flow Rate Monitoring

Under the staff's proposal, the OBD II system would be required to indicate an EGR system malfunction before the change (i.e., decrease or increase) in flow from the manufacturer's specified EGR flow rate causes vehicle emissions to exceed a certain threshold. In situations where no failure or deterioration of the EGR system that causes a decrease in flow could result in vehicle emissions exceeding the malfunction emission threshold, the OBD II system would be required to indicate a malfunction when the system has reached its control limits such that it cannot increase EGR flow to achieve the commanded flow rate.

EGR Response Rate Monitoring

Manufacturers will likely use transient EGR control to meet the emissions standards. EGR rates will be varied with transient engine operating conditions to maintain the balance between NOx and PM emissions. Therefore, staff is proposing a response rate diagnostic to verify that the system has sufficient response. Specifically, the OBD II system would be required to indicate a response malfunction of the EGR system if it is unable to achieve the commanded flow rate within a manufacturer-specified time with the consequence that emissions would exceed a certain threshold. These thresholds are the same as those required for EGR flow rate monitoring above.

Feedback Control Monitoring

Regarding feedback-controlled EGR systems, staff is proposing that manufacturers indicate a malfunction if the EGR system fails to begin feedback control within a manufacturer-specified time interval. Manufacturers would also be required to indicate a malfunction if failure or deterioration of components used as part of the feedback control strategy causes the system to go open-loop (i.e., stops feedback control) or default operation of the EGR system. Lastly, manufacturers would also be required to indicate a malfunction if feedback control has used up all of the adjustment allowed by the manufacturer. Malfunctions that cause delays in starting feedback control and malfunctions that cause open-loop operation could either be detected with an EGR system-specific monitor or with individual component monitors.

EGR Cooling System Monitoring

Insufficient EGR cooling can result in higher NOx emissions and can lead to default operation where EGR is shutoff. Accordingly, the staff is proposing monitoring requirements for proper EGR cooling system performance. Specifically, the OBD II system would be required to indicate an EGR cooling system malfunction when the reduction in cooling of the exhaust gas causes emissions to exceed a certain threshold. These thresholds are the same as those required for EGR flow rate monitoring above. For vehicles in which no failure or deterioration of the EGR system cooler could result in a vehicle's emissions exceeding the malfunction emission threshold, the OBD II system would be required to indicate a malfunction when the system has no detectable amount of EGR cooling. Some manufacturers using EGR coolers have indicated that the cooler is not used for emission reduction but rather for EGR valve and system durability. These manufacturers have also requested to forego monitoring of the EGR cooler. If a manufacturer demonstrates that emissions would not be affected under any reasonable driving condition due to a complete lack of EGR cooling, the manufacturer would not be required to monitor the EGR cooler.

Other Monitoring Requirements

Manufacturers would be required to monitor all electronic components of the EGR system (e.g., temperature sensors, valves) for proper function and rationality under the comprehensive component monitoring requirements.

Technical Feasibility of Proposed Monitoring Requirements

EGR Flow Rate Monitoring

The EGR control system has to determine and control the EGR flow. While the system designs from different manufacturers will vary, they will virtually all employ a similar closed-loop control strategy. Under such a strategy, the control system first determines the desired EGR flow rate based on the engine operating conditions. Manufacturers would likely store the desired flow rate/valve position in a lookup table in the engine control module (ECM) (e.g., the desired EGR values, which are based on engine operating conditions such as engine speed and engine load, are established when the manufacturer designs and calibrates the EGR system). The ECM then commands the valve to the position necessary to achieve the desired flow. EGR flow rate and/or valve position is feedback-controlled, and the ECM calculates or directly measures both fresh air charge and total intake charge. The difference between the total intake charge and fresh airflow is the actual EGR flow. The closed-loop control system continuously adjusts the EGR valve position until the actual EGR flow equals the desired EGR flow.

These closed-loop control strategies could be readily monitored and are the basis for many existing monitors on both gasoline and diesel light- and medium-duty vehicles. The OBD II system could evaluate the difference (i.e., error) between the look-up value and the final commanded value to achieve the desired flow rate. When the error exceeds a specific threshold, a malfunction would be indicated. Typically, as the feedback parameter or learned offset increases, there is an attendant increase in emissions, and a correlation could be made between feedback adjustment and emissions. This type of monitoring strategy could be used to detect both high and low flow malfunctions, and is currently in production on a medium-duty vehicle.[11]

While the closed-loop control strategy described above is effective in measuring and controlling EGR flow, some manufacturers are currently investigating the use of a

[11] "2003 MY OBD System Operation Summary for 6.0L Diesel Engine" at website http://www.motorcraftservice.com/vdirs/diagnostics/pdf/Dobdsm304.pdf.

second control loop based on an A/F sensor (also known as a wide-range oxygen sensor or a linear oxygen sensor) to further improve EGR control and emissions. With this second control loop, the desired air-fuel ratio is calculated based on engine operating conditions (i.e., intake airflow, commanded EGR flow and commanded fuel). The calculated air-fuel ratio is compared to the air-fuel ratio from the A/F sensor and refinements can be made to the EGR and airflow rates (i.e., the control can be "trimmed") to actually achieve the desired rates. On systems that use the second control loop, flow rate malfunctions could also be detected using the feedback information from the A/F sensor and by applying a similar monitoring strategy as discussed above for the primary EGR control loop.

The proposed amendments would require two types of leaking valves to be detected. One type is the failure of the valve to seal when in the closed position (e.g., if the valve or seating surface is eroded, the valve could close and seat, yet still allow some flow across the valve). A flow check is necessary to detect a malfunctioning valve that closes properly but still leaks. EGR flow (total intake charge minus fresh air charge) could be calculated with the valve closed using the monitoring strategy described above for high and low malfunctions, and when flow exceeds unacceptable levels, a malfunction would be indicated. Some cooled EGR systems will incorporate an EGR temperature sensor, which could also be used to detect a leaking EGR valve. For a properly functioning EGR valve, EGR temperature should be a minimum when the EGR valve is closed. An elevated EGR temperature when the valve is closed would indicate a malfunctioning valve. A leaking valve can also be caused by failure of the valve to close/seat (e.g., carbon deposits on the valve or seat that prevent the valve from fully closing). The flow check described above would detect failure of the valve to close/seat but would require a repair technician to further diagnose whether the problem is a sealing or seating problem. Failure of the valve to close/seat could be specifically monitored by checking the zero position of the valve with the position sensor when the valve is closed. If the valve position were out of the acceptable range for a closed valve, a malfunction would be indicated. This type of zero position sensor check is commonly used to verify the closed position of valves/actuators used in gasoline OBD II systems (e.g., gasoline EGR valves, electronic throttle) and would be feasible for diesel EGR valves.

EGR Response Rate Monitoring

The EGR response rate diagnostic is similar to the flow rate diagnostic. While the flow rate diagnostic would evaluate the ability of the EGR system to achieve a commanded flow rate under relatively steady state conditions, the response diagnostic would evaluate the ability of the EGR system to modulate (i.e., increase and decrease) EGR flow as engine operating conditions and, consequently, commanded EGR rates change. Specifically, as engine operating conditions and commanded EGR flow rates change, the monitor would evaluate the time it takes for the EGR control system to achieve the commanded change in EGR flow. This monitor could evaluate EGR response passively during transient engine operating conditions encountered during in-use operation. The monitor could also intrusively evaluate EGR response by commanding a change in EGR flow under a steady state engine operating condition and measuring the time it takes to achieve the new EGR flow rate. Similar passive and intrusive strategies have been developed for variable valve control and/or timing (VVT) monitoring on light- and medium-duty vehicles. The staff believes similar approaches can be used for EGR system monitoring.

EGR Cooling System Monitoring

Some diesel engine manufacturers are currently using exhaust gas temperature sensors as an input to their EGR control systems. On these systems, EGR temperature, which is measured downstream of the EGR cooler, could be used to monitor the effectiveness of the EGR cooler. For a given engine operating condition (e.g., a steady speed/load that generates a known exhaust mass flow and exhaust temperature to the EGR cooler), EGR temperature will increase as the performance of the EGR cooling system decreases. During the OBD calibration process, manufacturers could develop a correlation between increased EGR temperatures and cooling system performance (i.e., increased emissions). The EGR cooling monitor would use such a correlation and indicate a malfunction when the EGR temperature increases to the level that causes emissions to exceed the malfunction emission threshold.

While the staff anticipates that most, if not all, manufacturers will use EGR temperature sensors to meet future standards, EGR cooling system monitoring may also be feasible without an EGR temperature sensor by using the intake manifold temperature (IMT) sensor. EGR cooling system performance could be evaluated by looking at the change in IMT (i.e., "delta" IMT) with EGR turned on and EGR turned off (IMT would be higher with EGR turned-on). If there is significant cooling capacity with a normally functioning cooling system, there could be a significant difference in intake manifold temperature with EGR turned on and off. As cooling system performance decreases, the change in IMT would increase. The change in IMT could be correlated to decreased cooling system performance and increased emissions.

G. BOOST PRESSURE CONTROL SYSTEM MONITORING

Background

Turbochargers are used on internal combustion engines to enhance performance by increasing the mass and density of the intake air. Some of the benefits of turbocharging include increased horsepower, improved fuel economy, and decreased exhaust smoke density.[12] Most modern diesel engines take advantage of these benefits and are equipped with turbocharging systems. The power increase associated with turbocharging also brings higher engine stresses, so the robust design of the diesel engine makes the addition of a turbocharger less problematic compared to gasoline engines. While turbochargers increase the efficiency of the diesel engine, exhaust emissions are also improved. Moreover, smaller turbocharged diesel engines can be

[12] Ecopoint Inc., 2000. "Turbochargers for Diesel Engines", DieselNet Technology Guide.

used in place of larger non-turbocharged engines to achieve desired engine performance characteristics.

The most widely used turbochargers utilize exhaust gas to spin a turbine at speeds from 10,000 to over 150,000 rpm. The turbine is mounted on the same rotating shaft as an adjacent centrifugal pump. The energy that would otherwise be exhausted as waste heat is used to drive the turbine, which in turn drives the centrifugal pump. This pump draws in fresh air and compresses it to increase the density of the air charge to the cylinders, thereby increasing power.

A boost pressure sensor is typically located in the intake manifold to provide a feedback signal of the current turbo boost. As turbo speed (boost) increases, the pressure in the intake manifold also increases. Hence, engine designers may compare the boost pressure signal to a target boost for the given engine speed and load conditions. Target boost pressure is then obtained by either modulating a wastegate valve or turbo vanes.

Proper boost control is essential to optimize emission levels. Even short periods of over- or under-boost can result in undesired air-fuel ratio excursions and corresponding emission increases. Additionally, the boost control system directly affects exhaust and intake manifold pressures. Another critical emission control system, EGR, is very dependent on these two pressures and generally uses the differential between them to force exhaust gas into the intake manifold. If the boost control system is not operating correctly, the exhaust or intake pressures may not be as expected and EGR may not function as designed. In high-pressure EGR systems, higher exhaust pressures will generate more EGR flow and, conversely, lower pressures will reduce EGR flow. A malfunction that causes excessive exhaust pressures (e.g., wastegate stuck closed at high engine speed) can produce higher EGR flowrates at high load conditions and have a negative impact on emissions.[13]

Manufacturers commonly use charge air coolers to maximize the benefits of turbocharging. As the turbocharger compresses the intake air, the temperature of the intake air charge increases. This increasing air temperature causes the air to expand, which is directionally opposite of what turbocharging is attempting to accomplish. Charge air coolers are used to exchange heat between the compressed air and ambient air (or coolant) and cool the compressed air. Accordingly, a decrease in charge air cooler performance can affect emissions by causing higher intake air temperatures that can lead to increased NOx emissions from higher combustion temperatures.

One drawback of turbocharging is known as turbo lag. Turbo lag occurs when the driver attempts to accelerate quickly from a low engine speed. Since the turbocharger is a mechanical device, a delay exists from the driver demand for more boost until the exhaust flow can physically speed up the turbocharger. In addition to a negative effect on driveability and performance, improper fueling (e.g., over-fueling) during this lag can cause emission increases (typically PM).

---

[13] Ecopoint Inc., 2000. "Effects of EGR on Engine and Emissions", DieselNet Technology Guide.

To decrease the effects of turbo lag, manufacturers design turbos that spool up quickly at low engine speeds and low exhaust flowrates. However, designing a turbo that will accelerate quickly from a low engine speed but will not result in an over-speed/over-boost condition at higher engine speeds is difficult. That is, as the engine speed and exhaust flowrates near their maximum, the turbo speed increases to levels that cause excessive boost pressures and heat that could lead to engine or turbo damage. To prevent excessive turbine speeds and boost pressures at higher engine speeds, a wastegate is often used to bypass part of the exhaust stream around the turbocharger. The wastegate valve is typically closed at lower engine speeds so that all exhaust is directed through the turbocharger, thus providing quick response from the turbocharger when the driver accelerates quickly from low engine speeds. The wastegate is then opened at higher engine speeds to prevent engine or turbo damage from an over-speed/over-boost condition.

An alternative to using a wastegate is to use an improved turbocharger design commonly referred to as a variable geometry turbo (VGT). To prevent over-boost conditions and to decrease turbo lag, VGTs are designed such that the geometry of the turbocharger changes with engine speed. While various physical mechanisms are used to achieve the variable geometry, the overall result is essentially the same. At low engine speeds, the exhaust gas into the turbo is restricted in a manner that maximizes the use of the available energy to spin the turbo. This allows the turbo to spool up quickly and provide good acceleration response. At higher engine speeds, the turbo geometry changes such that exhaust gas flow into the turbo is not as restricted. In this configuration, more exhaust can flow through the turbocharger without causing an over-boost condition. The advantage that VGTs offer compared to a waste-gated turbocharger is that all exhaust flow is directed through the turbocharger under all operating conditions. This can be viewed as maximizing the use of the available exhaust energy.

The OBD II regulation currently requires individual electronic components (e.g., valves, sensors) used by the boost pressure control system to be monitored under the comprehensive component monitoring requirements.

<u>Proposed Monitoring Requirements</u>

Since boost control systems are a common feature of modern diesel engines and can have a large impact on emissions when they deteriorate, staff is proposing specific monitoring requirements for these systems. The staff is proposing manufacturers be required to monitor boost control systems for proper operation. Manufacturers would be required to continuously monitor for appropriate boost to verify that the turbocharger is operating as designed and conditions of over-boost or under-boost are not occurring. Specifically, the OBD system would be required to indicate a malfunction before an increase or decrease in boost pressure causes emissions to exceed a certain threshold. Details of the specific malfunction thresholds are provided in Table 2 at the beginning of section III.

The staff is also proposing that manufacturers be required to monitor for slow response malfunctions of the VGT system. That is, the OBD system would be required to monitor the time required to reach the desired boost, whether transitioning from high to low boost or low to high, and indicate a malfunction before an increase in the response time causes emissions to exceed a certain threshold. These thresholds are the same as those required for boost pressure monitoring above.

The proposed regulation would also require the OBD II system to monitor the electronic components of the boost control system (e.g., actuators, pressure sensors, position sensors) that provide or receive a signal from the engine control module (ECM) under the comprehensive component requirements for malfunctions such as circuit failures, rationality faults, and functional response to computer commands.

Lastly, the staff is proposing that charge air coolers be monitored for proper cooling of the intake air. That is, the OBD II system would be required to detect a charge air cooling system malfunction before a decrease in cooling from the manufacturer's specified cooling rate causes emissions to exceed a certain threshold. These thresholds are the same as those required for boost pressure monitoring above. If no charge air undercooling malfunction can cause emissions to exceed the malfunction emission threshold, then the cooler would need to be monitored for proper functionality (e.g., verify that some detectable level of cooling is occurring).

Regarding feedback-controlled boost pressure systems, staff is proposing that manufacturers indicate a malfunction if the boost pressure system fails to begin feedback control within a manufacturer-specified time interval. Manufacturers would also be required to indicate a malfunction if failure or deterioration of components used as part of the feedback control strategy causes the system to go open-loop (i.e., stops feedback control) or default operation of the boost pressure system. Lastly, manufacturers would also be required to indicate a malfunction if feedback control has used up all of the adjustment allowed by the manufacturer. Malfunctions that cause delays in starting feedback control and malfunctions that cause open-loop operation could either be detected with a boost pressure system specific monitor or with individual component monitors.

Technical Feasibility of Proposed Monitoring Requirements

To monitor boost control systems, manufacturers are expected to look at the difference between the actual pressure sensor reading (or calculation thereof) and the desired/target boost pressure. If the error between the two is too large or persists for too long, a malfunction would be detected. Manufacturers would need to calibrate the length of time and size of error to ensure robust detection of a fault occurs before the emission malfunction threshold is exceeded. Given the purpose of a closed-loop control system with a feedback sensor is to continually measure the difference between actual and desired boost pressure, the control system is already continually monitoring the difference and attempting to minimize it. As such, a diagnostic requirement to indicate a fault when the difference gets too large and the system can no longer properly achieve the desired boost is essentially an extension of the existing control strategy. Additionally, multiple diesel medium-duty engines are currently certified to the OBD II regulation requirements with OBD II systems that meet these proposed requirements.

To monitor for malfunction or deterioration of pressure sensors, manufacturers could validate sensor readings against other sensors present on the vehicle or against ambient conditions. For example, at initial key-on before the engine is running, the boost pressure sensor should read ambient pressure. If the vehicle is equipped with a barometric pressure sensor, the two sensors could be compared and a malfunction indicated when the two readings differ beyond the specific tolerances. A more crude rationality check of the boost pressure sensor may be accomplished by verifying that the pressure reading is within reasonable atmospheric limits for the conditions to which the vehicle will be subjected.

Rationality monitoring of VGT position sensors may be accomplished by comparing the measured sensor value to expected values for the given engine speed and load conditions. For example, at high engine speed and loads, the position sensor should indicate that the VGT position is open more than would be expected at low engine speed and loads. These rationality checks would need to be two-sided. That is, position sensors would be checked for appropriate readings at both high and low engine operating conditions.

Lastly, monitoring of boost pressure feedback control could be performed using the same strategies discussed for fuel system feedback control monitoring in section IV.D of this report.

H. NOx ADSORBER MONITORING

Background

NOx adsorbers are another NOx control technology that has been experiencing significant progress in development and optimization. This is one of the newer technologies being optimized for use in diesel vehicles as well as lean-burn gasoline vehicles. The adsorbers chemically bind (i.e., "trap") the oxides of nitrogen during lean engine operation. Generally, when the storage capacity of the adsorbers is saturated, regeneration occurs and the stored NOx is released and converted. This occurs under rich exhaust conditions and includes the chemical reduction of the released NOx to nitrogen by carbon monoxide, hydrogen, and hydrocarbons on a precious metal site. The rich exhaust conditions, which generally last for several seconds, are typically achieved using a combination of intake air throttling (to reduce the amount of intake air), exhaust gas recirculation, and post-combustion or in-exhaust fuel injection.

NOx adsorber systems have demonstrated NOx reduction efficiencies from 50 percent to in excess of 80 to 90 percent. However, this efficiency has been found to be highly dependent on the fuel sulfur content because NOx adsorbers are extremely sensitive to sulfur. Sulfur compounds can saturate the adsorber and limit the number of active sites for NOx adsorption, thereby lowering the NOx reduction efficiency. Accordingly, low sulfur fuel is required to achieve the greatest NOx reduction efficiencies. Although new adsorber washcoat materials are being developed with a higher resistance to sulfur poisoning and ultra-low sulfur fuel will be required in the future, it is projected that NOx adsorber systems will still be subject to sulfur poisoning and will require a sulfur regeneration mechanism.[14] Sulfur poisoning, however, is generally reversible through a desulfurization process, which requires high temperatures (i.e., 500 to 700 degrees Celsius) accompanied by a rich fuel mixture that can be achieved with post-injection and installation of a light-off catalyst upstream of the NOx adsorber. Because the sulfur regeneration process takes much longer (e.g., several minutes) and requires more fuel and heat than the NOx regeneration step, permanent thermal degradation of the NOx adsorber and fuel economy penalties may result from too frequent sulfur regeneration. However, if regeneration is not done frequently enough, NOx conversion efficiency is compromised and fuel economy penalties will also be incurred from excessive purging of the NOx adsorber.[15]

In order to achieve and maintain high NOx conversion efficiencies while limiting negative impacts on fuel economy and driveability, vehicles with NOx adsorption systems will require precise air-fuel control in the engine and in the exhaust stream. Many of these control strategies are still undergoing rapid development. However, diesel manufacturers are expected to utilize NOx sensors and temperature sensors to provide the most precise closed-loop control for the NOx adsorber system.[16] These sensors will provide the adsorber control system with valuable information regarding the NOx levels, oxygen levels/air-fuel ratio, and adsorber temperatures that are needed to achieve and maintain the highest NOx conversion efficiencies possible with minimum fuel consumption penalties during all types of operating conditions. Further, these same sensors can also be used to monitor the adsorber system as will be described later.

Alternatively, if NOx sensors are not used to control the NOx adsorber system, it is projected that A/F sensors (located upstream and downstream of the adsorber) can be used effectively as a substitute. A/F sensors are currently used by one manufacturer on a gasoline-fueled vehicle equipped with a NOx adsorber system to control and monitor the system. Although manufacturers have previously expressed concerns regarding the durability of A/F sensors in diesel applications, these concerns apparently have been sufficiently addressed since at least one diesel manufacturer is using A/F sensors for EGR control. On diesel applications, A/F sensors have several advantages over NOx sensors including lower cost, wide availability, and a mature technology. However, A/F sensors cannot provide an instantaneous indication of tailpipe NOx levels, which would allow the control system to precisely determine when the adsorber system is filled to capacity and regeneration should be initiated. If A/F sensors are used in lieu of NOx

---

[14] Bailey, O., H., Dou, D., and Molinier, M., "Sulfur Traps for NOx Adsorbers: Materials Development and Maintenance Strategies for Their Application," SAE Paper 2000-01-1205; "NOx Adsorbers," www.dieselnet.com.

[15] Ingram, G. A. and Surnilla, G., "On-Line Estimation of Sulfation Levels in a Lean NOx Trap," SAE Paper 2002-01-0731.

[16] "NOx Adsorbers," www.dieselnet.com.

sensors, an estimation of NOx engine-out emissions and their subsequent storage in the NOx adsorber can be achieved indirectly through modeling. However, this may require significant development work depending upon the sophistication of the model.

The OBD II regulation currently requires manufacturers to come in with a plan for Executive Officer approval under the "other emission control or source system monitoring" requirements detailing the monitoring strategy, malfunction criteria, and monitoring conditions for the NOx adsorber.

Proposed Monitoring Requirements

In developing the heavy-duty OBD requirements, staff has gained sufficient experience to provide more detailed monitoring requirements for NOx adsorbers. Therefore, the staff is proposing that manufacturers monitor the NOx adsorber for proper performance. The OBD II system would be required to indicate a malfunction when the adsorber capability decreases to a point such that emissions exceed a certain NMHC or NOx emission threshold and that this threshold would become increasingly stringent in the 2007 through 2013 model years. Details of the exact emission levels and model years are provided in Tables 2 and 3 at the beginning of section III. Additionally, if a malfunctioning NOx adsorber cannot cause emissions to exceed the malfunction emission threshold, a manufacturer would only be required to functionally monitor the system and indicate a malfunction when no NOx adsorber capability could be detected.

Additionally, for NOx adsorber systems that use active or intrusive injection (e.g., in-cylinder post-fuel injection) to achieve desorption of the adsorber, the OBD system would be required to indicate any malfunction of the injection system that would prevent proper desorption of the NOx adsorber.

Technical Feasibility of Proposed Monitoring Requirements

As mentioned earlier, either NOx sensors or A/F sensors along with a temperature sensor are projected to be used for controlling the NOx adsorber system. These same sensors could also be used to monitor the adsorber system. The use of NOx sensors placed upstream and downstream of the adsorber system would allow the system's NOx reduction performance to be continuously monitored. For example, the upstream NOx sensor on a properly functioning adsorber system operating with lean fuel mixtures, will read high NOx levels while the downstream NOx sensor should read low NOx levels. With a deteriorated NOx adsorber system, the upstream NOx levels will continue to be high while the downstream NOx levels will also be high. Therefore, a malfunction of the system can be detected by comparing the NOx levels measured by the downstream NOx sensor versus the upstream sensor. With further development, the staff projects that manufacturers will be able to model the upstream NOx levels (based on other engine operating parameters such as engine speed, fuel injection quantity and timing, EGR flow rate), thereby eliminating the need for the front NOx sensor for both control and monitoring purposes.

Alternatively, if NOx sensors are not used by the adsorber system for control purposes, monitoring of the system could be conducted by using A/F sensors to replace one or both of the NOx sensors. Under lean engine operation conditions with a properly operating NOx adsorber system, both the upstream and downstream A/F sensors will indicate lean mixtures. However, when the exhaust gas is intrusively commanded rich, the upstream A/F sensor will quickly indicate a rich mixture while the downstream oxygen sensor should continue to see a lean mixture in the exhaust due to the release and reduction of NO_2 in the adsorber. Once all of the stored NO_2 has been reduced, the downstream A/F sensor will indicate a rich reading. The more NOx that is stored in the adsorber, the longer the delay before the downstream A/F sensor indicates a rich exhaust gas. Thus, the time differential between the upstream and downstream A/F sensors' lean-to-rich indication is a gauge of the NOx adsorption capability of the adsorber and can be calibrated to indicate different levels of performance. Fresh NOx adsorber systems will have the highest NOx adsorption capability and consequently the longest "lean-to-rich switch" time differential while deteriorated adsorbers with no adsorption capability will have the shortest time differential. Therefore, the NOx adsorber system could be monitored by calibrating the lean-to-rich time differential to indicate a fault when the NOx adsorber system has deteriorated to a level such that the emission thresholds would be exceeded. Honda currently utilizes A/F sensors in a similar manner as described above to monitor the NOx adsorber on a 2003 model year gasoline vehicle.

Since sulfur poisoning reversibly diminishes the performance of the NOx adsorber system, it is imperative that sulfur poisoning be distinguished from a true deteriorated system. Otherwise, perfectly good NOx adsorber systems could erroneously be identified as being bad (i.e., false MILs could occur). Manufacturers of gasoline vehicles with NOx adsorber systems are aware of this issue and are taking various measures to account for adsorber sulfation. These approaches are also being pursued on diesel vehicles. When the NOx adsorption capacity decreases past a predetermined threshold, a desulfation event is intrusively commanded (e.g., with an external heat source or rich fuel mixture) to sufficiently heat up the adsorber for sulfur removal. After desulfation, the adsorber system's NOx capacity is again reevaluated. If the NOx capacity is now below the predetermined threshold, the NOx adsorber is judged good and the previous deteriorated result was due to sulfur poisoning. However, if the NOx capacity is still below the threshold, the NOx adsorber is truly bad and the MIL should be commanded on and a fault code identifying the deteriorated adsorber stored.

The injection system used to achieve desorption of the adsorber could also be monitored with A/F sensors. When the control system injects extra fuel to achieve a rich mixture, the front A/F sensor will respond to the change in fueling and can be used to directly measure whether or not the proper amount of fuel has been injected. If manufacturers employ a NOx adsorber system design that uses only a single A/F sensor downstream of the adsorber for monitoring and control of desorption, the downstream sensor could also be used to monitor the performance of the injection system. As discussed above, the sensor downstream of the adsorber will switch from a lean reading to a rich reading when the stored NO_2 has been released and reduced. If the sensor switches too quickly after rich fueling is initiated, it is an indication that either too much fuel is being injected or the adsorber itself has poor storage capability. Conversely, if the sensor takes too long to switch after rich fueling is initiated, it may be an indication that the adsorber has very good storage capability. However, excessive switch times (i.e., times that exceed the maximum storage capability of the adsorber) would be indicative of an injection system malfunction (i.e., insufficient fuel is being injected) or a sensor malfunction (i.e., the sensor has slow response).

I. PARTICULATE MATTER (PM) FILTER MONITORING

Background

In order to meet the stringent PM standards, manufacturers will generally use aftertreatment devices such as PM filters to achieve the necessary emission levels. PM filters are considered the most effective control technology for reduction of particulate emissions and can typically achieve PM reductions in excess of 90 percent. In general, a PM filter consists of a filter material that permits exhaust gases to pass through but traps the PM emissions. In order to maintain the performance of the PM filter and the vehicle, the trapped PM must be periodically removed before too much particulate is accumulated and exhaust backpressure reaches unacceptable levels. The process of periodically removing accumulated PM from the filter is known as regeneration and is very important for maintaining low PM emission levels. PM filter regeneration can be passive (i.e., occur continuously during regular operation of the filter), active (i.e., occur periodically after a predetermined quantity of particulates has been accumulated), or a combination of the two. With passive regeneration, oxidation catalyst material is typically incorporated into the PM filter to lower the temperature for oxidizing PM. This allows the filter to continuously oxidize trapped PM material during normal driving. In contrast, active systems utilize an external heat source such as an oxidation catalyst that is brought up to temperature at specific intervals by supplemental injected fuel (usually by in-cylinder post fuel injection), a fuel burner or perhaps an electric heater to facilitate PM filter regeneration. It is projected that virtually all PM filter systems will have some sort of active regeneration mechanism.

One of the key factors that needs to be taken into account for a filter regeneration control system is the amount of soot quantity that is stored in the PM filter (often called soot loading).[17] If too much soot is stored in the PM filter when regeneration is activated, the soot can burn uncontrollably and damage the filter. However, activating regeneration when there is too little trapped soot is also undesirable since there is a minimum amount of soot quantity needed to ensure good burn propagation. Another important factor to be considered in the control system design is the fuel economy penalty of filter regeneration. Prolonged operation with high backpressures in the exhaust and too frequent regenerations are both detrimental to fuel economy and durability of the filter. Given these considerations, the control system for the regeneration system is projected to utilize both pressure sensors and temperature

[17] Salvat, O., Marez, P., and Belot, G., "Passenger Car Serial Application of a Particulate Filter System on a Common Rail Direct Injection Diesel Engine," SAE Paper 2000-01-0473.

sensors to model soot loading among other properties. Sensors that can directly measure the amount of particulate matter in diesel exhaust are also being developed (PM sensors) and can be used in addition to the pressure and temperature sensors to provide a more accurate estimate of the soot loading on the filter. One of these sensors is capable of measuring particulate at engine out levels.[18] Another particulate sensor being developed will be capable of measuring very low particulate concentrations downstream of the particulate filter in order to provide a direct evaluation of the condition of the particulate filtering system. Through the information provided by these sensors, designers can optimize the PM filter for effectiveness and maximum durability while minimizing fuel economy and performance penalties.

The OBD II regulation currently requires the OBD II system to indicate a PM filter performance malfunction prior to emissions exceeding 1.5 times any of the applicable standards for 2004 and subsequent light-duty vehicles and medium-duty passenger vehicles and 2007 and subsequent medium-duty vehicles. If any malfunction of the PM filter cannot cause emissions to exceed 1.5 times any of the applicable standards, the OBD II system would be required to indicate a malfunction when catastrophic failure of the PM filter occurs.

Proposed Monitoring Requirements

The staff is proposing monitoring requirements that would verify the PM filter's filtering, regeneration, and (for catalyzed PM filters) NMHC conversion performances.

PM Filter Monitoring

The OBD II system would be required to indicate a malfunction of the PM filter (e.g., cracks or melting in the filter) when the filtering capability decreases to a point such that PM emissions exceed a specified emission threshold and the specified levels would become increasingly stringent from 2007 through the 2013 model year. Details of the proposed monitoring thresholds and the phase-ins are provided in Tables 2 and 3 at the beginning of section III. of this report. In addition, the proposed regulation would require the OBD II system to indicate a fault for an "empty can" (i.e., completely removed/destroyed substrate) or an inappropriately replaced filter (i.e., PM filter assembly replaced by a muffler or a straight pipe).

Additionally, for catalyzed PM filters that are able to convert NMHC emissions, the proposed regulation would require the OBD II system to indicate a malfunction when the NMHC conversion efficiency decreases to the point that NMHC emissions exceed emission thresholds specified in the regulation. If any malfunction of the NMHC conversion capability cannot cause NMHC emissions to exceed the malfunction emission threshold, the OBD II system would be required to indicate a malfunction when there is no detectable amount of NMHC conversion.

[18] David Kittelson, Hongbin Ma, Michael Rhodes, and Brian Krafthefer, "Particle Sensor for Diesel Combustion Monitoring," Presentation supported under DOE Cooperative Agreement DE-FC04-02AL67636, Honeywell, prime contractor, University of Minnesota, subcontractor.

PM Filter Regeneration Monitoring

Regeneration must be monitored by the OBD II system since this process is vital to maintaining the performance of the PM filter. Thus, staff is proposing that manufacturers monitor PM filters for proper performance of the regeneration process. The OBD II system would be required to indicate a malfunction when the regeneration frequency increases to a level past the manufacturer's specified regeneration frequency such that NMHC, CO (for light-duty vehicles), or, NOx emissions exceed a certain threshold. These thresholds are the same as those required for NMHC conversion monitoring of catalyzed PM filters above. If excess regeneration frequency cannot cause emissions to exceed malfunction emission thresholds, the OBD II system would be required to indicate a malfunction when the regeneration frequency exceeds the manufacturer's specified design limit for allowable regeneration frequency. The proposed requirements would also require the OBD II system to indicate a fault when no regeneration occurs during conditions where the manufacturer designates regeneration to occur.

Additionally, for PM filter systems that use active or intrusive injection (e.g., in-cylinder post-fuel injection) to achieve regeneration of the filter, the OBD II system would be required to indicate any malfunction of the injection system that would prevent regeneration of the PM filter.

Regarding feedback-controlled PM filter regeneration systems, staff is proposing that manufacturers indicate a malfunction if the regeneration control system fails to begin feedback control within a manufacturer-specified time interval. Manufacturers would also be required to indicate a malfunction if failure or deterioration of components used as part of the feedback control strategy cause the system to go open-loop (i.e., cease feedback control) or default operation of the injection system. Lastly, manufacturers would also be required to indicate a malfunction if feedback control has used up all of the adjustment allowed by the manufacturer. Malfunctions that cause delays in starting feedback control and malfunctions that cause open-loop operation could either be detected with a regeneration control system specific monitor or with individual component monitors.

<u>Technological Feasibility of Proposed Monitoring Requirements</u>

It is anticipated that manufacturers will not need additional hardware to meet the PM filter monitoring requirements with the exception of the addition of one PM sensor. The same sensors that are used to control trap regeneration are projected to be used for monitoring. In general, a differential pressure sensor placed across the filter and at least one temperature sensor located near the PM filter are used for the control system. As mentioned earlier, a differential pressure sensor is expected to be used on PM filter systems to prevent damage due to delayed or incomplete regeneration that could lead to excess temperatures. When the sensor senses high pressures, regeneration can be activated. However, while backpressure sensors are a necessary part of the control strategies for the PM filter, pressure sensors alone are not sufficient for proper control and protection of the filter. The staff understands from discussions with engine manufacturers, PM filter suppliers, and consultants, that backpressure by itself does not provide a robust indication of soot loading. To make up for the shortcomings of backpressure sensors, manufacturers will also utilize soot-loading models to predict the loading of the filter and to initiate regeneration. The model will estimate the degree of filter loading by tracking the difference between the modeled engine-out PM (i.e., the emissions that are being loaded on to the filter) and regenerated PM (i.e., the PM that is being burned off the filter due to the vehicle operating conditions and /or active regeneration). If the model indicates the PM filter is heavily loaded but the backpressure sensor does not indicate heavy loading, regeneration will be activated based on the model. As mentioned earlier, particulate matter sensors can also be used upstream of the filter in conjunction with the pressure and temperature sensors to better estimate the PM loading of the filter (i.e., the soot-loading model) and optimize filter regeneration frequency and duration. Currently, the sensitivity of these sensors is not sufficient for measuring the low PM levels downstream of the filter. However, with further development, staff believes that a PM sensor with the necessary sensitivity for measuring PM levels downstream of the filter will be available in the 2010 to 2013 timeframe. With such a sensor available, the proposed final emission thresholds for PM filter monitoring should be achievable.

A comprehensive and accurate soot-loading model is necessary for successful monitoring of the PM filter. The proposed monitoring requirements are feasible with further development of the PM filter soot-loading model to make it sufficiently accurate to detect when the actual filter loading inferred from the pressure sensor does not agree with the predicted loading from the soot loading model. The pressure sensor, in combination with the model, could also be used to determine if regeneration is functioning correctly and to evaluate the suitability of the filter for controlling particulate emissions. For example, after a regeneration event, the backpressure should drop significantly since the trapped soot and particles are removed. If backpressure does not drop within the range expected after a regeneration event as predicted by the model, the regeneration did not function correctly (or the filter could have excessive ash loading) and the OBD II system would alert the vehicle operator of a problem. Also, backpressure on a normal PM filter should progressively increase as the mass of soot and trapped particles increases. In general, the mass of soot and trapped particles should increase as the mileage traveled or time of operation increases. However, a cracked filter or missing filter may not experience increased backpressure as expected. Therefore, a cracked or missing filter can be detected if the backpressure fails to increase at the rate projected by the soot-loading model. Backpressure increases with both increased soot loading on the filter and with increasing exhaust flowrate (i.e., as engine load increases). To optimize comparison between the soot-loading model and the backpressure sensor, it is important to account for this increase in backpressure due to exhaust flow (e.g., by normalizing the backpressure based on exhaust flow rate).

Manufacturers have expressed concern, that over time, ash will accumulate on the PM filter, thus altering the soot-loading characteristics. A PM filter with significant ash loading will not drop to as low backpressure levels immediately following a thorough regeneration event and it will load up quicker (because the soot capacity will be reduced by the accumulated ash). If not accounted for, this ash loading could result in inappropriate indication of a fault. Ash loading is a normal byproduct of engine operation (the ash loading is largely a function of oil consumption by the engine and the ash content of the engine oil). Manufacturers could monitor the ash accumulation rate and include that in their soot-loading model. While the ash accumulation rate varies based on the ash content of the engine oil, one manufacturer has indicated it plans on specifying the type of engine oil that must be used so the ash accumulation rate can be accurately accounted for. If the ash accumulation rate significantly exceeds the normal acceptable rate predicted by the model, or the model has determined that the filter has reached its maximum ash loading and the required maintenance is not performed (manufacturers are investigating maintenance intervals and procedures to remove the ash from the filter), a malfunction could then be appropriately indicated.

Lastly, manufacturers have indicated that they are concerned that small differences in crack size or location may generate large differences in tailpipe emission levels, and they are not confident that they can reliably detect all leaks that would result in the emission levels proposed for the malfunction criteria. Accordingly, the manufacturers have suggested pursuing an alternate malfunction criterion independent of emission level such as a percent of exhaust flow leakage or a specified hole size for a leak. However, staff does not believe that pursuit of such alternate thresholds is appropriate at this time. Manufacturers have not even completed work on initial widespread implementation of PM filters for the 2007 model year, and staff expects substantial refinement and optimization will be made by manufacturers based on their field experience prior to the introduction of this monitor in the 2010 model year. Industry also explained that spontaneous small areas of self regeneration might occur in the PM filter during normal vehicle operation and that such episodes could affect the reliability of the monitoring strategies that have been outlined. Given that monitoring strategies are in their infancy, industry needs to develop their strategies further to overcome some of these possible issues. In any case, a successful downstream PM sensor would provide a direct reading of tailpipe PM and would not be subject to these latter concerns. Staff projects that only one PM sensor located either upstream or downstream of the PM filter will be needed for monitoring purposes.

As mentioned earlier, manufacturers are projected to also use temperature sensors for regeneration control purposes. As an additional benefit, this same sensor could also be used in these systems to monitor active regeneration of the filter. If excess temperatures are seen by the temperature sensor during active regeneration, the regeneration process can be stopped or slowed down to protect the filter. If active regeneration is commanded on and there isn't a sufficient temperature rise in the PM filter system for the amount of soot stored in the filter, the regeneration system is malfunctioning and the OBD II system would alert the driver of a problem.

Lastly, monitoring of PM filter regeneration feedback control could be performed using the same strategies discussed for fuel system feedback control monitoring in section IV.D of this report.

J. CRANKCASE VENTILATION (CV) SYSTEM MONITORING REQUIREMENTS

Background

During the engine combustion process, some exhaust gases can escape past the piston into the crankcase and subsequently to the atmosphere. The CV system is used to remove exhaust gases (also known as "blow-by") that have not combusted in the cylinder and direct them to the intake manifold to be burned by the engine. The CV system generally consists of a crankcase vapor outlet hose (through which the exhaust gas is directed from the crankcase to the intake ducting typically upstream of the compressor), and a CV valve to control the flow through the system. Many diesel systems also include a filter and/or oil separator to reduce the amount of oil and/or particulate matter that exits the CV system. As with CV systems on gasoline vehicles, staff believes the likely cause of CV system malfunctions and excess emissions is improper service or tampering of the CV system. These failures include misrouted or disconnected hoses, and missing or improperly installed valves, filters, or oil separators. Of these failures, hose disconnections on the vapor vent side of the systems and/or missing valves can cause emissions to be vented to the atmosphere.

For vehicles with diesel engines, the OBD II regulation currently requires (under the "Positive Crankcase Ventilation (PCV) System Monitoring" requirements) manufacturers to submit a plan for Executive Officer approval of the monitoring strategy, malfunction criteria, and monitoring conditions prior to introduction on a production vehicle. Executive Officer approval is based on the effectiveness of the monitoring strategy to monitor the performance of the CV system to the extent feasible with respect to the proposed malfunction criteria detailed in the current regulation, which essentially requires the OBD II system to monitor for disconnections between the crankcase and the CV valve and between the CV valve and the intake ducting. The regulation also does not require the stored fault code to specifically identify the disconnection if additional hardware would be required for this purpose, and provided service information generated by the manufacturer directs technicians to examine the connection as a possible cause of the indicated fault.

Proposed Monitoring Requirements

Instead of continuing to use the provision to allow manufacturers to submit a monitoring plan for ARB approval, the staff is proposing to apply essentially the same monitoring requirements that are currently being required for gasoline vehicles.
Thus, the staff is proposing that manufacturers be required to monitor the CV system for disconnections between the crankcase and the CV valve and between the CV valve and the intake ducting. Regarding disconnection between the CV valve and the crankcase, detection would likely be significantly more difficult, and could require additional hardware such as a pressure switch to ensure flow in the system. However, in order to

facilitate cost-effective compliance, the staff proposes to exempt manufacturers from detecting this type of disconnection if certain system design requirements are satisfied. Specifically, manufacturers can be exempted from monitoring in this area if the CV valve is fastened directly to the crankcase in a manner that makes technicians more likely to disconnect the intake ducting hose from the valve rather than disconnect the valve itself from the crankcase during service or if disconnection of the CV valve results in a rapid loss of oil such that the vehicle operator is certain to respond and have the vehicle repaired. Staff believes that this would eliminate most of the disconnected hose and valve events because technicians who do not reconnect the intake ducting hose when the service procedure is completed will be alerted to a diagnostic fault or oil leak that will lead the technician back to the improperly assembled component.

For CV system designs that utilize tubing between the crankcase and the valve or any additional tubing or hoses used to equalize pressure or to provide a ventilation path between various areas of the engine (e.g., crankcase and valve cover), the proposed regulation would allow for an exemption from detecting disconnection in this area. This exemption would be obtained if it is demonstrated that all of these connections are resistant to deterioration or accidental disconnection, are significantly more difficult to remove than the connections between the intake ducting and the valve, and are not subject to disconnection during any of the manufacturer's repair procedures for non-CV system repair work. Again, the staff believes these safeguards will eliminate most of the disconnected hose and valve failures previously observed in the field on gasoline systems while still providing manufacturers with adequate design flexibility to meet the requirement.

Under the existing certification requirements for medium-duty diesel engines, manufacturers are allowed to implement open CV systems (i.e., systems that release crankcase vapors to the atmosphere without routing them to the intake ducting or to the exhaust upstream of the aftertreatment) if the manufacturer accounts for the crankcase emissions to the atmosphere in the tailpipe certification values. Currently, all manufacturers will be implementing closed CV systems (i.e., systems that route crankcase vapors to the intake or exhaust upstream of the aftertreatment). As such staff is not proposing specific monitoring requirements for open systems at this time. However, the proposal would still require manufacturers to submit a monitoring plan for Executive Officer approval. The plan would be approved based on the effectiveness of the proposed monitor to detect disconnections and malfunctions in the system that prevent proper control of crankcase emissions (e.g., if the system is equipped with a filter to reduce crankcase emissions to the atmosphere, the OBD II system shall monitor the integrity of the filter).

<u>Technical Feasibility of Proposed Monitoring Requirements</u>

In general, diesel engine manufacturers would be required to meet design requirements for most of system in lieu of actually monitoring many of the hoses for disconnection. Specifically, the proposed regulation would allow for an exemption for any portion of the system that is resistant to deterioration or accidental disconnection and not subject to disconnection during any of the manufacturer's repair procedures for non-CV system repair work. These safeguards should eliminate most of the disconnected or improperly connected hoses while allowing manufacturers to meet the requirements without adding any additional hardware solely to meet the monitoring requirements. Where monitoring is required between the CV and the intake ducting, it is possible to use monitoring strategies similar to those used on gasoline vehicles. For example, if the components of the CV system are properly sized, a disconnected line will cause a large source of unmetered air to be inducted into the engine which can be detected by EGR or intake air mass flow rationality monitoring.

K. ENGINE COOLING MONITORING REQUIREMENTS

Manufacturers generally utilize engine coolant temperature (ECT) as an input for many of the emission-related engine control systems. Diesel engines generally use ECT to initiate closed-loop control of some emission control systems, such as EGR systems. Similar to closed-loop fuel control on gasoline engines, if the coolant temperature does not warm up, closed-loop control of these emission control systems will usually not begin, which will also result in increased emissions.

The OBD II regulation currently requires the OBD II system on diesel applications to indicate a fault when the ECT sensor does not achieve the stabilized minimum temperature needed for "warmed-up fuel control" within an Executive Officer-approved time interval after starting the engine. The staff is proposing to modify this language to require the OBD II system to indicate a fault when the ECT sensor does not achieve the stabilized minimum temperature needed "to begin closed-loop or feedback operation of emission-related engine controls (e.g., feedback control of fuel pressure, EGR flow, boost pressure)" within an Executive Officer-approved time interval after starting the engine. In other words, manufacturers would be required to monitor the ECT sensor to ensure that the vehicle achieved the highest minimum temperature needed for closed-loop control of all emission control systems (e.g., fuel system, EGR system) on diesel vehicles. The technical feasibility of the proposed amendments has already been demonstrated on other light- and medium-duty vehicles under the OBD II regulation.

L. VARIABLE VALVE TIMING AND/OR CONTROL (VVT) SYSTEM MONITORING REQUIREMENTS

The OBD II regulation currently requires the OBD II system to indicate a target error or slow response malfunction of the VVT system before emissions exceed 1.5 times the applicable standards. Based on experience gained during development of the heavy-duty OBD regulation, the staff is proposing to revise the malfunction emission threshold for diesel vehicles. Specific emission thresholds for the phase-in years are provided in Tables 2 and 3 in the beginning of section III.

VVT systems are in general use in light- and medium-duty gasoline applications, and under the OBD II regulation, such systems have been monitored for proper function on the applications that have used VVT systems since the 1996 model year. Most recently, these manufacturers have designed monitoring strategies to detect VVT system malfunctions that cause emissions to exceed an emission threshold, which is currently required in the OBD II regulation for all 2006 and subsequent model year Low Emission Vehicle II applications. Thus, technical feasibility has been demonstrated on these vehicles.

M. COMPREHENSIVE COMPONENT MONITORING REQUIREMENTS

The OBD II regulation currently requires the monitoring of comprehensive components, which covers all other electronic powertrain components or systems not mentioned above that either can affect vehicle emissions or are used as part of the OBD II diagnostic strategy for another monitored component or system. They are generally identified as input components, which provide input directly or indirectly to the on-board computer, or as output components or systems, which receive commands from the on-board computer. Typical examples of input components on diesel vehicles include the exhaust temperature sensor and the fuel pressure sensor. Typical examples of output components/systems on diesel vehicles include the idle governor, the wait-to-start lamp, and cold start aids (e.g., glow plugs). Monitoring of comprehensive components is essential since the proper performance of these components can be critical to the monitoring strategies of other components or systems. Generally, these components are also essential for proper fuel control or driveability, and malfunctions of them often cause an increase in emissions or impact fuel economy and/or vehicle performance.

The staff is proposing a few amendments to the comprehensive component monitoring requirements for diesel vehicles. The proposed changes mentioned for gasoline comprehensive component monitoring (i.e., electronic powertrain components driven by the engine, hybrid components) in section III.F of the Staff Report also apply to diesel vehicles. Additionally, the staff is revising the language for idle control system monitoring. Specifically, for diesel vehicles, manufacturers would be required to indicate a malfunction of the idle control system if either of the following occurs: (1) the system cannot achieve the target idle speed with a fuel injection quantity within +/-30 percent of the manufacturer-specified normal fuel quantity at idle and engine speed tolerances, or (2) the system cannot achieve the target idle speed or fuel injection quantity within the smallest engine speed or fueling quantity tolerance range required to enable other OBD II monitors.

N. EXCEPTIONS TO MONITORING REQUIREMENTS

While the proposed monitoring requirements in section 1968.2(f) detail malfunction criteria for medium-duty vehicles certified to an engine dynamometer tailpipe emission standard as all medium-duty diesel vehicles are and have been for the last 10 years, the requirements do not specify numeric malfunction criteria for chassis-certified medium-duty vehicles even though there are allowances for medium-duty vehicles to be certified to a chassis dynamometer tailpipe emission standard. The staff is proposing that these vehicles be required to follow the monitoring requirements and malfunction criteria applicable to diesel vehicles certified to an engine dynamometer tailpipe emission standard. However, because the malfunction emission thresholds specified in the regulation for engine dynamometer products are on a different basis (e.g., g/bhp-hr) than the emission standards for chassis certified vehicles (e.g., g/mile), manufacturers would be required to submit a proposal and request approval for a malfunction criterion that is equivalent to that required in section (f) for engine-certified products.

IV. PROPOSED REVISIONS TO STANDARDIZATION REQUIREMENTS

One of the most important and successful aspects of OBD II has been the requirement for manufacturers to standardize certain features in the OBD II system. Effective standardization assists all repair technicians by providing equal access to essential repair information, and requires structuring the information in a consistent format from manufacturer to manufacturer. With continual evolution of technology and the extensive feedback received from technicians in the field and I/M programs around the nation, ARB is proposing to clarify and update existing requirements and modify others as necessary to assist technicians in the repair industry and in OBD II-based I/M programs.

A. Reference Documents

The staff is proposing amendments that would update the list of Society of Automotive Engineers (SAE) documents that are incorporated by reference into the regulation. As is common practice with technical standards, industry periodically updates the standards to add specification or clarity. The current regulation incorporates the 2001 version of technical standard SAE J1939 and associated documents. The proposal would update the regulation to incorporate the March 2005 version of J1939. The current regulation also incorporates the 2001 version of ISO 15765-4 which has been subsequently updated in 2005. The proposal would also update the regulation to include the 2005 version. Several other SAE standards including SAE J1978 and SAE J1979 are currently being prepared for ballot and adoption. As these documents are only updated every few years, staff will monitor the progress of adoption of these updates and include them in this rulemaking (through staff suggested changes presented at the Board Hearing) if they are adopted within time. Furthermore, the staff is proposing to incorporate two additional SAE technical standard documents to the regulation. Specifically, the staff is proposing to add: (1) SAE J1699-3 – "OBD II Compliance Test Cases", May 2006; and (2) SAE J2534 – "Recommended Practice for Pass-Thru Vehicle Programming", February 2002. SAE J1699 and SAE J2534 are currently used by manufacturers for production vehicle evaluation (PVE) testing of standardized requirements (section 1968.2(j)(1)).

B. MIL Illumination Protocol

In many of today's advanced vehicles, the OBD II system illuminates the MIL by sending a command from the engine's on-board computer to the instrument panel's computer and then the instrument panel computer actually turns the MIL on. If a malfunction occurs in the connection between the engine computer and the instrument cluster computer, the MIL may not be illuminated even though it is commanded on. To ensure more consistent performance by all manufacturers in this scenario, proposed language is added that would require the instrument panel computer to default to a MIL on configuration if communication between the two computers is lost. As not all manufacturers are currently configured to meet this requirement, the proposed language requires this capability on all 2010 and subsequent model year vehicles.

C. Medium-Duty Diesel Protocol

The OBD II regulation currently allows manufacturers to use one of four protocols for communication between a generic scan tool and the vehicle's on-board computer until the 2008 model year, after which, all vehicles are required to utilize a single protocol. The current regulation, however, also allows medium-duty vehicles with engines certified on an engine dynamometer to use whatever protocol is designated as acceptable by the heavy-duty OBD requirements to allow commonality between engines that are used in both medium-duty and heavy-duty vehicles. In 2002 when this allowance was adopted, the heavy-duty OBD regulation had not yet been adopted. Since then, the heavy-duty OBD regulation was adopted and the protocols required on heavy-duty vehicles have been identified. Accordingly, the staff is proposing amendments to the current OBD II regulation language to reflect this and refer specifically to the adopted heavy-duty OBD regulation for allowable alternate protocols.

D. Permanent Fault Codes

Based on feedback and experience gained from the incorporation of OBD II inspections in the Smog Check program and other nationwide inspection and maintenance (I/M) programs, the staff is proposing a requirement to make it easier to distinguish vehicles undergoing recent repair from vehicles undergoing fraudulent actions to try and slip through the Smog Check program. Currently, a technician or vehicle owner can erase all fault codes and extinguish the MIL by issuing a command from a generic scan tool plugged into the vehicle or, in many cases, simply by disconnecting the vehicle battery. While this does reset internal flags known as the "readiness status" that are currently recorded in Smog Check, it also removes all trace of the previous fault that was detected on the vehicle. With some minimal additional vehicle operation, some of these internal flags can be reset before a fault is re-detected and, in some cases, the vehicle can erroneously pass a Smog Check inspection.

For vehicles that have the MIL on for one or more faults, the staff's proposal would require manufacturers to be able to store "permanent" fault codes. The system would be required to be capable of storing a minimum of four confirmed fault codes that are presently commanding the MIL "on" in non-volatile memory (NVRAM) at the end of every key cycle. By requiring these "permanent" fault codes to be stored in NVRAM, vehicle owners and technicians would not be able to erase them simply by disconnecting the battery. Further, manufacturers would not be allowed to clear or erase these "permanent" fault codes by any generic or manufacturer-specific scan tool command. Instead, these fault codes would only be allowed to be self-cleared by the OBD II system itself, once the monitor responsible for setting that fault code had indeed run and passed enough times to confirm that the fault was no longer present. Since not all manufacturers currently have sufficient NVRAM memory available in their on-board computers to store permanent fault codes, a phase-in implementation of permanent fault codes would be required starting in the 2010 model year and ending with all vehicles required by the 2012 model year (including 2012 model year medium-duty vehicles with 2011 model year engines certified on the engine dynamometer).

Permanent fault codes would allow the Smog Check program to target and reject for fail only those vehicles that have recently had the MIL illuminated and have not subsequently been driven enough to know if the fault has been repaired. The permanent fault code method also has advantages for a technician attempting to repair a vehicle and subsequently prepare it for inspection or proof of correction. The permanent fault code would identify the specific diagnostic that would need to be exercised after repair and prior to inspection to remove the permanent fault code. By combining this information with the vehicle manufacturer's service information, technicians could identify the exact conditions necessary to operate a particular monitor. As such, technicians could more effectively target after-repair verification and would be able to verify that the specific monitor that previously illuminated the MIL has run and confirm the repair has been made correctly. This also provides added incentive for the technician to "fix it right the first time" and reduces vehicle owner "come-backs" for incomplete or ineffective repairs.

E. <u>Access to Additional Data through a Generic Scan Tool</u>

Currently, manufacturers are required to report certain “real-time” data parameters in a format that a generic scan tool can process and read so technicians can access the data for trouble-shooting malfunctions. In recent years, feedback from technicians in the field has identified the need for additional parameters to be made available by the vehicles' OBD II system to assist them in effective repair. Thus, the proposed amendments define some additional parameters (data stream and freeze frame values) that manufacturers would be required to report. Further, the proposed amendments better address diesel vehicles by requiring many new diesel engine specific parameters to be reported on all diesel vehicles.

While the data parameters are generally used for technicians to assist them in repairs, some of the data is also used for the Smog Check program and for compliance or enforcement testing by ARB staff. An example of one of the parameters that manufacturers would be required to report to facilitate in-use emission compliance testing by ARB staff is the real-time status of the NOx and PM “not-to-exceed” (NTE) control areas. These parameters were previously included and adopted in heavy-duty OBD and are being copied for medium-duty applications because they are also tested for compliance in the same manner as the heavy-duty engines. Without this parameter, emission testing by ARB and U.S. EPA would be significantly more difficult to accomplish (e.g., by requiring off-board duplication of the internal engine computer's proprietary algorithms, models, and calculations). It is also expected that continued improvement and development in the in-use emission testing procedures and equipment currently being established for heavy-duty engines may identify the need for additional standardized parameters and/or modifications to proposed parameters that can be incorporated during a future regulatory revision.

F. Software Calibration Identification Number (CAL ID) and Calibration Verification Number (CVN)

OBD II systems have been required to support two additional parameters identifying the current software "version" or calibration (CAL ID) and an internal calculated result to verify the integrity of the software (calibration verification number (CVN)) since the 2002 model year. These two parameters are intended to be used during Smog Check to help verify that valid software is installed in the on-board computer and that the software has not been corrupted or tampered. As various states around the nation have begun to collect this data, the need for further revisions have become apparent. At the last rulemaking, staff had already revised the requirements for CVN and extended the phase-in to allow manufacturers to accommodate the revisions. Now, continued feedback from the field has identified even more necessary revisions to facilitate usage of these two parameters in Smog Check. As such, the proposed language includes several minor changes to the CAL ID and CVN requirements.

First, by 2009 model year, all vehicles are required to respond with an equal number of CAL IDs and CVNs and in the same order such that off-board equipment used during Smog Check could match up each CAL ID with its corresponding CVN. Further, manufacturers are required to either design the vehicles to respond with a single CAL ID and CVN combination for each on-board computer or to respond with them in a fixed order of importance (from most critical for proper emission control to least critical). These two changes will allow reasonable size databases to be established to gather and use the CAL ID and CVN data in Smog Check. Lastly, the staff had previously adopted documentation and reporting requirements for the CVN and CAL ID information with the assumption that a U.S. EPA workgroup would have developed a "standardized electronic format" by the 2005 model year. However, no "standardized electronic format" has yet been developed. Thus, the staff is planning to develop such a standardized template to be included in a future ARB mail-out and is proposing that this document be referenced in the regulation (the specific mail-out number will be made available at the Board Hearing and as part of the subsequent 15-day changes to the regulations). This will provide a uniform format to receive the data from all manufacturers and facilitate further testing to incorporate usage of the data in Smog Check.

G. Tracking Requirements

Engine Run Time, Idle Time, and PTO Activation Time

Consistent with what was already adopted for heavy-duty OBD, the staff is proposing requirements for manufacturers to track and log engine operating time in various operating conditions for all 2010 and subsequent model year diesel vehicles. First, for light-duty diesel vehicles, manufacturers would be required to track and log cumulative engine run time. For medium-duty diesel vehicles, manufacturers would be required to track and log cumulative engine run time, cumulative engine on idle time, and power take-off operation time. These parameters would provide basic information about how often the engine is operated and are commonly available on most medium- and heavy-duty diesel engines. They also provide a baseline for making percentage of time comparisons to other tracked data (described below). The proposed requirements would set a minimum resolution for each of these counters and require all these counters to be stored in non-volatile memory (NVRAM) so that vehicle owners or operators would not be able to erase them simply by disconnecting the battery or clearing codes with a scan tool.

Emission-Increasing AECD Activation Time

An additional important item relative to the effectiveness of diesel emission controls in-use is the usage of auxiliary emission control devices (AECDs). Typically, auxiliary emission control devices (AECDs) consist of alternate control strategies or actions taken by the engine controller for purposes of engine, engine component, or emission control component protection or durability. In some cases, activation of an AECD has been justified by the manufacturer as needed to protect the engine and it can result in substantial emission increases while the AECD is activated. AECDs have been an essential part of the certification process and the subject of numerous mail-outs and guidances by U.S. EPA and ARB to help ensure consistent interpretation and equity in usage among all manufacturers. Approval usually involves lengthy review and considerable scrutiny by ARB staff to try and understand the complex algorithms and strategies used by various manufacturers and additionally relies on data supplied by manufacturers as to the expected occurrence/operation of these items in-use. However, such data is often based on the operation of one or two trucks for a few hours of operation and are not likely to be representative of the extreme variances in engine duty cycles and vehicle operator habits that the diesel engines are exposed to in the real world. Further, the complicated algorithms and calculations used by manufacturers to activate such strategies are not easily decipherable nor comparable from one manufacturer to another, making consistent policy decisions and equity among all manufacturers extremely difficult, if not impossible, to achieve.

To help alleviate this issue, staff is proposing requirements for the vehicle's on-board computer to keep track of cumulative time that a subset of these AECDs is active. Specifically, the proposed language only requires tracking of AECDs that cause an emission increase (i.e., emission increasing AECDs or EI-AECDs). Further, the language only requires tracking of EI-AECDs that are justified by the manufacturer as needed for engine protection and are not related to engine starting or operated substantially during the emission test cycles. Additionally, there is a provision for some AECDs to be approved as not-to-exceed (NTE) deficiencies and any such AECDs is automatically excluded from being considered an EI-AECD. AECDs that are only invoked as a result of high altitude operation (above 8000 feet in elevation) would also be excluded from being considered an EI-AECD. Lastly, in the rare instance (if any) that there is an EI-AECD that is justified as needed for engine protection but it actually is comprised of no sensed, calculated, or measured value and no corresponding commanded action by the on-board computer to act differently as a result, it would also be excluded from being tracked as an EI-AECD.

For those strategies that meet all the requirements above to be considered an EI-AECD, the on-board computer would be require to count cumulative time each one is operated and update the stored counter at the end of each driving cycle with the total cumulative time during the driving cycle. Further, each EI-AECD would be counted and reported separately (EI-AECD #1, etc.). ARB staff would be able to use this data to confirm or refute previous assumptions about expected frequency of occurrence in-use and use the data to support modifications to future model year applications and better ensure equity among all manufacturers. This data will also help ARB staff identify "frail" engine designs that are under-designed relative to their competitors and inappropriately relying on EI-AECD activation to protect the under-designed system.

Manufacturers have raised several concerns regarding this required tracking citing technical concerns, confidentiality concerns, and the inappropriateness of including such a requirement in the OBD II regulations. Regarding technical concerns, manufacturers have argued that determination of which AECDs are emission-increasing will require additional emission testing time. However, staff has revised the provision to define emission-increasing as reducing the emission control system effectiveness and thus, make the determination based on engineering analysis, not any emission test data. Industry has also argued that many EI-AECDs have varied levels of emission increase and they are not simple on/off switches, thereby complicating the counting process and making no distinction between items with a large emission impact and those with only a minor emission impact. To address this, staff modified the proposal to split tracking of each EI-AECD that is not a simple on-off decision into two separate counters and separately track time spent with "mild" EI-AECD activation (defined as action taken up to 75 percent of the maximum action that particular EI-AECD can take) and "severe" EI-AECD activation (defined as action taken from 75 to 100 percent of the maximum action that particular EI-AECD can take). As an example, an EI-AECD that progressively derates and eventually shuts off EGR when the engine overheats would be tracked in the "mild" counter for time spent commanding EGR derating of 1 to 75 percent and tracked in the "severe" counter for time spent commanding EGR derating of 75 to 100 percent (fully closed). Manufacturers have also expressed concern about the complexity of tracking two EI-AECDs that may be overlapping and both commanding action. After further discussion with individual manufacturers about how their strategies were structured, staff modified the proposal to require independent tracking of the EI-AECDs and not require the software to decipher which of the overlapping EI-AECDs was actually having the bigger impact and only accumulate time in that counter.

Regarding confidentiality, manufacturers have indicated that their algorithms and strategies that compromise their EI-AECDs are extremely confidential and do not want their competitors to know the details. Manufacturers have indicated that they believe staff's proposal would provide competitors with more detail of their EI-AECDs and make reverse-engineering easier. Staff's proposal, however, does not provide any additional information to make it easier to reverse-engineer a competitor's strategies nor does it provide any detail about the strategies or algorithms used. The only data staff's proposal would make available is cumulative time an engine is operated with a specific numbered EI-AECD active (eg.., EI-AECD #6). Only the certifying manufacturer and ARB would know for any particular engine what strategy or algorithm a particular EI-AECD corresponded to. Further, since the cumulative time data is only update at the end of a drive cycle, a competitor could only ascertain that, at some previous time in the operation of this engine, a particular EI-AECD was activated a cumulative amount of time. The data would not indicate at what time during any previous drive cycles the EI-AECD was active, whether it was active for one long period or many short bursts of time, or the severity of the action (or even what action) was taken during the EI-AECD activation. As can be done today, a manufacturer would be better served emission testing the engine, identifying real time spikes in emissions, and analyzing the engine operating condtions where the spikes actually occurred to reverse engineer his competitor's products rather than looking at data that does not tell him when the actual activation may have occurred. Lastly, given that the only items of discussion here are EI-AECDs justified by the need to protect the engine, a manufacturer's desire for confidentiality can be motivated by only one concern—that it is currently activating an EI-AECD (and thus, protecting its engine) during conditions that its competitors are not (and thus, not equally protecting their engine) thereby giving the manufacturer a competitive advantage in engine durability. By definition, this means that the manufacturer is activating its EI-AECDs more often (in conditions where its competitors are not). But this is also some of the very same inequity that ARB staff struggle to eliminate in certification in cases where a manufacturer is overly conservative in concluding engine "protection" is necessary and/or staff use to distinguish a "frail" engine design relative to competitors' engines.

Regarding industry's argument that such a tracking requirement is a "test program" or doesn't belong in the OBD II regulation because it isn't directly related to diagnostics, staff has discussed this with the industry many times. The OBD II regulation is the only regulation where ARB specifies data that must be available in a standardized format and protocol through the OBD II vehicle connector and thus, it is the appropriate regulation to include the standardized data. Already, the regulation contains data not directly related to diagnostics but instead used by ARB staff or Smog Check to inspect vehicles or facilitate compliance testing. Further, staff has indicated to industry that it would be willing to rename the regulation or place it in a separate title 13 section during this rulemaking and industry has rejected those solutions as not addressing the real problem. Industry is also the first to point out the myriad of ways diesel engines are used in vehicles and the differences in vehicle operator habits and usage patterns. These points are often used by industry to justify why solutions that work for one type of engine or vehicle are unlikely to work for other engines or vehicles. However, in this case, the manufacturers are arguing that tracking and logging of data in all vehicles is unnecessary and a test program or data logging of a few vehicles would provide just as much data. By the manufacturer's own arguments in other areas, data from a few vehicles clearly would not be representative of the fleet as a whole and any data logging or test program involving a few trucks would provide very little insight as to the real world activation of EI-AECDs.

H. Service Information

At the last regulatory update in 2002, ARB had not yet finalized and put into effect a service information rule requiring disclosure of necessary OBD II diagnostic and repair information to the service community. As such, the current OBD II regulation contains language that details types of service information that must be made available and includes a provision that any ARB-adopted service information rule would supersede the service information requirements contained within the OBD II regulation. Since the last rulemaking, the ARB service information regulation has gone into effect and, accordingly, staff has removed the redundant (and now superseded) service information requirements in the OBD II regulation.

V. PROPOSED REVISIONS TO DEMONSTRATION TESTING REQUIREMENTS

The OBD II regulation requires manufacturers to submit emission test data demonstrating that the emission threshold-based monitors are able to detect a fault and illuminate the MIL before emissions exceed the malfunction criteria (e.g., 1.5 times the standards). Currently, each manufacturer performs demonstration testing on one to three test groups per model year depending on the number of test groups certified by the manufacturer for that model year. ARB adopted the requirement to demonstrate more than one test per model year at the 2002 Board hearing. At that time, staff's intent was to have "medium-sized" manufacturers conduct demonstrating testing on two test groups per year. However in implementing this requirement over the last few model years, medium-sized manufacturers typically have had more than eleven test groups per year, and as such, have been required to perform testing on three test groups. Some medium-sized manufacturers have approached staff about the workload burden needed to test the number of vehicles required, and ARB has considered their concerns and is proposing adjustments. Specifically, the proposed amendments would require manufacturers certifying six to fifteen test groups in a given model year to conduct testing on vehicles from two test groups and would require manufacturers certifying sixteen or more test groups in a given model year to conduct testing on vehicles from three test groups.

Staff is also proposing changes to the demonstration procedures for engine certified products. For medium-duty vehicles certified to an engine dynamometer tailpipe emission standard, the staff is proposing to allow manufacturers, with Executive Officer approval, use an alternate engine dynamometer test cycle or a chassis test cycle to demonstrate proper MIL illumination if the emission test cycle does not allow all of a monitor's enable conditions to be satisfied.

In addition to the general changes discussed above, staff is also proposing specific demonstration testing requirements for diesel vehicles to complement the proposed monitoring requirements detailed for diesels detailed under section IV of the Staff

Report. Consistent with the existing demonstration requirement for gasoline vehicles, demonstration testing for diesel vehicles would be performed for all of the emission threshold-based monitors.

When diesel manufacturers perform tailpipe emissions certification testing, they are required to adjust the test results to account for the emissions impact from regeneration events. The adjustments are required by the exhaust test procedures and are necessary when aftertreatment regeneration causes an increase in emissions and regeneration does not occur on every test cycle (i.e., the test results do not always include the impact of regeneration emissions). For example, PM filter regeneration commonly occurs every few hundred miles. In order to achieve PM filter regeneration, engine control has to be altered to generate the high exhaust temperatures necessary for regeneration to occur. This is achieved by using different fuel injection, EGR and boost control strategies which generate the high exhaust temperatures but can cause an attendant increase in HC and NOx emissions. A manufacturer determines the emission impact from regeneration by conducting an emissions test during which regeneration occurs. The manufacturer then determines how frequently regeneration occurs (e.g., once every ten emission tests). Using the test results from the regeneration emission test and the regeneration frequency, the manufacturer calculates an adjustment factor to be applied to emission tests where regeneration does not occur to yield the adjusted emission results. For certification, the adjusted results have to meet the certification standards.

The adjusted emission results are representative of average emissions from an engine equipped with aftertreatment that has infrequent regeneration and, as such, are required (and appropriate) for emissions certification testing. Similarly, OBD II calibration and demonstration test results need to be adjusted to assess compliance with the OBD II malfunction thresholds. Staff has proposed requirements for determining the adjustment factors in section (d)(6.2) of the regulation. Engine dynamometer emission test results would be adjusted using the methods specified in the Code of Federal Regulations (CFR). Manufacturers of light-duty vehicles and chassis certified medium-duty vehicles would be required to submit a plan for Executive Officer approval to adjust the emission results using an approach similar to that defined in the CFR for engine dynamometer certified products.

When calibrating their monitors and performing this demonstration testing, diesel manufacturers would use the adjusted emission value to determine whether or not the specified emission threshold is exceeded (e.g., is the malfunction detected before the adjusted emission value exceeds 1.5 times the standard) just like the adjusted values are used for determining whether or not the engine meets the tailpipe standards. However, because the malfunctioning component can cause an increase in regeneration frequency or an increase in regeneration emissions relative to a properly functioning emission control system, the adjustment factors need to be recalculated for each OBD II monitor calibrated to an emission threshold. For example, a fuel system pressure malfunction may cause increased engine-out PM emissions which are trapped by the PM filter (thereby avoiding/minimizing an immediate tailpipe emission increase).

However, the PM filter will load up faster with the increased engine-out PM and could cause regeneration to occur more frequently. If the baseline (i.e., tailpipe certification) adjustment factors were used, they would be underestimating actual in-use emissions because the adjustment factors are based on less frequent regeneration than what would actually occur when the fault was present. Therefore, to accurately assess the emission impact from a malfunction, it is necessary to determine a malfunction-specific adjustment factor. Manufactures will have to perform additional emission test during their OBD II calibration and demonstration testing to determine the malfunction-specific adjustment factors. To allow time to develop these additional factors, staff's proposal allows the use of the certification adjustment factors for the 2007 through 2009 model year vehicles, in lieu of establishing and using a specific adjustment factor for each monitor. However, for NMHC (or oxidation) catalyst malfunctions, staff's proposal requires the use of a malfunction-specific adjustment factor starting with the 2008 model year. This one component is singled out for earlier use of a specific adjustment factor because its primary function on many diesel applications is to facilitate PM filter regeneration. Accordingly, when it deteriorates or malfunctions, it can have a very large impact on regeneration emissions while having minimal impact on non-regeneration emissions. Using the certification adjustment factors for this component would greatly underestimate the true emission level when the component malfunctions.

VI. PROPOSED REVISIONS TO CERTIFICATION REQUIREMENTS

A. Certification Application

Based on the staff's reviews of manufacturers' applications in the past years, minor changes are being proposed to the OBD II certification submittal requirements to expedite the OBD II review and approval process. The regulation currently requires manufacturers to submit data identifying all disablement of misfire monitoring that occurs during the FTP and US06 cycles. Proposed amendments would require these data to be submitted in a standardized format that will be detailed in a future ARB mail-out to facilitate consistent and quick review by staff (the specific mail-out number will be made available at the Board Hearing and as part of the subsequent 15-day changes to the regulations). The staff is also proposing to require manufacturers to include a cover letter with each test group application identifying the deficiencies and concerns (if any exist) that apply to the equivalent test group in the previous model year and the changes and/or resolution of each concern or deficiency for the current model year. This would allow the ARB staff to spend less time determining if past problems have been corrected.

B. Model Year Designation for Certification

The OBD II regulation currently requires that the OBD II system on medium-duty vehicles utilizing engines certified on an engine dynamometer be certified to the OBD II requirements applicable to the designated vehicle model year, not engine model year. As explained in more detail in the previous 2002 OBD II Staff Report, this was intended to prevent confusion during certification as well as avoid difficulty in including medium-duty vehicles into the California Smog Check program, which typically tests vehicles based on the model year of the vehicle, not the engine. Medium-duty manufacturers have argued that it is more appropriate to align the OBD II requirements with the engine model year, as is done with the tailpipe emission standards especially when considering the great changes being made in engine emission control hardware in the 2007 and 2010 timeframes. Subsequent discussions with medium-duty manufacturers have identified a modification that would address both staff's and industry's concern. Specifically, the proposed amendments would allow engine manufacturers to meet the OBD II requirements applicable to the model year of the engine except in cases where the OBD II requirement is specifically intended for use in the California Smog Check program. In such cases, medium-duty manufacturers must meet the Smog Check requirements on a vehicle model year basis and the requirements where this exception apply are specifically identified in the regulation.

VII. PROPOSED REVISIONS TO PRODUCTION VEHICLE EVALUATION AND VERIFICATION TESTING

The current regulation includes three specific classes of vehicle testing that must be done by manufacturers on actual production vehicles each year. Since the testing began in the 2004 and 2005 model years, staff and manufacturers have gained experience in the testing and identified areas where further refinement could be applied. First, one of the testing elements verifies vehicles communicate properly to off-board equipment using the standardized protocol and messages required by the OBD II regulation. Since this testing requirement was first adopted, SAE has developed a specification and software for off-board equipment that can be used to conduct the testing. Accordingly, the proposed amendments would provide specific reference to the use of equipment meeting these SAE specifications (SAE J1699-3 and SAE J2534). Staff is also proposing changes to the reporting requirements for the results of standardized communications testing. Manufacturers are currently required to submit a report only when problems are identified during the testing. The proposal would require manufacturers to also submit a report of passing test results within three months of conducting the tests.

Secondly, manufacturers are required to test from two to six vehicles per year to verify all monitors have been correctly implemented in software. Staff's original intent was to structure the testing requirements to require small manufacturers to test two vehicles per year, medium size manufacturers to test four per year, and large manufacturers to test six per year. However, further analysis has shown that most medium size manufacturers are required to test six vehicles per year based on the rules previously established. As such, staff has revised the regulation to require manufacturers certifying 6 to 15 test groups per year (revised from 6 to 10) to test only four vehicles per year.

Lastly, manufacturers are required to collect actual monitoring frequency data from in-use vehicles within the first six months after they are introduced into commerce. An additional six months can be granted by ARB if the manufacturer has difficulty in gathering sufficient data within the six months. To date, most manufacturers have experienced difficulty in gathering the required data in the first six months and accordingly, staff is proposing changes that would change the timeframe to 12 months to better correspond to what manufacturers are typically achieving. A few manufacturers have also expressed difficulty in obtaining a sufficient number of vehicles for their low sales volume test groups. As such, staff is expanding a current provision that allows manufacturers to request a reduced sample size for these test groups to automatically approve such requests if the manufacturer uses the same sampling and vehicle procurement method as is used for higher sales volume test groups that do meet the minimum sample size. This should provide manufacturers more flexibility in collecting the data on these small volume test groups.

VIII. PROPOSED REVISIONS TO STANDARDIZED METHOD TO MEASURE REAL WORLD MONITORING PERFORMANCE

The OBD II regulation requires manufacturers to design their OBD II monitors to robustly detect malfunctions and to run frequently during real world driving. With a phase-in from 2005 through 2007 model year, manufacturers are required to implement software in the on-board computers to track how many times each of the major monitors has executed as well as how often the vehicle has been driven. By measuring both these values, the ratio of monitor operation relative to vehicle operation can be calculated to determine monitoring frequency (i.e., the in-use performance ratio). The regulation also establishes a minimum acceptable in-use performance ratio that many of the major monitors are required to meet in-use.

The current requirement began as a phase-in from 2005 to 2007 model year and established lower (less stringent) minimum ratios for the first few years to allow manufacturers to gain experience from vehicles in the field. However, since implementation of in-use performance tracking only recently begun with the 2005 model year, manufacturers have argued that they have not had enough experience with this requirement to ensure that their monitors will indeed meet the required minimum in-use ratios. As projected by the staff during the 2002 rulemaking, initial data from real world vehicles provided by manufacturers have shown that manufacturers are virtually all meeting the interim lower ratio and generally meeting the final higher ratios for a great majority of their monitors. However, industry is still concerned about the in-use data and the possibility of remedial action (e.g., recall) if they fail to meet the target. Specifically, industry has stated that more time is needed to collect sufficient in-use data and, where necessary, make modifications to ensure that their vehicles are indeed able to meet the final ratios.

Given that it appears the majority of vehicles are already meeting the final requirements and only a few are in need of significant improvements, and recognizing that it does take a significant amount of time to collect meaningful in-use data to determine what impact changes or improvements will have, the staff is proposing to extend the use of the lower interim ratios for an additional year. For newly adopted monitors for gasoline (i.e., cylinder air-fuel imbalance) and for all monitors for diesel, the amendments also provide longer usage of the lower interim ratios to give manufacturers experience with the new requirements.

While the current language requires this logging and reporting of in-use frequency for only five major monitors, additional review by the staff has identified the need to include one additional monitor to be tracked for gasoline vehicles. Specifically, manufacturers would be required to track secondary oxygen sensor monitors given their importance in ensure proper catalyst fault detection. The staff is also proposing to add additional diesel engine monitors that manufacturers would be required to track and report in-use performance. In addition to the currently required tracking for catalysts (oxidation, SCR NOx, and NOx adsorbers) and EGR monitors, the proposal includes tracking, beginning in the 2010 model year, of the PM filter, exhaust gas sensors, and some boost pressure control system component monitors. Consistent with draft SAE standards, the proposal would require separate tracking for oxidation catalysts and NOx aftertreatment (SCR NOx catalysts and NOx adsorbers). Like gasoline, this will ensure that the most critical emission control monitors (and usually the most difficult to run in-use) will indeed be operated with sufficient frequency in-use.

Finally, the staff is proposing alternate criteria to be used in tracking the frequency of operation of some of the diesel emission control monitors. Unlike gasoline where minimum acceptable frequency is generally in the magnitude of two monitoring events in a two week period, the staff has been discussing the allowance of much longer time periods between monitoring events for some diesel emission controls (e.g.. PM filter and oxidation catalysts). Given the relative infancy of development for several of these components, the staff has been receptive to discussions with manufacturers that would tie these monitoring events to an intrusive PM filter regeneration. Conversations with manufacturers have confirmed that these intrusive events are expected to occur every 300 to 500 miles and accordingly, the proposed language tracks the monitors for the PM filter and oxidation catalyst on a 500 mile interval. Specifically, it requires the counter tracking vehicle operation for these monitors to only increment once every 500 miles making the in-use ratio relative, not to the number of trips the vehicle has made, but to the number of 500 mile accumulations the vehicle has made. This will allow manufacturers to use the normally occurring intrusive events to also achieve monitoring (instead of invoking additional intrusive events on a more frequent basis). However, the staff is concerned that this may ultimately result in an insufficient frequency (e.g., monitoring to occur potentially once per month or much less) given that the proper operation of the emission controls are needed at all times the vehicle is operated. As such, the staff will continue to watch progress with monitoring techniques and real world data to determine the actual in-use frequency and may revisit the criteria at future regulatory reviews if the in-use frequency can be significantly improved.

IX. PROPOSED REVISIONS TO THE EMISSION WARRANTY REGULATIONS

In 1979, ARB originally adopted sections 2035 through 2041, title 13, CCR that contain the warranty requirements for passenger cars, light-duty trucks, and medium-duty vehicles. The regulations established requirements for manufacturers to warrant emission-related parts for both defects and performance for a period of three years and 50,000 miles. Additionally, a subset of "high-cost" emission-related parts was eligible to be warranted for seven years and 70,000 miles if they met specific inflation-adjusted cost numbers. The sections were subsequently amended in 1990 and minor changes were made in 1999 regarding the timing of submittal of information required under these sections.

ARB is proposing further amendments to the warranty regulations, specifically sections 2035, 2037, and 2038, to update the references to emission-related parts to account for emission control technology that is used today and to simplify the requirements, where possible. For section 2035, which details the purpose and definitions, and section 2038, which details warranty requirements for "performance" (e.g., I/M fails), the staff is proposing non-substantive changes to reformat and clean up the language. For section 2037, which details the warranty requirements for "defects" (e.g., faults that cause the MIL to be illuminated), the staff is proposing to eliminate the outdated emission-related parts list used to identify components eligible for the high-cost warranty and instead require high-cost warranty coverage for any component that is subject to warranty for 3 years and 50,000 miles and meets the inflation-adjusted cost limit. With this modification, the parts subject to the "high-cost" warranty will truly become a subset of the parts subject to the comprehensive 3 year/50,000 mile warranty. Several, but not all, manufacturers have indicated that they already have such a policy implemented. As such, the proposed revisions are primarily expected to ensure consistent emission warranty policy from manufacturer to manufacturer and provide a more consistent message to vehicle owners in directly relating MIL illumination to warranty repair. As the emission-related parts list currently used is quite outdated, this revision would also better comprehend newer vehicle technologies such as hybrid vehicles and the emission-related components on those vehicles to ensure expensive emission-related component repairs that happen within the first 7 years and 70,000 miles are not inappropriately passed on to the vehicle owner.

X. ANALYSIS OF ENVIRONMENTAL IMPACTS AND ENVIRONMENTAL JUSTICE ISSUES

As the OBD II requirements for gasoline vehicles are fairly mature and the proposed revisions are minor and mostly clarifications, the changes are not expected to significantly alter previously calculated emission benefits or findings. Regarding diesels, though higher interim malfunction emission thresholds are being proposed for light-duty diesel vehicles during the 2007 through 2012 model years, the staff believes these higher thresholds are necessary considering the diesel emission control technologies involved are new and evolving and have never previously existed on diesel vehicles. Additionally, given the limited number of diesel vehicles that are projected to be introduced into the state during these years, staff believes any adverse emission impact from the higher thresholds will be minimal.

For reference, during the 2002 OBD II regulatory update, staff calculated a combined benefit for OBD II and LEV II of 57 tons per day of ROG + NOx in the South Coast Air Basin alone. Details of the methodology can be found in the 2002 OBD II staff report. Given the substantial shortfall in emission reductions still needed to attain the National and State Ambient Air Quality Standards and the difficulty in identifying further sources of cost-effective emission reductions, it is vital that the emission reductions projected for the LEV II program be achieved. The proposed OBD II regulatory revisions apply almost exclusively to LEV II vehicles and better ensure these vehicles will contain to operate at the expected emission levels, a necessary step towards achieving this goal.

Having identified that the proposed amendments to the regulations will not result in any adverse environmental impacts but rather will help ensure that measurable emission benefits are achieved both statewide and in the South Coast Air Basin, the amendments should not adversely impact any community in the State, especially low-income or minority communities.

XI. COST IMPACT OF THE PROPOSED REQUIREMENTS

A. Cost of the Proposed Requirements

For light-duty vehicles, the proposed amendments to the OBD II regulation consist primarily of clarifications of existing requirements. In the very limited cases where a new monitor is required (i.e., cylinder air-fuel imbalance), lead time is provided to allow manufacturers to implement necessary changes in conjunction with scheduled vehicle upgrades. Currently, the light-duty vehicle sector in California consists entirely of gasoline vehicles. For these vehicles, staff projects that manufacturers will comply with the requirements by revising existing computer software and will not need additional new hardware. Additionally, it is expected that the proposed requirements would be addressed primarily with the existing motor vehicle manufacturer workforce. Considering that no additional hardware and staff are projected to be required for compliance with the proposed modifications, staff has estimated that light-duty gasoline vehicles will not incur any additional costs to the consumer.

However, several manufacturers have recently expressed an interest in introducing diesel vehicles into this sector. Therefore, staff has conducted a separate cost analysis for light-duty diesel vehicles. The cost analysis utilizes a similar methodology as used for ARB's heavy-duty OBD program that was adopted by the Board in July 2005.

In adjusting the analysis previously done for heavy-duty engines to account for light-duty diesel vehicles, staff made several assumptions:

1. An average light-duty diesel vehicle (LDDV) manufacturer has two engine families with a total annual U. S. engine production of 183,000 in the 2013 model year.
2. LDDV manufacturers are primarily horizontally integrated manufacturers with high efficiencies.
3. Proposed OBD II revisions for LDDVs represent a smaller incremental increase in monitoring capability relative to the current OBD II system

capability than the heavy-duty OBD requirements for HDDEs represented above their previous capability.

4. A PM sensor will be needed to comply with the final OBD thresholds for PM filter monitoring.
5. The baseline system for this cost estimate is a title 13, CCR, section 1968.1 compliant system.

Utilizing the above assumptions, staff has revised the cost analysis used for HD OBD. Similar to the HD OBD costs analysis, the goal of this analysis is to estimate the "learned-out" costs of the program in the form of a retail price increase to light-duty diesel vehicle purchasers for a "typical" vehicle. The analysis estimates the incremental costs of implementing the proposed OBD II revisions for an average light-duty diesel engine manufacturer. Based on adjustments to the analysis done for heavy-duty OBD for these light-duty vehicles, the incremental retail cost to the engine purchaser for a typical light-duty vehicle in 2013 is projected to be $140.64 per vehicle. Details of the cost analysis methodology are described in the heavy-duty OBD staff report of July 2005, which is incorporated by reference herein (a copy of which may be found at http://www.arb.ca.gov/regact/hdobd05/hdobd05.htm). Table 4 below summarizes the results of the costs analysis.

Table 4

Incremental Consumer Cost of Light-Duty Diesel OBD System

		LDDV (in dollars)
Variable costs	Component	124.63
	Assembly	0.78
	Warranty	3.16
	Shipping	1.50
Support costs	Research	0.43
	Engineering Support	0.00
	Legal	0.04
	Administrative	0.22
Investment recovery costs	Mach. & equipment	0.00
	Assembly plant changes	0.00
	Development/Testing	0.00
Capital recovery (a)		7.85
Manufacturer costs	Cost of capital recovery (b)	2.03
Total cost		140.64

(a) Cost of capital recovery was calculated at 6% of the total incremental costs.
(b) Cost of capital recovery was calculated at 6%. Vehicles are assumed to remain in inventory for 3 months.

For medium-duty vehicles, the current vehicle fleet consists of both gasoline and diesel vehicles. As such, staff has separately estimated the cost of compliance for each of these vehicle types. Similar to the light-duty vehicle cost assessment described earlier, gasoline vehicles are expected to comply with the requirements by revising existing software and will not require additional hardware or staff. Therefore, staff has not associated any additional costs for medium-duty gasoline vehicles. For diesel vehicles, staff has performed a cost analysis similar to the LDDV analysis above.

The assumptions used for medium-duty diesel vehicles are similar to the LDDV analysis. The assumptions are:

1. An average medium-duty diesel vehicle (MDDV) manufacturer has two engine families and one rating/engine family with a total annual U. S. engine production of 183,000 in the 2013 model year.
2. MDDE manufacturers are primarily horizontally integrated manufacturers with high efficiencies.
3. Proposed OBD II revisions for MDDV represent a smaller incremental increase in monitoring capability relative to the current OBD II system capability than the heavy-duty OBD requirements for HDDVs represented above their previous capability.
4. A PM sensor will be needed to comply with the final OBD thresholds for PM filter monitoring.
5. The baseline system for this cost estimate is a title 13, CCR, section 1968.1 compliant system.

The results of the analysis indicate the "learned-out" costs of the program in the form of a retail price increase to medium-duty diesel vehicle purchasers for a "typical" vehicle in 2013 is projected to be $153.19 per engine. Table 5 below summarizes the results of the costs analysis.

Table 5

Incremental Consumer Cost of Medium-Duty Diesel OBD System

		MDDV (in dollars)
Variable costs	Component	129.63
	Assembly	0.78
	Warranty	3.16
	Shipping	1.50
Support costs	Research	1.58
	Engineering Support	0.00
	Legal	0.14
	Administrative	0.82
Investment recovery costs	Mach. & equipment	0.00
	Assembly plant changes	0.00
	Development/Testing	4.83
Capital recovery (a)		8.55
Manufacturer costs	Cost of capital recovery (b)	2.21
Total cost		153.19

(a) Cost of capital recovery was calculated at 6% of the total incremental costs.

(b) Cost of capital recovery was calculated at 6%. Engines are assumed to remain in inventory for 3 months.

B. Cost Effectiveness of the Proposed Requirements

As stated above, the proposed OBD II revisions are not expected to add any significant cost to gasoline vehicles. Further, medium-duty diesel vehicles represent less than five percent of the current OBD II fleet so even an incremental increase of $153 per medium-duty vehicle only corresponds to an average increase of slightly more than $7 per OBD II vehicle. Additionally, the current light-duty segment consists solely of gasoline vehicles and thus, the incremental cost of $140 per light-duty diesel is not assigned to any portion of the light-duty fleet. Manufacturers choosing to introduce light-duty diesels in lieu of gasoline vehicles in the future would be doing so by their own choice and for economic reasons specific to that manufacturer. Accordingly, the cost-effectiveness numbers calculated from the 2002 regulation update are still applicable. For reference, in 2002 staff calculated two separate cost-analyses for OBD II systems. The first covered the useful life period of the vehicle (typically the first 120,000 miles) and combined with the LEV II program, was $2.18 per pound of ROG + NOx reduced. The second analysis was for the second phase of the vehicle's life, from 120,000 to 230,000 miles, when increased reliance on OBD II is necessary to maintain low in-use vehicle emissions. That cost effectiveness was calculated to be $4.57 per pound of ROG + NOx reduced. The methodologies for both analyses were detailed in the 2002 OBD II staff report, which is incorporated by reference herein (a copy of which may be found at http://www.arb.ca.gov/regact/obd02/obd02.htm).

XII. ECONOMIC IMPACT ANALYSIS

Overall, the proposed amendments to the regulations are expected to have no noticeable impact on the profitability of automobile manufacturers. These manufacturers are large and are mostly located outside California. There is only one motor vehicle manufacturing plant located in California, the New United Motor Manufacturing, Inc. (NUMMI), which is a joint venture between Toyota Motor Corporation and General Motors Corporation. No LDDVs or MDDVs are manufactured at this facility. The proposed changes involve minimal development and verification of software above what is already incorporated into OBD II systems. Additionally, because manufacturers would be provided sufficient lead time to incorporate the minimal proposed changes, incorporation and verification of the revised OBD II software would be accomplished during the regular design process at virtually no additional cost. Any additional engineering resources needed to comply with the proposed program would be small, and when spread over several years of vehicle production, these costs would be negligible. Staff believes, therefore, that the proposed amendments would cause no noticeable adverse impact in California employment, business status, and competitiveness.

A. Legal Requirements

Section 11346.3 of the Government Code requires State agencies to assess the potential for adverse economic impacts on California business enterprises and individuals when proposing to adopt or amend any administrative regulation. Section 43101 of the Health and Safety Code similarly requires that the Board consider the impact of adopted standards on the California economy. This assessment shall include a consideration of the impact of the proposed regulation on California jobs, business expansion, elimination, or creation, and the ability of California business to compete.

B. Affected Businesses and Potential Impacts

Any business involved in manufacturing, purchasing or servicing passenger cars, light-duty trucks and medium-duty vehicles could be affected by the proposed amendments. Also affected are businesses that supply parts for these vehicles. California accounts for only a small share of total nationwide motor vehicle and parts manufacturing. There are 34 companies worldwide that manufacture California-certified light- and medium-duty vehicles and heavy-duty gasoline engines. As stated, only one motor vehicle manufacturing plant is located in California, the NUMMI facility.

C. Potential Impacts on Vehicle Operators

The proposed amendments would provide improved OBD II information and encourage manufacturers to build more durable vehicles, which should result in the need for fewer vehicle repairs and savings for consumers. Additionally, as stated above, the proposed amendments are anticipated to have a negligible impact on manufacturer costs and new vehicle prices.

D. Potential IMpacts on Business Competitiveness

The proposed amendments would have no adverse impact on the ability of California businesses to compete with businesses in other states as the proposed amendments are anticipated to have only a negligible impact on retail prices of new vehicles.

E. Potential Impacts on Employment

The proposed amendments are not expected to cause a noticeable change in California employment because California accounts for only a small share of motor vehicle and parts manufacturing employment.

F. Potential Impact on Business Creation, Elimination or Expansion

The proposed amendments are not expected to affect business creation, elimination or expansion.

XIII. PROPOSED REVISIONS TO OBD II ENFORCEMENT PROVISIONS

The staff is proposing minor changes to the OBD II-specific enforcement regulation (title 13, CCR section 1968.5) to be consistent with the amendments being proposed for the OBD II regulation, including malfunction thresholds and applicability dates. The staff is proposing more appropriate in-use thresholds (i.e., thresholds at which a vehicle would be found to have a nonconforming OBD II system and would be subject to possible enforcement action) for OBD II emission testing of diesel vehicles certified to the higher interim malfunction thresholds required for 2007 through 2012 model year vehicles. Consistent with past ARB policy for both tailpipe emission standards and OBD II emission threshold standards, these interim higher in-use standards allow manufacturers some relief in-use during initial or phase-in years of more stringent emission levels. This provides manufacturers a small amount of latitude to cover cases where the vehicle was designed and certified to the actual standard but unexpected factors caused the vehicle to slightly exceed the standards in-use. Over time, manufacturers gain experience with design changes, if any, needed to maintain the standards in-use and the interim higher in-use thresholds phase-out.

The staff is also proposing changes to criteria listed under the mandatory recall section. Specifically, the enforcement regulation currently states that vehicles fall under mandatory recall if "the motor vehicle class cannot be tested so as to obtain valid test results in accordance with the procedures of the California Inspection & Maintenance (I/M) program applicable at the time of vehicle certification." The staff is proposing to delete references to "the procedures of the California I/M program" because that document is outside of ARB's control and has not been updated to keep pace with OBD II technology nor reflect the planned inspection methods for future OBD II vehicles (and those currently being used by many other states in the nation). Instead, the proposed amendments would provide vehicle manufacturers with a single document/source of criteria that could result in non-compliance or a finding of recall related to the OBD II system. The proposed changes list every parameter that vehicles would be required to communicate properly to ensure valid testing results in the California I/M program. Specifically, staff analyzed the parameters currently being used in California, those that are recommended to be used by the U.S. EPA, those that are currently being used by other states, and those that have been included in the OBD II requirements for the primary or sole purpose of facilitating Smog Check. The criteria have been scrutinized to ensure only those that are necessary to accurately determine the pass/fail status of the vehicle or to detect a fraudulent test are included in the mandatory recall criteria. Other criteria that may be used in I/M but are not essential for pass/fail would still be considered noncompliant and appropriate enforcement action, including and up to recall, could be taken.

REFERENCES

Below is a list of documents and other information that the ARB staff relied upon in developing the Staff Report.

1) Song, Q. and Zhu, G., "Model-based Closed-loop Control of Urea SCR Exhaust Aftertreatment System for Diesel Engine," SAE Paper 2002-01-0287.

2) Kato, N., Kokune, N., Lemire, B., and Walde, T., "Long Term Stable NOx Sensor with Integrated In-Connector Control Electronics," SAE Paper 1999-01-0202.

3) Kobayashi, N., et al., "Development of Simultaneous NOx/NH3 Sensor in Exhaust Gas," Mitsubishi Heavy Industries, Ltd., Technical Review Vol.38 No.3 (Oct. 2001).

4) Schaer, C. M., Onder, C. H., Geering, H. P., and Elsener, M., "Control of a Urea SCR Catalytic Converter System for a Mobile Heavy Duty Diesel Engine," SAE Paper 2003-01-0776.

5) Walker, A. P., Chandler, G. R., Cooper, B. J., et al., "An Integrated SCR and Continuously Regenerating Trap System to Meet Future NOx and PM Legislation," SAE Paper 2000-01-0188.

6) "Van Helden, R., van Genderen, M., van Aken, M., et al., "Engine Dynamometer and Vehicle Performance of a Urea SCR-System for Heavy-Duty truck Engines," SAE Paper 2002-01-0286.

7) Tullis, S., Greeves G., 1996. "Improving NOx Versus BSFC with EUI 200 Using EGR and Pilot Injection for Heavy-Duty Diesel Engines", SAE 96084319 (www.dieselnet.com, Diesel Fuel Injection, Common-Rail Fuel Injection).

8) Greeves, G., Tullis, S., and Barker, B., 2003, "Advanced Two-Actuator EUI and Emission Reduction for Heavy-Duty Diesel Engines", SAE 2003-01-0698.

9) "Advanced Technologies: Fuel Injection and Combustion," www.dieselnet.com.

10) "Controls for Modern Diesel Engines: Model-Based Control Systems," www.dieselnet.com

---

[19] Copies of Society of Automotive Engineers (SAE) papers are available through the SAE at:
SAE Customer Service
400 Commonwealth Drive
Warrendale, PA 15096-0001, U.S.A.
Phone: 1-877-606-7323 (U.S. and Canada only)
724-776-4970 (outside U.S. and Canada)
Fax: 724-776-0790
E-mail: CustomerService@sae.org
Website: http://www.sae.org

11)"2003 MY OBD System Operation Summary for 6.0L Diesel Engine," http://www.motorcraftservice.com/vdirs/diagnostics/pdf/Dobdsm304.pdf

12)Ecopoint Inc., 2000. "Turbochargers for Diesel Engines", DieselNet Technology Guide.

13)Ecopoint Inc., 2000. "Effects of EGR on Engine and Emissions", DieselNet Technology Guide.

14)Bailey, O., H., Dou, D., and Molinier, M., "Sulfur Traps for NOx Adsorbers: Materials Development and Maintenance Strategies for Their Application," SAE Paper 2000-01-1205.

15)Ingram, G. A. and Surnilla, G., "On-Line Estimation of Sulfation Levels in a Lean NOx Trap," SAE Paper 2002-01-0731.

16)"NOx Adsorbers," www.dieselnet.com.

17)Salvat, O., Marez, P., and Belot, G., "Passenger Car Serial Application of a Particulate Filter System on a Common Rail Direct Injection Diesel Engine," SAE Paper 2000-01-0473.

18)David Kittelson, Hongbin Ma, Michael Rhodes, and Brian Krafthefer, "Particle Sensor for Diesel Combustion Monitoring," Presentation supported under DOE Cooperative Agreement DE-FC04-02AL67636, Honeywell, prime contractor, University of Minnesota, subcontractor.

19)Staff Report: Initial Statement of Reasons (ISOR): Technical Status and Revisions to Malfunction and Diagnostic System Requirements for 2004 and Subsequent Model Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles and Engines (OBD II), March 8, 2002.

20)Staff Report: Initial Statement of Reasons (ISOR): "Malfunction and Diagnostic System Requirements for 2010 and Subsequent Model Year Heavy-Duty Engines (HD OBD)," June 3, 2005.

Below is a list of documents newly incorporated by reference in the OBD II regulation.

21)SAE J1939 March 2005 -"Recommended Practice for a Serial Control and Communications Vehicle Network" and the associated subparts included in SAE HS-1939, "Truck and Bus Control and Communications Network Standards Manual", 2005 Edition.

22)SAE J1699-3 – "OBD II Compliance Test Cases", May 2006.

23)SAE J2534 – "Recommended Practice for Pass-Thru Vehicle Programming", April 2004.

24)ISO 15765-4:2005 "Road Vehicles - Diagnostics on Controller Area Network (CAN) - Part 4: Requirements for emission-related systems.

Attachment A

Title 13, California Code Regulations, Section 1968.2, Malfunction and Diagnostic System Requirements for 2004 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles and Engines (OBD II)

Table of Contents

§1968.2. Malfunction and Diagnostic System Requirements--2004 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles and Engines

(a) *PURPOSE*

The purpose of this regulation is to establish emission standards and other requirements for onboard diagnostic systems (OBD II systems) that are installed on 2004 and subsequent model-year passenger cars, light-duty trucks, and medium-duty vehicles and engines certified for sale in California. The OBD II systems, through the use of an onboard computer(s), shall monitor emission systems in-use for the actual life of the vehicle and shall be capable of detecting malfunctions of the monitored emission systems, illuminating a malfunction indicator light (MIL) to notify the vehicle operator of detected malfunctions, and storing fault codes identifying the detected malfunctions.

(b) *APPLICABILITY*

Except as specified elsewhere in this regulation (title 13, CCR section 1968.2), all 2004 and subsequent model-year vehicles, defined as passenger cars, light-duty trucks, and medium-duty vehicles, including medium-duty vehicles with engines certified on an engine dynamometer and medium-duty passenger vehicles, shall be equipped with an OBD II system and shall meet all applicable requirements of this regulation (title 13, CCR section 1968.2). Except as specified in section (d)(2.2.5), medium-duty vehicles with engines certified on an engine dynamometer may comply with these requirements on an engine model year certification basis rather than a vehicle model year basis.

(c) *DEFINITIONS*

~~(1)~~ *"Actual life"* refers to the entire period that a vehicle is operated on public roads in California up to the time a vehicle is retired from use.

"Alternate phase-in" is a phase-in schedule that achieves equivalent compliance volume by the end of the last year of a scheduled phase-in provided in this regulation. The compliance volume is the number calculated by multiplying the percent of vehicles (based on the manufacturer's projected sales volume of all vehicles) meeting the new requirements per year by the number of years implemented prior to and including the last year of the scheduled phase-in and then summing these yearly results to determine a cumulative total (e.g., a three year, 30/60/100 percent scheduled phase-in would be calculated as (30%*3 years) + (60%*2 years) + (100%*1 year) = 310). On phase-ins scheduled to begin prior to the 2004 model year, manufacturers are allowed to include vehicles introduced before the first year of the scheduled phase-in (e.g., in the previous example, 10 percent introduced one year before the scheduled phase-in begins would be calculated as (10%*4 years) and added to the cumulative total). However, on phase-ins scheduled to begin in 2004 or subsequent model years, manufacturers are only allowed to include vehicles introduced up to one model year before the first year of the scheduled phase-in. The Executive Officer shall consider acceptable any alternate phase-in which results in an equal or larger cumulative total by the end of the last year of the scheduled phase-in~~; however,~~ and results in all vehicles ~~shall~~ complying with the respective requirements subject to the phase-in within one model

year following the last year of the scheduled phase-in. The Executive Officer shall also consider acceptable any alternate phase-in which results in an equal or larger cumulative total by the end of the last year of the scheduled phase-in and results in all vehicles complying with the respective requirements subject to the phase-in within two model years following the last year of the scheduled phase-in; however, the compliance volume calculation shall include a negative calculation for vehicles not complying until one or two model years following the last year of the scheduled phase-in. The negative calculation shall be calculated by multiplying the percent of vehicles not meeting the new requirements in the final year of the phase-in by negative one and the percent of vehicles not meeting the new requirements in the one year after the final year of the phase-in by negative two (e.g., in the previous example, 10 percent not complying in the final year of the scheduled phase-in would be calculated as (10*(-1 years)) and 5 percent not complying in the one year after the final year of the phase-in would be calculated as (5*(-2 years)) and added to the cumulative total).

"*Applicable standards*" refers to the specific exhaust emission standards or family emission limits (FEL) of the Federal Test Procedure (FTP) to which the vehicle or engine is certified. For 2010 and subsequent model year diesel engines, "applicable standards" shall also refer to the specific exhaust emission standards or family emission limits (FEL) of either the FTP or the Supplemental Emission Test (SET) to which the engine is certified, as determined according to section (d)(6).

"Auxiliary Emission Control Device (AECD)" refers to any approved AECD (as defined by 40 Code of Federal Regulations (CFR) 86.082-2 and 86.094-2).

"Emission Increasing Auxiliary Emission Control Device (EI-AECD)" refers to any approved AECD that: reduces the effectiveness of the emission control system under conditions which may reasonably be expected to be encountered in normal vehicle operation and use; and the need for the AECD is justified in terms of protecting the vehicle against damage or accident. For medium-duty vehicles certified to an engine dynamometer tailpipe emission standard, an AECD that is certified as an NTE deficiency shall not be considered an EI-AECD. An AECD that does not sense, measure, or calculate any parameter or command or trigger any action, algorithm, or alternate strategy shall not be considered an EI-AECD. An AECD that is activated solely due to operation of the vehicle above 8000 feet in elevation shall not be considered an EI-AECD.

~~(3)~~ ***"Base fuel schedule"*** refers to the fuel calibration schedule programmed into the Powertrain Control Module or PROM when manufactured or when updated by some off-board source, prior to any learned on-board correction.

~~(4)~~ *"Calculated load value"* refers to an indication of the percent engine capacity that is being used and is defined in Society of Automotive Engineers (SAE) J1979 "E/E Diagnostic Test Modes – Equivalent to ISO/DIS 15031-5:April 30, 2002", April 2002 (SAE J1979), incorporated by reference (section ~~(f)~~(g)(1.~~9~~4)[1]). For diesel applications, the calculated load value is determined by the ratio of current output torque to maximum output torque at current engine speed as defined by suspect parameter number (SPN) 92 of SAE J1939 "Recommended Practice for a Serial Control and Communications Vehicle Network" (SAE J1939), incorporated by reference.

[1] Unless otherwise noted, all section references refer to section 1968.2 of title 13, CCR.

~~(5)~~*"Confirmed fault code"* is defined as the diagnostic trouble code stored when an OBD II system has confirmed that a malfunction exists (e.g., typically on the second driving cycle that the malfunction is detected) in accordance with the requirements of sections (e), (f), and ~~(f)~~(g)(4.4).

~~(6)~~*"Continuously,"* if used in the context of monitoring conditions for circuit continuity, lack of circuit continuity, circuit faults, and out-of-range values, means monitoring is always enabled and sampling of the signal used for monitoring occurs at a rate ~~no less than two samples per second. If for~~equal to the rate used for engine control purposes~~, a computer input component is sampled less frequently, the signal of the component may instead be evaluated each time sampling occurs~~.

~~(7)~~*"Deactivate"* means to turn-off, shutdown, desensitize, or otherwise make inoperable through software programming or other means during the actual life of the vehicle.

~~(8)~~*"Diagnostic or emission critical"* electronic powertrain control unit refers to the engine and transmission control unit(s). For the 2005 and subsequent model years, it also includes any other on-board electronic powertrain control unit containing software that has primary control over any of the monitors required by sections (e)(1.0) through (e)(1~~5~~4.0), ~~and~~ (e)(1~~7~~6.0), (f)(1) through (f)(14), and (f)(16) or, excluding anti-lock brake system (ABS) control units or stability/traction control units, has primary control over the diagnostics for more than two of the components required to be monitored by sections (e)(1~~6~~5.0) and (f)(15).

~~(9)~~*"Diesel engines"* refers to engines using a compression ignition thermodynamic cycle.

~~(10)~~*"Driving cycle"* consists of engine startup and engine shutoff and includes the period of engine off time up to the next engine startup. For vehicles that employ engine shutoff strategies (e.g., engine shutoff at idle), the manufacturer may request Executive Officer approval to use an alternate definition for driving cycle (e.g., key on and key off). Executive Officer approval of the alternate definition shall be based on equivalence to engine startup and engine shutoff signaling the beginning and ending of a single driving event for a conventional vehicle. For applications that are used in both medium-duty and heavy-duty classes, the manufacturer may use the driving cycle definition of title 13, CCR, section 1971.1 in lieu of this definition. Engine restarts following an engine shut-off that has been neither commanded by the vehicle operator nor by the engine control strategy but caused by an event such as an engine stall may be considered a new driving cycle or a continuation of the existing driving cycle.

~~(11)~~*"Engine misfire"* means lack of combustion in the cylinder due to absence of spark, poor fuel metering, poor compression, or any other cause. This does not include lack of combustion events in non-active cylinders due to default fuel shut-off or cylinder deactivation strategies.

~~(12)~~*"Engine start"* is defined as the point when the engine reaches a speed 150 rpm below the normal, warmed-up idle speed (as determined in the drive position for vehicles equipped with an automatic transmission). For hybrid vehicles or for engines employing alternate engine start hardware or strategies (e.g., integrated starter and generators, etc.), the manufacturer may request Executive Officer approval to use an alternate definition for engine start (e.g., ignition key "on"). Executive Officer approval of the alternate definition shall be based on equivalence to an engine start for a conventional vehicle.

"*Family Emission Limit (FEL)*" refers to the exhaust emission levels to which an engine family is certified under the averaging, banking, and trading program incorporated by reference in title 13, CCR section 1956.8.

~~(13)~~ *"Fault memory"* means information pertaining to malfunctions stored in the onboard computer, including fault codes, stored engine conditions, and MIL status.

~~(14)~~ *"Federal Test Procedure (FTP) test"* refers to an exhaust emission test conducted according to the test procedures incorporated by reference in title 13, CCR section 1961(d) that is used to determine compliance with the FTP standard to which a vehicle is certified.

~~(14.1)~~ *"FTP cycle"*. For passenger vehicles, light-duty trucks, and medium-duty vehicles certified on a chassis dynamometer, FTP cycle refers to the driving schedule in Code of Federal Regulations (CFR) 40, Appendix 1, Part 86, section (a) entitled, "EPA Urban Dynamometer Driving Schedule for Light-Duty Vehicles and Light-Duty Trucks." For medium-duty engines certified on an engine dynamometer, FTP cycle refers to the engine dynamometer schedule in CFR 40, Appendix 1, Part 86, section (f)(1), entitled, "EPA Engine Dynamometer Schedule for Heavy-Duty Otto-Cycle Engines," or section (f)(2), entitled, "EPA Engine Dynamometer Schedule for Heavy-Duty Diesel Engines."

~~(14.2)~~ *"FTP standard"* refers to the certification tailpipe exhaust emission ~~standards (both 50,000 mile and FTP~~ full useful life standards~~)~~ and test procedures applicable to the FTP cycle and to the class to which the vehicle is certified.

~~(14.3)~~ *"FTP full useful life standard"* refers to the FTP standard applicable when the vehicle reaches the end of its full useful life as defined in the certification requirements and test procedures incorporated by reference in title 13, CCR section 1961(d).

~~(15)~~ *"Fuel trim"* refers to feedback adjustments to the base fuel schedule. Short-term fuel trim refers to dynamic or instantaneous adjustments. Long-term fuel trim refers to much more gradual adjustments to the fuel calibration schedule than short-term trim adjustments.

~~(16)~~ *"Functional check"* for an output component or system means verification of proper response of the component and system to a computer command.

"*Gasoline engine*" refers to an Otto-cycle engine or an alternate-fueled engine.

"*Keep-alive memory (KAM)*," for the purposes of this regulation, is defined as a type of memory that retains its contents as long as power is provided to the on-board control unit. KAM is not erased upon shutting off the engine but may be erased if power to the on-board control unit is interrupted (e.g., vehicle battery disconnected, fuse to control unit removed). In some cases, portions of KAM may be erased with a scan tool command to reset KAM.

~~(17)~~ *"Key on, engine off position"* refers to a vehicle with the ignition key in the engine run position (not engine crank or accessory position) but with the engine not running.

~~(18)~~ *"Light-duty truck"* is defined in title 13, CCR section 1900 (b).

~~(19)~~ *"Low Emission Vehicle I application"* refers to a vehicle or engine certified in California to the exhaust emission standards defined in title 13, CCR sections 1956.8(g), 1960.1(g)(1), and 1960.1(h)(1) for any of the following vehicle emission categories: Transitional Low Emission Vehicle (TLEV), Low Emission Vehicle (LEV), Ultra Low Emission Vehicle (ULEV), or Super Ultra Low Emission Vehicle (SULEV). Additionally, vehicles certified to Federal emission standards (bins) in California but categorized in a Low Emission Vehicle I vehicle emission category for purposes of calculating NMOG fleet average in accordance with the certification requirements and test procedures incorporated by reference in title 13, CCR section 1961 (d) are subject to all monitoring requirements applicable to Low Emission Vehicle I applications but shall use the Federal tailpipe emission standard (i.e., the Federal bin) for purposes of determining the malfunction thresholds in sections (e) and (f).

~~(19.1)~~ *"MDV SULEV vehicles"* refer only to medium-duty Low Emission Vehicle I applications certified to the SULEV vehicle emission category.

~~(19.2)~~ *"TLEV vehicles"* refer only to Low Emission Vehicle I applications certified to the TLEV vehicle emission category.

~~(19.3)~~ *"LEV vehicles"* refer only to Low Emission Vehicle I applications certified to the LEV vehicle emission category.

~~(19.4)~~ *"ULEV vehicles"* refer only to Low Emission Vehicle I applications certified to the ULEV vehicle emission category.

~~(20)~~ *"Low Emission Vehicle II application"* refers to a vehicle or engine certified in California to the exhaust emission standards defined in title 13, CCR section 1961, or optionally certified to the exhaust emission standards defined in title 13, CCR section 1956.8, for any of the following ~~vehicle~~ emission categories: LEV, ULEV, or SULEV. Additionally, except as provided for in sections (e)(1~~8~~7.1.3) and (f)(17.1.2), vehicles certified to Federal emission standards (bins) in California but categorized in a Low Emission Vehicle II vehicle emission category for purposes of calculating NMOG fleet average in accordance with the certification requirements and test procedures incorporated by reference in title 13, CCR section 1961 (d) are subject to all monitoring requirements applicable to Low Emission Vehicle II applications but shall use the Federal tailpipe emission standard (i.e., the Federal bin) for purposes of determining the malfunction thresholds in sections (e) and (f).

~~(20.1)~~ *"PC/LDT SULEV II vehicles"* refer only to passenger car and light-duty truck Low Emission Vehicle II applications certified to the SULEV vehicle emission category.

~~(20.2)~~ *"MDV SULEV II vehicles"* refer only to medium-duty Low Emission Vehicle II applications certified to the SULEV vehicle emission category.

~~(20.3)~~ *"LEV II vehicles"* refer only to Low Emission Vehicle II applications certified to the LEV vehicle emission category.

~~(20.4)~~ *"ULEV II vehicles"* refer only to Low Emission Vehicle II applications certified to the ULEV vehicle emission category.

~~(21)~~ *"Malfunction"* means any deterioration or failure of a component that causes the performance to be outside of the applicable limits in sections (e) and (f).

~~(22)~~ *"Medium-duty vehicle"* is defined in title 13, CCR section 1900 (b).

~~(22.1)~~ *"Medium-duty passenger vehicle"* or *"MDPV"* is defined in Title 40, Section 86.1803-01, Code of Federal Regulations.

"Non-volatile random access memory (NVRAM)," for the purposes of this regulation, is defined as a type of memory that retains its contents even when power to the on-board control unit is interrupted (e.g., vehicle battery disconnected, fuse to control unit removed). NVRAM is typically made non-volatile either by use of a

back-up battery within the control unit or through the use of an electrically erasable and programmable read-only memory (EEPROM) chip.

"Not-To-Exceed (NTE) control area" refers to the bounded region of the engine's torque and speed map, as defined in 40 CFR 86.1370-2007, where emissions must not exceed a specific emission cap for a given pollutant under the NTE requirement.

"Manufacturer-specific NOx NTE carve-out area" refers to regions within the NTE control area for NOx where the manufacturer has limited NTE testing as allowed by 40 CFR 86.1370-2007(b)(7).

"Manufacturer-specific PM NTE carve-out area" refers to regions within the NTE control area for PM where the manufacturer has limited NTE testing as allowed by 40 CFR 86.1370-2007(b)(7).

"NTE deficiency" refers to regions or conditions within the NTE control area for NOx or PM where the manufacturer has received a deficiency as allowed by 40 CFR 86.007-11(a)(4)(iv).

(23) *"Normal production"* is the time after the start of production when the manufacturer has produced 2% two percent of the projected volume for the test group or calibration, whichever is being evaluated in accordance with section (j).

(24) *"Passenger car"* is defined in title 13, CCR section 1900 (b).

(25) *"Pending fault code"* is defined as the diagnostic trouble code stored upon the initial detection of a malfunction (e.g., typically on a single driving cycle) prior to illumination of the MIL in accordance with the requirements of sections (e), (f), and (f)(g)(4.4).

(26) "Percentage of misfire" as used in (e)(3.2) and (f)(3.2) means the percentage of misfires out of the total number of firing events for the specified interval.

"Permanent fault code" is defined as a confirmed fault code that is currently commanding the MIL on and is stored in NVRAM as specified in sections (d)(2) and (f)(g)(4.4).

(27) *"Power Take-Off -(PTO) unit"* refers to an engine driven output provision for the purposes of powering auxiliary equipment (e.g., a dump-truck bed, aerial bucket, or tow-truck winch).

(28) *"Rationality fault diagnostic"* for an input component means verification of the accuracy of the input signal while in the range of normal operation and when compared to all other available information.

(29) *"Redline engine speed"* shall be defined by the manufacturer as either the recommended maximum engine speed as normally displayed on instrument panel tachometers or the engine speed at which fuel shutoff occurs.

(30) *"Response rate"* for oxygen exhaust gas sensors refers to the delay between from when the sensor is exposed to a different make-up of exhaust gas constituents until it outputs a signal reflecting the different make-up of exhaust gas constituents. For example, for oxygen sensors, response rate is the delay from when the oxygen sensor is exposed to a change in exhaust gas from richer/leaner than stoichiometric to leaner/richer than stoichiometric to the time when the oxygen sensor indicates the lean/rich condition. Similarly, for wide-range air-fuel (A/F) sensors, response rate is the delay from when the sensor is exposed to a different A/F ratio to the time it indicates the different A/F ratio. For NOx and PM sensors, response rate is the delay from when the sensor is exposed to a different NOx or PM exhaust gas level until it indicates the different NOx or PM exhaust gas level. a switch of the sensor

from lean to rich or vice versa in response to a commanded change in air/fuel ratio. Specifically, the response rate is the delay from the time when the oxygen sensor is exposed to a change in exhaust gas from richer/leaner than stoichiometric to leaner/richer than stoichiometric to the time when the oxygen sensor indicates the lean/rich condition.

(31) *"SC03 emission standards"* refers to the certification tailpipe exhaust emission standards for the air conditioning (A/C) test of the Supplemental Federal Test Procedure Off-Cycle Emission Standards specified in title 13, CCR section 1961(a) applicable to the class to which the vehicle is certified.

(32) *"Secondary air"* refers to air introduced into the exhaust system by means of a pump or aspirator valve or other means that is intended to aid in the oxidation of HC and CO contained in the exhaust gas stream.

(33) *"Similar conditions"* as used in sections (e)(3), and (e)(6), (f)(3), and (f)(4) means engine conditions having an engine speed within 375 rpm, load conditions within 20 percent, and the same warm-up status (i.e., cold or hot) as the engine conditions stored pursuant to (e)(3.4.4), and (e)(6.4.5), (f)(3.4.2)(C), and (f)(4.4.2)(E). The Executive Officer may approve other definitions of similar conditions based on comparable timeliness and reliability in detecting similar engine operation.

(34) *"Small volume manufacturer"* is defined in title 13, CCR section 1900(b). However, for a manufacturer that transitions from a small volume manufacturer to a non-small volume manufacturer, the manufacturer is still considered a small volume manufacturer for the first three model years that it no longer meets the definition in title 13, CCR section 1900(b).

"Supplemental Emission Test (SET) cycle" refers to the driving schedule defined as the "supplemental steady state emission test" in 40 CFR 86.1360-2007.

"SET standard" refers to the certification exhaust emission standards and test procedures applicable to the SET cycle incorporated by reference in title 13, CCR sections 1956.8(b) and (d) to which the engine is certified.

(35) *"Unified cycle"* is defined in "Speed Versus Time Data for California's Unified Driving Cycle", dated December 12, 1996, incorporated by reference.

(36) *"US06 cycle"* refers to the driving schedule in CFR 40, Appendix 1, Part 86, section (g) entitled, "EPA US06 Driving Schedule for Light-Duty Vehicles and Light-Duty Trucks."

(37) *"Warm-up cycle"* means sufficient vehicle operation such that the coolant temperature has risen by at least 40 degrees Fahrenheit from engine starting and reaches a minimum temperature of at least 160 degrees Fahrenheit (140 degrees Fahrenheit for applications with diesel engines).

(d) *GENERAL REQUIREMENTS*

Section (d) sets forth the general requirements of the OBD II system. Specific performance requirements for components and systems that shall be monitored are set forth in sections (e) and (f) below.

(1) The OBD II System.

(1.1) If a malfunction is present as specified in sections (e) and (f), the OBD II system shall detect the malfunction, store a pending or confirmed fault code in the onboard computer's memory, and illuminate the MIL as required.

(1.2) The OBD II system shall be equipped with a standardized data link connector to provide access to the stored fault codes as specified in section ~~(f)~~(g).

(1.3) The OBD II system shall be designed to operate, without any required scheduled maintenance, for the actual life of the vehicle in which it is installed and may not be programmed or otherwise designed to deactivate based on age and/or mileage of the vehicle during the actual life of the vehicle. This section is not intended to alter existing law and enforcement practice regarding a manufacturer's liability for a vehicle beyond its useful life, except where a vehicle has been programmed or otherwise designed so that an OBD II system deactivates based on age and/or mileage of the vehicle.

(1.4) Computer-coded engine operating parameters may not be changeable without the use of specialized tools and procedures (e.g. soldered or potted computer components or sealed (or soldered) computer enclosures). Subject to Executive Officer approval, manufacturers may exempt from this requirement those product lines that are unlikely to require protection. Criteria to be evaluated in making an exemption include current availability of performance chips, high performance capability of the vehicle, and sales volume.

(2) MIL and Fault Code Requirements.

(2.1) MIL Specifications.

(2.1.1) The MIL shall be located on the driver's side instrument panel and be of sufficient illumination and location to be readily visible under all lighting conditions and shall be amber in color when illuminated. The MIL, when illuminated, shall display the phrase "Check Engine" or "Service Engine Soon". The word "Powertrain" may be substituted for "Engine" in the previous phrases. Alternatively, the International Standards Organization (ISO) engine symbol may be substituted for the word "Engine" or for the entire phrase.

(2.1.2) The MIL shall illuminate in the key on, engine off position before engine cranking to indicate that the MIL is functional. For all 2005 and subsequent model year vehicles, the MIL shall continuously illuminate during this functional check for a minimum of 15-20 seconds. During this functional check of the MIL, the data stream value for MIL status shall indicate commanded off (see section ~~(f)~~(g)(4.2)) unless the MIL has also been commanded on for a detected malfunction. This functional check of the MIL is not required during vehicle operation in the key on, engine off position subsequent to the initial engine cranking of each driving cycle (e.g., due to an engine stall or other non-commanded engine shutoff).

~~(2.1.3) The MIL shall also illuminate within 10 seconds to inform the vehicle operator whenever the powertrain enters a default or "limp home" mode of operation that can affect emissions or the performance of the OBD II system or in the event of a malfunction of an on-board computer(s) itself that can affect the performance of the OBD II system. If the default or "limp home" mode of operation is recoverable (i.e., operation automatically returns to normal at the beginning of the following driving cycle), the OBD II system may wait and illuminate the MIL only if the default or "limp home" mode of operation is again entered before the end of the next driving cycle in lieu of illuminating the MIL within 10 seconds~~

~~on the first driving cycle where the default or "limp home" mode of operation is entered.~~

~~(2.1.4)~~(2.1.3) At the manufacturer's option, the MIL may be used to indicate readiness status in a standardized format (see section ~~(f)~~(g)(4.1.3)) in the key on, engine off position.

~~(2.1.5)~~(2.1.4) A manufacturer may request Executive Officer approval to also use the MIL to indicate which, if any, fault codes are currently stored (e.g., to "blink" the stored codes). The Executive Officer shall approve the request upon determining that the manufacturer has demonstrated that the method used to indicate the fault codes will not be activated during a California Inspection and Maintenance test or during routine driver operation.

~~(2.1.6)~~(2.1.5) The MIL may not be used for any purpose other than specified in this regulation.

(2.2) MIL Illumination and Fault Code Storage Protocol.

(2.2.1) Upon detection of a malfunction, the OBD system shall store a pending fault code within ten seconds indicating the likely area of the malfunction.

(2.2.2) After storage of a pending fault code, if the identified malfunction is again detected before the end of the next driving cycle in which monitoring occurs, the MIL shall illuminate continuously and a confirmed fault code shall be stored within 10 seconds. If a malfunction is not detected before the end of the next driving cycle in which monitoring occurs (i.e., there is no indication of the malfunction at any time during the driving cycle), the corresponding pending fault code set according to section (d)(2.2.1) shall be erased at the end of the driving cycle.

(2.2.3) The OBD system shall illuminate the MIL and store a fault code within 10 seconds to inform the vehicle operator whenever the powertrain enters a default or "limp home" mode of operation that can affect emissions or the performance of the OBD II system or in the event of a malfunction of an on-board computer(s) itself that can affect the performance of the OBD II system.

(A) If the default or "limp home" mode of operation is recoverable (i.e., operation automatically returns to normal at the beginning of the following driving cycle), the OBD II system may wait and illuminate the MIL only if the default or "limp home" mode of operation is again entered before the end of the next driving cycle in lieu of illuminating the MIL within 10 seconds on the first driving cycle where the default or "limp home" mode of operation is entered.

(B) MIL illumination and fault code storage is not required for engine overtemperature default strategies that are only initiated after the temperature gauge indicates a temperature in the red zone, or after an overtemperature "hot" light is illuminated, or due to the verified occurrence of severe operating conditions (e.g., extended trailer towing up a grade).

(2.2.4) For all 2010 and subsequent model year vehicles, the OBD II system shall default to a MIL on state if the instrument panel receives and/or processes instructions or commands from other diagnostic or emission critical electronic powertrain control units to illuminate the MIL and a malfunction occurs (e.g., communication is lost) such that the instrument panel is no longer able to properly receive the MIL illumination requests. Storage of a fault code is not required for this malfunction.

(2.2.5) For 50 percent of all 2010, 75 percent of all 2011, and 100 percent of all 2012 and subsequent model year vehicles (including 2012 model year medium-duty vehicles with 2011 model year engines certified on an engine dynamometer), before the end of an ignition cycle, the OBD II system shall store confirmed fault codes that are currently causing the MIL to be illuminated in NVRAM as permanent fault codes (as defined in section (g)(4.4.6)).

~~(2.2.3)~~(2.2.6) A manufacturer may request Executive Officer approval to employ alternate statistical MIL illumination and fault code storage protocols to those specified in these requirements. The Executive Officer shall grant approval upon determining that the manufacturer has provided data and/or engineering evaluation that demonstrate that the alternative protocols can evaluate system performance and detect malfunctions in a manner that is equally effective and timely. Except as otherwise provided in section (e) for evaporative system malfunctions, strategies requiring on average more than six driving cycles for MIL illumination may not be accepted.

~~(2.2.4)~~(2.2.7) A manufacturer shall store and erase "freeze frame" conditions (as defined in section ~~(f)~~(g)(4.3)) present at the time a malfunction is detected. A manufacturer shall store and erase freeze frame conditions in conjunction with storage and erasure of either pending or confirmed fault codes as required elsewhere in section (d)(2.2).

(2.3) Extinguishing the MIL.
Except as otherwise provided in sections (e)(3.4.5), (e)(4.4.2), ~~and~~ (e)(6.4.6), (f)(3.4.2)(D), and (f)(4.4.2)(F) for misfire, evaporative system, and fuel system malfunctions, once the MIL has been illuminated it may be extinguished after three subsequent sequential driving cycles during which the monitoring system responsible for illuminating the MIL functions and the previously detected malfunction is no longer present provided no other malfunction has been detected that would independently illuminate the MIL according to the requirements outlined above.

(2.4) Erasing a confirmed fault code.
The OBD II system may erase a confirmed fault code if the identified malfunction has not been again detected in at least 40 engine warm-up cycles, and the MIL is presently not illuminated for that malfunction.

(2.5) Erasing a permanent fault code. The OBD II system shall erase a permanent fault code only if either of the following conditions occur:

(2.5.1) The OBD II system itself determines that the malfunction that caused the permanent fault code to be stored is no longer present and is not commanding the MIL on, concurrent with the requirements of section (d)(2.3), or

(2.5.2) Subsequent to a clearing of the fault information in the on-board computer (i.e., through the use of a scan tool or battery disconnect), the diagnostic for the malfunction that caused the permanent fault code to be stored has fully executed (i.e., has executed the minimum number of checks necessary for MIL illumination) and determined the malfunction is no longer present.

~~(2.5) Exceptions to MIL and Fault Code Requirements.~~

~~For 2004 model year vehicles only, wherever the requirements of section (d)(2) reflect a substantive change from the MIL and fault code requirements of title 13, CCR section 1968.1 for 2003 model year vehicles, the manufacturer may request Executive Officer approval to continue to use the requirements of section 1968.1 in lieu of the requirements of section (d)(2). The Executive Officer shall approve the request upon determining that the manufacturer has submitted data and/or engineering evaluation which demonstrate that software or hardware changes would be required to comply with the requirements of section (d)(2) and that the system complies with the MIL and fault code requirements of title 13, CCR section 1968.1.~~

(3) Monitoring Conditions.

Section (d)(3) sets forth the general monitoring requirements while sections (e) and (f) ~~sets~~ forth the specific monitoring requirements as well as identify~~ies~~ which of the following general monitoring requirements in section (d)(3) are applicable for each monitored component or system identified in sections (e) and (f).

(3.1) For all 2004 and subsequent model year vehicles:

(3.1.1) As specifically provided for in sections (e) and (f), manufacturers shall define monitoring conditions, subject to Executive Officer approval, for detecting malfunctions identified in sections (e) and (f). The Executive Officer shall approve manufacturer defined monitoring conditions that are determined (based on manufacturer submitted data and/or other engineering documentation) to be: technically necessary to ensure robust detection of malfunctions (e.g., avoid false passes and false indications of malfunctions), designed to ensure monitoring will occur under conditions which may reasonably be expected to be encountered in normal urban vehicle operation and use, and designed to ensure monitoring will occur during the FTP cycle or Unified cycle.

(3.1.2) Monitoring shall occur at least once per driving cycle in which the monitoring conditions are met.

(3.1.3) Manufacturers may request Executive Officer approval to define monitoring conditions that are not encountered during the FTP cycle or Unified cycle as required in section (d)(3.1.1). In evaluating the manufacturer's request, the Executive Officer shall consider the degree to which the requirement to run during the FTP or Unified cycle restricts in-use monitoring, the technical necessity for defining monitoring conditions that are not encountered during the FTP or Unified cycle, data and/or an engineering evaluation submitted by the manufacturer which demonstrate that the component/system does not normally function, or monitoring is otherwise not feasible, during the FTP or Unified cycle, and, where applicable in section (d)(3.2), the ability of the manufacturer to demonstrate the monitoring conditions will satisfy the minimum acceptable in-use monitor performance ratio requirement as defined in section (d)(3.2) (e.g., data which show in-use driving meets the minimum requirements).

(3.2) As specifically provided for in sections (e) and (f), manufacturers shall define monitoring conditions in accordance with the criteria in sections (d)(3.2.1) through (3.2.3). The requirements of section (d)(3.2) shall be phased in as follows: 30 percent of all 2005 model year vehicles, 60 percent of all 2006 model year vehicles, and 100 percent of all 2007 and subsequent model year vehicles. Manufacturers may use an alternate phase-in schedule in lieu of the required phase-in schedule if the alternate phase-in schedule provides for equivalent compliance volume as defined in section (c) with the exception that 100 percent of 2007 and subsequent model year vehicles shall comply with the requirements. Small volume manufacturers shall meet the requirements on 100 percent of 2007 and subsequent model year vehicles but shall not be required to meet the specific phase-in requirements for the 2005 and 2006 model years.

(3.2.1) Manufacturers shall define monitoring conditions that, in addition to meeting the criteria in section (d)(3.1), ensure that the monitor yields an in-use performance ratio (as defined in section (d)(4)) that meets or exceeds the minimum acceptable in-use monitor performance ratio on in-use vehicles. For purposes of this regulation, except as provided below in section (d)(3.2.1)(D), the minimum acceptable in-use monitor performance ratio is:

(A) 0.260 for secondary air system monitors and other cold start related monitors utilizing a denominator incremented in accordance with section (d)(4.3.2)(E);

(B) For evaporative system monitors:

(i) 0.260 for monitors designed to detect malfunctions identified in section (e)(4.2.2)(C) (i.e., 0.020 inch leak detection); and

(ii) 0.520 for monitors designed to detect malfunctions identified in section (e)(4.2.2)(A) and (B) (i.e., purge flow and 0.040 inch leak detection);

(C) 0.336 for catalyst, oxygen sensor, EGR, VVT system, and all other monitors specifically required in sections (e) and (f) to meet the monitoring condition requirements of section (d)(3.2); ~~and~~

(D) For introductory years:

~~(D)~~(i) through the 2007 model year, for the first ~~two~~ three years a vehicle is certified to the in-use performance ratio monitoring requirements of section (d)(3.2), 0.100 for all monitors specified in section (d)(3.2.1)(A) through (C) above. For example, the 0.100 ratio shall apply to the 2004, 2005, and 2006~~5~~ model years for vehicles first certified in the 2004 model year and to the 2007, 2008, and 2009~~8~~ model years for vehicles first certified in the 2007 model year.

(ii) through the 2014 model year, for fuel system air-fuel ratio cylinder imbalance monitors, 0.100;

(iii) through the 2012 model year, for vehicles subject to the monitoring requirements of section (f), 0.100 for all monitors specified in section (d)(3.2.1)(C) above.

(3.2.2) In addition to meeting the requirements of section (d)(3.2.1), manufacturers shall implement software algorithms in the OBD II system to individually track and report in-use performance of the following monitors in the standardized format specified in section (d)(5):

a. Catalyst (section (e)(1.3) or, where applicable, (~~e~~f)(1.3)~~5.3)~~);

b. Oxygen/exhaust gas sensor (section (e)(7.3.1)(A) or, where applicable, (f)(5.3.1)(A));
c. Evaporative system (section (e)(4.3.2));
d. EGR system (section (e)(8.3.1)) and VVT system (section (e)(13.3) or, where applicable, (f)(6.3.1)(A), (f)(6.3.2), (f)(6.3.4), and, (f)(13.3)); ~~and~~
e. Secondary air system (section (e)(5.3.2)(B));
f. PM filter (section (f)(9.3));
g. NOx adsorber (section (f)(8.3.1)) and NOx catalyst (section (f)(2.3.1));
h. Secondary oxygen sensor (section (e)(7.3.2)(A)); and
i. Boost pressure control system (sections (f)(7.3.2) and (f)(7.3.3)).

The OBD II system is not required to track and report in-use performance for monitors other than those specifically identified above.

(3.2.3) Manufacturers may not use the calculated ratio (or any element thereof) or any other indication of monitor frequency as a monitoring condition for any monitor (e.g., using a low ratio to enable more frequent monitoring through diagnostic executive priority or modification of other monitoring conditions, or using a high ratio to enable less frequent monitoring).

(4) In-Use Monitor Performance Ratio Definition.

(4.1) For monitors required to meet the minimum in-use monitor performance ratio in section (d)(3.2.1), the ratio shall be calculated in accordance with the following specifications for the numerator, denominator, and ratio.

(4.2) Numerator Specifications

(4.2.1) Definition: The numerator is defined as a measure of the number of times a vehicle has been operated such that all monitoring conditions necessary for a specific monitor to detect a malfunction have been encountered.

(4.2.2) Specifications for incrementing:

(A) Except as provided for in sections (d)(4.2.2)(E) and (F), the numerator, when incremented, shall be incremented by an integer of one. The numerator may not be incremented more than once per driving cycle.

(B) The numerator for a specific monitor shall be incremented within ten seconds if and only if the following criteria are satisfied on a single driving cycle:

(i) Every monitoring condition necessary for the monitor of the specific component to detect a malfunction and store a pending fault code has been satisfied, including enable criteria, presence or absence of related fault codes, sufficient length of monitoring time, and diagnostic executive priority assignments (e.g., diagnostic "A" must execute prior to diagnostic "B", etc.). For the purpose of incrementing the numerator, satisfying all the monitoring conditions necessary for a monitor to determine the component is passing may not, by itself, be sufficient to meet this criteria;

(ii) For monitors that require multiple stages or events in a single driving cycle to detect a malfunction, every monitoring condition necessary for all events to have completed must be satisfied;

(iii) For monitors that require intrusive operation of components to detect a malfunction, a manufacturer shall request Executive Officer approval of the strategy used to determine that, had a malfunction been present, the monitor would have detected the malfunction. Executive Officer approval of the request shall be based on the equivalence of the strategy to actual intrusive operation and the ability of the strategy to accurately determine if every monitoring condition necessary for the intrusive event to occur was satisfied.

(iv) In addition to the requirements of section (d)(4.2.2)(B)(i) through (iii) above, the secondary air system monitor numerator(s) shall be incremented if and only if the criteria in section (B) above have been satisfied during normal operation of the secondary air system for vehicles that require monitoring during normal operation (sections (e)(5.2.2) through (5.2.4)). Monitoring during intrusive operation of the secondary air system later in the same driving cycle solely for the purpose of monitoring may not, by itself, be sufficient to meet this criteria.

(C) For monitors that can generate results in a "gray zone" or "non-detection zone" (i.e., results that indicate neither a passing system nor a malfunctioning system) or in a "non-decision zone" (e.g., monitors that increment and decrement counters until a pass or fail threshold is reached), the manufacturer shall submit a plan for appropriate incrementing of the numerator to the Executive Officer for review and approval. In general, the Executive Officer shall not approve plans that allow the numerator to be incremented when the monitor indicates a result in the "non-detection zone" or prior to the monitor reaching a decision. In reviewing the plan for approval, the Executive Officer shall consider data and/or engineering evaluation submitted by the manufacturer demonstrating the expected frequency of results in the "non-detection zone" and the ability of the monitor to accurately determine if a monitor would have detected a malfunction instead of a result in the "non-detection zone" had an actual malfunction been present.

(D) For monitors that run or complete during engine off operation, the numerator shall be incremented within 10 seconds after the monitor has completed during engine off operation or during the first 10 seconds of engine start on the subsequent driving cycle.

(E) Except as specified in section (d)(4.2.2)(F) for exponentially weighted moving averages, ~~M~~manufacturers utilizing alternate statistical MIL illumination protocols as allowed in section (d)(2.2.~~3~~6) for any of the monitors requiring a numerator shall submit a plan for appropriate incrementing of the numerator to the Executive Officer for review and approval. Executive Officer approval of the plan shall be conditioned upon the manufacturer providing supporting data and/or engineering evaluation for the proposed plan, the equivalence of the incrementing in the manufacturer's plan to the incrementing specified in section (d)(4.2.2) for monitors using the standard MIL illumination protocol, and the overall equivalence of the manufacturer's plan in determining that the minimum acceptable in-use performance ratio in section (d)(3.2.1) is satisfied.

(F) Manufacturers using an exponentially weighted moving average (EWMA) as the alternate statistical MIL illumination protocol approved in accordance with section (d)(2.2.6) shall increment the numerator as follows:

(i) Following a reset or erasure of the EWMA result, the numerator may not be incremented until after the requisite number of decisions necessary for MIL illumination have been fully executed.

(ii) After the number of decisions required in section (d)(4.2.2)(F)(i) above, the numerator, when incremented, shall be incremented by an integer of one and may not be incremented more than once per driving cycle. Incrementing of the numerator shall also be in accordance with sections (d)(4.2.2)(B), (C), and (D).

(4.3) Denominator Specifications

(4.3.1) Definition: The denominator is defined as a measure of the number of times a vehicle has been operated as defined in (d)(4.3.2).

(4.3.2) Specifications for incrementing:

(A) The denominator, when incremented, shall be incremented by an integer of one. The denominator may not be incremented more than once per driving cycle.

(B) The denominator for each monitor shall be incremented within ten seconds if and only if the following criteria are satisfied on a single driving cycle:

(i) Cumulative time since engine start is greater than or equal to 600 seconds while at an elevation of less than 8,000 feet above sea level and at an ambient temperature of greater than or equal to 20 degrees Fahrenheit;

(ii) Cumulative vehicle operation at or above 25 miles per hour occurs for greater than or equal to 300 seconds while at an elevation of less than 8,000 feet above sea level and at an ambient temperature of greater than or equal to 20 degrees Fahrenheit (medium-duty vehicles with diesel engines certified on an engine dynamometer may use cumulative operation at or above 15% calculated load in lieu of at or above 25 miles per hour for purposes of this criteria);

(iii) Continuous vehicle operation at idle (i.e., accelerator pedal released by driver and vehicle speed less than or equal to one mile per hour) for greater than or equal to 30 seconds while at an elevation of less than 8,000 feet above sea level and at an ambient temperature of greater than or equal to 20 degrees Fahrenheit;

(C) In addition to the requirements of section (d)(4.3.2)(B) above, the secondary air system monitor denominator(s) shall be incremented if and only if commanded "on" operation of the secondary air system occurs for a time greater than or equal to ten seconds. For purposes of determining this commanded "on" time, the OBD II system may not include time during intrusive operation of the secondary air system solely for the purposes of monitoring;

(D) In addition to the requirements of section (d)(4.3.2)(B) above, the evaporative system monitor denominator(s) shall be incremented if and only if:

(i) Cumulative time since engine start is greater than or equal to 600 seconds while at an ambient temperature of greater than or equal to

40 degrees Fahrenheit but less than or equal to 95 degrees Fahrenheit; and

(ii) Engine cold start occurs with engine coolant temperature at engine start greater than or equal to 40 degrees Fahrenheit but less than or equal to 95 degrees Fahrenheit and less than or equal to 12 degrees Fahrenheit higher than ambient temperature at engine start.

(E) In addition to the requirements of section (d)(4.3.2)(B) above, the denominator(s) for the following monitors shall be incremented if and only if the component or strategy is commanded "on" for a time greater than or equal to ten seconds:

(i) Heated catalyst (section (e)(2))

(ii) Cold Start Emission Reduction Strategy (sections (e)(11) and (f)(12))

(iii) Components or systems that operate only at engine start-up (e.g., glow plugs, intake air heaters, etc.) and are subject to monitoring under "other emission control or source devices" (sections (e)(176) and (f)(16)) or comprehensive component output components (sections (e)(165) and (f)(15))

For purposes of determining this commanded "on" time, the OBD II system may not include time during intrusive operation of any of the components or strategies later in the same driving cycle solely for the purposes of monitoring.

(F) In addition to the requirements of section (d)(4.3.2)(B) above, the denominator(s) for the following monitors of output components (except those operated only at engine start-up and subject to the requirements of the previous section (d)(4.3.2)(E)) shall be incremented if and only if the component is commanded to function (e.g., commanded "on", "open", "closed", "locked", etc.) on two or more occasions during the driving cycle or for a time greater than or equal to ten seconds, whichever occurs first:

(i) Air conditioning system (section (e)(12))

(ii) Variable valve timing and/or control system (sections (e)(13) and (f)(13))

(iii) "Other emission control or source device" (sections (e)(176) and (f)(16))

(iv) Comprehensive component output component (sections (e)(165) and (f)(15)) (e.g., turbocharger waste-gates, variable length manifold runners, torque converter clutch lock-up solenoids, etc.)

(G) For the following monitors, the denominator(s) shall be incremented by one if and only if, in addition to meeting the requirements of section (d)(4.3.2)(B) on at least one driving cycle, at least 500 cumulative miles of vehicle operation have been experienced since the last time the denominator was incremented:

(i) Diesel NMHC converting catalyst (section (f)(1))

(ii) Diesel PM filter (section (f)(9))

~~(G)~~(H) For monitors of the following components, the manufacturer may request Executive Officer approval to use alternate or additional criteria to that set forth in section (d)(4.3.2)(B) above for incrementing the denominator. Executive Officer approval of the proposed criteria shall be based on the equivalence of the proposed criteria in measuring the frequency of monitor operation relative to the amount of vehicle operation in accordance with the criteria in section (d)(4.3.2)(B) above:

(i) Engine cooling system input components (sections (e)(10) and (f)(11))

(ii) Air conditioning system input components (section (e)(12))

(iii) Direct ozone reduction systems (section (e)(14))

~~(iv) Particulate matter trapsPM filters (section (e)(15))~~

~~(v)~~(iv) "Other emission control or source devices" (sections (e)(1~~7~~6) and (f)(16))

~~(vi)~~(v) Comprehensive component input components that require extended monitoring evaluation (sections (e)(1~~6~~5) and (f)(15)) (e.g., stuck fuel level sensor rationality)

(vi) Comprehensive component input component temperature sensor rationality monitors (sections (e)(15) and (f)(15)) (e.g, intake air temperature sensor, ambient temperature sensor, fuel temperature sensor)

~~(H)~~(I) For hybrid vehicles, vehicles that employ alternate engine start hardware or strategies (e.g., integrated starter and generators), or alternate fuel vehicles (e.g., dedicated, bi-fuel, or dual-fuel applications), the manufacturer may request Executive Officer approval to use alternate criteria to that set forth in section (d)(4.3.2)(B) above for incrementing the denominator. In general, the Executive Officer shall not approve alternate criteria for vehicles that only employ engine shut off at or near idle/vehicle stop conditions. Executive Officer approval of the alternate criteria shall be based on the equivalence of the alternate criteria to determine the amount of vehicle operation relative to the measure of conventional vehicle operation in accordance with the criteria in section (d)(4.3.2)(B) above.

(4.4) Ratio Specifications

(4.4.1) Definition: The ratio is defined as the numerator divided by the denominator.

(4.5) Disablement of Numerators and Denominators

(4.5.1) Within ten seconds of a malfunction that disables a monitor required to meet the monitoring conditions in section (d)(3.2.1) being detected (i.e., a pending or confirmed code is stored), the OBD II system shall disable further incrementing of the corresponding numerator and denominator for each monitor that is disabled. When the malfunction is no longer detected (i.e., the pending code is erased through self-clearing or through a scan tool command), incrementing of all corresponding numerators and denominators shall resume within ten seconds.

(4.5.2) Within ten seconds of the start of a PTO (see section (c)) operation that disables a monitor required to meet the monitoring conditions in section (d)(3.2.1), the OBD II system shall disable further incrementing of the corresponding numerator and denominator for each monitor that is disabled. When the PTO operation ends, incrementing of all corresponding numerators and denominators shall resume within ten seconds.

(4.5.3) The OBD II system shall disable further incrementing of all numerators and denominators within ten seconds if a malfunction of any component to indicate a malfunction before emissions exceed an emission threshold based on the applicable standard, the manufacturer shall:

(6.1.1) Use the emission test cycle and standard (i.e., FTP or SET) determined by the manufacturer, through use of data and/or engineering analysis, to be more stringent (i.e., to result in higher emissions with the same level of monitored component malfunction) as the "applicable standard".

(6.1.2) Identify in the certification documentation required under section (i) the test cycle and standard determined by the manufacturer to be more stringent for each applicable monitor.

(6.1.3) If the Executive Officer reasonably believes that a manufacturer has incorrectly determined the test cycle and standard that is more stringent, the Executive Officer shall require the manufacturer to provide emission data and/or engineering analysis showing that the other test cycle and standard are less stringent.

(6.2) For 2007 and subsequent model year light-duty and medium-duty vehicles equipped with emission controls that experience infrequent regeneration events (e.g., active PM filter regeneration, NOx adsorber desulfation), a manufacturer shall adjust the emission test results that are used to determine the malfunction criterion for monitors that are required to indicate a malfunction before emissions exceed a certain emission threshold. For each monitor on medium-duty vehicles using engines certified on an engine dynamometer, the manufacturer shall adjust the emission result using the procedure described in CFR title 40, part 86.004-28(i) with the component for which the malfunction criteria is being established deteriorated to the malfunction threshold. For light-duty and medium-duty vehicles certified on a chassis dynamometer, the manufacturer shall submit a plan for Executive Officer approval to adjust the emission results using an approach similar to the procedure described in CFR title 40, part 86.004-28(i). Executive Officer approval shall be based on the effectiveness of the proposed plan to quantify the emission impact and frequency of regeneration events. The adjusted emission value shall be used for purposes of determining whether or not the specified emission threshold is exceeded (e.g., a malfunction must be detected before the adjusted emission value exceeds 1.5 times any applicable standard).

(6.2.1) For purposes of section (d)(6.2), "regeneration" means an event during which emission levels change while the emission control performance is being restored by design.

(6.2.2) For purposes of section (d)(6.2), "infrequent" means having an expected frequency of less than once per FTP cycle.

(6.2.3) Except as specified in section (d)(6.2.4) for NMHC catalyst monitoring, for 2007 through 2009 model year vehicles, in lieu of establishing the adjustment factor for each monitor with the component for which the malfunction criteria is being established deteriorated to the malfunction threshold as required in section (d)(6.2), the manufacturer may use the adjustment factor established for certification (e.g., without components deteriorated to the malfunction threshold).

(6.2.4) For NMHC catalyst monitoring (section (f)(1)) on 2008 and subsequent model year vehicles, a manufacturer shall establish the adjustment factor for the NMHC catalyst monitor with the NMHC catalyst deteriorated to the malfunction threshold as required in section (d)(6.2).

(6.2.5) For purposes of determining the adjustment factors for each monitor, the manufacturer shall submit engineering data, analysis, and/or emission data to the Executive Officer for approval. The Executive Officer shall approve the factors upon finding the submitted information supports the adjustment factors.

(6.2.6) For purposes of enforcement testing in accordance with section (d)(7) and title 13, CCR section 1968.5, the adjustment factors established for each monitor by the manufacturer according to section (d)(6.2) shall be used when determining compliance with emission thresholds.

(6.3) For every 2007 through 2012 model year light-duty vehicle test group certified to the higher allowable emission thresholds specified in section (f) (e.g., 5.0 or 3.0 times the applicable standards for NMHC converting catalyst monitoring) for vehicles prior to the 2013 model year, the manufacturer shall conduct in-use enforcement testing for compliance with the tailpipe emission standards in accordance with title 13, CCR sections 2136 through 2140. Within six months after OBD II certification of a test group, the manufacturer shall submit a plan for conducting the testing to the Executive Officer for approval. The Executive Officer shall approve the plan upon determining that the testing will be done in accordance with the procedures used by ARB when conducting such testing, that the plan will allow for a valid sample of at least 10 vehicles in the mileage range of 30,000 to 40,000 miles for comparison to the FTP intermediate (e.g., 50,000 mile) useful life standard and at least 10 vehicles in the mileage range of 90,000 to 100,000 miles for comparison to the FTP full useful life standard, and that copies of all records and data collected during the program will be provided to ARB. The Executive Officer may use the submitted data in lieu of or in addition to data collected pursuant to title 13, CCR section 2139 for purposes of the notification and use of test results described in title 13, CCR section 2140.

(7) Enforcement Testing.

~~(6.1)~~(7.1) The procedures used to assure compliance with the requirements of title 13, CCR section 1968.2 are set forth in title 13, CCR section 1968.5.

~~(6.2)~~(7.2) Consistent with the requirements of title 13, CCR section 1968.5(b)(4)(A) for enforcement OBD II emission testing, the manufacturer shall make available upon request by the Executive Officer all test equipment (e.g., malfunction simulators, deteriorated "threshold" components, etc.) necessary to determine the malfunction criteria in sections (e) and (f) for major monitors subject to OBD II emission testing as defined in title 13, CCR section 1968.5. To meet the requirements of this section, the manufacturers shall only be required to make available test equipment necessary to duplicate "threshold" testing performed by the manufacturer. This test equipment shall include, but is not limited to, aged "threshold" catalyst systems and computer equipment used to simulate misfire, oxygen sensor, fuel system, VVT system, and cold start reduction strategy system faults. The manufacturer is not required to make available test equipment for vehicles that exceed the applicable full useful life age (e.g., 10 years for vehicles certified to a full useful life of 10 years and 100,000 miles).

(e) *MONITORING REQUIREMENTS FOR GASOLINE/SPARK-IGNITED ENGINES*

(1) CATALYST MONITORING

(1.1) Requirement: The OBD II system shall monitor the catalyst system for proper conversion capability.

(1.2) Malfunction Criteria:

(1.2.1) Low Emission Vehicle I applications: The OBD II system shall detect a catalyst system malfunction when the catalyst system's conversion capability decreases to the point that either of the following occurs:

(A) Non-Methane Organic Gas (NMOG) emissions exceed 1.75 times the FTP full useful life standards to which the vehicle has been certified with NMOG emissions multiplied by the certification reactivity adjustment factor for the vehicle;

(B) The average FTP test Non-Methane Hydrocarbon (NMHC) conversion efficiency of the monitored portion of the catalyst system falls below 50 percent (i.e., the cumulative NMHC emissions measured at the outlet of the monitored catalyst(s) are more than 50 percent of the cumulative engine-out emissions measured at the inlet of the catalyst(s)). With Executive Officer approval, manufacturers may use a conversion efficiency malfunction criteria of less than 50 percent if the catalyst system is designed such that the monitored portion of the catalyst system must be replaced along with an adjacent portion of the catalyst system sufficient to ensure that the total portion replaced will meet the 50 percent conversion efficiency criteria. Executive Officer approval shall be based on data and/or engineering evaluation demonstrating the conversion efficiency of the monitored portion and the total portion designed to be replaced, and the likelihood of the catalyst system design to ensure replacement of the monitored and adjacent portions of the catalyst system.

(1.2.2) Low Emission Vehicle II applications and all 2009 and subsequent model year vehicles:

(A) 2004 model year vehicles.

(i) All LEV II, ULEV II, and MDV SULEV II vehicles shall use the malfunction criteria specified for Low Emission Vehicle I applications in section (e)(1.2.1).

(ii) All PC/LDT SULEV II vehicles shall use the malfunction criteria specified for Low Emission Vehicle I applications in section (e)(1.2.1) except the malfunction criterion in paragraph (e)(1.2.1)(A) shall be 2.5 times the applicable FTP full useful life NMOG standard.

(B) Except as provided below in section (e)(1.2.4), for 2005 ~~and~~ through 2008 ~~2006~~ model years, the OBD II system shall detect a catalyst system malfunction when the catalyst system's conversion capability decreases to the point that any of the following occurs:

(i) For ~~LEV II, ULEV II, and MDV SULEV II~~ all vehicles other than PC/LDT SULEV II vehicles.
   a. NMOG emissions exceed the criteria specified for Low Emission Vehicle I applications in section (e)(1.2.1)(A).
   b. The average FTP test NMHC conversion efficiency is below the criteria specified for Low Emission Vehicle I applications in section (e)(1.2.1)(B).
   c. Oxides of nitrogen (NOx) emissions exceed 3.5 times the FTP full useful life NOx standard to which the vehicle has been certified.

(ii) PC/LDT SULEV II vehicles shall use the same malfunction criteria as 2005 ~~and 2006~~through 2008 model year LEV II, ULEV II, and MDV SULEV II vehicles (section (e)(1.2.2)(B)(i)) except the malfunction criteria in paragraph a. shall be 2.5 times the applicable FTP full useful life NMOG standard.

(C) Except as provided below in section (e)(1.2.5), for ~~2007~~ 2009 and subsequent model years, the OBD II system shall detect a catalyst system malfunction when the catalyst system's conversion capability decreases to the point that any of the following occurs.

(i) For ~~LEV II, ULEV II, and MDV SULEV II~~ all vehicles other than PC/LDT SULEV II vehicles.
   a. NMOG emissions exceed the criteria specified for Low Emission Vehicle I applications in section (e)(1.2.1)(A).
   b. The average FTP test NMHC conversion efficiency is below the criteria specified for Low Emission Vehicle I applications in section (e)(1.2.1)(B).
   c. NOx emissions exceed 1.75 times the FTP full useful life NOx standard to which the vehicle has been certified.

(ii) For PC/LDT SULEV II vehicles.
   a. NMOG emissions exceed 2.5 times the applicable FTP full useful life NMOG standard to which the vehicle has been certified.
   b. The average FTP test NMHC conversion efficiency is below the criteria specified for Low Emission Vehicle I applications in section (e)(1.2.1)(B).
   c. NOx emissions exceed 2.5 times the applicable FTP full useful life NOx standard to which the vehicle has been certified.

(1.2.3) 2004 through 2008 model year ~~N~~non-Low Emission Vehicle I or II applications: The OBD II system shall detect a catalyst system malfunction when the catalyst system's conversion capability decreases to the point that NMHC emissions increase by more than 1.5 times the applicable FTP full useful life standards over an FTP test performed with a representative 4000 mile catalyst system.

(1.2.4) In lieu of using the malfunction criteria in section (e)(1.2.2)(B) for all 2005 and 2006 model year Low Emission Vehicle II applications, a manufacturer may phase-in the malfunction criteria on a portion of its Low Emission Vehicle II applications as long as that portion of Low Emission Vehicle II applications comprises at least 30~~%~~ percent of all 2005 model year vehicles and 60~~%~~ percent of all 2006 model year vehicles. For 2005 and 2006 model year Low Emission Vehicle II applications not included in the phase-in, the malfunction criteria in section (e)(1.2.2)(A) shall be used.

(1.2.5) In lieu of using the malfunction criteria in section (e)(1.2.2)(C) for all ~~2007~~ 2009 model year ~~Low Emission Vehicle II applications~~vehicles, for the ~~2007~~ 2009 model year only, a manufacturer may continue to use the malfunction criteria in section (e)(1.2.2)(B) for any ~~Low Emission Vehicle II applications~~ vehicles previously certified in the 2005, 2006, 2007, or ~~2006~~ 2008 model year to the malfunction criteria in section (e)(1.2.2.)(B) and carried over to the ~~2007~~ 2009 model year.

(1.2.6) For purposes of determining the catalyst system malfunction criteria in sections (e)(1.2.1), (1.2.2)(A), and (1.2.3), the malfunction criteria shall be established by using a catalyst system with all monitored catalysts simultaneously deteriorated to the malfunction criteria while unmonitored catalysts shall be deteriorated to the end of the vehicle's full useful life.

(1.2.7) For purposes of determining the catalyst system malfunction criteria in sections (e)(1.2.2)(B) and (C):

(A) The manufacturer shall use a catalyst system deteriorated to the malfunction criteria using methods established by the manufacturer to represent real world catalyst deterioration under normal and malfunctioning operating conditions.

(B) Except as provided below in section (e)(1.2.7)(C), the malfunction criteria shall be established by using a catalyst system with all monitored and unmonitored (downstream of the sensor utilized for catalyst monitoring) catalysts simultaneously deteriorated to the malfunction criteria.

(C) For vehicles using fuel shutoff to prevent over-fueling during misfire conditions (see section (e)(3.4.1)(D)), the malfunction criteria shall be established by using a catalyst system with all monitored catalysts simultaneously deteriorated to the malfunction criteria while unmonitored catalysts shall be deteriorated to the end of the vehicle's full useful life.

(1.3) Monitoring Conditions: Manufacturers shall define the monitoring conditions for malfunctions identified in section (e)(1.2) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). For purposes of tracking and reporting as required in section (d)(3.2.2), all monitors used to detect malfunctions identified in section (e)(1.2) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).

(1.4) MIL Illumination and Fault Code Storage:

(1.4.1) General requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(1.4.2) The monitoring method for the catalyst(s) shall be capable of detecting when a catalyst fault code has been cleared (except OBD II system self-clearing), but the catalyst has not been replaced (e.g., catalyst overtemperature approaches may not be acceptable).

~~(1.5)CATALYST MONITORING FOR DIESELS~~

~~(1.5.1)Requirement: On all 2004 and subsequent model year diesel passenger cars, light-duty trucks, and medium-duty passenger vehicles (see section (c)) and all 2005 and subsequent model year diesel medium-duty~~

~~vehicles, the OBD II system shall monitor the catalyst system for proper conversion capability.~~

~~(1.5.2)Malfunction Criteria:~~

~~(A)For 2004 and subsequent model year diesel passenger cars, light-duty trucks, and medium-duty passenger vehicles certified to a chassis dynamometer tailpipe emission standard:~~

~~(i)The OBD II system shall detect a catalyst system malfunction when the catalyst system's conversion capability decreases to the point that emissions exceed 1.75 times the applicable FTP full useful life NMHC, NOx, or PM standard (or, if applicable, NMHC+NOx standard).~~

~~(ii)Except as provided below in section (e)(1.5.2)(A)(iv), if no failure or deterioration of the catalyst system NMHC conversion capability could result in a vehicle's emissions exceeding 1.75 times any of the applicable standards, the OBD II system shall detect a malfunction when the system has no detectable amount of NMHC conversion capability.~~

~~(iii)Except as provided below in section (e)(1.5.2)(A)(v), if no failure or deterioration of the catalyst system NOx conversion capability could result in a vehicle's emissions exceeding 1.75 times any of the applicable standards, the OBD II system shall detect a malfunction when the system has no detectable amount of NOx conversion capability.~~

~~(iv)For the 2004 through 2009 model year, a manufacturer may request to be exempted from the requirements for NMHC conversion catalyst system monitoring. The Executive Officer shall approve the request upon determining that the manufacturer has demonstrated, through data and/or engineering evaluation, that the average FTP test NMHC conversion efficiency of the system is less than 30 percent (i.e., the cumulative NMHC emissions measured at the outlet of the catalyst are more than 70 percent of the cumulative engine-out NMHC emissions measured at the inlet of the catalyst(s)).~~

~~(v)For the 2004 through 2009 model year, a manufacturer may request to be exempted from the requirements for NOx conversion catalyst system monitoring. The Executive Officer shall approve the request upon determining that the manufacturer has demonstrated, through data and/or engineering evaluation, that the average FTP test NOx conversion efficiency of the system is less than 30 percent (i.e., the cumulative NOx emissions measured at the outlet of the catalyst are more than 70 percent of the cumulative engine-out NOx emissions measured at the inlet of the catalyst(s)).~~

~~(B)For 2005 and 2006 model year diesel medium-duty vehicles (including medium-duty passenger vehicles certified to an engine dynamometer tailpipe standard):~~

~~(i)Except as provided below, the OBD II system shall detect a NOx conversion catalyst system malfunction when the catalyst system's conversion capability decreases to the point that emissions exceed 1.75 times the applicable FTP full useful life NOx or PM standard (or, if applicable, NMHC+NOx standard).~~

(ii)A manufacturer may request to be exempted from the requirements for NOx conversion catalyst system monitoring. The Executive Officer shall approve the request upon determining that the manufacturer has demonstrated, through data and/or engineering evaluation, that no failure or deterioration of the system will cause emissions to exceed the emission threshold specified in section (e)(1.5.2)(B)(i).

(iii)Monitoring of the NMHC conversion catalyst system for NMHC conversion performance is not required.

(C)For 2007 and subsequent model year diesel medium-duty vehicles (including medium-duty passenger vehicles certified to an engine dynamometer tailpipe standard):

(i)The OBD II system shall detect a catalyst system malfunction when the catalyst system's conversion capability decreases to the point that emissions exceed 1.75 times the applicable FTP full useful life NMHC, NOx, or PM standard (or, if applicable, NMHC+NOx standard).

(ii)Except as provided below in section (e)(1.5.2)(C)(iv), if no failure or deterioration of the catalyst system NMHC conversion capability could result in a vehicle's emissions exceeding 1.75 times any of the applicable standards, the OBD II system shall detect a malfunction when the system has no detectable amount of NMHC conversion capability.

(iii)Except as provided below in section (e)(1.5.2)(C)(v), if no failure or deterioration of the catalyst system NOx conversion capability could result in a vehicle's emissions exceeding 1.75 times any of the applicable standards, the OBD II system shall detect a malfunction when the system has no detectable amount of NOx conversion capability.

(iv)For the 2007 through 2009 model year, a manufacturer may request to be exempted from the requirements for NMHC conversion catalyst system monitoring. The Executive Officer shall approve the request upon determining that the manufacturer has demonstrated, through data and/or engineering evaluation, that the average FTP test NMHC conversion efficiency of the system is less than 30 percent (i.e., the cumulative NMHC emissions measured at the outlet of the catalyst are more than 70 percent of the cumulative engine-out NMHC emissions measured at the inlet of the catalyst(s)).

(v)For the 2007 through 2009 model year, a manufacturer may request to be exempted from the requirements for NOx conversion catalyst system monitoring. The Executive Officer shall approve the request upon determining that the manufacturer has demonstrated, through data and/or engineering evaluation, that the average FTP test NOx conversion efficiency of the system is less than 30 percent (i.e., the cumulative NOx emissions measured at the outlet of the catalyst are more than 70 percent of the cumulative engine-out NOx emissions measured at the inlet of the catalyst(s)).

(1.5.3)Monitoring Conditions: Manufacturers shall define the monitoring conditions for malfunctions identified in section (e)(1.5.2) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). For

~~purposes of tracking and reporting as required in section (d)(3.2.2), all monitors used to detect malfunctions identified in section (e)(1.5.2) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).~~

~~(1.5.4)MIL Illumination and Fault Code Storage:~~

~~(A)General requirements for MIL illumination and fault code storage are set forth in section (d)(2).~~

~~(B)The monitoring method for the catalyst(s) shall be capable of detecting all instances, except diagnostic self-clearing, when a catalyst fault code has been cleared but the catalyst has not been replaced (e.g., catalyst overtemperature approaches may not be acceptable).~~

(2) HEATED CATALYST MONITORING

(2.1) Requirement:

(2.1.1) The OBD II system shall monitor all heated catalyst systems for proper heating.

(2.1.2) The efficiency of heated catalysts shall be monitored in conjunction with the requirements of section (e)(1).

(2.2) Malfunction Criteria:

(2.2.1) The OBD II system shall detect a catalyst heating system malfunction when the catalyst does not reach its designated heating temperature within a requisite time period after engine starting. The manufacturer shall determine the requisite time period, but the time period may not exceed the time that would cause emissions from a vehicle equipped with the heated catalyst system to exceed 1.75 times any of the applicable FTP full useful life standards.

(2.2.2) Manufacturers may use other monitoring strategies for the heated catalyst but must submit the alternate plan to the Executive Officer for approval. The Executive Officer shall approve alternate strategies for monitoring heated catalyst systems based on comparable reliability and timeliness to these requirements in detecting a catalyst heating malfunction.

(2.3) Monitoring Conditions: Manufacturers shall define the monitoring conditions for malfunctions identified in section (e)(2.2) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements).

(2.4) MIL Illumination and Fault Code Storage: General requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(3) MISFIRE MONITORING

(3.1) Requirement:

(3.1.1) The OBD II system shall monitor the engine for misfire causing catalyst damage and misfire causing excess emissions.

(3.1.2) The OBD II system shall identify the specific cylinder that is experiencing misfire. Manufacturers may request Executive Officer approval to store a general misfire fault code instead of a cylinder specific fault code under certain operating conditions. The Executive Officer shall approve the request upon determining that the manufacturer has submitted data and/or an engineering evaluation that demonstrate that the misfiring cylinder cannot be reliably identified when the conditions occur.

(3.1.3) If more than one cylinder is misfiring, a separate fault code shall be stored indicating that multiple cylinders are misfiring except as allowed below. When identifying multiple cylinder misfire, the manufacturer is not required to also identify each of the misfiring cylinders individually through separate fault codes. For 2005 and subsequent model year vehicles, if more than 90 percent of the detected misfires occur in a single cylinder, the manufacturer may elect to store the appropriate fault code indicating the specific misfiring cylinder in lieu of the multiple cylinder misfire fault code. If, however, two or more cylinders individually have more than 10 percent of the total number of detected misfires, a multiple cylinder fault code must be stored.

(3.2) Malfunction Criteria: The OBD II system shall detect a misfire malfunction pursuant to the following:

(3.2.1) Misfire causing catalyst damage:

(A) Manufacturers shall determine the percentage of misfire evaluated in 200 revolution increments for each engine speed and load condition that would result in a temperature that causes catalyst damage. The manufacturer shall submit documentation to support this percentage of misfire as required in section ~~(h)~~(i)(2.5). For every engine speed and load condition that this percentage of misfire is determined to be lower than five percent, the manufacturer may set the malfunction criteria at five percent.

(B) Subject to Executive Officer approval, a manufacturer may employ a longer interval than 200 revolutions but only for determining, on a given driving cycle, the first misfire exceedance as provided in section (e)(3.4.1)(A) below. Executive Officer approval shall be granted upon determining that the manufacturer has submitted data and/or an engineering evaluation that demonstrate that catalyst damage would not occur due to unacceptably high catalyst temperatures before the interval has elapsed.

(C) A misfire malfunction shall be detected if the percentage of misfire established in section (e)(3.2.1)(A) is exceeded.

(D) For purposes of establishing the temperature at which catalyst damage occurs as required in section (e)(3.2.1)(A), on 2005 and subsequent model year vehicles, manufacturers may not define catalyst damage at a temperature more severe than what the catalyst system could be operated at for ten consecutive hours and still meet the applicable FTP full useful life standards.

(3.2.2) Misfire causing emissions to exceed 1.5 times the FTP standards:

(A) Manufacturers shall determine the percentage of misfire evaluated in 1000 revolution increments that would cause emissions from an emission durability demonstration vehicle to exceed 1.5 times any of the applicable FTP standards if the percentage of misfire were present from the beginning of the test. To establish this percentage of misfire, the manufacturer shall utilize misfire events occurring at equally spaced, complete engine cycle intervals, across randomly selected cylinders throughout each 1000-revolution increment. If this percentage of misfire is determined to be lower than one percent, the manufacturer may set the malfunction criteria at one percent.

(B) Subject to Executive Officer approval, a manufacturer may employ other revolution increments. The Executive Officer shall grant approval upon determining that the manufacturer has demonstrated that the strategy would be equally effective and timely in detecting misfire.

(C) A malfunction shall be detected if the percentage of misfire established in section (3.2.2)(A) is exceeded regardless of the pattern of misfire events (e.g., random, equally spaced, continuous, etc.).

(3.3) Monitoring Conditions:

(3.3.1) Manufacturers shall continuously monitor for misfire under the following conditions:

(A) From no later than the end of the second crankshaft revolution after engine start,

(B) During the rise time and settling time for engine speed to reach the desired idle engine speed at engine start-up (i.e., "flare-up" and "flare-down"), and

(C) Under all positive torque engine speeds and load conditions except within the following range: the engine operating region bound by the positive torque line (i.e., engine load with the transmission in neutral), and the two following engine operating points: an engine speed of 3000 rpm with the engine load at the positive torque line, and the redline engine speed (defined in section (c)) with the engine's manifold vacuum at four inches of mercury lower than that at the positive torque line.

(3.3.2) If a monitoring system cannot detect all misfire patterns under all required engine speed and load conditions as required in section (e)(3.3.1) above, the manufacturer may request Executive Officer approval to accept the monitoring system. In evaluating the manufacturer's request, the Executive Officer shall consider the following factors: the magnitude of the region(s) in which misfire detection is limited, the degree to which misfire detection is limited in the region(s) (i.e., the probability of detection of misfire events), the frequency with which said region(s) are expected to be encountered in-use, the type of misfire patterns for which misfire detection is troublesome, and demonstration that the monitoring technology employed is not inherently incapable of detecting misfire under required conditions (i.e., compliance can be achieved on other engines). The evaluation shall be based on the following misfire patterns: equally spaced misfire occurring on randomly selected cylinders, single cylinder continuous misfire, and paired cylinder (cylinders firing at the same crank angle) continuous misfire.

(3.3.3) A manufacturer may request Executive Officer approval of a monitoring system that has reduced misfire detection capability during the portion of the first 1000 revolutions after engine start that a cold start emission reduction strategy that reduces engine torque (e.g., spark retard strategies) is active. The Executive Officer shall approve the request upon determining that the manufacturer has demonstrated that the probability of detection is greater than or equal to 75 percent during the worst case condition (i.e., lowest generated torque) for a vehicle operated continuously at idle (park/neutral idle) on a cold start between 50-86 degrees Fahrenheit and that the technology cannot reliably detect a higher percentage of the misfire events during the conditions.

(3.3.4) A manufacturer may request Executive Officer approval to disable misfire monitoring or employ an alternate malfunction criterion when misfire cannot be distinguished from other effects.

(A) Upon determining that the manufacturer has presented documentation that demonstrates the disablement interval or period of use of an alternate malfunction criterion is limited only to that necessary for avoiding false detection, the Executive Officer shall approve the disablement or use of the alternate malfunction criterion for conditions involving:

(i) rough road,

(ii) fuel cut,

(iii) gear changes for manual transmission vehicles,

(iv) traction control or other vehicle stability control activation such as anti-lock braking or other engine torque modifications to enhance vehicle stability,

(v) off-board control or intrusive activation of vehicle components or diagnostics during service or assembly plant testing,

(vi) portions of intrusive evaporative system or EGR diagnostics that can significantly affect engine stability (i.e., while the purge valve is open during the vacuum pull-down of a evaporative system leak check but not while the purge valve is closed and the evaporative system is sealed or while an EGR diagnostic causes the EGR valve to be intrusively cycled on and off during positive torque conditions), or

(vii) engine speed, load, or torque transients due to throttle movements more rapid than occurs over the US06 cycle for the worst case vehicle within each test group.

(B) Additionally, the Executive Officer will approve a manufacturer's request in accordance with sections (e)(1~~8~~7.3), (17.4), and ~~through~~ (1~~8~~7.~~5~~6) to disable misfire monitoring when fuel level is 15 percent or less of the nominal capacity of the fuel tank, when PTO units are active, or while engine coolant temperature is below 20 degrees Fahrenheit. The Executive Officer will approve a request to continue disablement on engine starts when engine coolant temperature is below 20 degrees Fahrenheit at engine start until engine coolant temperature exceeds 70 degrees Fahrenheit.

(C) In general, for 2005 and subsequent model year vehicles, the Executive Officer shall not approve disablement for conditions involving normal air conditioning compressor cycling from on-to-off or off-to-on, automatic transmission gear shifts (except for shifts occurring during wide open throttle operation), transitions from idle to off-idle, normal engine speed or load changes that occur during the engine speed rise time and settling time (i.e., "flare-up" and "flare-down") immediately after engine starting without any vehicle operator-induced actions (e.g., throttle stabs), or excess acceleration (except for acceleration rates that exceed the maximum acceleration rate obtainable at wide open throttle while the vehicle is in gear due to abnormal conditions such as slipping of a clutch).

(D) The Executive Officer may approve misfire monitoring disablement or use of an alternate malfunction criterion for any other condition on a case by case basis upon determining that the manufacturer has demonstrated that the request is based on an unusual or unforeseen circumstance and that it is applying the best available computer and monitoring technology.

(3.3.5) For engines with more than eight cylinders that cannot meet the requirements of section (e)(3.3.1), a manufacturer may request Executive Officer approval to use alternative misfire monitoring conditions. The Executive Officer shall approve the request upon determining that the manufacturer has submitted data and/or an engineering evaluation which demonstrate that misfire detection throughout the required operating region cannot be achieved when employing proven monitoring technology (i.e., a technology that provides for compliance with these requirements on other engines) and provided misfire is detected to the fullest extent permitted by the technology. However, the Executive Officer may not grant the request if the misfire detection system is unable to monitor during all positive torque operating conditions encountered during an FTP cycle.

(3.4) MIL Illumination and Fault Code Storage:

(3.4.1) Misfire causing catalyst damage. Upon detection of the ~~level~~ percentage of misfire specified in section (e)(3.2.1) above, the following criteria shall apply for MIL illumination and fault code storage:

(A) Pending fault codes

(i) A pending fault code shall be stored immediately if, during a single driving cycle, the specified percentage of misfire ~~level~~ is exceeded three times when operating in the positive torque region encountered during an FTP cycle or is exceeded on a single occasion when operating at any other engine speed and load condition in the positive torque region defined in section (e)(3.3.1).

(ii) Immediately after a pending fault code is stored as specified in section (e)(3.4.1)(A)(i) above, the MIL shall blink once per second at all times while misfire is occurring during the driving cycle.

a. The MIL may be extinguished during those times when misfire is not occurring during the driving cycle.

b. If, at the time a misfire malfunction occurs, the MIL is already illuminated for a malfunction other than misfire, the MIL shall blink as previously specified in section (e)(3.4.1)(A)(ii) while misfire is occurring. If misfiring ceases, the MIL shall stop blinking but remain illuminated as required by the other malfunction.

(B) Confirmed fault codes

(i) If a pending fault code for exceeding the percentage of misfire ~~level~~ set forth in section (e)(3.2.1) is stored, the OBD II system shall immediately store a confirmed fault code if the percentage of misfire specified in section (e)(3.2.1) is again exceeded one or more times during either: (a) the driving cycle immediately following the storage of the pending fault code, regardless of the conditions encountered during the driving cycle; or (b) on the next driving cycle in which similar conditions (see section (c)) to the engine conditions that occurred when the pending fault code was stored are encountered.

(ii) If a pending fault code for exceeding the percentage of misfire ~~level~~ set forth in section (e)(3.2.2) is stored from a previous drive cycle, the OBD II system shall immediately store a confirmed fault code if the percentage of misfire specified in section (e)(3.2.1) is exceeded one or more times regardless of the conditions encountered.

(iii) Upon storage of a confirmed fault code, the MIL shall blink as specified in subparagraph (e)(3.4.1)(A)(ii) above as long as misfire is occurring and the MIL shall remain continuously illuminated if the misfiring ceases.

(C) Erasure of pending fault codes

Pending fault codes shall be erased at the end of the next driving cycle in which similar conditions to the engine conditions that occurred when the pending fault code was stored have been encountered without any exceedance of the specified percentage of misfire ~~levels~~. The pending code may also be erased if similar driving conditions are not encountered during the next 80 driving cycles subsequent to the initial detection of a malfunction.

(D) Exemptions for vehicles with fuel shutoff and default fuel control. Notwithstanding sections (e)(3.4.1)(A) and (B) above, in vehicles that provide for fuel shutoff and default fuel control to prevent over fueling during catalyst damage misfire conditions, the MIL need not blink. Instead, the MIL may illuminate continuously in accordance with the requirements for continuous MIL illumination in sections (e)(3.4.1)(B)(iii) above upon detection of misfire, provided that the fuel shutoff and default control are activated as soon as misfire is detected. Fuel shutoff and default fuel control may be deactivated only to permit fueling outside of the misfire range. Manufacturers may also periodically, but not more than once every 30 seconds, deactivate fuel shutoff and default fuel control to determine if the specified percentage of misfire for catalyst damage ~~misfire level~~ is still being exceeded. Normal fueling and fuel control may be resumed if the specified percentage of misfire for catalyst damage ~~misfire level~~ is no longer being exceeded.

(E) Manufacturers may request Executive Officer approval of strategies that continuously illuminate the MIL in lieu of blinking the MIL during extreme catalyst damage misfire conditions (i.e., catalyst damage misfire occurring at all engine speeds and loads). Executive Officer approval shall be granted upon determining that the manufacturer employs the strategy only when catalyst damage misfire levels cannot be avoided during reasonable driving conditions and the manufacturer has demonstrated that the strategy will encourage operation of the vehicle in conditions that will minimize catalyst damage (e.g., at low engine speeds and loads).

(3.4.2) Misfire causing emissions to exceed 1.5 times the FTP standards. Upon detection of the percentage of misfire ~~level~~ specified in section (e)(3.2.2), the following criteria shall apply for MIL illumination and fault code storage:

(A) Misfire within the first 1000 revolutions after engine start.

(i) A pending fault code shall be stored no later than after the first exceedance of the specified percentage of misfire ~~level~~ during a single driving cycle if the exceedance occurs within the first 1000 revolutions after engine start (defined in section (c)) during which misfire detection is active.

(ii) If a pending fault code is stored, the OBD II system shall illuminate the MIL and store a confirmed fault code within ten seconds if an exceedance of the specified percentage of misfire ~~level~~ is again detected in the first 1000 revolutions during any subsequent driving cycle, regardless of the conditions encountered during the driving cycle.

(iii) The pending fault code shall be erased at the end of the next driving cycle in which similar conditions to the engine conditions that occurred when the pending fault code was stored have been encountered without an exceedance of the specified percentage of misfire. The pending code may also be erased if similar conditions are not encountered during the next 80 driving cycles immediately following the initial detection of the malfunction.

(B) Exceedances after the first 1000 revolutions after engine start.

(i) A pending fault code shall be stored no later than after the fourth exceedance of the percentage of misfire specified in section (e)(3.2.2) during a single driving cycle.

(ii) If a pending fault code is stored, the OBD II system shall illuminate the MIL and store a confirmed fault code within ten seconds if the percentage of misfire specified in section (e)(3.2.2) is again exceeded four times during: (a) the driving cycle immediately following the storage of the pending fault code, regardless of the conditions encountered during the driving cycle; or (b) on the next driving cycle in which similar conditions (see section (c)) to the engine conditions that occurred when the pending fault code was stored are encountered.

(iii) The pending fault code may be erased at the end of the next driving cycle in which similar conditions to the engine conditions that occurred when the pending fault code was stored have been encountered without an exceedance of the specified percentage of misfire. The pending code may also be erased if similar conditions are not encountered during the next 80 driving cycles immediately following initial detection of the malfunction.

(3.4.3) Storage of freeze frame conditions.

(A) A manufacturer shall store and erase freeze frame conditions either in conjunction with storing and erasing a pending fault code or in conjunction with storing and erasing a confirmed fault code.

(B) If freeze frame conditions are stored for a malfunction other than misfire or fuel system malfunction (see section (e)(6)) when a fault code is stored as specified in section (e)(3.4) above, the stored freeze frame information shall be replaced with freeze frame information regarding the misfire malfunction.

(3.4.4) Storage of misfire conditions for similar conditions determination. Upon detection of misfire under sections (e)(3.4.1) or (3.4.2), manufacturers shall store the following engine conditions: engine speed, load, and warm-up status of the first misfire event that resulted in the storage of the pending fault code.

(3.4.5) Extinguishing the MIL. The MIL may be extinguished after three sequential driving cycles in which similar conditions have been encountered without an exceedance of the specified percentage of misfire.

~~(3.5) MISFIRE MONITORING FOR DIESELS~~

~~(3.5.1) Requirement:~~

~~(A) The OBD II system on a diesel engine shall be capable of detecting misfire occurring continuously in one or more cylinders. To the extent possible without adding hardware for this specific purpose, the OBD II system shall also identify the specific continuously misfiring cylinder.~~

~~(B) If more than one cylinder is continuously misfiring, a separate fault code shall be stored indicating that multiple cylinders are misfiring. When identifying multiple cylinder misfire, the manufacturer is not required to also identify each of the continuously misfiring cylinders individually through separate fault codes.~~

~~(3.5.2) Malfunction Criteria: The OBD II system shall detect a misfire malfunction when one or more cylinders are continuously misfiring.~~

~~(3.5.3) Monitoring Conditions: The OBD II system shall monitor for misfire during engine idle conditions at least once per driving cycle in which the monitoring conditions for misfire are met. A manufacturer shall submit monitoring conditions to the Executive Officer for approval. The Executive Officer shall approve manufacturer defined monitoring conditions that are determined (based on manufacturer submitted data and/or other engineering documentation) to: (i) be technically necessary to ensure robust detection of malfunctions (e.g., avoid false passes and false detection of malfunctions), (ii) require no more than 1000 cumulative engine revolutions, and (iii) do not require any single continuous idle operation of more than 15 seconds to make a determination that a malfunction is present (e.g., a decision can be made with data gathered during several idle operations of 15 seconds or less). For 2004 model year vehicles only, a manufacturer may comply with the monitoring conditions for diesel misfire monitoring in title 13, CCR section 1968.1 in lieu of meeting the monitoring conditions in section (e)(3.5.3).~~

~~(3.5.4) MIL Illumination and Fault Code Storage: General requirements for MIL illumination and fault code storage are set forth in section (d)(2).~~

(4) EVAPORATIVE SYSTEM MONITORING

(4.1) Requirement: The OBD II system shall verify purge flow from the evaporative system and shall monitor the complete evaporative system, excluding the tubing and connections between the purge valve and the intake manifold, for vapor leaks to the atmosphere. Individual components of the evaporative system (e.g. valves, sensors, etc.) shall be monitored in accordance with the comprehensive components requirements in section (e)(1~~6~~5) (e.g., for circuit continuity, out of range values, rationality, proper functional response, etc.). Vehicles not required to be equipped with evaporative emission systems shall be exempt from monitoring of the evaporative system.

(4.2) Malfunction Criteria:

(4.2.1) For purposes of section (e)(4), an orifice shall be defined as an O'Keefe Controls Co. precision metal "Type B" orifice with NPT connections with a diameter of the specified dimension (e.g., part number B-20-SS for a stainless steel 0.020 inch diameter orifice).

(4.2.2) The OBD II system shall detect an evaporative system malfunction when any of the following conditions exist:

(A) No purge flow from the evaporative system to the engine can be detected by the OBD II system;

(B) The complete evaporative system contains a leak or leaks that cumulatively are greater than or equal to a leak caused by a 0.040 inch diameter orifice; ~~and~~or

(C) The complete evaporative system contains a leak or leaks that cumulatively are greater than or equal to a leak caused by a 0.020 inch diameter orifice.

(4.2.3) On vehicles with fuel tank capacity greater than 25.0 gallons, a manufacturer may request the Executive Officer to revise the orifice size in sections (e)(4.2.2)(B) and/or (C) if the most reliable monitoring method available cannot reliably detect a system leak of the magnitudes specified. The Executive Officer shall approve the request upon determining that the manufacturer has provided data and/or engineering analysis that demonstrate the need for the request.

(4.2.4) Upon request by the manufacturer and upon determining that the manufacturer has submitted data and/or engineering evaluation which support the request, the Executive Officer shall revise the orifice size in sections (e)(4.2.2)(B) and/or (C) upward to exclude detection of leaks that cannot cause evaporative or running loss emissions to exceed 1.5 times the applicable standards.

(4.2.5) A manufacturer may request Executive Officer approval to revise the orifice size in section (e)(4.2.2)(B) to a 0.090 inch diameter orifice. The Executive Officer shall approve the request upon the manufacturer submitting data and/or engineering analysis and the Executive Officer finding that:

(A) the monitoring strategy for detecting orifices specified in section (e)(4.2.2)(C) meets the monitoring conditions requirements of section (e)(4.3.2); and

(B) the monitoring strategy for detecting 0.090 inch diameter orifices ~~substantially exceeds the monitoring conditions requirements of section (e)(4.3.1) for monitoring strategies designed to detect orifices specified in section (e)(4.2.2)(B)~~yields an in-use monitor performance ratio (as defined in section (d)(4)) that meets or exceeds 0.620.

(4.2.6) For the 2004 and 2005 model years only, manufacturers that use separate monitors to identify leaks (as specified in (e)(4.2.2.)(B) or (C)) in different portions of the complete evaporative system (e.g., separate monitors for the fuel tank to canister portion and for the canister to purge valve portion of the system) may request Executive Officer approval to revise the malfunction criteria in sections (e)(4.2.2)(B) and (C) to identify a malfunction when the separately monitored portion of the evaporative system (e.g., the fuel tank to canister portion) has a leak (or leaks) that is greater than or equal to the specified size in lieu of when the complete evaporative system has a leak (or leaks) that is greater than or equal to the specified size. The Executive Officer shall approve the request upon determining that the manufacturer utilized the same monitoring strategy (e.g., monitoring portions of the complete system with separate monitors) on vehicles prior to the 2004 model year and that the monitoring strategy provides further isolation of the malfunction for repair technicians by utilizing separate fault codes for each monitored portion of the evaporative system.

(4.2.7) For vehicles that utilize more than one purge flow path (e.g., a turbo-charged engine with a low pressure purge line and a high pressure purge line), the OBD II system shall verify the criteria of (e)(4.2.2)(A) (i.e., purge flow to the engine) for both purge flow paths. If a manufacturer demonstrates that blockage, leakage, or disconnection of one of the purge flow paths cannot cause a measurable emission increase during any reasonable in-use driving conditions, monitoring of that flow path is not required.

(4.3) Monitoring Conditions:

(4.3.1) Manufacturers shall define the monitoring conditions for malfunctions identified in sections (e)(4.2.2)(A) and (B) (i.e., purge flow and 0.040 inch leak detection) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements).

(4.3.2) Manufacturers shall define the monitoring conditions for malfunctions identified in section (e)(4.2.2)(C) (i.e., 0.020 inch leak detection) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). For purposes of tracking and reporting as required in section (d)(3.2.2), all monitors used to detect malfunctions identified in section (e)(4.2.2)(C) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).

(4.3.3) Manufacturers may disable or abort an evaporative system monitor when the fuel tank level is over 85 percent of nominal tank capacity or during a refueling event.

(4.3.4) Manufacturers may request Executive Officer approval to execute the evaporative system monitor only on driving cycles determined by the manufacturer to be cold starts if the condition is needed to ensure reliable monitoring. The Executive Officer may not approve criteria that exclude engine starts from being considered as cold starts solely on the basis that ambient temperature exceeds (i.e., indicates a higher temperature than) engine coolant temperature at engine start. The Executive Officer shall approve the request upon determining that data and/or an engineering evaluation submitted by the manufacturer demonstrate that a reliable check can only be made on driving cycles when the cold start criteria are satisfied.

(4.3.5) Manufacturers may temporarily disable the evaporative purge system to perform an evaporative system leak check.

(4.4) MIL Illumination and Fault Code Storage:

(4.4.1) Except as provided below for fuel cap leaks and alternate statistical MIL illumination protocols, general requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(4.4.2) If the OBD II system is capable of discerning that a system leak is being caused by a missing or improperly secured fuel cap:

(A) The manufacturer is not required to illuminate the MIL or store a fault code if the vehicle is equipped with an alternative indicator for notifying the vehicle operator of the malfunction. The alternative indicator shall be of sufficient illumination and location to be readily visible under all lighting conditions.

(B) If the vehicle is not equipped with an alternative indicator and the MIL illuminates, the MIL may be extinguished and the corresponding fault codes erased once the OBD II system has verified that the fuel cap has been securely fastened and the MIL has not been illuminated for any other type of malfunction.

(C) The Executive Officer may approve other strategies that provide equivalent assurance that a vehicle operator will be promptly notified of a missing or improperly secured fuel cap and that corrective action will be undertaken.

(4.4.3) Notwithstanding section (d)(2.2.~~3~~6), manufacturers may request Executive Officer approval to use alternative statistical MIL illumination and fault code storage protocols that require up to twelve driving cycles on average for monitoring strategies designed to detect malfunctions specified by section (e)(4.2.2)(C). Executive Officer approval shall be granted in accordance with the bases identified in section (d)(2.2.~~3~~6) and upon determination that the manufacturer has submitted data and/or an engineering analysis demonstrating that the most reliable monitoring method available cannot reliably detect a malfunction of the specified size without the additional driving cycles and that the monitoring system will still meet the monitoring conditions requirements specified in sections (d)(3.1) and (3.2).

(5) SECONDARY AIR SYSTEM MONITORING

(5.1) Requirement: The OBD II system on vehicles equipped with any form of secondary air delivery system shall monitor the proper functioning of the secondary air delivery system including all air switching valve(s). The individual electronic components (e.g., actuators, valves, sensors, etc.) in the secondary air system shall be monitored in accordance with the comprehensive component requirements in section (e)(1~~6~~5).

(5.2) Malfunction Criteria:

(5.2.1) For purposes of section (e)(5), "air flow" is defined as the air flow delivered by the secondary air system to the exhaust system. For vehicles using secondary air systems with multiple air flow paths/distribution points, the air flow to each bank (i.e., a group of cylinders that share a common exhaust manifold, catalyst, and control sensor) shall be monitored in accordance with the malfunction criteria in sections (e)(5.2.3) and (5.2.4) unless complete blocking of air delivery to one bank does not cause a measurable increase in emissions.

(5.2.2) For all Low Emission Vehicle I applications:

(A) Except as provided in sections (e)(5.2.2)(B) and (e)(5.2.4), the OBD II system shall detect a secondary air system malfunction prior to a decrease from the manufacturer's specified air flow that would cause a vehicle's emissions to exceed 1.5 times any of the applicable FTP standards.

(B) Manufacturers may request Executive Officer approval to detect a malfunction when no detectable amount of air flow is delivered in lieu of the malfunction criteria in section (e)(5.2.2)(A). The Executive Office shall grant approval upon determining that deterioration of the secondary air system is unlikely based on data and/or engineering evaluation submitted by the manufacturer demonstrating that the materials used for the secondary air system (e.g., air hoses, tubing, valves, connectors, etc.) are inherently resistant to disconnection, corrosion, or other deterioration.

(5.2.3) For all Low Emission Vehicle II applications and all 2009 and subsequent model year vehicles:

(A) For 2004 and 2005 model year vehicles, manufacturers shall use the malfunction criteria specified for Low Emission Vehicle I applications in section (e)(5.2.2).

(B) For 2006 and subsequent model year vehicles, except as provided in sections (e)(5.2.3)(C) and (e)(5.2.4), the OBD II system shall detect a secondary air system malfunction prior to a decrease from the manufacturer's specified air flow during normal operation that would cause a vehicle's emissions to exceed 1.5 times any of the applicable FTP standards. For purposes of sections (e)(5.2) and (5.3), "normal operation" shall be defined as the condition when the secondary air system is activated during catalyst and/or engine warm-up following engine start and may not include the condition when the secondary air system is intrusively turned on solely for the purpose of monitoring.

(C) For 2006 and 2007 model year vehicles only, a manufacturer may request Executive Officer approval to detect a malfunction when no detectable amount of air flow is delivered during normal operation in lieu of the malfunction criteria in section (e)(5.2.3)(B) (e.g., 1.5 times the standard) during normal operation. Executive Officer approval shall be granted upon determining that the manufacturer has submitted data and/or engineering analysis that demonstrate that the monitoring system is capable of detecting malfunctions prior to a decrease from the manufacturer's specified air flow that would cause a vehicle's emissions to exceed 1.5 times any of the applicable FTP standards during an intrusive operation of the secondary air system later in the same driving cycle.

(5.2.4) For vehicles in which no deterioration or failure of the secondary air system would result in a vehicle's emissions exceeding 1.5 times any of the applicable standards, the OBD II system shall detect a malfunction when no detectable amount of air flow is delivered. For vehicles subject to the malfunction criteria in section (e)(5.2.3)(B), this monitoring for no detectable amount of air flow shall occur during normal operation of the secondary air system.

(5.3) Monitoring Conditions:

(5.3.1) For all Low Emission Vehicle I applications: Manufacturers shall define the monitoring conditions in accordance with section (d)(3.1).

(5.3.2) For all Low Emission Vehicle II applications and all 2009 and subsequent model year vehicles:

(A) For 2004 and 2005 model year vehicles, manufacturers shall define the monitoring conditions in accordance with section (d)(3.1).

(B) For 2006 and subsequent model year vehicles, manufacturers shall define the monitoring conditions in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). For purposes of tracking and reporting as required in section (d)(3.2.2), all monitors used to detect malfunctions identified in section (e)(5.2) during normal operation of the secondary air system shall be tracked separately but reported as a single set of values as specified in sections ~~(d)(4.2.2)(C) and~~ (d)(5.2.2).

(5.4) MIL Illumination and Fault Code Storage: General requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(6) FUEL SYSTEM MONITORING

(6.1) Requirement:

(6.1.1) ~~For all vehicles except vehicles with diesel engines, t~~The OBD II system shall monitor the fuel delivery system to determine its ability to provide compliance with emission standards.

~~(6.1.2)For vehicles with diesel engines, the manufacturer shall monitor the performance of all electronic fuel system components to the extent feasible with respect to the malfunction criteria specified in section (e)(6.2) below.~~

(6.2) Malfunction Criteria:

(6.2.1) The OBD II system shall detect a malfunction of the fuel delivery system ~~(including feedback control based on a secondary oxygen sensor)~~ when:

(A) ~~t~~The fuel delivery system is unable to maintain a vehicle's emissions at or below 1.5 times any of the applicable FTP standards; or

(B) If equipped, the feedback control based on a secondary oxygen or exhaust gas sensor is unable to maintain a vehicle's emissions (except as a result of a malfunction specified in section (e)(6.2.1)(C)) at or below 1.5 times any of the applicable FTP standards; or

(C) Except as required in section (e)(6.2.6), for 25 percent of all 2011 model year vehicles, 50 percent of all 2012 model year vehicles, 75 percent of all 2013 model year vehicles, and 100 percent of all 2014 model year vehicles, an air-fuel ratio cylinder imbalance (e.g., the air-fuel ratio in one or more cylinders is different than the other cylinders due to a cylinder specific malfunction such as an intake manifold leak at a particular cylinder, fuel injector problem, an individual cylinder EGR runner flow delivery problem, an individual variable cam lift malfunction such that an individual cylinder is operating on the wrong cam lift profile, or other similar problems) occurs in one or more cylinders such that the fuel delivery system is unable to maintain a vehicle's emissions at or below:

3.0 times the applicable FTP standards for 2011 through 2013 model year vehicles; and 1.5 times the applicable FTP standards for 2014 and subsequent model year vehicles. In lieu of using 1.5 times the applicable FTP standards for all 2014 model year applications, for the 2014 model year only, a manufacturer may continue to use 3.0 times the applicable FTP standards for any applications previously certified in the 2011, 2012, or 2013 model year to 3.0 times the applicable FTP standards and carried over to the 2014 model year.

(6.2.2) Except as provided for in section (e)(6.2.3) below, if the vehicle is equipped with adaptive feedback control, the OBD II system shall detect a malfunction when the adaptive feedback control has used up all of the adjustment allowed by the manufacturer.

(6.2.3) If the vehicle is equipped with feedback control that is based on a secondary oxygen (or equivalent) sensor, the OBD II system is not required to detect a malfunction of the fuel system solely when the feedback control based on a secondary oxygen sensor has used up all of the adjustment allowed by the manufacturer. However, if a failure or deterioration results in vehicle emissions that exceed the malfunction criteria in section (e)(6.2.1), the OBD II system is required to detect a malfunction.

(6.2.4) The OBD II system shall detect a malfunction whenever the fuel control system fails to enter closed-loop operation (if employed) within a manufacturer specified time interval.

(6.2.5) Manufacturers may adjust the criteria and/or limit(s) to compensate for changes in altitude, for temporary introduction of large amounts of purge vapor, or for other similar identifiable operating conditions when they occur.

(6.2.6) Notwithstanding the phase-in specified in section (e)(6.2.1)(C), if a vehicle is equipped with separate EGR flow delivery passageways (internal or external) that deliver EGR flow to individual cylinders (e.g., an EGR system with individual delivery pipes to each cylinder), the OBD II system shall monitor the fuel delivery system for malfunctions specified in section (e)(6.2.1)(C) on all 2011 and subsequent model year vehicles so equipped.

(6.3) Monitoring Conditions:

(6.3.1) Except as provided in section (e)(6.3.2), ~~T~~the fuel system shall be monitored continuously for the presence of a malfunction.

(6.3.2) Manufacturers shall define monitoring conditions for malfunctions identified in section (e)(6.2.1)(C) (i.e., air-fuel ratio cylinder imbalance malfunctions) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements).

(6.4) MIL Illumination and Fault Code Storage:

(6.4.1) A pending fault code shall be stored immediately upon the fuel system exceeding the malfunction criteria established pursuant to section (e)(6.2).

(6.4.2) Except as provided below, if a pending fault code is stored, the OBD II system shall immediately illuminate the MIL and store a confirmed fault code if a malfunction is again detected during either of the following two events: (a) the driving cycle immediately following the storage of the pending fault code, regardless of the conditions encountered during the driving cycle; or (b) on the next driving cycle in which similar conditions (see section (c)) to those that occurred when the pending fault code was stored are encountered.

(6.4.3) The pending fault code may be erased at the end of the next driving cycle in which similar conditions have been encountered without an exceedance of the specified fuel system malfunction criteria. The pending code may also be erased if similar conditions are not encountered during the 80 driving cycles immediately after the initial detection of a malfunction for which the pending code was set.

(6.4.4) Storage of freeze frame conditions.

(A) ~~A manufacturer~~The OBD II system shall store and erase freeze frame conditions either in conjunction with storing and erasing a pending fault code or in conjunction with storing and erasing a confirmed fault code.

(B) If freeze frame conditions are stored for a malfunction other than misfire (see section (e)(3)) or fuel system malfunction when a fault code is stored as specified in section (e)(6.4) above, the stored freeze frame information shall be replaced with freeze frame information regarding the fuel system malfunction.

(6.4.5) Storage of fuel system conditions for determining similar conditions of operation.

(A) –Upon detection of a fuel system malfunction under section (e)(6.2), ~~manufacturers~~ the OBD II system shall store the engine speed, load, and warm-up status of the first fuel system malfunction that resulted in the storage of the pending fault code.

(B) For fuel system faults detected using feedback control that is based on a secondary oxygen (or equivalent) sensor, the manufacturer may request Executive Officer approval to use an alternate definition of similar conditions in lieu of the definition specified in section (c). The Executive Officer shall approve the alternate definition upon the manufacturer providing data or analysis demonstrating that the alternate definition provides for equivalent robustness in detection of fuel system faults that vary in severity depending on engine speed, load, and/or warm-up status.

(6.4.6) Extinguishing the MIL. The MIL may be extinguished after three sequential driving cycles in which similar conditions have been encountered without a malfunction of the fuel system.

(7) ~~OXYGEN~~ EXHAUST GAS SENSOR MONITORING

(7.1) Requirement:

(7.1.1) The OBD II system shall monitor the output voltage, response rate, and any other parameter which can affect emissions of all primary (fuel control) oxygen ~~(lambda)~~ sensors (conventional switching sensors and wide range or universal sensors) for malfunction. ~~Both the lean-to-rich and rich-to-lean response rates shall be monitored.~~

(7.1.2) The OBD II system shall also monitor all secondary oxygen sensors (those used for fuel trim control or as a monitoring device) for proper output voltage, activity, and/or response rate.

(7.1.3) For vehicles equipped with heated oxygen sensors, the OBD II system shall monitor the heater for proper performance.

(7.1.4) For other types of sensors (e.g., wide range or universal lambda sensorshydrocarbon sensors, NOx sensors, etc.), the manufacturer shall submit a monitoring plan to the Executive Officer for approval. The Executive Officer shall approve the request upon determining that the manufacturer has submitted data and an engineering evaluation that demonstrate that the monitoring plan is as reliable and effective as the monitoring plan required for conventional sensors under section (e)(7).

(7.2) Malfunction Criteria:

(7.2.1) Primary Sensors:

(A) The OBD II system shall detect a malfunction prior to any failure or deterioration of the oxygen sensor voltage, response rate, amplitude, or other characteristic(s) (including drift or bias corrected for by secondary sensors) that would cause a vehicle's emissions to exceed 1.5 times any of the applicable FTP standards. For response rate (see section (c)), the OBD II system shall detect asymmetric malfunctions (i.e., malfunctions that primarily affect only the lean-to-rich response rate or only the rich-to-lean response rate) and symmetric malfunctions (i.e., malfunctions that affect both the lean-to-rich and rich-to-lean response rates). As defined in section (c), response rate includes delays in the sensor to initially react to a change in exhaust gas composition as well as delays during the transition from a rich-to-lean (or lean-to-rich) sensor output. For 25 percent of 2009, 50 percent of 2010, and 100 percent of 2011 and subsequent model year vehicles, the manufacturer shall submit data and/or engineering analysis to demonstrate that the calibration method used ensures proper detection of all symmetric and asymmetric response rate malfunctions as part of the certification application.

(B) The OBD II system shall detect malfunctions of the oxygen sensor caused by either a lack of circuit continuity or out--of--range values.

(C) The OBD II system shall detect a malfunction of the oxygen sensor when a sensor failure or deterioration causes the fuel system to stop using that sensor as a feedback input (e.g., causes default or open loop operation) or causes the fuel system to fail to enter closed-loop operation within a manufacturer-specified time interval.

(D) The OBD II system shall detect a malfunction of the oxygen sensor when the sensor output voltage, amplitude, activity, or other characteristics are no longer sufficient for use as an OBD II system monitoring device (e.g., for catalyst monitoring).

(7.2.2) Secondary Sensors:

(A) The OBD II system shall detect a malfunction prior to any failure or deterioration of the oxygen sensor voltage, response rate, amplitude, or other characteristic(s) that would cause a vehicle's emissions to exceed 1.5 times any of the applicable FTP standards.

(B) The OBD II system shall detect malfunctions of the oxygen sensor caused by a lack of circuit continuity.

(C) Sufficient sensor performance for other monitors.

(i) T~~o the extent feasible, t~~he OBD II system shall detect a malfunction of the oxygen sensor when the sensor output voltage, amplitude, activity, or other characteristics are no longer sufficient for use as an OBD II system monitoring device (e.g., for catalyst monitoring). For this requirement, "sufficient" is defined as the capability of the worst performing acceptable sensor to detect the best performing unacceptable other monitored system or component (e.g., catalyst).

(ii) For systems where it is not technically feasible to satisfy the criteria of section (e)(7.2.2)(C)(i) completely, the OBD II system shall, at a minimum, detect a slow rich-to-lean response malfunction during a fuel shut-off event (e.g., deceleration fuel cut event). The rich-to-lean response check shall monitor both the sensor response time from a rich condition (e.g., 0.7 Volts) prior to the start of fuel shut-off to a lean condition (e.g., 0.1 Volts) expected during fuel shut-off conditions and the sensor transition time in the intermediate sensor range (e.g., from 0.55 Volts to 0.3 Volts). Monitoring of the rich-to-lean response shall be phased in on at least 30 percent of the 2009, 60 percent of the 2010, and 100 percent of the 2011 model year vehicles.

(iii) Additionally, for systems where it is not technically feasible to satisfy the criteria in section (e)(7.2.2)(C)(i), prior to certification of 2009 model year vehicles, the manufacturer must submit a comprehensive plan to the Executive Officer demonstrating the manufacturer's efforts to minimize any gap remaining between the worst performing acceptable sensor and a sufficient sensor. The plan should include quantification of the gap and supporting documentation for efforts to close the gap including sensor monitoring improvements, other system component monitor improvements (e.g., changes to make the catalyst monitor less sensitive to oxygen sensor response), and sensor specification changes, if any. The Executive Officer shall approve the plan upon determining the submitted information supports the necessity of the gap and the plan demonstrates that the manufacturer is taking reasonable efforts to minimize or eliminate the gap in a timely manner.

(D) The OBD II system shall detect malfunctions of the oxygen sensor caused by out-of-range values.

(7.2.3) Sensor Heaters:

(A) The OBD II system shall detect a malfunction of the heater performance when the current or voltage drop in the heater circuit is no longer within the manufacturer's specified limits for normal operation (i.e., within the criteria required to be met by the component vendor for heater circuit performance at high mileage). Subject to Executive Officer approval, other malfunction criteria for heater performance malfunctions may be used upon the Executive Officer determining that the manufacturer has submitted data and/or an engineering evaluation that demonstrate the monitoring reliability and timeliness to be equivalent to the stated criteria in section (e)(7.2.3)(A).

(B) The OBD II system shall detect malfunctions of the heater circuit including open or short circuits that conflict with the commanded state of the heater (e.g., shorted to 12 Volts when commanded to 0 Volts (ground), etc.).

(7.3) Monitoring Conditions:

(7.3.1) Primary Sensors

(A) Manufacturers shall define the monitoring conditions for malfunctions identified in sections (e)(7.2.1)(A) and (D) (e.g., proper response rate) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). For purposes of tracking and reporting as required in section (d)(3.2.2), all monitors used to detect malfunctions identified in sections (e)(7.2.1)(A) and (D) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).

(B) Except as provided in section (e)(7.3.1)(C), monitoring for malfunctions identified in sections (e)(7.2.1)(B) and (C) (i.e., circuit continuity, out-of-range, and open-loop malfunctions) shall be:

(i) Conducted in accordance with title 13, CCR section 1968.1 for Low Emission Vehicle I applications and 2004 and 2005 model year Low Emission Vehicle II applications;

(ii) Conducted continuously for all 2006 ~~and subsequent~~ through 2008 model year Low Emission Vehicle II applications and all 2009 and subsequent model year vehicles.

(C) A manufacturer may request Executive Officer approval to disable continuous oxygen sensor monitoring when an oxygen sensor malfunction cannot be distinguished from other effects (e.g., disable out-of-range low monitoring during fuel cut conditions). The Executive Officer shall approve the disablement upon determining that the manufacturer has submitted test data and/or documentation that demonstrate a properly functioning sensor cannot be distinguished from a malfunctioning sensor and that the disablement interval is limited only to that necessary for avoiding false detection.

(7.3.2) Secondary Sensors

(A) Manufacturers shall define monitoring conditions for malfunctions identified in sections (e)(7.2.2)(A)~~, (B),~~ and (C) (e.g., proper sensor activity) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). For all 2010 and subsequent model year vehicles, for purposes of tracking and reporting as required in section (d)(3.2.2), all monitors used to detect malfunctions identified in sections (e)(7.2.2)(A) and (C) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).

(B) Except as provided in section (e)(7.3.2)(C), monitoring for malfunctions identified in sections (e)(7.2.2)(B) and (D) (i.e., open circuit, out-of-range malfunctions) shall be:

(i) Conducted in accordance with title 13, CCR section 1968.1 for Low Emission Vehicle I applications and 2004 and 2005 model year Low Emission Vehicle II applications;

(ii) Conducted continuously for all 2006 ~~and subsequent~~ through 2008 model year Low Emission Vehicle II applications and all 2009 and subsequent model year vehicles.

(C) A manufacturer may request Executive Officer approval to disable continuous oxygen sensor monitoring when an oxygen sensor malfunction cannot be distinguished from other effects (e.g., disable out-of-range low monitoring during fuel cut conditions). The Executive Officer shall approve the disablement upon determining that the manufacturer has submitted test data and/or documentation that demonstrate a properly functioning sensor cannot be distinguished from a malfunctioning sensor and that the disablement interval is limited only to that necessary for avoiding false detection.

(7.3.3) Sensor Heaters

(A) Manufacturers shall define monitoring conditions for malfunctions identified in section (e) (7.2.3)(A) (e.g., sensor heater performance) in accordance sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements).

(B) Monitoring for malfunctions identified in section (e)(7.2.3)(B) (e.g., circuit malfunctions) shall be:

(i) Conducted in accordance with title 13, CCR section 1968.1 for 2004 and 2005 model year vehicles;

(ii) Conducted continuously for all 2006 and subsequent model year vehicles.

(7.4) MIL Illumination and Fault Code Storage: General requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(8) EXHAUST GAS RECIRCULATION (EGR) SYSTEM MONITORING

(8.1) Requirement: The OBD II system shall monitor the EGR system on vehicles so-equipped for low and high flow rate malfunctions. The individual electronic components (e.g., actuators, valves, sensors, etc.) that are used in the EGR system shall be monitored in accordance with the comprehensive component requirements in section (e)(1~~6~~5).

(8.2) Malfunction Criteria:

(8.2.1) The OBD II system shall detect a malfunction of the EGR system prior to an increase or decrease from the manufacturer's specified EGR flow rate that would cause a vehicle's emissions to exceed 1.5 times any of the applicable FTP standards.

(8.2.2) For vehicles in which no failure or deterioration of the EGR system could result in a vehicle's emissions exceeding 1.5 times any of the applicable standards, the OBD II system shall detect a malfunction when the system has no detectable amount of EGR flow.

(8.3) Monitoring Conditions:

(8.3.1) Manufacturers shall define the monitoring conditions for malfunctions identified in section (e)(8.2) (e.g., flow rate) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). For purposes of tracking and reporting as required in section (d)(3.2.2), all monitors used to detect malfunctions identified in section (e)(8.2) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).

(8.3.2) Manufacturers may request Executive Officer approval to temporarily disable the EGR system check under specific conditions (e.g., when freezing may affect performance of the system). The Executive Officer shall approve the request upon determining that the manufacturer has submitted data and/or an engineering evaluation which demonstrate that a reliable check cannot be made when these conditions exist.

(8.4) MIL Illumination and Fault Code Storage: General requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(9) POSITIVE CRANKCASE VENTILATION (PCV) SYSTEM MONITORING

(9.1) Requirement:

(9.1.1) On all 2004 and subsequent model year vehicles, manufacturers shall monitor the PCV system on vehicles so-equipped for system integrity. A manufacturer may use an alternate phase-in schedule in lieu of meeting the requirements of section (e)(9) on all 2004 model year vehicles if the alternate phase-in schedule provides for equivalent compliance volume (as defined in section (c)) to the phase-in schedule specified in title 13, CCR section 1968.1(b)(10.1). Vehicles not required to be equipped with PCV systems shall be exempt from monitoring of the PCV system.

~~(9.1.2) For vehicles with diesel engines, the manufacturer shall submit a plan for Executive Officer approval of the monitoring strategy, malfunction criteria, and monitoring conditions prior to introduction on a production vehicle. Executive Officer approval shall be based on the effectiveness of the monitoring strategy to monitor the performance of the PCV system to the extent feasible with respect to the malfunction criteria in section (e)(9.2) below and the monitoring conditions required by the diagnostic.~~

(9.2) Malfunction Criteria:

(9.2.1) For the purposes of section (e)(9), "PCV system" is defined as any form of crankcase ventilation system, regardless of whether it utilizes positive pressure. "PCV valve" is defined as any form of valve or orifice used to restrict or control crankcase vapor flow. Further, any additional external PCV system tubing or hoses used to equalize crankcase pressure or to provide a ventilation path between various areas of the engine (e.g., crankcase and valve cover) are considered part of the PCV system "between the crankcase and the PCV valve" and subject to the malfunction criteria in section (e)(9.2.2) below.

(9.2.2) Except as provided below, the OBD II system shall detect a malfunction of the PCV system when a disconnection of the system occurs between either the crankcase and the PCV valve, or between the PCV valve and the intake manifold.

(9.2.3) If the PCV system is designed such that the PCV valve is fastened directly to the crankcase in a manner which makes it significantly more difficult to remove the valve from the crankcase rather than disconnect the line between the valve and the intake manifold (taking aging effects into consideration), the Executive Officer shall exempt the manufacturer from detection of disconnection between the crankcase and the PCV valve.

(9.2.4) Subject to Executive Officer approval, system designs that utilize tubing between the valve and the crankcase shall also be exempted from the portion of the monitoring requirement for detection of disconnection between the crankcase and the PCV valve. The manufacturer shall file a request and submit data and/or engineering evaluation in support of the request. The Executive Officer shall approve the request upon determining that the connections between the valve and the crankcase are: (i) resistant to deterioration or accidental disconnection, (ii) significantly more difficult to disconnect than the line between the valve and the intake manifold, and (iii) not subject to disconnection per manufacturer's repair procedures for non-PCV system repair work.

(9.2.5) Manufacturers are not required to detect disconnections between the PCV valve and the intake manifold if said disconnection (1) causes the vehicle to stall immediately during idle operation; or (2) is unlikely to occur due to a PCV system design that is integral to the induction system (e.g., machined passages rather than tubing or hoses).

(9.3) Monitoring Conditions: Manufacturers shall define the monitoring conditions for malfunctions identified in section (e)(9.2) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements).

(9.4) MIL Illumination and Fault Code Storage: General requirements for MIL illumination and fault code storage are set forth in section (d)(2). The stored fault code need not specifically identify the PCV system (e.g., a fault code for idle speed control or fuel system monitoring can be stored) if the manufacturer demonstrates that additional monitoring hardware would be necessary to make this identification, and provided the manufacturer's diagnostic and repair procedures for the detected malfunction include directions to check the integrity of the PCV system.

(10) ENGINE COOLING SYSTEM MONITORING

(10.1) Requirement:

(10.1.1) The OBD II system shall monitor the thermostat on vehicles so-equipped for proper operation.

(10.1.2) The OBD II system shall monitor the engine coolant temperature (ECT) sensor for circuit continuity, out-of-range values, and rationality faults.

(10.2) Malfunction Criteria:

(10.2.1) Thermostat

(A) The OBD II system shall detect a thermostat malfunction if, within an Executive Officer approved time interval after starting the engine, either of the following two conditions occur:

(i) The coolant temperature does not reach the highest temperature required by the OBD II system to enable other diagnostics;

(ii) The coolant temperature does not reach a warmed-up temperature within 20 degrees Fahrenheit of the manufacturer's nominal thermostat regulating temperature. Subject to Executive Officer approval, a manufacturer may utilize lower temperatures for this criterion upon the Executive Officer determining that the manufacturer has demonstrated that the fuel, spark timing, and/or other coolant temperature-based modifications to the engine control strategies would not cause an emission increase of 50 or more percent of any of the applicable standards (e.g., 50 degree Fahrenheit emission test, etc.).

(B) Executive Officer approval of the time interval after engine start shall be granted upon determining that the data and/or engineering evaluation submitted by the manufacturer supports the specified times.

(C) With Executive Officer approval, a manufacturer may use alternate malfunction criteria and/or monitoring conditions (see section (e)(10.3)) that are a function of temperature at engine start on vehicles that do not reach the temperatures specified in the malfunction criteria when the thermostat is functioning properly. Executive Officer approval shall be granted upon determining that the manufacturer has submitted data that demonstrate that a properly operating system does not reach the specified temperatures, that the monitor is capable of meeting the specified malfunction criteria at engine start temperatures greater than 50°F, and that the overall effectiveness of the monitor is comparable to a monitor meeting these thermostat monitoring requirements at lower temperatures.

(D) With Executive Officer approval, manufacturers may omit this monitor. Executive Officer approval shall be granted upon determining that the manufacturer has demonstrated that a malfunctioning thermostat cannot cause a measurable increase in emissions during any reasonable driving condition nor cause any disablement of other monitors.

(10.2.2) ECT Sensor

(A) Circuit Continuity. The OBD II system shall detect a malfunction when a lack of circuit continuity or out-of-range values occurs.

(B) Time to Reach Closed-Loop Enable Temperature.

(i) The OBD II system shall detect a malfunction if the ECT sensor does not achieve the stabilized minimum temperature which is needed for the fuel control system to begin closed-loop operation (closed-loop enable temperature) within an Executive Officer approved time interval after starting the engine. ~~For diesel applications, the minimum temperature needed for warmed-up fuel control to begin shall be used instead of the closed-loop enable temperature.~~

(ii) The time interval shall be a function of starting ECT and/or a function of intake air temperature and, except as provided below in section (e)(10.2.2)(B)(iii), may not exceed:

a. two minutes for engine start temperatures at or above 50 degrees Fahrenheit and five minutes for engine start temperatures at or above 20 degrees Fahrenheit and below 50 degrees Fahrenheit for Low Emission Vehicle I applications and 2004 and 2005 model year Low Emission Vehicle II applications;

b. two minutes for engine start temperatures up to 15 degrees Fahrenheit below the closed-loop enable temperature and five minutes for engine start temperatures between 15 and 35 degrees Fahrenheit below the closed-loop enable temperature for all 2006 ~~and subsequent~~ through 2008 model year Low Emission Vehicle II applications and all 2009 and subsequent model year vehicles.

(iii) Executive Officer approval of the time interval shall be granted upon determining that the data and/or engineering evaluation submitted by the manufacturer supports the specified times. The Executive Officer shall allow longer time intervals upon determining that the manufacturer has submitted data and/or an engineering evaluation that demonstrate that the vehicle requires a longer time to warm up under normal conditions.

(iv) The Executive Officer shall exempt manufacturers from the requirement of section (e)(10.2.2)(B) if the manufacturer does not utilize ECT to enable closed loop fuel control.

(C) Stuck in Range Below the Highest Minimum Enable Temperature. To the extent feasible when using all available information, the OBD II system shall detect a malfunction if the ECT sensor inappropriately indicates a temperature below the highest minimum enable temperature required by the OBD II system to enable other diagnostics (e.g., an OBD II system that requires ECT to be greater than 140 degrees Fahrenheit to enable a diagnostic must detect malfunctions that cause the ECT sensor to inappropriately indicate a temperature below 140 degrees Fahrenheit). Manufacturers are exempted from this requirement for temperature regions in which the monitors required under sections (e)(10.2.1) or (e)(10.2.2)(B) will detect ECT sensor malfunctions as defined in section (e)(10.2.2)(C).

(D) Stuck in Range Above the Lowest Maximum Enable Temperature.

(i) To the extent feasible when using all available information, the OBD II system shall detect a malfunction if the ECT sensor inappropriately indicates a temperature above the lowest maximum enable temperature required by the OBD II system to enable other diagnostics (e.g., an OBD II system that requires ECT to be less than 90 degrees Fahrenheit at engine start to enable a diagnostic must detect malfunctions that cause the ECT sensor to inappropriately indicate a temperature above 90 degrees Fahrenheit).

(ii) Manufacturers are exempted from this requirement for temperature regions in which the monitors required under sections (e)(10.2.1), (e)(10.2.2)(B), or (e)(10.2.2)(C) (i.e., ECT sensor or thermostat malfunctions) will detect ECT sensor malfunctions as defined in section (e)(10.2.2)(D) or in which the MIL will be illuminated under the requirements of section (d)(2.~~1~~2.3) for default mode operation (e.g., overtemperature protection strategies).

(iii) For Low Emission Vehicle I applications and 2004 and 2005 model year Low Emission Vehicle II applications only, manufacturers are also exempted from the requirements of section (e)(10.2.2)(D) for vehicles that have a temperature gauge (not a warning light) on the instrument panel and utilize the same ECT sensor for input to the OBD II system and the temperature gauge.

(iv) For 2006 ~~and subsequent~~ through 2008 model year Low Emission Vehicle II applications and all 2009 and subsequent model year vehicles, manufacturers are also exempted from the requirements of section (e)(10.2.2)(D) for temperature regions where the temperature gauge indicates a temperature in the red zone (engine overheating zone) for vehicles that have a temperature gauge (not a warning light) on the instrument panel and utilize the same ECT sensor for input to the OBD II system and the temperature gauge.

(10.3) Monitoring Conditions:

(10.3.1) Thermostat

(A) Manufacturers shall define the monitoring conditions for malfunctions identified in section (e)(10.2.1)(A) in accordance with section (d)(3.1) except as provided for in section (e)(10.3.1)(D). Additionally, except as provided for in sections (e)(10.3.1)(B) and (C), monitoring for malfunctions identified in section (e)(10.2.1)(A) shall be conducted once per driving cycle on every driving cycle in which the ECT sensor indicates, at engine start, a temperature lower than the temperature established as the malfunction criteria in section (e)(10.2.1)(A).

(B) Manufacturers may disable thermostat monitoring at ambient ~~starting~~ temperatures below 20 degrees Fahrenheit.

(C) Manufacturers may request Executive Officer approval to suspend or disable thermostat monitoring if the vehicle is subjected to conditions which could lead to false diagnosis (e.g., vehicle operation at idle for more than 50 percent of the warm-up time, hot restart conditions, etc.). In general, the Executive Officer shall not approve disablement of the monitor on engine starts where the ECT at engine start is more than 35 degrees Fahrenheit lower than the thermostat malfunction threshold temperature determined under section (e)(10.2.1)(A). The Executive Officer shall approve the request upon determining that the manufacturer has provided data and/or engineering analysis that demonstrate the need for the request.

(D) With respect to defining enable conditions that are encountered during the FTP or Unified cycle as required in (d)(3.1.1) for malfunctions identified in section (e)(10.2.1)(A), the FTP cycle or Unified cycle shall refer to on-road driving following the FTP or Unified cycle in lieu of testing on a chassis dynamometer.

(10.3.2) ECT Sensor

(A) Except as provided below in section (e)(10.3.2)(E), monitoring for malfunctions identified in section (e)(10.2.2)(A) (i.e., circuit continuity and out-of-range) shall be conducted continuously.

(B) Manufacturers shall define the monitoring conditions for malfunctions identified in section (e)(10.2.2)(B) in accordance with section (d)(3.1). Additionally, except as provided for in section (e)(10.3.2)(D), monitoring for malfunctions identified in section (e)(10.2.2)(B) shall be conducted once per driving cycle on every driving cycle in which the ECT sensor indicates a temperature lower than the closed loop enable temperature at engine start (i.e., all engine start temperatures greater than the ECT sensor out of range low temperature and less than the closed loop enable temperature).

(C) Manufacturers shall define the monitoring conditions for malfunctions identified in sections (e)(10.2.2)(C) and (D) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements).

(D) Manufacturers may suspend or delay the time to reach closed loop enable temperature diagnostic if the vehicle is subjected to conditions which could lead to false diagnosis (e.g., vehicle operation at idle for more than 50 to 75 percent of the warm-up time).

(E) A manufacturer may request Executive Officer approval to disable continuous ECT sensor monitoring when an ECT sensor malfunction cannot be distinguished from other effects. The Executive Officer shall approve the disablement upon determining that the manufacturer has submitted test data and/or engineering evaluation that demonstrate a properly functioning sensor cannot be distinguished from a malfunctioning sensor and that the disablement interval is limited only to that necessary for avoiding false detection.

(10.4) MIL Illumination and Fault Code Storage: General requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(11) COLD START EMISSION REDUCTION STRATEGY MONITORING

(11.1) Requirement:

(11.1.1) For all 2006 ~~and subsequent~~ through 2008 model year Low Emission Vehicle II applications and all 2009 and subsequent model year applications, if a vehicle incorporates a specific engine control strategy to reduce cold start emissions, the OBD II system shall monitor the ~~key control or feedback parameters~~ commanded elements for proper function (e.g., increased engine idle speed, ~~mass air flow,~~ commanded ignition timing retard, etc.), other than secondary air, while the control strategy is active to ensure proper operation of the control strategy. Secondary air systems shall be monitored under the provisions of section (e)(5).

(11.1.2) In lieu of meeting the requirements of section (e)(11) on all 2006 ~~and subsequent~~ through 2008 model year Low Emission Vehicle II applications, a manufacturer may phase in the requirements on a portion of its Low Emission Vehicle II applications as long as that portion of Low Emission Vehicle II applications comprises at least 30 percent of all 2006 model year vehicles, 60 percent of all 2007 model year vehicles, and 100 percent of all 2008 and subsequent model year vehicles.

(11.2) Malfunction Criteria:

(11.2.1) For vehicles not included in the phase-in specified in section (e)(11.2.2):

(A) The OBD II system shall detect a malfunction prior to any failure or deterioration of the individual components associated with the cold start emission reduction control strategy that would cause a vehicle's emissions to exceed 1.5 times the applicable FTP standards. Manufacturers shall:

~~(A)~~(i) Establish the malfunction criteria based on data from one or more representative vehicle(s).

~~(B)~~(ii) Provide an engineering evaluation for establishing the malfunction criteria for the remainder of the manufacturer's product line. The Executive Officer shall waive the evaluation requirement each year if, in the judgement of the Executive Officer, technological changes do not affect the previously determined malfunction criteria.

~~(11.2.2)~~(B) For components where no failure or deterioration of the component used for the cold start emission reduction strategy could result in a vehicle's emissions exceeding 1.5 times the applicable standards, the individual component shall be monitored for proper functional response in accordance with the malfunction criteria in section (e)(165.2) while the control strategy is active.

(11.2.2) For 25 percent of 2010, 50 percent of 2011, and 100 percent of 2012 and subsequent model year vehicles, the OBD II system shall detect a malfunction if either of the following occurs:

(A) Any single commanded element does not properly respond to the commanded action while the cold start strategy is active. For elements involving spark timing (e.g., retarded spark timing), the monitor may verify final commanded spark timing in lieu of verifying actual delivered spark timing. For purposes of this section, "properly respond" is defined as when the element responds:

(i) by a robustly detectable amount; and

(ii) in the direction of the desired command; and

(iii) above and beyond what the element would achieve on start-up without the cold start strategy active (e.g., if the cold start strategy commands a higher idle engine speed, a fault must be detected if there is no detectable amount of engine speed increase above what the system would achieve without the cold start strategy active);

(B) Any failure or deterioration of the cold start emission reduction control strategy that would cause a vehicle's emissions to be equal to or above 1.5 times the applicable FTP standards. For this requirement, the OBD II system shall either monitor elements of the system as a whole (e.g., measuring air flow and modeling overall heat into the exhaust) or the individual elements (e.g., increased engine speed, commanded final spark timing) for failures that cause vehicle emissions to exceed 1.5 times the applicable FTP standards.

(11.3) Monitoring Conditions: Manufacturers shall define the monitoring conditions for malfunctions identified in section (e)(11.2) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements).

(11.4) MIL Illumination and Fault Code Storage: General requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(12) AIR CONDITIONING (A/C) SYSTEM COMPONENT MONITORING

(12.1) Requirement: If a vehicle incorporates an engine control strategy that alters off-idle fuel and/or spark control when the A/C system is on, the OBD II system shall monitor all electronic air conditioning system components for malfunctions that cause the system to fail to invoke the alternate control while the A/C system is on or cause the system to invoke the alternate control while the A/C system is off. Additionally, the OBD II system shall monitor for malfunction all electronic air conditioning system components that are used as part of the diagnostic strategy for any other monitored system or component. The requirements of section (e)(12) shall be phased in as follows: 30 percent of all 2006 model year vehicles, 60 percent of all 2007 model year vehicles, and 100 percent of all 2008 and subsequent model year vehicles.

(12.2) Malfunction Criteria:

(12.2.1) The OBD II system shall detect a malfunction prior to any failure or deterioration of an electronic component of the air conditioning system that would cause a vehicle's emissions to exceed 1.5 times any of the appropriate applicable emission standards or would, through software, effectively disable any other monitored system or component covered by this regulation. For malfunctions that result in the alternate control being erroneously invoked while the A/C system is off, the appropriate emission standards shall be the FTP standards. For malfunctions that result in the alternate control failing to be invoked while the A/C system is on, the appropriate emission standards shall be the SC03 emission standards.

(12.2.2) If no single electronic component failure or deterioration causes emissions to exceed 1.5 times any of the appropriate applicable emission standards as defined above in section (e)(12.2.1) nor is used as part of the diagnostic strategy for any other monitored system or component, manufacturers are not required to monitor any air conditioning system component for purposes of section (e)(12).

(12.3) Monitoring Conditions: Manufacturers shall define the monitoring conditions for malfunctions identified in section (e)(12.2) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements).

(12.4) MIL Illumination and Fault Code Storage: General requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(13) VARIABLE VALVE TIMING AND/OR CONTROL (VVT) SYSTEM MONITORING

(13.1) Requirement: On all 2006 through 2008 ~~and subsequent~~ model year Low Emission Vehicle II applications and all 2009 and subsequent model year vehicles, the OBD II system shall monitor the VVT system on vehicles so-equipped for target error and slow response malfunctions. The individual electronic components (e.g., actuators, valves, sensors, etc.) that are used in the VVT system shall be monitored in accordance with the comprehensive components requirements in section (e)(1~~6~~5). VVT systems on Low Emission Vehicle I applications and 2004 and 2005 model year Low Emission Vehicle II applications shall be monitored in accordance with the comprehensive components requirements in section (e)(1~~6~~5).

(13.2) Malfunction Criteria:

(13.2.1) Target Error. The OBD II system shall detect a malfunction prior to any failure or deterioration in the capability of the VVT system to achieve the commanded valve timing and/or control within a crank angle and/or lift tolerance that would cause a vehicle's emissions to exceed 1.5 times any of the applicable FTP standards.

(13.2.2) Slow Response. The OBD II system shall detect a malfunction prior to any failure or deterioration in the capability of the VVT system to achieve the commanded valve timing and/or control within a time that would cause a vehicle's emissions to exceed 1.5 times any of the applicable FTP standards.

(13.2.3) For vehicles in which no failure or deterioration of the VVT system could result in a vehicle's emissions exceeding 1.5 times any of the applicable standards, the VVT system shall be monitored for proper functional response in accordance with the malfunction criteria in section (e)(1~~6~~5.2).

(13.3) Monitoring Conditions: Manufacturers shall define the monitoring conditions for VVT system malfunctions identified in section (e)(13.2) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements), with the exception that monitoring shall occur every time the monitoring conditions are met during the driving cycle in lieu of once per driving cycle as required in section (d)(3.1.2). Additionally, manufacturers shall track and report VVT system monitor performance under section (d)(3.2.2). For purposes of tracking and reporting as required in section (d)(3.2.2), all monitors used to detect malfunctions identified in section (e)(13.2) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).

(13.4) MIL Illumination and Fault Code Storage: General requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(14) DIRECT OZONE REDUCTION (DOR) SYSTEM MONITORING

(14.1) Requirement:

(14.1.1) The OBD II system shall monitor the DOR system on vehicles so-equipped for malfunctions that reduce the ozone reduction performance of the system.

(14.1.2) For 2003, 2004, and 2005 model year vehicles subject to the malfunction criteria of section (e)(14.2.1) below, manufacturers may request to be exempted from DOR system monitoring. The Executive Officer shall approve the exemption upon the manufacturer:

(A) Agreeing that the DOR system receive only 50 percent of the NMOG credit assigned to the DOR system as calculated under Air Resources Board (ARB) Manufacturers Advisory Correspondence (MAC) No. 99-06, December 20, 1999, which is hereby incorporated by reference herein.

(B) Identifying the DOR system component(s) as an emission control device on both the underhood emission control label and a separate label as specified below. The DOR system shall be included in the list of emission control devices on the underhood emission control label and be identified as a "DOR system" or other equivalent term from SAE J1930 "Electrical/Electronic Systems Diagnostic Terms, Definitions, Abbreviations, and Acronyms – Equivalent to ISO/TR 15031-2:April 30, 2002 (SAE 1930)", incorporated by reference. A separate label shall be located on or near the DOR system component(s) in a location that is visible to repair technicians prior to the removal of any parts necessary to replace the DOR system component(s) and shall identify the components as a "DOR system" or other equivalent SAE J1930 term.

(14.2) Malfunction Criteria:

(14.2.1) For vehicles in which the NMOG credit assigned to the DOR system, as calculated in accordance with ARB MAC No. 99-06, is less than or equal to 50 percent of the applicable FTP NMOG standard, the OBD II system shall detect a malfunction when the DOR system has no detectable amount of ozone reduction.

(14.2.2) For vehicles in which the NMOG credit assigned to the DOR system, as calculated in accordance with ARB MAC No. 99-06, is greater than 50 percent of the applicable FTP NMOG standard, the OBD II system shall detect a malfunction when the ozone reduction performance of the DOR system deteriorates to a point where the difference between the NMOG credit assigned to the properly operating DOR system and the NMOG credit calculated for a DOR system performing at the level of the malfunctioning system exceeds 50 percent of the applicable FTP NMOG standard.

(14.2.3) For vehicles equipped with a DOR system, the manufacturer may modify any of the applicable NMOG malfunction criteria in sections (e)(1)-(3), (e)(5)-(8), (e)(11)-(e)(13), and (e)(1~~7~~6) by adding the NMOG credit received by the DOR system to the required NMOG malfunction criteria (e.g., a malfunction criteria of 1.5 x NMOG standard would be modified to (1.5 x NMOG standard) + DOR system NMOG credit).

(14.3) Monitoring Conditions: Manufacturers shall define the monitoring conditions for malfunctions identified in section (e)(14.2) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements).

(14.4) MIL Illumination and Fault Code Storage: General requirements for MIL illumination and fault code storage are set forth in section (d)(2).

~~(15)PARTICULATE MATTER (PM) TRAP MONITORING~~

~~(15.1)Requirement: On all 2004 and subsequent model year diesel passenger cars, light-duty trucks, and medium-duty passenger vehicles (see section (c)) and all 2005 and subsequent model year diesel medium-duty vehicles, manufacturers shall monitor the PM trap on vehicles so-equipped for proper performance.~~

~~(15.2)Malfunction Criteria:~~

~~(15.2.1)For 2004 and subsequent model year diesel passenger cars, light-duty trucks, and medium-duty passenger vehicles certified to a chassis dynamometer tailpipe standard, the OBD II system shall detect a malfunction prior to a decrease in the capability of the PM trap that would cause a vehicle's emissions to exceed 1.5 times the applicable standards.~~

~~(15.2.2)For 2005 and 2006 model year diesel medium-duty vehicles (including medium-duty passenger vehicles certified to an engine dynamometer tailpipe standard), the OBD II system shall detect a malfunction of the PM trap when catastrophic failure occurs. The Executive Officer shall exempt vehicles from this PM trap monitoring requirement upon determining that the manufacturer has demonstrated with data and/or engineering evaluation that catastrophic failure of the PM trap will not cause emissions to exceed 1.5 times the applicable standards.~~

~~(15.2.3)For 2007 and subsequent model year diesel medium-duty vehicles, the OBD II system shall detect a malfunction prior to a decrease in the capability of the PM trap that would cause a vehicle's emissions to exceed 1.5 times the applicable standards.~~

~~(15.2.4)For vehicles subject to the malfunction criteria in sections (e)(15.2.1) or (15.2.3) above, if no failure or deterioration of the PM trap could result in a vehicle's emissions exceeding 1.5 times any of the applicable standards, the OBD II system shall detect a malfunction when catastrophic failure of the PM trap occurs.~~

~~(15.3)Monitoring Conditions: Manufacturers shall define the monitoring conditions for malfunctions identified in section (e)(15.2) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements).~~

~~(15.4)MIL Illumination and Fault Code Storage: General requirements for MIL illumination and fault code storage are set forth in section (d)(2).~~

~~(16)~~(15) COMPREHENSIVE COMPONENT MONITORING

~~(16.1)~~(15.1) Requirement:

~~(16.1.1)~~(15.1.1) Except as provided in sections (e)(15~~6~~.1.3), (e)(15.1.4), and (e)(1~~7~~6), the OBD II system shall monitor for malfunction any electronic powertrain component/system not otherwise described in sections (e)(1) through (e)(1~~5~~4) that either provides input to (directly or indirectly) or receives commands from the on-board computer(s), and: (1) can affect emissions during any reasonable in-use driving condition, or (2) is used as part of the diagnostic strategy for any other monitored system or component.

(A) Input Components: Input components required to be monitored may include the vehicle speed sensor, crank angle sensor, knock sensor, throttle position sensor, cam position sensor, fuel composition sensor (e.g. flexible fuel vehicles), and transmission electronic components such as sensors, modules, and solenoids which provide signals to the powertrain control system.

(B) Output Components/Systems: Output components/systems required to be monitored may include the idle speed control system, automatic transmission solenoids or controls, variable length intake manifold runner systems, supercharger or turbocharger electronic components, heated fuel preparation systems, ~~the wait-to-start lamp on diesel applications,~~ and a warm-up catalyst bypass valve.

~~(16.1.2)~~(15.1.2) For purposes of criteria (1) in section (e)(1~~6~~5.1.1) above, the manufacturer shall determine whether a powertrain input or output component/system can affect emissions. If the Executive Officer reasonably believes that a manufacturer has incorrectly determined that a component/system cannot affect emissions, the Executive Officer shall require the manufacturer to provide emission data showing that the component/system, when malfunctioning and installed in a suitable test vehicle, does not have an emission effect. The Executive Officer may request ~~E~~emission data ~~may be requested~~ for any reasonable driving condition.

~~(16.1.3)~~(15.1.3) Manufacturers shall monitor for malfunction electronic powertrain input or output components/systems associated with an electronic transfer case, electronic power steering system, or other components that are driven by the engine and not related to the control of fueling, air handling, or emissions only if the ~~transfer case~~ component or system is used as part of the diagnostic strategy for any other monitored system or component.

(15.1.4) Except as specified for hybrids in section (e)(15.1.5), manufacturers shall monitor for malfunction electronic powertrain input or output components/systems associated with components that only affect emissions by causing additional electrical load to the engine and are not related to the control of fueling, air handling, or emissions only if the component or system is used as part of the diagnostic strategy for any other monitored system or component.

(15.1.5) For hybrids, manufacturers shall submit a plan to the Executive Officer for approval of the hybrid components determined by the manufacturer to be subject to monitoring in section (e)(15.1.1). In general, the Executive Officer shall approve the plan if it includes monitoring of all components/systems used as part of the diagnostic strategy for any other monitored system or component, monitoring of all energy input devices to the electrical propulsion system, monitoring of battery and charging system performance, monitoring of electric motor performance, and monitoring of regenerative braking performance.

~~(16.2)~~(15.2) Malfunction Criteria:

~~(16.2.1)~~(15.2.1) Input Components:

(A) The OBD II system shall detect malfunctions of input components caused by a lack of circuit continuity, out of range values, and, where feasible, rationality faults. To the extent feasible, the rationality fault diagnostics shall verify that a sensor output is neither inappropriately high nor inappropriately low (e.g., "two-sided" diagnostics).

(B) To the extent feasible on all 2005 and subsequent model year vehicles, rationality faults shall be separately detected and store different fault codes than the respective lack of circuit continuity and out of range diagnostics. Additionally, input component lack of circuit continuity and out of range faults shall be separately detected and store different fault codes for each distinct malfunction (e.g., out-of-range low, out-of-range high, open circuit, etc.). Manufacturers are not required to store separate fault codes for lack of circuit continuity faults that cannot be distinguished from other out-of-range circuit faults.

(C) For vehicles that require precise alignment between the camshaft and the crankshaft, the OBD II system shall monitor the crankshaft position sensor(s) and camshaft position sensor(s) to verify proper alignment between the camshaft and crankshaft in addition to monitoring the sensors for circuit continuity and rationality malfunctions. Proper alignment monitoring between a camshaft and a crankshaft shall only be required in cases where both are equipped with position sensors. For 2006 ~~and subsequent~~ through 2008 model year Low Emission Vehicle II applications and all 2009 and subsequent model year vehicles equipped with VVT systems and a timing belt or chain, the OBD II system shall detect a malfunction if the alignment between the camshaft and crankshaft is off by one or more cam/crank sprocket cogs (e.g., the timing belt/chain has slipped by one or more teeth/cogs). If a manufacturer demonstrates that a single tooth/cog misalignment cannot cause a measurable increase in emissions during any reasonable driving condition, the manufacturer shall detect a malfunction when the minimum number of teeth/cogs misalignment needed to cause a measurable emission increase has occurred. For the 2006 through ~~2008~~ 2009 model years only, a manufacturer may also request Executive Officer approval to use a larger threshold than one tooth/cog. The Executive Officer shall approve the request upon determining that the manufacturer has demonstrated that hardware modifications are necessary to meet the one tooth/cog threshold and that further software modifications are not able to reduce the larger threshold.

~~(16.2.2)~~(15.2.2) Output Components/Systems:

(A) The OBD II system shall detect a malfunction of an output component/system when proper functional response of the component and system to computer commands does not occur. If a functional check is not feasible, the OBD II system shall detect malfunctions of output components/systems caused by a lack of circuit continuity or circuit fault (e.g., short to ground or high voltage). For output component lack of circuit continuity faults and circuit faults, manufacturers are not required to store different fault codes for each distinct malfunction (e.g., open circuit, shorted low, etc.). Manufacturers are not required to activate an output component/system when it would not normally be active ~~exclusively~~ for the purposes of performing functional monitoring of output components/systems as required in section (e)(1~~6~~5).

(B) The idle speed control system shall be monitored for proper functional response to computer commands. For strategies based on deviation from target idle speed, a malfunction shall be detected when either of the following conditions occur:

(i) The idle speed control system cannot achieve the target idle speed within 200 revolutions per minute (rpm) above the target speed or 100 rpm below the target speed. The Executive Officer shall allow larger engine speed tolerances upon determining that a manufacturer has submitted data and/or an engineering evaluation which demonstrate that the tolerances can be exceeded without a malfunction being present.

(ii) The idle speed control system cannot achieve the target idle speed within the smallest engine speed tolerance range required by the OBD II system to enable any other monitors.

~~(C)Glow plugs shall be monitored for proper functional response to computer commands. The glow plug circuit(s) shall be monitored for proper current and voltage drop. The Executive Officer shall approve other monitoring strategies based on manufacturer's data and/or engineering analysis demonstrating equally reliable and timely detection of malfunctions. Manufacturers shall detect a malfunction when a single glow plug no longer operates within the manufacturer's specified limits for normal operation. If a manufacturer demonstrates that a single glow plug failure cannot cause a measurable increase in emissions during any reasonable driving condition, the manufacturer shall detect a malfunction for the minimum number of glow plugs needed to cause an emission increase. Further, to the extent feasible on existing engine designs (without adding additional hardware for this purpose) and on all new design engines, the stored fault code shall identify the specific malfunctioning glow plug(s).~~

~~(16.3)~~(15.3) Monitoring Conditions:

~~(16.3.1)~~(15.3.1) Input Components:

(A) Except as provided in section (e)(1~~6~~5.3.1)(C), input components shall be monitored continuously for proper range of values and circuit continuity.

(B) For rationality monitoring (where applicable):

(i) For 2004 model year vehicles, manufacturers shall define the monitoring conditions for detecting malfunctions in accordance with section (d)(3.1).

(ii) For 2005 and subsequent model year vehicles, manufacturers shall define the monitoring conditions for detecting malfunctions in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements), with the exception that rationality monitoring shall occur every time the monitoring conditions are met during the driving cycle in lieu of once per driving cycle as required in section (d)(3.1.2).

(C) A manufacturer may request Executive Officer approval to disable continuous input component proper range of values or circuit continuity monitoring when a malfunction cannot be distinguished from other effects. The Executive Officer shall approve the disablement upon determining that the manufacturer has submitted test data and/or documentation that demonstrate a properly functioning input component cannot be distinguished from a malfunctioning input component and that the disablement interval is limited only to that necessary for avoiding false detection.

~~(16.3.2)~~(15.3.2) Output Components/Systems:

(A) Except as provided in section (e)(1~~6~~5.3.2)(D), monitoring for circuit continuity and circuit faults shall be conducted continuously.

(B) Except as provided in section (e)(1~~6~~5.3.2)(C), for functional monitoring, manufacturers shall define the monitoring conditions for detecting malfunctions in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements).

(C) For the idle speed control system on all 2005 and subsequent model year vehicles, manufacturers shall define the monitoring conditions for functional monitoring in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements), with the exception that functional monitoring shall occur every time the monitoring conditions are met during the driving cycle in lieu of once per driving cycle as required in section (d)(3.1.2).

(D) A manufacturer may request Executive Officer approval to disable continuous output component circuit continuity or circuit fault monitoring when a malfunction cannot be distinguished from other effects. The Executive Officer shall approve the disablement upon determining that the manufacturer has submitted test data and/or documentation that demonstrate a properly functioning output component cannot be distinguished from a malfunctioning output component and that the disablement interval is limited only to that necessary for avoiding false detection.

~~(16.4)~~(15.4) MIL Illumination and Fault Code Storage:

~~(16.4.1)~~(15.4.1) Except as provided in section (e)(15~~6~~.4.2) below, general requirements for MIL illumination and fault code storage are set forth in section (d)(2).

~~(16.4.2)~~(15.4.2) Exceptions to general requirements for MIL illumination. MIL illumination is not required in conjunction with storing a confirmed fault code for any comprehensive component if:

(A) the component or system, when malfunctioning, could not cause vehicle emissions to increase by:

(i) 25 percent or more ~~of the FTP standard~~ for PC/LDT SULEV II vehicles, or

(ii) 15 percent or more ~~of the FTP standard~~ for all other vehicles, and

(B) the component or system is not used as part of the diagnostic strategy for any other monitored system or component.

(15.4.3) For purposes of determining the emission increase in section (e)(15.4.2)(A), the manufacturer shall request Executive Officer approval of the test cycle/vehicle operating conditions for which the emission increase will be determined. Executive Officer approval shall be granted upon determining that the manufacturer has submitted data and/or engineering evaluation that demonstrate that the testing conditions represent in-use driving conditions where emissions are likely to be most affected by the malfunctioning component. For purposes of determining whether the specified percentages in section (e)(15.4.2)(A) are exceeded, if the approved testing conditions are comprised of an emission test cycle with an emission standard, the measured increase shall be compared to a percentage of the emission standard (e.g., if the increase is equal to or more than 15 percent of the emission standard for that test cycle). If the approved testing conditions are comprised of a test cycle or vehicle operating condition that does not have an emission standard, the measured increase shall be calculated as a percentage of the baseline test (e.g., if the increase from a back-to-back test sequence between normal and malfunctioning condition is equal to or more than 15 percent of the baseline test results from the normal condition).

~~(17)~~(16) OTHER EMISSION CONTROL OR SOURCE SYSTEM MONITORING

~~(17.1)~~(16.1) Requirement: For other emission control or source systems that are: (1) not identified or addressed in sections (e)(1) through (e)(1~~6~~5) (e.g., hydrocarbon traps, homogeneous charge compression ignition (HCCI) controls, NOx storage devices, fuel-fired passenger compartment heaters, etc.), or (2) identified or addressed in section (e)(1~~6~~5) but not corrected or compensated for by the adaptive fuel control system (e.g., swirl control valves), manufacturers shall submit a plan for Executive Officer approval of the monitoring strategy, malfunction criteria, and monitoring conditions prior to introduction on a production vehicle intended for sale in California. Executive Officer approval shall be based on the effectiveness of the monitoring strategy, the malfunction criteria utilized, the monitoring conditions required by the diagnostic, and, if applicable, the determination that the requirements of section (e)(1~~7~~6.3) below are satisfied.

~~(17.2)~~(16.2) For purposes of section (e)(1~~7~~6), emission source systems are components or devices that emit pollutants subject to vehicle evaporative and exhaust emission standards (e.g., NMOG, CO, NOx, PM, etc.) and include non-electronic components and non-powertrain components (e.g., fuel-fired passenger compartment heaters, on-board reformers, etc.).

~~(17.3)~~(16.3) Except as provided below in this paragraph, for 2005 and subsequent model year vehicles that utilize emission control systems that alter intake air flow or cylinder charge characteristics by actuating valve(s), flap(s), etc. in the intake air delivery system (e.g., swirl control valve systems), the manufacturers, in addition to meeting the requirements of section (e)(176.1) above, may elect to have the OBD II system monitor the shaft to which all valves in one intake bank are physically attached in lieu of monitoring the intake air flow, cylinder charge, or individual valve(s)/flap(s) for proper functional response. For non-metal shafts or segmented shafts, the monitor shall verify all shaft segments for proper functional response (e.g., by verifying the segment or portion of the shaft furthest from the actuator properly functions). For systems that have more than one shaft to operate valves in multiple intake banks, manufacturers are not required to add more than one set of detection hardware (e.g., sensor, switch, etc.) per intake bank to meet this requirement. Vehicles utilizing these emission control systems designed and certified for 2004 or earlier model year vehicles and carried over to the 2005 through 2008 2009 model year shall be not be required to meet the provisions of section (e)(176.3) until the engine or intake air delivery system is redesigned.

(18)(17) EXCEPTIONS TO MONITORING REQUIREMENTS

(18.1)(17.1) Except as provided in sections (e)(187.1.1) through (187.1.3) below, upon request of a manufacturer or upon the best engineering judgment of the ARB, the Executive Officer may revise the emission threshold for a malfunction on any check diagnostic required in section (e) on a Low Emission Vehicle I application or Low Emission Vehicle II application if the most reliable monitoring method developed requires a higher threshold to prevent significant errors of commission in detecting a malfunction.

(18.1.1)(17.1.1) For PC/LDT SULEV II vehicles, the Executive Officer shall approve a malfunction criteria of 2.5 times the applicable FTP standards in lieu of 1.5 wherever required in section (e).

(18.1.2)(17.1.2) For 2004 model year PC/LDT SULEV II vehicles only, the Executive Officer shall approve monitors with thresholds that exceed 2.5 times the applicable FTP standard if the manufacturer demonstrates that a higher threshold is needed given the state of development of the vehicle and that the malfunction criteria and monitoring approach and technology (e.g., fuel system limits, percent misfire, monitored catalyst volume, etc.) are at least as stringent as comparable ULEV (not ULEV II) vehicles.

(18.1.3)(17.1.3) For vehicles certified to Federal Bin 3 or Bin 4 emission standards, manufacturers shall utilize the ULEV II vehicle NMOG and CO malfunction criteria (e.g., 1.5 times the Bin 3 or Bin 4 NMOG and CO standards) and the PC/LDT SULEV II vehicle NOx malfunction criteria (e.g., 2.5 times the Bin 3 or Bin 4 NOx standards).

(17.1.4) For medium-duty vehicles certified to an engine dynamometer tailpipe emission standard, the manufacturer shall request Executive Officer approval of a malfunction criterion that is equivalent to that proposed for each monitor in section (e). The Executive Officer shall approve the request upon finding that the manufacturer has used good engineering judgment in determining the equivalent malfunction criterion and that the criterion will provide for similar timeliness in detection of malfunctioning components.

~~(18.2)~~(17.2) Whenever the requirements in section (e) of this regulation require a manufacturer to meet a specific phase-in schedule (e.g., (e)(11) cold start emission reduction strategy monitoring requires 30 percent in 2006 model year, 60 percent in 2007 model year, and 100 percent in 2008 model year):

~~(18.2.1)~~(17.2.1) The phase-in percentages shall be based on the manufacturer's projected sales volume for all vehicles subject to the requirements of title 13, CCR section 1968.2 unless specifically stated otherwise in section (e).

~~(18.2.2)~~(17.2.2) Manufacturers may use an alternate phase-in schedule in lieu of the required phase-in schedule if the alternate phase-in schedule provides for equivalent compliance volume as defined in section (c) except as specifically noted for the phase in of in-use monitor performance ratio monitoring conditions in section (d)(3.2).

~~(18.2.3)~~(17.2.3) Small volume manufacturers may use an alternate phase-in schedule in accordance with section (e)(1~~8~~7.2.2) in lieu of the required phase-in schedule or may meet the requirement on all vehicles by the final year of the phase-in in lieu of meeting the specific phase-in requirements for each model year (e.g., in the example in section (e)(1~~8~~7.2), small volume manufacturers are required to meet 100~~%~~ percent in the 2008 model year for cold start emission reduction strategy monitoring, but not 30~~%~~ percent in the 2006 model year or 60~~%~~ percent in the 2007 model year).

~~(18.3)~~(17.3) Manufacturers may request Executive Officer approval to disable an OBD II system monitor at ambient ~~engine starting~~ temperatures below twenty degrees Fahrenheit (20°F) (low ambient temperature conditions may be determined based on intake air or engine coolant temperature at engine starting) or at elevations above 8000 feet above sea level. The Executive Officer shall approve the request upon determining that the manufacturer has provided data and/or an engineering evaluation that demonstrate that monitoring during the conditions would be unreliable. A manufacturer may further request, and the Executive Officer shall approve, that an OBD II system monitor be disabled at other ambient ~~engine starting~~ temperatures upon determining that the manufacturer has demonstrated with data and/or an engineering evaluation that misdiagnosis would occur at the ambient temperatures because of its effect on the component itself (e.g., component freezing).

~~(18.4)~~(17.4) Manufacturers may request Executive Officer approval to disable monitoring systems that can be affected by low fuel level or running out of fuel (e.g., misfire detection) when the fuel level is 15 percent or less of the nominal capacity of the fuel tank. The Executive Officer shall approve the request upon determining that the manufacturer has submitted data and/or an engineering evaluation that demonstrate that monitoring at the fuel levels would be unreliable.

~~(18.5)~~(17.5) Manufacturers may disable monitoring systems that can be affected by vehicle battery or system voltage levels.

~~(18.5.1)~~(17.5.1) For monitoring systems affected by low vehicle battery or system voltages, manufacturers may disable monitoring systems when the battery or system voltage is below 11.0 Volts. Manufacturers may request Executive Officer approval to utilize a voltage threshold higher than 11.0 Volts to disable system monitoring. The Executive Officer shall approve the request upon determining that the manufacturer has submitted data and/or an engineering evaluation that demonstrate that monitoring at the voltages would be unreliable and that either operation of a vehicle below the disablement criteria for extended periods of time is unlikely or the OBD II system monitors the battery or system voltage and will detect a malfunction at the voltage used to disable other monitors.

~~(18.5.2)~~(17.5.2) For monitoring systems affected by high vehicle battery or system voltages, manufacturers may request Executive Officer approval to disable monitoring systems when the battery or system voltage exceeds a manufacturer-defined voltage. The Executive Officer shall approve the request upon determining that the manufacturer has submitted data and/or an engineering evaluation that demonstrate that monitoring above the manufacturer-defined voltage would be unreliable and that either the electrical charging system/alternator warning light is illuminated (or voltage gauge is in the "red zone") or that the OBD II system monitors the battery or system voltage and will detect a malfunction at the voltage used to disable other monitors.

~~(18.6)~~(17.6) A manufacturer may disable affected monitoring systems in vehicles designed to accommodate the installation of Power Take-Off -(PTO) units (as defined in section (c)), provided disablement occurs only while the PTO unit is active, and the OBD II readiness status is cleared by the on-board computer (i.e., all monitors set to indicate "not complete") while the PTO unit is activated (see section ~~(f)~~(g)(4.1)~~-below~~). If the disablement occurs, the readiness status may be restored to its state prior to PTO activation when the disablement ends.

~~(18.7)~~(17.7) A manufacturer may request Executive Officer approval to disable affected monitoring systems in vehicles equipped with tire pressure monitoring systems that cause a vehicle to enter a default mode of operation (e.g., reduced top speed) when a tire pressure problem is detected. The Executive Officer shall approve the request upon determining that the manufacturer has submitted data and/or an engineering evaluation that demonstrate that the default mode can affect monitoring system performance, that the tire pressure monitoring system will likely result in action by the consumer to correct the problem, and that the disablement will not prevent or hinder effective testing in an Inspection and Maintenance program.

(17.8) Whenever the requirements in section (e) of this regulation require monitoring "to the extent feasible", the manufacturer shall submit its proposed monitor(s) for Executive Officer approval. The Executive Officer shall approve the proposal upon determining that the proposed monitor(s) meets the criteria of "to the extent feasible" by considering the best available monitoring technology, the extent and degree to which the monitoring requirements are met in full, the limitations of monitoring necessary to prevent significant errors of commission and omission, and the extent to which the manufacturer has considered and pursued alternative monitoring concepts to meet the requirements in full. The manufacturer's consideration and pursuit of alternative monitoring concepts shall include evaluation of other modifications to the proposed monitor(s), the monitored components themselves, and other monitors that use the monitored components (e.g., altering other monitors to lessen the sensitivity and reliance on the component or characteristic of the component subject to the proposed monitor(s)).

~~(18.8)~~(17.9) For 2004 model year vehicles certified to run on alternate fuels, manufacturers may request the Executive Officer to waive specific monitoring requirements in section (e) for which monitoring may not be reliable with respect to the use of alternate fuels. The Executive Officer shall grant the request upon determining that the manufacturer has demonstrated that the use of the alternate fuel could cause false illumination of the MIL even when using the best available monitoring technologies.

~~(18.9)~~(17.10) For 2004 model year vehicles only, wherever the requirements of section (e) ~~(except for diesel catalyst (section (e)(1.5)) and particulate matter trap (section (e)(15)) monitoring)~~ reflect a substantive change from the requirements of title 13, CCR section 1968.1(b) for 2003 model year vehicles, the manufacturer may request Executive Officer approval to continue to use the requirements of section 1968.1 in lieu of the requirements of section (e). The Executive Officer shall approve the request upon determining that the manufacturer has submitted data and/or engineering evaluation that demonstrate that software or hardware changes would be required to comply with the requirements of section (e) and that the system complies with the requirements of section 1968.1(b).

(f) *MONITORING REQUIREMENTS FOR DIESEL/COMPRESSION-IGNITION ENGINES*

(1) NON-METHANE HYDROCARBON (NMHC) CONVERTING CATALYST MONITORING

(1.1) Requirement: The OBD II system shall monitor the NMHC converting catalyst(s) for proper NMHC conversion capability. For vehicles equipped with catalyzed PM filters that convert NMHC emissions, the catalyst function of the PM filter shall be monitored in accordance with the PM filter requirements in section (f)(9).

(1.2) Malfunction Criteria:

(1.2.1) For purposes of section (f)(1), each catalyst in a series configuration that converts NMHC shall be monitored either individually or in combination with others.

(1.2.2) Conversion Efficiency:

(A) The OBD II system shall detect an NMHC catalyst malfunction when the catalyst conversion capability decreases to the point that NMHC emissions exceed:

(i) For passenger cars, light-duty trucks, and MDPVs certified to a chassis dynamometer tailpipe emission standard:

a. 5.0 times the applicable FTP standards for 2004 through 2009 model year vehicles;

b. 3.0 times the applicable FTP standards for 2010 through 2012 model year vehicles; and

c. 1.75 times the applicable FTP standards for 2013 and subsequent model year vehicles.

(ii) For medium-duty vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard:

a. 2.5 times the applicable standards for 2007 through 2012 model year vehicles; and

b. 2.0 times the applicable standards for 2013 and subsequent model year vehicles.

(B) Except as provided below in section (f)(1.2.2)(C), if no failure or deterioration of the catalyst NMHC conversion capability could result in NMHC emissions exceeding the applicable malfunction criteria of section (f)(1.2.2)(A), the OBD II system shall detect a malfunction when the catalyst has no detectable amount of NMHC conversion capability.

(C) For 2004 through 2009 model year vehicles, a manufacturer may request to be exempted from the requirements for NMHC catalyst conversion efficiency monitoring. The Executive Officer shall approve the request upon determining that the manufacturer has demonstrated, through data and/or engineering evaluation, that the average FTP test NMHC conversion efficiency of the system is less than 30 percent (i.e., the cumulative NMHC emissions measured at the outlet of the catalyst are more than 70 percent of the cumulative engine-out NMHC emissions measured at the inlet of the catalyst(s)).

(1.2.3) Other Aftertreatment Assistance Functions. Additionally, for 2010 and subsequent model year vehicles, the catalyst(s) shall be monitored for other aftertreatment assistance functions:

(A) For catalysts used to generate an exotherm to assist PM filter regeneration, the OBD II system shall detect a malfunction when the catalyst is unable to generate a sufficient exotherm to achieve regeneration of the PM filter.

(B) For catalysts used to generate a feedgas constituency to assist SCR systems (e.g., to increase NO_2 concentration upstream of an SCR system), the OBD II system shall detect a malfunction when the catalyst is unable to generate the necessary feedgas constituents for proper SCR system operation.

(C) For catalysts located downstream of a PM filter and used to convert NMHC emissions during PM filter regeneration, the OBD II system shall detect a malfunction when the catalyst has no detectable amount of NMHC conversion capability.

(D) For catalysts located downstream of an SCR system and used to prevent ammonia slip, the OBD II system shall detect a malfunction when the catalyst has no detectable amount of NMHC, CO, NOx, or PM conversion capability. ~~m~~Monitoring of the catalyst shall not be required if there is no measurable emission impact on the criteria pollutants (i.e., NMHC, CO, NOx, and PM) during any reasonable driving condition where the catalyst is most likely to affect criteria pollutants (e.g., during conditions most likely to result in ammonia generation or excessive reductant delivery).

(1.2.4) Catalyst System Aging and Monitoring

(A) For purposes of determining the catalyst malfunction criteria in sections (f)(1.2.2) and (1.2.3) for individually monitored catalysts, the manufacturer shall use a catalyst(s) deteriorated to the malfunction criteria using methods established by the manufacturer to represent real world catalyst deterioration under normal and malfunctioning engine operating conditions. If the catalyst system contains catalysts in parallel (e.g., a two bank exhaust system where each bank has its own catalyst), the malfunction criteria shall be determined with the "parallel" catalysts equally deteriorated.

(B) For purposes of determining the catalyst malfunction criteria in sections (f)(1.2.2) and (1.2.3) for catalysts monitored in combination with others, the manufacturer shall submit a catalyst system aging and monitoring plan to the Executive Officer for review and approval. The plan shall include the description, emission control purpose, and location of each component, the monitoring strategy for each component and/or combination of components, and the method for determining the malfunction criteria of sections (f)(1.2.2) and (1.2.3) including the deterioration/aging process. If the catalyst system contains catalysts in parallel (e.g., a two bank exhaust system where each bank has its own catalyst), the malfunction criteria shall be determined with the "parallel" catalysts equally deteriorated. Executive Officer approval of the plan shall be based on the representativeness of the aging to real world catalyst system component deterioration under normal and malfunctioning engine operating conditions, the effectiveness of the method used to determine the malfunction criteria of section (f)(1.2), the ability of the component monitor(s) to pinpoint the likely area of malfunction and ensure the correct components are repaired/replaced in-use, and the ability of the component monitor(s) to accurately verify that each catalyst component is functioning as designed and as required in sections (f)(1.2.2) and (1.2.3).

(1.3) Monitoring Conditions:

(1.3.1) Manufacturers shall define the monitoring conditions for malfunctions identified in sections (f)(1.2.2) and (1.2.3) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). For purposes of tracking and reporting as required in section (d)(3.2.2), all monitors used to detect malfunctions identified in sections (f)(1.2.2) and (1.2.3) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).

(1.4) MIL Illumination and Fault Code Storage:

(1.4.1) General requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(1.4.2) The monitoring method for the catalyst(s) shall be capable of detecting all instances, except diagnostic self-clearing, when a catalyst fault code has been cleared but the catalyst has not been replaced (e.g., catalyst overtemperature histogram approaches are not acceptable).

(2) OXIDES OF NITROGREN (NOx) CONVERTING CATALYST MONITORING

(2.1) Requirement: The OBD II system shall monitor the NOx converting catalyst(s) for proper conversion capability. For vehicles equipped with selective catalytic reduction (SCR) systems or other catalyst systems that utilize an active/intrusive reductant injection (e.g., active lean NOx catalysts utilizing diesel fuel injection), the OBD II system shall monitor the SCR or active/intrusive reductant injection system for proper performance. The individual electronic components (e.g., actuators, valves, sensors, heaters, pumps) in the SCR or active/intrusive reductant injection system shall be monitored in accordance with the comprehensive component requirements in section (f)(15).

(2.2) Malfunction Criteria:

(2.2.1) For purposes of section (f)(2), each catalyst in a series configuration that converts NOx shall be monitored either individually or in combination with others.

(2.2.2) Conversion Efficiency:

(A) The OBD II system shall detect a NOx catalyst malfunction when the catalyst conversion capability decreases to the point that NOx or NMHC emissions exceed:

(i) For passenger cars, light-duty trucks, and MDPVs certified to a chassis dynamometer tailpipe emission standard:

a. 3.0 times the applicable FTP standards for 2004 through 2009 model year vehicles;

b. 2.5 times the applicable FTP standards for 2010 through 2012 model year vehicles; and

c. 1.75 times the applicable FTP standards for 2013 and subsequent model year vehicles.

(ii) For medium-duty vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard:

a. the applicable NOx standard by more than 0.5 g/bhp-hr (e.g., cause NOx emissions to exceed 0.7 g/bhp-hr if the emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test or 3.5 times the applicable NMHC standard for 2007 through 2009 model year vehicles;

b. the applicable NOx standard by more than 0.3 g/bhp-hr (e.g., cause NOx emissions to exceed 0.5 g/bhp-hr if the emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test or 2.5 times the applicable NMHC standard for 2010 through 2012 model year vehicles; and

c. the applicable NOx standard by more than 0.2 g/bhp-hr (e.g., cause NOx emissions to exceed 0.4 g/bhp-hr if the emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test or 2.0 times the applicable NMHC standard for 2013 and subsequent model year vehicles.

(B) Except as provided below in section (f)(2.2.2)(C), if no failure or deterioration of the catalyst NOx or NMHC conversion capability could result in NOx or NMHC emissions exceeding the applicable malfunction criteria of section (f)(2.2.2), the OBD II system shall detect a malfunction when the catalyst has no detectable amount of NOx or NMHC conversion capability.

(C) For 2004 through 2009 model year vehicles, a manufacturer may request to be exempted from the requirements for NOx catalyst conversion efficiency monitoring. The Executive Officer shall approve the request upon determining that the manufacturer has demonstrated, through data and/or engineering evaluation, that the average FTP test NOx conversion efficiency of the system is less than 30 percent (i.e., the cumulative NOx emissions measured at the outlet of the catalyst are more than 70 percent of the cumulative engine-out NOx emissions measured at the inlet of the catalyst(s)).

(2.2.3) Selective Catalytic Reduction (SCR) or Other Active/Intrusive Reductant Injection System Performance:

(A) Reductant Delivery Performance:

(i) For 2007 and subsequent model year vehicles, the OBD II system shall detect a system malfunction prior to any failure or deterioration of the system to properly regulate reductant delivery (e.g., urea injection, separate injector fuel injection, post injection of fuel, air assisted injection/mixing) that would cause a vehicle's NOx or NMHC emissions to exceed the applicable emission levels specified in sections (f)(2.2.2)(A).

(ii) If no failure or deterioration of the reductant delivery system could result in a vehicle's NOx or NMHC emissions exceeding the applicable malfunction criteria specified in section (f)(2.2.3)(A)(i), the OBD II system shall detect a malfunction when the system has reached its control limits such that it is no longer able to deliver the desired quantity of reductant.

(B) If the catalyst system uses a reductant other than the fuel used for the engine or uses a reservoir/tank for the reductant that is separate from the fuel tank used for the engine, the OBD II system shall detect a malfunction when there is no longer sufficient reductant available to properly operate the reductant system (e.g., the reductant tank is empty).

(C) If the catalyst system uses a reservoir/tank for the reductant that is separate from the fuel tank used for the vehicle, the OBD II system shall detect a malfunction when an improper reductant is used in the reductant reservoir/tank (e.g., the reductant tank is filled with something other than the reductant).

(D) Feedback control: Except as provided for in section (f)(2.2.3)(E), if the vehicle is equipped with feedback control of the reductant injection, the OBD II system shall detect a malfunction:

(i) If the system fails to begin feedback control within a manufacturer specified time interval;

(ii) If a failure or deterioration causes open loop or default operation; or

(iii) If feedback control has used up all of the adjustment allowed by the manufacturer and cannot achieve the feedback target.

(E) A manufacturer may request Executive Officer approval to temporarily disable monitoring for the malfunction criteria specified in section (f)(2.2.3)(D)(iii) during conditions that a manufacturer cannot robustly distinguish between a malfunctioning system and a properly operating system. The Executive Officer shall approve the disablement upon the manufacturer submitting data and/or analysis demonstrating that the control system, when operating as designed on a vehicle with all emission controls working properly, routinely operates during these conditions with all of the adjustment allowed by the manufacturer used up.

(F) In lieu of detecting the malfunctions specified in sections (f)(2.2.3)(D)(i) and (ii) with a reductant injection system-specific monitor, the OBD II system may monitor the individual parameters or components that are used as inputs for reductant injection feedback control provided that the monitors detect all malfunctions that meet the criteria in sections (f)(2.2.3)(D)(i) and (ii).

(2.2.4) Catalyst System Aging and Monitoring

(A) For purposes of determining the catalyst malfunction criteria in section (f)(2.2.2) for individually monitored catalysts, the manufacturer shall use a catalyst deteriorated to the malfunction criteria using methods established by the manufacturer to represent real world catalyst deterioration under normal and malfunctioning engine operating conditions. If the catalyst system contains catalysts in parallel (e.g., a two bank exhaust system where each bank has its own catalyst), the malfunction criteria shall be determined with the "parallel" catalysts equally deteriorated.

(B) For purposes of determining the catalyst malfunction criteria in section (f)(2.2.2) for catalysts monitored in combination with others, the manufacturer shall submit a catalyst system aging and monitoring plan to the Executive Officer for review and approval. The plan shall include the description, emission control purpose, and location of each component, the monitoring strategy for each component and/or combination of components, and the method for determining the malfunction criteria of section (f)(2.2.2) including the deterioration/aging process. If the catalyst system contains catalysts in parallel (e.g., a two bank exhaust system where each bank has its own catalyst), the malfunction criteria shall be determined with the "parallel" catalysts equally deteriorated. Executive Officer approval of the plan shall be based on the representativeness of the aging to real world catalyst system component deterioration under normal and malfunctioning engine operating conditions, the effectiveness of the method used to determine the malfunction criteria of section (f)(2.2.2), the ability of the component monitor(s) to pinpoint the likely area of malfunction and ensure the correct components are repaired/replaced in-use, and the ability of the component monitor(s) to accurately verify that each catalyst component is functioning as designed and as required in section (f)(2.2.2).

(2.3) Monitoring Conditions:

(2.3.1) Manufacturers shall define the monitoring conditions for malfunctions identified in section (f)(2.2.2) (i.e., catalyst efficiency) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). For purposes of tracking and reporting as required in section (d)(3.2.2), all monitors used to detect malfunctions identified in section (f)(2.2.2) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).

(2.3.2) The OBD II system shall monitor continuously for malfunctions identified in section (f)(2.2.3) (e.g., SCR performance).

(2.4) MIL Illumination and Fault Code Storage:

(2.4.1) Except as provided below for reductant faults, general requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(2.4.2) If the OBD II system is capable of discerning that a system fault is being caused by a empty reductant tank:

(A) The manufacturer may request Executive Officer approval to delay illumination of the MIL if the vehicle is equipped with an alternative indicator for notifying the vehicle operator of the malfunction. The Executive Officer shall approve the request upon determining the alternative indicator is of sufficient illumination and location to be readily visible under all lighting conditions and provides equivalent assurance that a vehicle operator will be promptly notified and that corrective action will be undertaken.

(B) If the vehicle is not equipped with an alternative indicator and the MIL illuminates, the MIL may be immediately extinguished and the corresponding fault codes erased once the OBD II system has verified that the reductant tank has been properly refilled and the MIL has not been illuminated for any other type of malfunction.

(C) The Executive Officer may approve other strategies that provide equivalent assurance that a vehicle operator will be promptly notified and that corrective action will be undertaken.

(2.4.3) The monitoring method for the catalyst(s) shall be capable of detecting all instances, except diagnostic self-clearing, when a catalyst fault code has been cleared but the catalyst has not been replaced (e.g., catalyst overtemperature histogram approaches are not acceptable).

(3) MISFIRE MONITORING

(3.1) Requirement:

(3.1.1) The OBD II system shall monitor the engine for misfire causing excess emissions. The OBD II system shall be capable of detecting misfire occurring in one or more cylinders. To the extent possible without adding hardware for this specific purpose, the OBD II system shall also identify the specific misfiring cylinder.

(3.1.2) If more than one cylinder is misfiring, a separate fault code shall be stored indicating that multiple cylinders are misfiring. When identifying multiple cylinder misfire, the OBD II system is not required to also identify each of the misfiring cylinders individually through separate fault codes.

(3.2) Malfunction Criteria:

(3.2.1) The OBD II system shall detect a misfire malfunction when one or more cylinders are continuously misfiring.

(3.2.2) Additionally, for 2010 and subsequent model year vehicles equipped with sensors that can detect combustion or combustion quality (e.g., for use in homogeneous charge compression ignition (HCCI) control systems):

(A) The OBD II system shall detect a misfire malfunction that would cause a vehicle's NMHC, CO, NOx, or PM emissions to exceed:

(i) For passenger cars, light-duty trucks, and MDPVs certified to a chassis dynamometer tailpipe emission standard, 1.5 times any of the applicable FTP standards.

(ii) For medium-duty vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard, 2.0 times any of the applicable NMHC, CO, and NOx standards or 0.03 g/bhp-hr PM as measured from an applicable cycle emission test.

(B) Manufacturers shall determine the percentage of misfire evaluated in 1000 revolution increments that would cause NMHC, CO, NOx, or PM emissions from an emission durability demonstration vehicle to exceed the levels specified in section (f)(3.2.2)(A) if the percentage of misfire were present from the beginning of the test. To establish this percentage of misfire, the manufacturer shall utilize misfire events occurring at equally spaced, complete engine cycle intervals, across randomly selected cylinders throughout each 1000-revolution increment. If this percentage of misfire is determined to be lower than one percent, the manufacturer may set the malfunction criteria at one percent.

(C) Subject to Executive Officer approval, a manufacturer may employ other revolution increments. The Executive Officer shall grant approval upon determining that the manufacturer has demonstrated that the strategy would be equally effective and timely in detecting misfire.

(3.2.3) A malfunction shall be detected if the percentage of misfire established in section (f)(3.2.2)(B) is exceeded regardless of the pattern of misfire events (e.g., random, equally spaced, continuous).

(3.3) Monitoring Conditions:

(3.3.1) The OBD II system shall monitor for misfire during engine idle conditions at least once per driving cycle in which the monitoring conditions for misfire are met. A manufacturer shall submit monitoring conditions to the Executive Officer for approval. The Executive Officer shall approve manufacturer-defined monitoring conditions that are determined (based on manufacturer-submitted data and/or other engineering documentation) to: (i) be technically necessary to ensure robust detection of malfunctions (e.g., avoid false passes and false detection of malfunctions), (ii) require no more than 1000 cumulative engine revolutions, and (iii) do not require any single continuous idle operation of more than 15 seconds to make a determination that a malfunction is present (e.g., a decision can be made with data gathered during several idle operations of 15 seconds or less); or satisfy the requirements of (d)(3.1) with alternative engine operating conditions.

(3.3.2) Manufacturers may request Executive Officer approval to use alternate monitoring conditions (e.g., off-idle). The Executive Officer shall approve alternate monitoring conditions that are determined (based on manufacturer-submitted data and/or other engineering documentation) to ensure equivalent robust detection of malfunctions and equivalent timeliness in detection of malfunctions.

(3.3.3) Additionally, for 2010 and subsequent model year vehicles subject to (f)(3.2.2):

(A) The OBD II system shall continuously monitor for misfire under all positive torque engine speeds and load conditions.

(B) If a monitoring system cannot detect all misfire patterns under all required engine speed and load conditions as required in section (f)(3.3.3)(A), the manufacturer may request Executive Officer approval to accept the monitoring system. In evaluating the manufacturer's request, the Executive Officer shall consider the following factors: the magnitude of the region(s) in which misfire detection is limited, the degree to which misfire detection is limited in the region(s) (i.e., the probability of detection of misfire events), the frequency with which said region(s) are expected to be encountered in-use, the type of misfire patterns for which misfire detection is troublesome, and demonstration that the monitoring technology employed is not inherently incapable of detecting misfire under required conditions (i.e., compliance can be achieved on other engines). The evaluation shall be based on the following misfire patterns: equally spaced misfire occurring on randomly selected cylinders, single cylinder continuous misfire, and paired cylinder (cylinders firing at the same crank angle) continuous misfire.

(3.4) MIL Illumination and Fault Code Storage:

(3.4.1) General requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(3.4.2) Additionally, for 2010 and subsequent model year vehicles subject to (f)(3.2.2):

(A) Upon detection of the percentage of misfire specified in section (f)(3.2.2)(B), the following criteria shall apply for MIL illumination and fault code storage:

(i) A pending fault code shall be stored no later than after the fourth exceedance of the percentage of misfire specified in section (f)(3.2.2)(B) during a single driving cycle.

(ii) If a pending fault code is stored, the OBD II system shall illuminate the MIL and store a confirmed fault code within 10 seconds if the percentage of misfire specified in section (f)(3.2.2)(B) is again exceeded four times during: (a) the driving cycle immediately following the storage of the pending fault code, regardless of the conditions encountered during the driving cycle; or (b) on the next driving cycle in which similar conditions (see section (c)) to the engine conditions that occurred when the pending fault code was stored are encountered.

(iii) The pending fault code may be erased at the end of the next driving cycle in which similar conditions to the engine conditions that occurred when the pending fault code was stored have been encountered without an exceedance of the specified percentage of misfire. The pending code may also be erased if similar conditions are not encountered during the next 80 driving cycles immediately following initial detection of the malfunction.

(B) Storage of freeze frame conditions.

(i) The OBD II system shall store and erase freeze frame conditions either in conjunction with storing and erasing a pending fault code or in conjunction with storing a confirmed fault code and erasing a confirmed fault code.

(ii) If freeze frame conditions are stored for a malfunction other than a misfire malfunction when a fault code is stored as specified in section (f)(3.4.2), the stored freeze frame information shall be replaced with freeze frame information regarding the misfire malfunction.

(C) Storage of misfire conditions for similar conditions determination. Upon detection of misfire under section (f)(3.4.2), the OBD II system shall store the following engine conditions: engine speed, load, and warm-up status of the first misfire event that resulted in the storage of the pending fault code.

(D) Extinguishing the MIL. The MIL may be extinguished after three sequential driving cycles in which similar conditions have been encountered without an exceedance of the specified percentage of misfire.

(4) FUEL SYSTEM MONITORING

(4.1) Requirement:

The OBD II system shall monitor the fuel delivery system to determine its ability to comply with emission standards. The individual electronic components (e.g., actuators, valves, sensors, pumps) that are used in the fuel system and not specifically addressed in this section shall be monitored in accordance with the comprehensive component requirements in section (f)(15).

(4.2) Malfunction Criteria:

(4.2.1) Fuel system pressure control:

(A) The OBD II system shall detect a malfunction of the fuel system pressure control system (e.g., fuel, hydraulic fluid) prior to any failure or deterioration that would cause a vehicle's NMHC, CO, NOx, or PM emissions to exceed:

(i) For passenger cars, light-duty trucks, and MDPVs certified to a chassis dynamometer tailpipe emission standard:

a. 3.0 times the applicable FTP standards for 2004 through 2009 model year vehicles;

b. 2.0 times the applicable FTP standards for 2010 through 2012 model year vehicles; and

c. 1.5 times the applicable FTP NMHC, CO, or NOx standards or 2.0 times the applicable FTP PM standard for 2013 and subsequent model year vehicles.

(ii) For medium-duty vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard:

a. 1.5 times any of the applicable NMHC, CO, and NOx standards or 0.03 g/bhp-hr PM as measured from an applicable cycle emission test for 2007 and subsequent model year vehicles certified to an engine dynamometer tailpipe NOx emission standard of greater than 0.50 g/bhp-hr NOx;

b. 2.5 times any of the applicable NMHC or CO standards, the applicable NOx standard by more than 0.3 g/bhp-hr (e.g., cause NOx emissions to exceed 0.5 g/bhp-hr if the emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test, or 0.03 g/bhp-hr PM as measured from an applicable cycle emission test for 2007 through 2012 model year vehicles certified to an engine dynamometer tailpipe NOx emission standard of less than or equal to 0.50 g/bhp-hr NOx; and

c. 2.0 times any of the applicable NMHC or CO standards, the applicable NOx standard by more than 0.2 g/bhp-hr (e.g., cause NOx emissions to exceed 0.4 g/bhp-hr if the emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test, or 0.03 g/bhp-hr PM as measured from an applicable cycle emission test for 2013 and subsequent model year certified to an engine dynamometer tailpipe NOx emission standard of less than or equal to 0.50 g/bhp-hr NOx;

(B) For vehicles in which no failure or deterioration of the fuel system pressure control could result in a vehicle's emissions exceeding the applicable malfunction criteria specified in section (f)(4.2.1)(A), the OBD II system shall detect a malfunction when the system has reached its control limits such that the commanded fuel system pressure cannot be delivered.

(4.2.2) Injection quantity. Additionally, for all 2010 and subsequent model year vehicles, the fuel system shall be monitored for injection quantity:

(A) The OBD II system shall detect a malfunction of the fuel injection system when the system is unable to deliver the commanded quantity of fuel necessary to maintain a vehicle's NMHC, CO, NOx and PM emissions at or below:

(i) For passenger cars, light-duty trucks, and MDPVs certified to a chassis dynamometer tailpipe emission standard:

a. 3.0 times the applicable FTP standards for 2010 through 2012 model year vehicles; and

b. 1.5 times the applicable FTP NMHC, CO, or NOx standards or 2.0 times the applicable FTP PM standard for 2013 and subsequent model year vehicles.

(ii) For medium-duty vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard, the applicable emission levels specified in sections (f)(4.2.1)(A)(ii).

(B) For vehicles in which no failure or deterioration of the fuel injection quantity could result in a vehicle's emissions exceeding the applicable malfunction criteria specified in section (f)(4.2.2)(A), the OBD II system shall detect a malfunction when the system has reached its control limits such that the commanded fuel quantity cannot be delivered.

(4.2.3) Injection Timing. Additionally, for all 2010 and subsequent model year vehicles, the fuel system shall be monitored for injection timing:

(A) The OBD II system shall detect a malfunction of the fuel injection system when the system is unable to deliver fuel at the proper crank angle/timing (e.g., injection timing too advanced or too retarded) necessary to maintain a vehicle's NMHC, CO, NOx, and PM emissions at or below the applicable emission levels specified in sections (f)(4.2.2)(A).

(B) For vehicles in which no failure or deterioration of the fuel injection timing could result in a vehicle's emissions exceeding the applicable malfunction criteria specified in section (f)(4.2.3)(A), the OBD II system shall detect a malfunction when the system has reached its control limits such that the commanded fuel injection timing cannot be achieved.

(4.2.4) Feedback control:

(A) Except as provided for in section (f)(4.2.4)(B), if the vehicle is equipped with feedback control of the fuel system (e.g., feedback control of pressure or pilot injection quantity), the OBD II system shall detect a malfunction:

(i) If the system fails to begin feedback control within a manufacturer specified time interval;

(ii) If a failure or deterioration causes open loop or default operation; or

(iii) If feedback control has used up all of the adjustment allowed by the manufacturer and cannot achieve the feedback target.

(B) A manufacturer may request Executive Officer approval to temporarily disable monitoring for the malfunction criteria specified in section (f)(4.2.4)(A)(iii) during conditions that a manufacturer cannot robustly distinguish between a malfunctioning system and a properly operating system. The Executive Officer shall approve the disablement upon the manufacturer submitting data and/or analysis demonstrating that the control system, when operating as designed on a vehicle with all emission controls working properly, routinely operates during these conditions with all of the adjustment allowed by the manufacturer used up.

(C) In lieu of detecting the malfunctions specified in sections (f)(4.2.4)(A)(i) and (ii) with a fuel system-specific monitor, the OBD II system may monitor the individual parameters or components that are used as inputs for fuel system feedback control provided that the monitors detect all malfunctions that meet the criteria in sections (f)(4.2.4)(A)(i) and (ii).

(4.3) Monitoring Conditions:

(4.3.1) The OBD II system shall monitor continuously for malfunctions identified in sections (f)(4.2.1) and (f)(4.2.4) (i.e., fuel pressure control and feedback operation).

(4.3.2) Manufacturers shall define the monitoring conditions for malfunctions identified in sections (f)(4.2.2) and (f)(4.2.3) (i.e., injection quantity and timing) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements).

(4.4) MIL Illumination and Fault Code Storage:

(4.4.1) General requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(4.4.2) Additionally, for malfunctions identified in section (f)(4.2.1) (i.e., fuel pressure control) on all 2010 and subsequent model year vehicles:

(A) A pending fault code shall be stored immediately upon the fuel system exceeding the malfunction criteria established pursuant to section (f)(4.2.1).

(B) Except as provided below, if a pending fault code is stored, the OBD II system shall immediately illuminate the MIL and store a confirmed fault code if a malfunction is again detected during either of the following two events: (a) the driving cycle immediately following the storage of the pending fault code, regardless of the conditions encountered during the driving cycle; or (b) on the next driving cycle in which similar conditions (see section (c)) to those that occurred when the pending fault code was stored are encountered.

(C) The pending fault code may be erased at the end of the next driving cycle in which similar conditions have been encountered without an exceedance of the specified fuel system malfunction criteria. The pending code may also be erased if similar conditions are not encountered during the 80 driving cycles immediately after the initial detection of a malfunction for which the pending code was set.

(D) Storage of freeze frame conditions.

(i) A manufacturer shall store and erase freeze frame conditions either in conjunction with storing and erasing a pending fault code or in conjunction with storing and erasing a confirmed fault code.

(ii) If freeze frame conditions are stored for a malfunction other than misfire (see section (f)(3)) or fuel system malfunction when a fault code is stored as specified in section (f)(4.4.2) above, the stored freeze frame information shall be replaced with freeze frame information regarding the fuel system malfunction.

(E) Storage of fuel system conditions for determining similar conditions of operation. Upon detection of a fuel system malfunction under section (f)(4.4.2), the OBD II system shall store the engine speed, load, and warm-up status of the first fuel system malfunction that resulted in the storage of the pending fault code.

(F) Extinguishing the MIL. The MIL may be extinguished after three sequential driving cycles in which similar conditions have been encountered without a malfunction of the fuel system.

(5) EXHAUST GAS SENSOR MONITORING

(5.1) Requirement:

(5.1.1) The OBD II system shall monitor all exhaust gas sensors (e.g., oxygen, air-fuel ratio, NOx) used for emission control system feedback (e.g., EGR control/feedback, SCR control/feedback, NOx adsorber control/feedback) or as a monitoring device for proper output signal, activity, response rate, and any other parameter that can affect emissions.

(5.1.2) For vehicles equipped with heated exhaust gas sensors, the OBD II system shall monitor the heater for proper performance.

(5.2) Malfunction Criteria:

(5.2.1) Air-Fuel Ratio Sensors:

(A) For sensors located upstream of the exhaust aftertreatment:

(i) Sensor performance faults: The OBD II system shall detect a malfunction prior to any failure or deterioration of the sensor voltage, resistance, impedance, current, response rate, amplitude, offset, or other characteristic(s) that would cause a vehicle's NMHC, CO, NOx, or PM emissions to exceed:

a. For passenger cars, light-duty trucks, and MDPVs certified to a chassis dynamometer tailpipe emission standard:

1. 2.5 times the applicable FTP standards for 2004 through 2009 model year vehicles;
2. 2.0 times the applicable FTP standards for 2010 through 2012 model year vehicles; and
3. 1.5 times the applicable FTP NMHC, CO, or NOx standards or 2.0 times the applicable FTP PM standard for 2013 and subsequent model year vehicles.

b. For medium-duty vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard:

1. 1.5 times the applicable NMHC, CO, and NOx standards or 0.03 g/bhp-hr PM as measured from an applicable cycle emission test for 2007 and subsequent model year vehicles certified to an engine dynamometer tailpipe NOx emission standard of greater than 0.50 g/bhp-hr NOx;
2. 2.5 times the applicable NMHC or CO standards, the applicable NOx standard by more than 0.3 g/bhp-hr (e.g., cause NOx emissions to exceed 0.5 g/bhp-hr if the emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test, or 0.03 g/bhp-hr PM as measured from an applicable cycle emission test for 2007 through 2012 model year vehicles certified to an engine dynamometer tailpipe NOx emission standard of less than or equal to 0.50 g/bhp-hr NOx; and
3. 2.0 times the applicable NMHC or CO standards, the applicable NOx standard by more than 0.2 g/bhp-hr (e.g., cause NOx emissions to exceed 0.4 g/bhp-hr if the emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test, or 0.03 g/bhp-hr PM as measured from an applicable cycle emission test for 2013 and subsequent model year vehicles certified to an engine dynamometer tailpipe NOx emission standard of less than or equal to 0.50 g/bhp-hr NOx.

(ii) Circuit faults: The OBD II system shall detect malfunctions of the sensor caused by either a lack of circuit continuity or out-of-range values.

(iii) Feedback faults: The OBD II system shall detect a malfunction of the sensor when a sensor failure or deterioration causes an emission control system (e.g., EGR, SCR, or NOx adsorber) to stop using that sensor as a feedback input (e.g., causes default or open-loop operation).

(iv) Monitoring capability: To the extent feasible, the OBD II system shall detect a malfunction of the sensor when the sensor output voltage, resistance, impedance, current, amplitude, activity, offset, or other characteristics are no longer sufficient for use as an OBD II system monitoring device (e.g., for catalyst, EGR, SCR, or NOx adsorber monitoring).

(B) For sensors located downstream of the exhaust aftertreatment:

(i) Sensor performance faults: The OBD II system shall detect a malfunction prior to any failure or deterioration of the sensor voltage, resistance, impedance, current, response rate, amplitude, offset, or other characteristic(s) that would cause a vehicle's NMHC, CO, NOx, or PM emissions to exceed:

a. For passenger cars, light-duty trucks, and MDPVs certified to a chassis dynamometer tailpipe emission standard:

1. 3.5 times the applicable FTP NMHC, CO, or NOx standards or 5.0 times the applicable FTP PM standard for 2004 through 2009 model year vehicles;
2. 2.5 times the applicable FTP NMHC, CO, or NOx standards or 4.0 times the applicable FTP PM standard for 2010 through 2012 model year vehicles;
3. 1.5 times the applicable FTP NMHC or CO standards, 1.75 times the applicable FTP NOx standard, or 2.0 times the applicable FTP PM standard for 2013 and subsequent model year vehicles.

b. For medium-duty vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard:

1. 2.5 times the applicable NMHC or CO standards, the applicable NOx standard by more than 0.5 g/bhp-hr (e.g., cause NOx emissions to exceed 0.7 g/bhp-hr if the emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test, or 0.05 g/bhp-hr PM as measured from an applicable cycle emission test for 2007 through 2009 model year vehicles certified to an engine dynamometer tailpipe NOx emission standard of greater than 0.50 g/bhp-hr NOx;
2. 2.5 times the applicable NMHC or CO standards, the applicable NOx standard by more than 0.3 g/bhp-hr (e.g., cause NOx emissions to exceed 0.5 g/bhp-hr if the emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test, or 0.05 g/bhp-hr PM as measured from an applicable cycle emission test for 2007 through 2012 model year vehicles certified to an engine dynamometer tailpipe NOx emission standard of less than or equal to 0.50 g/bhp-hr NOx; and
3. 2.0 times the applicable NMHC or CO standards, the applicable NOx standard by more than 0.2 g/bhp-hr (e.g., cause NOx emissions to exceed 0.4 g/bhp-hr if the emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test, or 0.03 g/bhp-hr PM as measured from an applicable cycle emission test for 2013 and subsequent model year vehicles certified to an engine dynamometer tailpipe NOx emission standard of less than or equal to 0.50 g/bhp-hr NOx.

(ii) Circuit faults: The OBD II system shall detect malfunctions of the sensor caused by either a lack of circuit continuity or out-of-range values.

(iii) Feedback faults: The OBD II system shall detect a malfunction of the sensor when a sensor failure or deterioration causes an emission control system (e.g., EGR, SCR, or NOx adsorber) to stop using that sensor as a feedback input (e.g., causes default or open-loop operation).

(iv) Monitoring capability: To the extent feasible, the OBD II system shall detect a malfunction of the sensor when the sensor output voltage, resistance, impedance, current, amplitude, activity, offset, or other characteristics are no longer sufficient for use as an OBD II system monitoring device (e.g., for catalyst, EGR, SCR, or NOx adsorber monitoring).

(5.2.2) NOx and PM sensors:

(A) Sensor performance faults: The OBD II system shall detect a malfunction prior to any failure or deterioration of the sensor voltage, resistance, impedance, current, response rate, amplitude, offset, or other characteristic(s) that would cause a vehicle's emissions to exceed:

(i) For passenger cars, light-duty trucks, and MDPVs certified to a chassis dynamometer tailpipe emission standard:

1. 3.5 times the applicable FTP NMHC, CO, or NOx standards or 5.0 times the applicable FTP PM standard for 2004 through 2009 model year vehicles;
2. 2.5 times the applicable FTP NMHC, CO, or NOx standards, or 4.0 times the applicable FTP PM standard for 2010 through 2012 model year vehicles;
3. 1.5 times the applicable FTP NMHC or CO standards, 1.75 times the applicable FTP NOx standard, or 2.0 times the applicable FTP PM standard for 2013 and subsequent model year vehicles.

(ii) For medium-duty vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard:

a. 2.5 times the applicable NMHC standards, the applicable NOx standard by more than 0.5 g/bhp-hr (e.g., cause NOx emissions to exceed 0.7 g/bhp-hr if the emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test or 0.05 g/bhp-hr PM as measured from an applicable cycle emission test for 2007 through 2009 model year vehicles;

b. 2.5 times the applicable NMHC standards, the applicable NOx standard by more than 0.3 g/bhp-hr (e.g., cause NOx emissions to exceed 0.5 g/bhp-hr if the emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test or 0.05 g/bhp-hr PM as measured from an applicable cycle emission test for 2010 through 2012 model year vehicles; and

c. 2.0 times the applicable NMHC standards, the applicable NOx standard by more than 0.2 g/bhp-hr (e.g., cause NOx emissions to exceed 0.4 g/bhp-hr if the emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test or 0.03 g/bhp-hr PM as measured from an applicable cycle emission test for 2013 and subsequent model year vehicles.

(B) Circuit faults: The OBD II system shall detect malfunctions of the sensor caused by either a lack of circuit continuity or out-of-range values.
(C) Feedback faults: The OBD II system shall detect a malfunction of the sensor when a sensor failure or deterioration causes an emission control system (e.g., EGR, SCR, or NOx adsorber) to stop using that sensor as a feedback input (e.g., causes default or open-loop operation).
(D) Monitoring capability: To the extent feasible, the OBD II system shall detect a malfunction of the sensor when the sensor output voltage, resistance, impedance, current, amplitude, activity, offset, or other characteristics are no longer sufficient for use as an OBD II system monitoring device (e.g., for catalyst, EGR, PM filter, SCR, or NOx adsorber monitoring).

(5.2.3) Other exhaust gas sensors:
(A) For other exhaust gas sensors, the manufacturer shall submit a monitoring plan to the Executive Officer for approval. The Executive Officer shall approve the request upon determining that the manufacturer has submitted data and an engineering evaluation that demonstrate that the monitoring plan is as reliable and effective as the monitoring plan required for air-fuel ratio sensors and NOx sensors under sections (f)(5.2.1) and (f)(5.2.2).

(5.2.4) Sensor Heaters:
(A) The OBD II system shall detect a malfunction of the heater performance when the current or voltage drop in the heater circuit is no longer within the manufacturer's specified limits for normal operation (i.e., within the criteria required to be met by the component vendor for heater circuit performance at high mileage). Subject to Executive Officer approval, other malfunction criteria for heater performance malfunctions may be used upon the Executive Officer determining that the manufacturer has submitted data and/or an engineering evaluation that demonstrate the monitoring reliability and timeliness to be equivalent to the stated criteria in section (f)(5.2.4)(A).
(B) The OBD II system shall detect malfunctions of the heater circuit including open or short circuits that conflict with the commanded state of the heater (e.g., shorted to 12 Volts when commanded to 0 Volts (ground)).

(5.3) Monitoring Conditions:

(5.3.1) Exhaust Gas Sensors
(A) Manufacturers shall define the monitoring conditions for malfunctions identified in sections (f)(5.2.1)(A)(i), (5.2.1)(B)(i), and (5.2.2)(A) (e.g., sensor performance faults) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). For all 2010 and subsequent model year vehicles, for purposes of tracking and reporting as required in section (d)(3.2.2), all monitors used to detect malfunctions identified in sections (f)(5.2.1)(A)(i), (5.2.1)(B)(i), and (5.2.2)(A) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).
(B) Manufacturers shall define the monitoring conditions for malfunctions identified in sections (f)(5.2.1)(A)(iv), (5.2.1)(B)(iv), and (5.2.2)(D) (e.g., monitoring capability) in accordance with sections (d)(3.1) and (d)(3.2)

(i.e., minimum ratio requirements) with the exception that monitoring shall occur every time the monitoring conditions are met during the driving cycle in lieu of once per driving cycle as required in section (d)(3.1.2).

(C) Except as provided in section (f)(5.3.1)(D), monitoring for malfunctions identified in sections (f)(5.2.1)(A)(ii), (5.2.1)(A)(iii), (5.2.1)(B)(ii), (5.2.1)(B)(iii), (5.2.2)(B), and (5.2.2)(C) (i.e., circuit continuity, out-of-range, and open-loop malfunctions) shall be conducted continuously.

(D) A manufacturer may request Executive Officer approval to disable continuous exhaust gas sensor monitoring when an exhaust gas sensor malfunction cannot be distinguished from other effects (e.g., disable out-of-range low monitoring during fuel cut conditions). The Executive Officer shall approve the disablement upon determining that the manufacturer has submitted test data and/or documentation that demonstrate a properly functioning sensor cannot be distinguished from a malfunctioning sensor and that the disablement interval is limited only to that necessary for avoiding false detection.

(5.3.2) Sensor Heaters

(A) Manufacturers shall define monitoring conditions for malfunctions identified in section (f)(5.2.4)(A) (i.e., sensor heater performance) in accordance sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements).

(B) Monitoring for malfunctions identified in section (f)(5.2.4)(B) (i.e., circuit malfunctions) shall be conducted continuously.

(5.4) MIL Illumination and Fault Code Storage: General requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(6) EXHAUST GAS RECIRCULATION (EGR) SYSTEM MONITORING

(6.1) Requirement: The OBD II system shall monitor the EGR system on vehicles so-equipped for low flow rate, high flow rate, and slow response malfunctions. For vehicles equipped with EGR coolers (e.g., heat exchangers), the OBD II system shall monitor the cooler for insufficient cooling malfunctions. The individual electronic components (e.g., actuators, valves, sensors) that are used in the EGR system shall be monitored in accordance with the comprehensive component requirements in section (f)(15).

(6.2) Malfunction Criteria:

(6.2.1) Low Flow:

(A) The OBD II system shall detect a malfunction of the EGR system at or prior to a decrease from the manufacturer's specified EGR flow rate that would cause a vehicle's NMHC, CO, NOx, or PM emissions to exceed:

(i) For passenger cars, light-duty trucks, and MDPVs certified to a chassis dynamometer tailpipe emission standard:

a. 3.0 times the applicable FTP standards for 2004 through 2009 model year vehicles;

b. 2.5 times the applicable FTP standards for 2010 through 2012 model year vehicles; and

c. 1.5 times the applicable FTP NMHC, CO, or NOx standards or 2.0 times the applicable FTP PM standard for 2013 and subsequent model year vehicles.

(ii) For medium-duty vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard:

a. 1.5 times the applicable FTP standards for 2004 through 2006 model year vehicles;

b. 2.5 times the applicable NMHC or CO standards, the applicable NOx standard by more than 0.3 g/bhp-hr (e.g., cause NOx emissions to exceed 0.5 g/bhp-hr if the emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test, or 0.03 g/bhp-hr PM as measured from an applicable cycle emission test for 2007 through 2012 model year vehicles; and

c. 2.0 times the applicable NMHC or CO standards, the applicable NOx standard by more than 0.2 g/bhp-hr (e.g., cause NOx emissions to exceed 0.4 g/bhp-hr if the emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test, or 0.03 g/bhp-hr PM as measured from an applicable cycle emission test for 2013 and subsequent model year vehicles.

(B) For vehicles in which no failure or deterioration of the EGR system that causes a decrease in flow could result in a vehicle's emissions exceeding the malfunction criteria specified in section (f)(6.2.1)(A), the OBD II system shall detect a malfunction when the system has reached its control limits such that it cannot increase EGR flow to achieve the commanded flow rate.

(6.2.2) High Flow:

(A) The OBD II system shall detect a malfunction of the EGR system, including a leaking EGR valve (i.e., exhaust gas flowing through the valve when the valve is commanded closed), at or prior to an increase from the manufacturer's specified EGR flow rate that would cause a vehicle's NMHC, CO, NOx, or PM emissions to exceed the applicable emission levels specified in sections (f)(6.2.1)(A);

(B) For vehicles in which no failure or deterioration of the EGR system that causes an increase in flow could result in a vehicle's emissions exceeding the malfunction criteria specified in section (f)(6.2.2)(A), the OBD II system shall detect a malfunction when the system has reached its control limits such that it cannot reduce EGR flow to achieve the commanded flow rate.

(6.2.3) Slow Response. Additionally, for 2010 and subsequent model year vehicles, the EGR system shall be monitored for slow response:

(A) The OBD II system shall detect a malfunction of the EGR system at or prior to any failure or deterioration in the capability of the EGR system to achieve the commanded flow rate within a manufacturer-specified time that would cause a vehicle's NMHC, CO, NOx, or PM emissions to exceed the applicable emission levels specified in sections (f)(6.2.1)(A).

(B) The OBD II system shall monitor the capability of the EGR system to respond to both a commanded increase in flow and a commanded decrease in flow.

(6.2.4) Feedback control:

(A) Except as provided for in section (f)(6.2.4)(B), if the vehicle is equipped with feedback control of the EGR system (e.g., feedback control of flow, valve position, pressure differential across the valve via intake throttle or exhaust backpressure), the OBD II system shall detect a malfunction:

(i) If the system fails to begin feedback control within a manufacturer specified time interval;

(ii) If a failure or deterioration causes open loop or default operation; or

(iii) If feedback control has used up all of the adjustment allowed by the manufacturer and cannot achieve the feedback target.

(B) A manufacturer may request Executive Officer approval to temporarily disable monitoring for the malfunction criteria specified in section (f)(6.2.4)(A)(iii) during conditions that a manufacturer cannot robustly distinguish between a malfunctioning system and a properly operating system. The Executive Officer shall approve the disablement upon the manufacturer submitting data and/or analysis demonstrating that the control system, when operating as designed on a vehicle with all emission controls working properly, routinely operates during these conditions with all of the adjustment allowed by the manufacturer used up.

(C) In lieu of detecting the malfunctions specified in sections (f)(6.2.4)(A)(i) and (ii) with an EGR system-specific monitor, the OBD II system may monitor the individual parameters or components that are used as inputs for EGR system feedback control provided that the monitors detect all malfunctions that meet the criteria in sections (f)(6.2.4)(A)(i) and (ii).

(6.2.5) EGR Cooler Performance:

(A) The OBD II system shall detect a malfunction of the EGR system cooler at or prior to a reduction from the manufacturer's specified cooling performance that would cause a vehicle's NMHC, CO, NOx, or PM emissions to exceed the applicable emission levels specified in sections (f)(6.2.1)(A);

(B) For vehicles in which no failure or deterioration of the EGR system cooler could result in a vehicle's emissions exceeding the malfunction criteria specified in section (f)(6.2.5)(A), the OBD II system shall detect a malfunction when the system has no detectable amount of EGR cooling.

(6.3) Monitoring Conditions:

(6.3.1) For malfunctions identified in sections (f)(6.2.1) and (f)(6.2.2) (i.e., EGR low and high flow), manufacturers shall define monitoring conditions:

(A) For 2004 through 2009 model year vehicles, in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). For purposes of tracking and reporting as required in section (d)(3.2.2), all monitors used to detect malfunctions identified in sections (f)(6.2.1) and (f)(6.2.2) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2);

(B) Conducted continuously for all 2010 and subsequent model year vehicles.

(6.3.2) Manufacturers shall define the monitoring conditions for malfunctions identified in section (f)(6.2.3) (i.e., slow response) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements), with the exception that monitoring shall occur every time the monitoring conditions are met during the driving cycle in lieu of once per driving cycle as required in section (d)(3.1.2). For purposes of tracking and reporting as required in section (d)(3.2.2), all monitors used to detect malfunctions identified in section (f)(6.2.3) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).

(6.3.3) The OBD II system shall monitor continuously for malfunctions identified in section (f)(6.2.4) (i.e., EGR feedback control).

(6.3.4) Manufacturers shall define the monitoring conditions for malfunctions identified in section (f)(6.2.5) (i.e., cooler performance) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). For purposes of tracking and reporting as required in section (d)(3.2.2), all monitors used to detect malfunctions identified in section (f)(6.2.5) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).

(6.3.5) Manufacturers may request Executive Officer approval to temporarily disable the EGR system check under specific conditions (e.g., when freezing may affect performance of the system). The Executive Officer shall approve the request upon determining that the manufacturer has submitted data and/or an engineering evaluation which demonstrate that a reliable check cannot be made when these conditions exist.

(6.4) MIL Illumination and Fault Code Storage: General requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(7) BOOST PRESSURE CONTROL SYSTEM MONITORING

(7.1) Requirement: For 2010 and subsequent model year vehicles, the OBD II system shall monitor the boost pressure control system (e.g., turbocharger) on vehicles so-equipped for under and over boost malfunctions. For vehicles equipped with variable geometry turbochargers (VGT), the OBD II system shall monitor the VGT system for slow response malfunctions. For vehicles equipped with charge air cooler systems, the OBD II system shall monitor the charge air cooler system for cooling system performance malfunctions. For 2004 and subsequent model year vehicles, the individual electronic components (e.g., actuators, valves, sensors) that are used in the boost pressure control system shall be monitored in accordance with the comprehensive component requirements in section (f)(15).

(7.2) Malfunction Criteria:

(7.2.1) Underboost:

(A) The OBD II system shall detect a malfunction of the boost pressure control system at or prior to a decrease from the manufacturer's commanded boost pressure that would cause a vehicle's NMHC, CO, NOx, or PM emissions to exceed:

(i) For passenger cars, light-duty trucks, and MDPVs certified to a chassis dynamometer tailpipe emission standard:

a. 2.0 times the applicable FTP standards for 2010 through 2012 model year vehicles; and

b. 1.5 times the applicable FTP NMHC, CO, or NOx standards or 2.0 times the applicable FTP PM standard for 2013 and subsequent model year vehicles.

(ii) For medium-duty vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard:

a. 2.5 times the applicable NMHC or CO standards, the applicable NOx standard by more than 0.3 g/bhp-hr (e.g., cause NOx emissions to exceed 0.5 g/bhp-hr if the emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test, or 0.03 g/bhp-hr PM as measured from an applicable cycle emission test for 2010 through 2012 model year vehicles; and

b. 2.0 times the applicable NMHC or CO standards, the applicable NOx standard by more than 0.2 g/bhp-hr (e.g., cause NOx emissions to exceed 0.4 g/bhp-hr if the emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test, or 0.03 g/bhp-hr PM as measured from an applicable cycle emission test for 2013 and subsequent model year vehicles.

(B) For vehicles in which no failure or deterioration of the boost pressure control system that causes a decrease in boost could result in a vehicle's emissions exceeding the malfunction criteria specified in section (f)(7.2.1)(A), the OBD II system shall detect a malfunction when the system has reached its control limits such that it cannot increase boost to achieve the commanded boost pressure.

(7.2.2) Overboost:

(A) The OBD II system shall detect a malfunction of the boost pressure control system at or prior to an increase from the manufacturer's commanded boost pressure that would cause a vehicle's NMHC, CO, NOx, or PM emissions to exceed the applicable emission levels specified in sections (f)(7.2.1)(A).

(B) For vehicles in which no failure or deterioration of the boost pressure control system that causes an increase in boost could result in a vehicle's emissions exceeding the malfunction criteria specified in section (f)(7.2.2)(A), the OBD II system shall detect a malfunction when the system has reached its control limits such that it cannot decrease boost to achieve the commanded boost pressure.

(7.2.3) VGT slow response:

(A) The OBD II system shall detect a malfunction at or prior to any failure or deterioration in the capability of the VGT system to achieve the commanded turbocharger geometry within a manufacturer-specified time that would cause a vehicle's NMHC, CO, NOx, or PM emissions to exceed the applicable emission levels specified in sections (f)(7.2.1)(A).

(B) For vehicles in which no failure or deterioration of the VGT system response could result in a vehicle's emissions exceeding the malfunction criteria specified in section (f)(7.2.3)(A), the OBD II system shall detect a malfunction of the VGT system when proper functional response of the system to computer commands does not occur.

(7.2.4) Charge Air Undercooling:

(A) The OBD II system shall detect a malfunction of the charge air cooling system at or prior to a decrease from the manufacturer's specified cooling rate that would cause a vehicle's NMHC, CO, NOx, or PM emissions to exceed the applicable emission levels specified in sections (f)(7.2.1)(A).

(B) For vehicles in which no failure or deterioration of the charge air cooling system that causes a decrease in cooling performance could result in a vehicle's emissions exceeding the malfunction criteria specified in section (f)(7.2.4)(A), the OBD II system shall detect a malfunction when the system has no detectable amount of charge air cooling.

(7.2.5) Feedback control:

(A) Except as provided for in section (f)(7.2.5)(B), if the vehicle is equipped with feedback control of the boost pressure system (e.g., control of VGT position, turbine speed, manifold pressure) the OBD II system shall detect a malfunction:

(i) If the system fails to begin feedback control within a manufacturer specified time interval;

(ii) If a failure or deterioration causes open loop or default operation; or

(iii) If feedback control has used up all of the adjustment allowed by the manufacturer and cannot achieve the feedback target.

(B) A manufacturer may request Executive Officer approval to temporarily disable monitoring for the malfunction criteria specified in section (f)(7.2.5)(A)(iii) during conditions that a manufacturer cannot robustly distinguish between a malfunctioning system and a properly operating system. The Executive Officer shall approve the disablement upon the manufacturer submitting data and/or analysis demonstrating that the control system, when operating as designed on a vehicle with all emission controls working properly, routinely operates during these conditions with all of the adjustment allowed by the manufacturer used up.

(C) In lieu of detecting the malfunctions specified in sections (f)(7.2.5)(A)(i) and (ii) with a boost pressure system-specific monitor, the OBD II system may monitor the individual parameters or components that are used as inputs for boost pressure system feedback control provided that the monitors detect all malfunctions that meet the criteria in sections (f)(7.2.5)(A)(i) and (ii).

(7.3) Monitoring Conditions:

(7.3.1) The OBD II system shall monitor continuously for malfunctions identified in sections (f)(7.2.1), (7.2.2), and (7.2.5) (i.e., over and under boost, feedback control).

(7.3.2) Manufacturers shall define the monitoring conditions for malfunctions identified in section (f)(7.2.3) (i.e., VGT slow response) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements), with the exception that monitoring shall occur every time the monitoring conditions are met during the driving cycle in lieu of once per driving cycle as required in section (d)(3.1.2). For all 2010 and subsequent model year vehicles, for purposes of tracking and reporting as required in section (d)(3.2.2), all monitors used to detect malfunctions identified in section (f)(7.2.3) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).

(7.3.3) Manufacturers shall define the monitoring conditions for malfunctions identified in section (f)(7.2.4) (i.e., charge air cooler performance) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). For purposes of tracking and reporting as required in section (d)(3.2.2), all monitors used to detect malfunctions identified in section (f)(7.2.4) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).

(7.4) MIL Illumination and Fault Code Storage: General requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(8) NOx ADSORBER MONITORING

(8.1) Requirement: The OBD II system shall monitor the NOx adsorber on vehicles so-equipped for proper performance. For vehicles equipped with active/intrusive injection (e.g., in-exhaust fuel and/or air injection) to achieve desorption of the NOx adsorber, the OBD II system shall monitor the active/intrusive injection system for proper performance. The individual electronic components (e.g., injectors, valves, sensors) that are used in the active/intrusive injection system shall be monitored in accordance with the comprehensive component requirements in section (f)(15).

(8.2) Malfunction Criteria:

(8.2.1) NOx adsorber capability:

(A) The OBD II system shall detect a NOx adsorber system malfunction when the NOx adsorber capability decreases to the point that would cause a vehicle's NOx or NMHC emissions to exceed:

(i) For passenger cars, light-duty trucks, and MDPVs certified to a chassis dynamometer tailpipe emission standard:

a. 3.0 times the applicable FTP standards for 2004 through 2009 model year vehicles;

b. 2.5 times the applicable FTP standards for 2010 through 2012 model year vehicles; and

c. 1.75 times the applicable FTP standards for 2013 and subsequent model year vehicles.

(ii) For medium-duty vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard:

a. the applicable NOx standard by more than 0.5 g/bhp-hr (e.g., cause NOx emissions to exceed 0.7 g/bhp-hr if the emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test or 3.5 times the applicable NMHC standard for 2007 through 2009 model year vehicles;

b. the applicable NOx standard by more than 0.3 g/bhp-hr (e.g., cause NOx emissions to exceed 0.5 g/bhp-hr if the emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test or 2.5 times the applicable NMHC standard for 2010 through 2012 model year vehicles; and

c. the applicable NOx standard by more than 0.2 g/bhp-hr (e.g., cause NOx emissions to exceed 0.4 g/bhp-hr if the emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test or 2.0 times the applicable NMHC standard for 2013 and subsequent model year vehicles.

(B) If no failure or deterioration of the NOx adsorber capability could result in a vehicle's NOx emissions exceeding the applicable malfunction criteria specified in section (f)(8.2.1)(A), the OBD II system shall detect a malfunction when the system has no detectable amount of NOx adsorber capability.

(8.2.2) For systems that utilize active/intrusive injection (e.g., in-cylinder post fuel injection, in-exhaust air-assisted fuel injection) to achieve desorption of the NOx adsorber, the OBD II system shall detect a malfunction if any failure or deterioration of the injection system's ability to properly regulate injection causes the system to be unable to achieve desorption of the NOx adsorber.

(8.2.3) Feedback control:

(A) Except as provided for in section (f)(8.2.3)(B), if the vehicle is equipped with feedback control of the NOx adsorber or active/intrusive injection system (e.g., feedback control of injection quantity, time), the OBD II system shall detect a malfunction:

(i) If the system fails to begin feedback control within a manufacturer specified time interval;

(ii) If a failure or deterioration causes open loop or default operation; or

(iii) If feedback control has used up all of the adjustment allowed by the manufacturer and cannot achieve the feedback target.

(B) A manufacturer may request Executive Officer approval to temporarily disable monitoring for the malfunction criteria specified in section (f)(8.2.3)(A)(iii) during conditions that a manufacturer cannot robustly distinguish between a malfunctioning system and a properly operating system. The Executive Officer shall approve the disablement upon the manufacturer submitting data and/or analysis demonstrating that the control system, when operating as designed on a vehicle with all emission controls working properly, routinely operates during these conditions with all of the adjustment allowed by the manufacturer used up.

(C) In lieu of detecting the malfunctions specified in sections (f)(8.2.3)(A)(i) and (ii) with a NOx adsorber-specific monitor, the OBD II system may monitor the individual parameters or components that are used as inputs for NOx adsorber or active/intrusive injection system feedback control provided that the monitors detect all malfunctions that meet the criteria in sections (f)(8.2.3)(A)(i) and (ii).

(8.3) Monitoring Conditions:

(8.3.1) Manufacturers shall define the monitoring conditions for malfunctions identified in section (f)(8.2.1) (i.e., adsorber capability) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements). For purposes of tracking and reporting as required in section (d)(3.2.2), all monitors used to detect malfunctions identified in sections (f)(8.2.1) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).

(8.3.2) The OBD II system shall monitor continuously for malfunctions identified in sections (f)(8.2.2) and (8.2.3) (e.g., injection function, feedback control).

(8.4) MIL Illumination and Fault Code Storage: General requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(9) PARTICULATE MATTER (PM) FILTER MONITORING

(9.1) Requirement: The OBD II system shall monitor the PM filter on vehicles so-equipped for proper performance. For vehicles equipped with active regeneration systems that utilize an active/intrusive injection (e.g., in-exhaust fuel injection, in-exhaust fuel/air burner), the OBD II system shall monitor the active/intrusive injection system for proper performance. The individual electronic components (e.g., injectors, valves, sensors) that are used in the active/intrusive injection system shall be monitored in accordance with the comprehensive component requirements in section (f)(15).

(9.2) Malfunction Criteria:

(9.2.1) Filtering Performance:

(A) The OBD II system shall detect a malfunction prior to a decrease in the filtering capability of the PM filter that would cause a vehicle's PM emissions to exceed:

(i) For passenger cars, light-duty trucks, and MDPVs certified to a chassis dynamometer tailpipe emission standard:

a. 5.0 times the applicable FTP standard for 2004 through 2009 model year vehicles;

b. 4.0 times the applicable FTP standard for 2010 through 2012 model year vehicles; and

c. 1.75 times the applicable FTP standard for 2013 and subsequent model year vehicles.

(ii) For medium-duty vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard:

a. 0.09 g/bhp-hr PM as measured from an applicable cycle emission test for 2004 through 2009 model year vehicles;

b. 0.05 g/bhp-hr PM as measured from an applicable cycle emission test for 2010 through 2012 model year vehicles; and

c. 0.03 g/bhp-hr PM as measured from an applicable cycle emission test for 2013 and subsequent model year vehicles.

(B) If no failure or deterioration of the PM filtering performance could result in a vehicle's PM emissions exceeding the applicable malfunction criteria specified in section (f)(9.2.1)(A), the OBD II system shall detect a malfunction when no detectable amount of PM filtering occurs.

(9.2.2) Frequent Regeneration:

(A) For 2007 through 2009 model year vehicles, the OBD II system shall detect a malfunction when the PM filter regeneration frequency exceeds the manufacturer's specified design limits for allowable regeneration frequency.

(B) For 2010 and subsequent model year vehicles, the OBD II system shall detect a malfunction when PM filter regeneration occurs more frequently than (i.e., occurs more often than) the manufacturer's specified regeneration frequency such that it would cause a vehicle's emissions to exceed:

(i) For passenger cars, light-duty trucks, and MDPVs certified to a chassis dynamometer tailpipe emission standard:

a. 3.0 times the applicable FTP NMHC, CO, or NOx standards for 2010 through 2012 model year vehicles; and

(10.2.2) Except as provided below, the OBD II system shall detect a malfunction of the CV system when a disconnection of the system occurs between either the crankcase and the CV valve, or between the CV valve and the intake ducting.

(10.2.3) If disconnection in the system results in a rapid loss of oil or other overt indication of a CV system malfunction such that the vehicle operator is certain to respond and have the vehicle repaired, the Executive Officer shall exempt the manufacturer from detection of that disconnection.

(10.2.4) Detection of a disconnection is not required if the disconnection cannot be made without first disconnecting a monitored portion of the system (e.g., the CV system is designed such that the CV valve is fastened directly to the crankcase in a manner which makes it significantly more difficult to remove the valve from the crankcase before disconnecting the line between the valve and the intake ducting (taking aging effects into consideration) and the line between the valve and the intake ducting is monitored for disconnection).

(10.2.5) Subject to Executive Officer approval, system designs that utilize tubing between the valve and the crankcase shall also be exempted from the monitoring requirement for detection of disconnection between the crankcase and the CV valve. The manufacturer shall file a request and submit data and/or engineering evaluation in support of the request. The Executive Officer shall approve the request upon determining that the connections between the valve and the crankcase are: (i) resistant to deterioration or accidental disconnection, (ii) significantly more difficult to disconnect than the line between the valve and the intake ducting, and (iii) not subject to disconnection per manufacturer's maintenance, service, and/or repair procedures for non-CV system repair work.

(10.2.6) Manufacturers are not required to detect disconnections that are unlikely to occur due to a CV system design that is integral to the induction system (e.g., internal machined passages rather than tubing or hoses).

(10.2.7) For medium-duty vehicles with engines certified on an engine dynamometer having an open CV system (i.e., a system that releases crankcase emissions to the atmosphere without routing them to the intake ducting or to the exhaust upstream of the aftertreatment), the manufacturer shall submit a plan for Executive Officer approval of the monitoring strategy, malfunction criteria, and monitoring conditions prior to OBD certification. Executive Officer approval shall be based on the effectiveness of the monitoring strategy to (i) monitor the performance of the CV system to the extent feasible with respect to the malfunction criteria in section (f)(10.2.1) through (f)(10.2.4) and the monitoring conditions required by the diagnostic, and (ii) monitor the ability of the CV system to control crankcase vapor emitted to the atmosphere relative to the manufacturer's design and performance specifications for a properly functioning system (e.g., if the system is equipped with a filter to reduce crankcase emissions to the atmosphere, the OBD II system shall monitor the integrity of the filter).

(10.3) Monitoring Conditions: Manufacturers shall define the monitoring conditions for malfunctions identified in section (f)(10.2) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements).

(10.4) MIL Illumination and Fault Code Storage: General requirements for MIL illumination and fault code storage are set forth in section (d)(2). The stored fault code need not specifically identify the CV system (e.g., a fault code for EGR or intake air mass flow rationality monitoring can be stored) if the manufacturer demonstrates that additional monitoring hardware would be necessary to make this identification and provided that the manufacturer's diagnostic and repair procedures for the detected malfunction include directions to check the integrity of the CV system.

(11) ENGINE COOLING SYSTEM MONITORING

(11.1) Requirement:

(11.1.1) The OBD II system shall monitor the thermostat on vehicles so-equipped for proper operation.

(11.1.2) The OBD II system shall monitor the engine coolant temperature (ECT) sensor for circuit continuity, out-of-range values, and rationality faults.

(11.2) Malfunction Criteria:

(11.2.1) Thermostat

(A) The OBD II system shall detect a thermostat malfunction (e.g., leaking or early-to-open thermostat) if, within an Executive Officer approved time interval after starting the engine, either of the following two conditions occur:

(i) The coolant temperature does not reach the highest temperature required by the OBD II system to enable other diagnostics;

(ii) The coolant temperature does not reach a warmed-up temperature within 20 degrees Fahrenheit of the manufacturer's nominal thermostat regulating temperature. Subject to Executive Officer approval, a manufacturer may utilize lower temperatures for this criterion upon the Executive Officer determining that the manufacturer has demonstrated that the fuel, injection timing, and/or other coolant temperature-based modifications to the engine control strategies would not cause an emission increase of 50 or more percent of any of the applicable standards.

(B) Executive Officer approval of the time interval after engine start shall be granted upon determining that the data and/or engineering evaluation submitted by the manufacturer supports the specified times.

(C) With Executive Officer approval, a manufacturer may use alternate malfunction criteria and/or monitoring conditions (see section (f)(11.3)) that are a function of temperature at engine start on vehicles that do not reach the temperatures specified in the malfunction criteria when the thermostat is functioning properly. Executive Officer approval shall be granted upon determining that the manufacturer has submitted data that demonstrate that a properly operating system does not reach the specified temperatures, that the monitor is capable of meeting the specified malfunction criteria at engine start temperatures greater than 50 degrees Fahrenheit, and that the overall effectiveness of the monitor is comparable to a monitor meeting these thermostat monitoring requirements at lower temperatures.

(D) With Executive Officer approval, manufacturers may omit this monitor. Executive Officer approval shall be granted upon determining that the manufacturer has demonstrated that a malfunctioning thermostat cannot cause a measurable increase in emissions during any reasonable driving condition nor cause any disablement of other monitors.

(11.2.2) ECT Sensor

(A) Circuit Continuity. The OBD II system shall detect a malfunction when a lack of circuit continuity or out-of-range value occurs.

(B) Time to Reach Closed-Loop Enable Temperature.

(i) The OBD II system shall detect a malfunction if the ECT sensor does not achieve the stabilized minimum temperature which is needed to begin closed-loop or feedback operation of emission-related engine controls (e.g., feedback control of fuel pressure, EGR flow, boost pressure) within an Executive Officer approved time interval after starting the engine. The time interval shall be a function of starting ECT and/or a function of intake or ambient temperature.

(ii) Executive Officer approval of the time interval shall be granted upon determining that the data and/or engineering evaluation submitted by the manufacturer supports the specified times.

(iii) The Executive Officer shall exempt manufacturers from the requirement of section (f)(11.2.2)(B) if the manufacturer does not utilize ECT to enable closed loop or feedback operation of emission-related engine controls.

(C) Stuck in Range Below the Highest Minimum Enable Temperature. To the extent feasible when using all available information, the OBD II system shall detect a malfunction if the ECT sensor inappropriately indicates a temperature below the highest minimum enable temperature required by the OBD II system to enable other diagnostics (e.g., an OBD II system that requires ECT to be greater than 140 degrees Fahrenheit to enable a diagnostic must detect malfunctions that cause the ECT sensor to inappropriately indicate a temperature below 140 degrees Fahrenheit). Manufacturers are exempted from this requirement for temperature regions in which the monitors required under sections (f)(11.2.1) or (f)(11.2.2)(B) will detect ECT sensor malfunctions as defined in section (f)(11.2.2)(C).

(D) Stuck in Range Above the Lowest Maximum Enable Temperature.

(i) To the extent feasible when using all available information, the OBD II system shall detect a malfunction if the ECT sensor inappropriately indicates a temperature above the lowest maximum enable temperature required by the OBD II system to enable other diagnostics (e.g., an OBD II system that requires ECT to be less than 90 degrees Fahrenheit at engine start to enable a diagnostic must detect malfunctions that cause the ECT sensor to inappropriately indicate a temperature above 90 degrees Fahrenheit).

(ii) Manufacturers are exempted from this requirement for temperature regions in which the monitors required under sections (f)(11.2.1), (f)(11.2.2)(B), or (f)(11.2.2)(C) (i.e., ECT sensor or thermostat malfunctions) will detect ECT sensor malfunctions as defined in section (f)(11.2.2)(D) or in which the MIL will be illuminated under the requirements of section (d)(2.2.3) for default mode operation (e.g., overtemperature protection strategies).

(iii) For 2006 and subsequent model year applications, manufacturers are also exempted from the requirements of section (f)(11.2.2)(D) for temperature regions where the temperature gauge indicates a temperature in the red zone (engine overheating zone) or an overtemperature warning light is illuminated for vehicles that have a temperature gauge or warning light on the instrument panel and utilize the same ECT sensor for input to the OBD II system and the temperature gauge/warning light.

(11.3) Monitoring Conditions:

(11.3.1) Thermostat

(A) Manufacturers shall define the monitoring conditions for malfunctions identified in section (f)(11.2.1)(A) in accordance with section (d)(3.1) except as provided for in section (f)(11.3.1)(D). Additionally, except as provided for in sections (f)(11.3.1)(B) and (C), monitoring for malfunctions identified in section (f)(11.2.1)(A) shall be conducted once per driving cycle on every driving cycle in which the ECT sensor indicates, at engine start, a temperature lower than the temperature established as the malfunction criteria in section (f)(11.2.1)(A).

(B) Manufacturers may disable thermostat monitoring at ambient temperatures below 20 degrees Fahrenheit.

(C) Manufacturers may request Executive Officer approval to suspend or disable thermostat monitoring if the vehicle is subjected to conditions which could lead to false diagnosis (e.g., vehicle operation at idle for more than 50 percent of the warm-up time, hot restart conditions, etc.). In general, the Executive Officer shall not approve disablement of the monitor on engine starts where the ECT at engine start is more than 35 degrees Fahrenheit lower than the thermostat malfunction threshold temperature determined under section (f)(11.2.1)(A). The Executive Officer shall approve the request upon determining that the manufacturer has provided data and/or engineering analysis that demonstrate the need for the request.

(D) With respect to defining enable conditions that are encountered during the FTP or Unified cycle as required in (d)(3.1.1) for malfunctions identified in section (f)(11.2.1)(A), the FTP cycle shall refer to on-road driving following the FTP cycle in lieu of testing on a chassis or engine dynamometer.

(11.3.2) ECT Sensor

(A) Except as provided below in section (f)(11.3.2)(E), monitoring for malfunctions identified in section (f)(11.2.2)(A) (i.e., circuit continuity and out-of-range) shall be conducted continuously.

(B) Manufacturers shall define the monitoring conditions for malfunctions identified in section (f)(11.2.2)(B) in accordance with section (d)(3.1). Additionally, except as provided for in section (f)(11.3.2)(D), monitoring for malfunctions identified in section (f)(11.2.2)(B) shall be conducted once per driving cycle on every driving cycle in which the ECT sensor indicates a temperature lower than the closed-loop enable temperature at engine start (i.e., all engine start temperatures greater than the ECT sensor out-of-range low temperature and less than the closed-loop enable temperature).

(C) Manufacturers shall define the monitoring conditions for malfunctions identified in sections (f)(11.2.2)(C) and (D) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements).

(D) Manufacturers may suspend or delay the time to reach closed-loop enable temperature diagnostic if the vehicle is subjected to conditions which could lead to false diagnosis (e.g., vehicle operation at idle for more than 50 to 75 percent of the warm-up time).

(E) A manufacturer may request Executive Officer approval to disable continuous ECT sensor monitoring when an ECT sensor malfunction cannot be distinguished from other effects. The Executive Officer shall approve the disablement upon determining that the manufacturer has submitted test data and/or engineering evaluation that demonstrate a properly functioning sensor cannot be distinguished from a malfunctioning sensor and that the disablement interval is limited only to that necessary for avoiding false detection.

(11.4) MIL Illumination and Fault Code Storage: General requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(12) COLD START EMISSION REDUCTION STRATEGY MONITORING

(12.1) Requirement:

(12.1.1) For all 2010 and subsequent model year vehicles, if a vehicle incorporates a specific engine control strategy to reduce cold start emissions, the OBD II system shall monitor the commanded elements for proper function (e.g., injection timing, increased engine idle speed, increased engine load via intake or exhaust throttle activation) while the control strategy is active to ensure proper operation of the control strategy.

(12.2) Malfunction Criteria: The OBD II system shall detect a malfunction if either of the following occurs:

(12.2.1) Any single commanded element does not properly respond to the commanded action while the cold start strategy is active. For purposes of this section, "properly respond" is defined as when the element responds:

(A) by a robustly detectable amount by the monitor; and

(B) in the direction of the desired command; and

(C) above and beyond what the element would achieve on start-up without the cold start strategy active (e.g., if the cold start strategy commands a higher idle engine speed, a fault must be detected if no detectable amount of engine speed increase above what the system would achieve without the cold start strategy active);

(12.2.2) Any failure or deterioration of the cold start emission reduction control strategy that would cause a vehicle's NMHC, CO, NOx, or PM emissions to exceed:

(A) For passenger cars, light-duty trucks, and MDPVs certified to a chassis dynamometer tailpipe emission standard:
(i) 2.5 times the applicable FTP standards for 2010 through 2012 model year vehicles; and
(ii) 1.5 times the applicable FTP NMHC, CO, or NOx standards or 2.0 times the applicable FTP PM standard for 2013 and subsequent model year vehicles.
(B) For medium-duty vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard:
(i) 2.0 times the applicable NMHC or CO standards, the applicable NOx standard by more than 0.2 g/bhp-hr (e.g., cause NOx emissions to exceed 0.4 g/bhp-hr if the emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test, or 0.03 g/bhp-hr PM as measured from an applicable cycle emission test for 2013 and subsequent model year vehicles.

(12.2.3) For section (f)(12.2.2), the OBD II system shall either monitor the combined effect of the elements of the system as a whole or the individual elements (e.g., increased engine speed, increased engine load from restricting an exhaust throttle) for failures that cause emissions to exceed the applicable emission levels specified in section (f)(12.2.2).

(12.3) Monitoring Conditions: Manufacturers shall define the monitoring conditions for malfunctions identified in section (f)(12.2) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements).

(12.4) MIL Illumination and Fault Code Storage: General requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(13) VARIABLE VALVE TIMING AND/OR CONTROL (VVT) SYSTEM MONITORING

(13.1) Requirement: On all 2006 and subsequent model year applications, the OBD II system shall monitor the VVT system on vehicles so-equipped for target error and slow response malfunctions. The individual electronic components (e.g., actuators, valves, sensors, etc.) that are used in the VVT system shall be monitored in accordance with the comprehensive components requirements in section (f)(15).

(13.2) Malfunction Criteria:

(13.2.1) Target Error: The OBD II system shall detect a malfunction prior to any failure or deterioration in the capability of the VVT system to achieve the commanded valve timing and/or control within a crank angle or lift tolerance that would cause a vehicle's NMHC, CO, NOx, or PM emissions to exceed:
(A) For passenger cars, light-duty trucks, and MDPVs certified to a chassis dynamometer tailpipe emission standard:
(i) 3.0 times the applicable FTP standards for 2006 through 2009 model year vehicles;
(ii) 2.5 times the applicable FTP standards for 2010 through 2012 model year vehicles; and
(iii) 1.5 times the applicable FTP NMHC, CO, or NOx standards or 2.0 times the applicable FTP PM standard for 2013 and subsequent model year vehicles.

(B) For medium-duty vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard:

(i) 2.5 times the applicable NMHC or CO standards, the applicable NOx standard by more than 0.3 g/bhp-hr (e.g., cause NOx emissions to exceed 0.5 g/bhp-hr if the emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test, or 0.03 g/bhp-hr PM as measured from an applicable cycle emission test for 2006 through 2012 model year vehicles; and

(ii) 2.0 times the applicable NMHC or CO standards, the applicable NOx standard by more than 0.2 g/bhp-hr (e.g., cause NOx emissions to exceed 0.4 g/bhp-hr if the emission standard is 0.2 g/bhp-hr) as measured from an applicable cycle emission test, or 0.03 g/bhp-hr PM as measured from an applicable cycle emission test for 2013 and subsequent model year vehicles.

(13.2.2) Slow Response: The OBD II system shall detect a malfunction prior to any failure or deterioration in the capability of the VVT system to achieve the commanded valve timing and/or control within a time that would cause a vehicle's emissions to exceed the applicable emission levels specified in sections (f)(13.2.1).

(13.2.3) For vehicles in which no failure or deterioration of the VVT system could result in a vehicle's emissions exceeding the levels specified in sections (f)(13.2.1), the VVT system shall be monitored for proper functional response in accordance with the malfunction criteria in section (f)(15.2).

(13.3) Monitoring Conditions: Manufacturers shall define the monitoring conditions for VVT system malfunctions identified in section (f)(13.2) in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements), with the exception that monitoring shall occur every time the monitoring conditions are met during the driving cycle in lieu of once per driving cycle as required in section (d)(3.1.2). Additionally, manufacturers shall track and report VVT system monitor performance under section (d)(3.2.2). For purposes of tracking and reporting as required in section (d)(3.2.2), all monitors used to detect malfunctions identified in section (f)(13.2) shall be tracked separately but reported as a single set of values as specified in section (d)(5.2.2).

(13.4) MIL Illumination and Fault Code Storage: General requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(14) [RESERVED]

(15) COMPREHENSIVE COMPONENT MONITORING

(15.1) Requirement:

(15.1.1) Except as provided in sections (f)(15.1.3), (f)(15.1.4), and (f)(16), the OBD II system shall monitor for malfunction any electronic powertrain component/system not otherwise described in sections (f)(1) through (f)(14) that either provides input to (directly or indirectly) or receives commands from the on-board computer(s), and: (1) can affect emissions during any reasonable in-use driving condition, or (2) is used as part of the diagnostic strategy for any other monitored system or component.

(A) Input Components: Input components required to be monitored may include the vehicle speed sensor, crank angle sensor, pedal position sensor, mass air flow sensor, cam position sensor, fuel pressure sensor, intake air temperature sensor, exhaust temperature sensor, and transmission electronic components such as sensors, modules, and solenoids which provide signals to the powertrain control system.

(B) Output Components/Systems: Output components/systems required to be monitored may include the idle governor, fuel injectors, automatic transmission solenoids or controls, turbocharger electronic components, the wait-to-start lamp, and cold start aids (e.g., glow plugs, intake air heaters).

(15.1.2) For purposes of criteria (1) in section (f)(15.1.1) above, the manufacturer shall determine whether a powertrain input or output component/system can affect emissions. If the Executive Officer reasonably believes that a manufacturer has incorrectly determined that a component/system cannot affect emissions, the Executive Officer shall require the manufacturer to provide emission data showing that the component/system, when malfunctioning and installed in a suitable test vehicle, does not have an emission effect. The Executive Officer may request emission data for any reasonable driving condition.

(15.1.3) Manufacturers shall monitor for malfunction electronic powertrain input or output components/systems associated with an electronic transfer case, electronic power steering system, two speed axle, or other components that are driven by the engine and not related to the control of fueling, air handling, or emissions only if the component or system is used as part of the diagnostic strategy for any other monitored system or component.

(15.1.4) Except as specified for hybrids in section (f)(15.1.5), manufacturers shall monitor for malfunction electronic powertrain input or output components/systems associated with components that only affect emissions by causing additional electrical load to the engine and are not related to the control of fueling, air handling, or emissions only if the component or system is used as part of the diagnostic strategy for any other monitored system or component.

(15.1.5) For hybrids, manufacturers shall submit a plan to the Executive Officer for approval of the hybrid components determined by the manufacturer to be subject to monitoring in section (f)(15.1.1). In general, the Executive Officer shall approve the plan if it includes monitoring of all components/systems used as part of the diagnostic strategy for any other monitored system or component, monitoring of all energy input devices to the electrical propulsion system, monitoring of battery and charging system performance, monitoring of electric motor performance, and monitoring of regenerative braking performance.

(15.2) Malfunction Criteria:

(15.2.1) Input Components:

(A) The OBD II system shall detect malfunctions of input components caused by a lack of circuit continuity, out-of-range values, and, where feasible, rationality faults. To the extent feasible, the rationality fault diagnostics shall verify that a sensor output is neither inappropriately high nor inappropriately low (e.g., "two-sided" diagnostics).

(B) To the extent feasible, rationality faults shall be separately detected and store different fault codes than the respective lack of circuit continuity and out of range diagnostics. Additionally, input component lack of circuit continuity and out of range faults shall be separately detected and store different fault codes for each distinct malfunction (e.g., out-of-range low, out-of-range high, open circuit, etc.). Manufacturers are not required to store separate fault codes for lack of circuit continuity faults that cannot be distinguished from other out-of-range circuit faults.

(15.2.2) Output Components/Systems:

(A) The OBD II system shall detect a malfunction of an output component/system when proper functional response of the component and system to computer commands does not occur. If a functional check is not feasible, the OBD II system shall detect malfunctions of output components/systems caused by a lack of circuit continuity or circuit fault (e.g., short to ground or high voltage). For output component lack of circuit continuity faults and circuit faults, manufacturers are not required to store different fault codes for each distinct malfunction (e.g., open circuit, shorted low, etc.). Manufacturers are not required to activate an output component/system when it would not normally be active ~~exclusively~~ for the purposes of performing functional monitoring of output components/systems as required in section (f)(15).

(B) The idle fuel control system shall be monitored for proper functional response to computer commands. A malfunction shall be detected when either of the following conditions occur:

(i) The idle fuel control system cannot achieve the target idle speed or fuel injection quantity within +/- 30 percent of the manufacturer-specified fuel quantity and engine speed tolerances.

(ii) The idle fuel control system cannot achieve the target idle speed or fuel injection quantity within the smallest engine speed or fueling quantity tolerance range required by the OBD II system to enable any other monitor.

(C) Glow plugs/intake air heaters shall be monitored for proper functional response to computer commands. The glow plug/intake air heater circuit(s) shall be monitored for proper current and voltage drop. The Executive Officer shall approve other monitoring strategies based on manufacturer's data and/or engineering analysis demonstrating equally reliable and timely detection of malfunctions. If a manufacturer demonstrates that a single glow plug failure cannot cause a measurable increase in emissions during any reasonable driving condition, the manufacturer shall detect a malfunction for the minimum number of glow plugs needed to cause an emission increase. Further, to the extent feasible on existing engine designs (without adding additional hardware for this purpose) and on all new design engines, the stored fault code shall identify the specific malfunctioning glow plug(s). For 2010 and subsequent model year vehicles, manufacturers shall detect a malfunction when a single glow plug/intake air heater no longer operates within the manufacturer's specified limits for normal operation (e.g., within specifications established by the manufacturer with the part supplier for acceptable part performance at high mileage).

(D) The wait-to-start lamp circuit shall be monitored for malfunctions that cause the lamp to fail to illuminate when commanded on (e.g., burned out bulb).

(E) For 2013 and subsequent model year vehicles that utilize fuel control system components (e.g., injectors, fuel pump) that have tolerance compensation features implemented in hardware or software during production or repair procedures (e.g., individually coded injectors for flow characteristics that are programmed into an electronic control unit to compensate for injector to injector tolerances, fuel pumps that use in-line resistors to correct for differences in fuel pump volume output), the components shall be monitored to ensure the proper compensation is being used. The system shall detect a fault if the compensation being used by the control system does not match the compensation designated for the installed component (e.g., the flow characteristic coding designated on a specific injector does not match the compensation being used by the fuel control system for that injector). If a manufacturer demonstrates that a single component (e.g., injector) using the wrong compensation cannot cause a measurable increase in emissions during any reasonable driving condition, the manufacturer shall detect a malfunction for the minimum number of components using the wrong compensation needed to cause an emission increase. Further, the stored fault code shall identify the specific component that does not match the compensation.

(15.3) Monitoring Conditions:

(15.3.1) Input Components:

(A) Except as provided in section (f)(15.3.1)(C), input components shall be monitored continuously for proper range of values and circuit continuity.

(B) For rationality monitoring (where applicable), manufacturers shall define the monitoring conditions for detecting malfunctions in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements), with the exception that rationality monitoring shall occur every time the monitoring conditions are met during the driving cycle in lieu of once per driving cycle as required in section (d)(3.1.2).:

(C) A manufacturer may request Executive Officer approval to disable continuous input component proper range of values or circuit continuity monitoring when a malfunction cannot be distinguished from other effects. The Executive Officer shall approve the disablement upon determining that the manufacturer has submitted test data and/or documentation that demonstrate a properly functioning input component cannot be distinguished from a malfunctioning input component and that the disablement interval is limited only to that necessary for avoiding false detection.

(15.3.2) Output Components/Systems:

(A) Except as provided in section (f)(15.3.2)(D), monitoring for circuit continuity and circuit faults shall be conducted continuously.

(B) Except as provided in section (f)(15.3.2)(C), for functional monitoring, manufacturers shall define the monitoring conditions for detecting malfunctions in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements).

(C) For the idle fuel control system, manufacturers shall define the monitoring conditions for functional monitoring in accordance with sections (d)(3.1) and (d)(3.2) (i.e., minimum ratio requirements), with the exception that functional monitoring shall occur every time the monitoring conditions are met during the driving cycle in lieu of once per driving cycle as required in section (d)(3.1.2).

(D) A manufacturer may request Executive Officer approval to disable continuous output component circuit continuity or circuit fault monitoring when a malfunction cannot be distinguished from other effects. The Executive Officer shall approve the disablement upon determining that the manufacturer has submitted test data and/or documentation that demonstrate a properly functioning output component cannot be distinguished from a malfunctioning output component and that the disablement interval is limited only to that necessary for avoiding false detection.

(15.4) MIL Illumination and Fault Code Storage:

(15.4.1) Except as provided in section (f)(15.4.2) below, general requirements for MIL illumination and fault code storage are set forth in section (d)(2).

(15.4.2) Exceptions to general requirements for MIL illumination. MIL illumination is not required in conjunction with storing a confirmed fault code for any comprehensive component if:

(A) the component or system, when malfunctioning, could not cause vehicle emissions to increase by:

(i) 25 percent or more for PC/LDT SULEV II vehicles, or

(ii) 15 percent or more for all other vehicles, and

(B) the component or system is not used as part of the diagnostic strategy for any other monitored system or component.

(15.4.3) For purposes of determining the emission increase in section (f)(15.4.2)(A), the manufacturer shall request Executive Officer approval of the test cycle/vehicle operating conditions for which the emission increase will be determined. Executive Officer approval shall be granted upon determining that the manufacturer has submitted data and/or engineering evaluation that demonstrate that the testing conditions represent in-use driving conditions where emissions are likely to be most affected by the malfunctioning component. For purposes of determining whether the specified percentages in section (f)(15.4.2)(A) are exceeded, if the approved testing conditions are comprised of an emission test cycle with an emission standard, the measured increase shall be compared to a percentage of the emission standard (e.g., if the increase is equal to or more than 15 percent of the emission standard for that test cycle). If the approved testing conditions are comprised of a test cycle or vehicle operating condition that does not have an emission standard, the measured increase shall be calculated as a percentage of the baseline test (e.g., if the increase from a back-to-back test sequence between normal and malfunctioning condition is equal to or more than 15 percent of the baseline test results from the normal condition).

(16) OTHER EMISSION CONTROL OR SOURCE SYSTEM MONITORING

(16.1) Requirement: For other emission control or source systems that are not identified or addressed in sections (f)(1) through (f)(15) (e.g., homogeneous charge compression ignition (HCCI) controls, hydrocarbon traps, fuel-fired passenger compartment heaters), manufacturers shall submit a plan for Executive Officer approval of the monitoring strategy, malfunction criteria, and monitoring conditions prior to introduction on a production vehicle intended for sale in California. Executive Officer approval shall be based on the effectiveness of the monitoring strategy, the malfunction criteria utilized, and the monitoring conditions required by the diagnostic.

(16.2) For purposes of section (f)(16), emission source systems are components or devices that emit pollutants subject to vehicle evaporative and exhaust emission standards (e.g., NMOG, CO, NOx, PM) and include non-electronic components and non-powertrain components (e.g., fuel-fired passenger compartment heaters, on-board reformers).

(17) EXCEPTIONS TO MONITORING REQUIREMENTS

(17.1) Except as provided in sections (f)(17.1.1) through (17.1.4) below, upon request of a manufacturer or upon the best engineering judgment of the ARB, the Executive Officer may revise the emission threshold for a malfunction on any diagnostic required in section (f) for medium-duty vehicles if the most reliable monitoring method developed requires a higher threshold to prevent significant errors of commission in detecting a malfunction. Additionally, for 2007 through 2009 model year light-duty vehicles and 2007 through 2012 model year medium-duty vehicles, the Executive Officer may revise the PM filter malfunction criteria of section (f)(9.2.1) to exclude detection of specific failure modes (e.g., combined failure of partially melted and partially cracked substrates) if the most reliable monitoring method developed requires the exclusion of specific failure modes to prevent significant errors of commission in detecting a malfunction.

(17.1.1) For PC/LDT SULEV II vehicles, the Executive Officer shall approve a malfunction criterion of 2.5 times the applicable FTP standards in lieu of 1.5 or 1.75 wherever required in section (f).

(17.1.2) For vehicles certified to Federal Bin 3 or Bin 4 emission standards, manufacturers shall utilize the ULEV II vehicle NMOG and CO malfunction criteria (e.g., 1.5 times the Bin 3 or Bin 4 NMOG and CO standards) and the PC/LDT SULEV II vehicle NOx malfunction criteria (e.g., 2.5 times the Bin 3 or Bin 4 NOx standards).

(17.1.3) For medium-duty diesel vehicles (including MDPVs) certified to an engine dynamometer tailpipe emission standard, the Executive Officer shall approve a malfunction criteria of "the applicable PM standard plus 0.02 g/bhp-hr PM (e.g., unable to maintain PM emissions at or below 0.03 g/bhp-hr if the emission standard is 0.01 g/bhp-hr) as measured from an applicable cycle emission test" in lieu of "0.03 g/bhp-hr PM as measured from an applicable cycle emission test" wherever required in section (f). The Executive Officer shall also approve a malfunction criteria of "the applicable PM standard plus 0.04 g/bhp-hr PM (e.g., unable to maintain PM emissions at or below 0.05 g/bhp-hr if the emission standard is 0.01 g/bhp-hr) as measured from an applicable cycle emission test" in lieu of "0.05 g/bhp-hr PM as measured from an applicable cycle emission test" wherever required in section (f).

(17.1.4) For 2007 through 2009 medium-duty diesel vehicles (including MDPVs) certified to an engine dynamometer FTP tailpipe PM emission standard of greater than or equal 0.08 g/bhp-hr, the Executive Officer shall approve a malfunction of criteria of 1.5 times the applicable PM standard in lieu of the applicable PM malfunction criteria required for any monitor in section (f).

(17.1.5) For medium-duty diesel vehicles (except MDPVs) certified to a chassis dynamometer tailpipe emission standard, the monitoring requirements and malfunction criteria in section (f) applicable to medium-duty diesel vehicles certified to an engine dynamometer tailpipe emission standard shall apply. However, the manufacturer shall request Executive Officer approval of a chassis dynamometer-based malfunction criterion that is equivalent to that required for each monitor in section (f). The Executive Officer shall approve the request upon finding that the manufacturer has used good engineering judgment in determining the equivalent malfunction criterion and that the criterion will provide for similar timeliness in detection of malfunctioning components.

(17.2) Whenever the requirements in section (f) of this regulation require a manufacturer to meet a specific phase-in schedule:

(17.2.1) The phase-in percentages shall be based on the manufacturer's projected sales volume for all vehicles subject to the requirements of title 13, CCR section 1968.2 unless specifically stated otherwise in section (f).

(17.2.2) Manufacturers may use an alternate phase-in schedule in lieu of the required phase-in schedule if the alternate phase-in schedule provides for equivalent compliance volume as defined in section (c) except as specifically noted for the phase in of in-use monitor performance ratio monitoring conditions in section (d)(3.2).

(17.2.3) Small volume manufacturers may use an alternate phase-in schedule in accordance with section (f)(17.2.2) in lieu of the required phase-in schedule or may meet the requirement on all vehicles by the final year of the phase-in in lieu of meeting the specific phase-in requirements for each model year.

(17.3) Manufacturers may request Executive Officer approval to disable an OBD II system monitor at ambient temperatures below twenty degrees Fahrenheit (20°F) (low ambient temperature conditions may be determined based on intake air or engine coolant temperature at engine starting) or at elevations above 8000 feet above sea level. The Executive Officer shall approve the request upon determining that the manufacturer has provided data and/or an engineering evaluation that demonstrate that monitoring during the conditions would be unreliable. A manufacturer may further request, and the Executive Officer shall approve, that an OBD II system monitor be disabled at other ambient temperatures upon determining that the manufacturer has demonstrated with data and/or an engineering evaluation that misdiagnosis would occur at the ambient temperatures because of its effect on the component itself (e.g., component freezing).

(17.4) Manufacturers may request Executive Officer approval to disable monitoring systems that can be affected by low fuel level or running out of fuel (e.g., misfire detection) when the fuel level is 15 percent or less of the nominal capacity of the fuel tank. The Executive Officer shall approve the request upon determining that the manufacturer has submitted data and/or an engineering evaluation that demonstrate that monitoring at the fuel levels would be unreliable.

(17.5) Manufacturers may disable monitoring systems that can be affected by vehicle battery or system voltage levels.

(17.5.1) For monitoring systems affected by low vehicle battery or system voltages, manufacturers may disable monitoring systems when the battery or system voltage is below 11.0 Volts. Manufacturers may request Executive Officer approval to utilize a voltage threshold higher than 11.0 Volts to disable system monitoring. The Executive Officer shall approve the request upon determining that the manufacturer has submitted data and/or an engineering evaluation that demonstrate that monitoring at the voltages would be unreliable and that either operation of a vehicle below the disablement criteria for extended periods of time is unlikely or the OBD II system monitors the battery or system voltage and will detect a malfunction at the voltage used to disable other monitors.

(17.5.2) For monitoring systems affected by high vehicle battery or system voltages, manufacturers may request Executive Officer approval to disable monitoring systems when the battery or system voltage exceeds a manufacturer-defined voltage. The Executive Officer shall approve the request upon determining that the manufacturer has submitted data and/or an engineering evaluation that demonstrate that monitoring above the manufacturer-defined voltage would be unreliable and that either the electrical charging system/alternator warning light is illuminated (or voltage gauge is in the "red zone") or that the OBD II system monitors the battery or system voltage and will detect a malfunction at the voltage used to disable other monitors.

(17.6) A manufacturer may disable affected monitoring systems in vehicles designed to accommodate the installation of Power Take-Off (PTO) units (as defined in section (c)), provided disablement occurs only while the PTO unit is active, and the OBD II readiness status is cleared by the on-board computer (i.e., all monitors set to indicate "not complete") while the PTO unit is activated (see section (g)(4.1) below). If the disablement occurs, the readiness status may be restored to its state prior to PTO activation when the disablement ends.

(17.7) Whenever the requirements in section (f) of this regulation require monitoring "to the extent feasible", the manufacturer shall submit its proposed monitor(s) for Executive Officer approval. The Executive Officer shall approve the proposal upon determining that the proposed monitor(s) meets the criteria of "to the extent feasible" by considering the best available monitoring technology, the extent and degree to which the monitoring requirements are met in full, the limitations of the monitoring necessary to prevent significant errors of commission and omission, and the extent to which the manufacturer has considered and pursued alternative monitoring concepts to meet the requirements in full. The manufacturer's consideration and pursuit of alternative monitoring concepts shall include evaluation of other modifications to the proposed monitor(s), the monitored components themselves, and other monitors that use the monitored components (e.g., altering other monitors to lessen the sensitivity and reliance on the component or characteristic of the component subject to the proposed monitor(s)).

(f)(g) *STANDARDIZATION REQUIREMENTS*

(1) Reference Documents:
The following Society of Automotive Engineers (SAE) and International Organization of Standards (ISO) documents are incorporated by reference into this regulation:

(1.1) SAE J1930 "Electrical/Electronic Systems Diagnostic Terms, Definitions, Abbreviations, and Acronyms – Equivalent to ISO/TR 15031-2:April 30, 2002", April 2002 (SAE J1930).

(1.2) SAE J1962 "Diagnostic Connector – Equivalent to ISO/DIS 15031-3:December 14, 2001", April 2002 (SAE J1962).

(1.3) SAE J1978 "OBD II Scan Tool – Equivalent to ISO/DIS 15031-4:December 14, 2001", April 2002 (SAE J1978).

(1.4) SAE J1979 "E/E Diagnostic Test Modes – Equivalent to ISO/DIS 15031-5:April 30, 2002", April 2002 (SAE J1979).

(1.5) SAE J1850 "Class B Data Communications Network Interface", May 2001 (SAE 1850).

(1.6) SAE J2012 "Diagnostic Trouble Code Definitions – Equivalent to ISO/DIS 15031-6:April 30, 2002", April 2002 (SAE J2012).

(1.7) ISO 9141-2:1994 "Road Vehicles-Diagnostic Systems-CARB Requirements for Interchange of Digital Information", February 1994 (ISO 9141-2).

(1.8) ISO 14230-4:2000 "Road Vehicles-Diagnostic Systems-KWP 2000 Requirements for Emission-related Systems", June 2000 (ISO 14230-4).

(1.9) ISO 15765-4:2001 2005 "Road Vehicles-Diagnostics on Controller Area Network (CAN) - Part 4: Requirements for emission-related systems", December 2001 (ISO 15765-4).

(1.10) SAE J1939 APR00March 2005 -"Recommended Practice for a Serial Control and Communications Vehicle Network" and the associated subparts included in SAE HS-1939, "Truck and Bus Control and Communications Network Standards Manual", 20015 Edition (SAE J1939).

(1.11) SAE J1699-3 – "OBD II Compliance Test Cases", May 2006 (SAE J1699-3).

(1.12) SAE J2534 – "Recommended Practice for Pass-Thru Vehicle Programming", April 2004 (SAE J2534).

(2) Diagnostic Connector:
A standard data link connector conforming to SAE J1962 specifications (except as specified in section ~~(f)~~(g)(2.3)) shall be incorporated in each vehicle.

(2.1) The connector shall be located in the driver's side foot-well region of the vehicle interior in the area bound by the driver's side of the vehicle and the driver's side edge of the center console (or the vehicle centerline if the vehicle does not have a center console) and at a location no higher than the bottom of the steering wheel when in the lowest adjustable position. The connector may not be located on or in the center console (i.e., neither on the horizontal faces near the floor-mounted gear selector, parking brake lever, or cup-holders nor on the vertical faces near the car stereo, climate system, or navigation system controls). The location of the connector shall be capable of being easily identified by a "crouched" technician entering the vehicle from the driver's side.

(2.2) If the connector is covered, the cover must be removable by hand without the use of any tools and be labeled to aid technicians in identifying the location of the connector. Access to the diagnostic connector may not require opening or the removal of any storage accessory (e.g., ashtray, coinbox, etc.). The label shall be submitted to the Executive Officer for review and approval, at or before the time the manufacturer submits its certification application. The Executive Officer shall approve the label upon determining that it clearly identifies that the connector is located behind the cover and is consistent with language and/or symbols commonly used in the automotive industry.

(2.3) Any pins in the connector that provide electrical power shall be properly fused to protect the integrity and usefulness of the connector for diagnostic purposes and may not exceed 20.0 Volts DC regardless of the nominal vehicle system or battery voltage (e.g., 12V, 24V, 42V, etc.).

(3) Communications to a Scan Tool:
Manufacturers shall use one of the following standardized protocols for communication of all required emission related messages from on-board to off-board network communications to a scan tool meeting SAE J1978 specifications:

(3.1) SAE J1850. All required emission related messages using this protocol shall use the Cyclic Redundancy Check and the three byte header, may not use inter-byte separation or checksums, and may not require a minimum delay of 100 ms between SAE J1978 scan tool requests. This protocol may not be used on any 2008 or subsequent model year vehicle.

(3.2) ISO 9141-2. This protocol may not be used on any 2008 or subsequent model year vehicle.

(3.3) ISO 14230-4. This protocol may not be used on any 2008 or subsequent model year vehicle.

(3.4) ISO 15765-4. This protocol shall be allowed on any 2003 and subsequent model year vehicle and required on all 2008 and subsequent model year vehicles. All required emission-related messages using this protocol shall use a 500 kbps baud rate.

(4) Required Emission Related Functions:
The following standardized functions shall be implemented in accordance with the specifications in SAE J1979 to allow for access to the required information by a scan tool meeting SAE J1978 specifications:

(4.1) Readiness Status: In accordance with SAE J1979 specifications, the OBD II system shall indicate "complete" or "not complete" for each of the installed monitored components and systems identified in sections (e)(1) through (e)(8), (e)(13), (e)(15), (f)(1) through (f)(4), (f)(6), (f)(8), (f)(15), and, additionally for 2010 and subsequent model year diesel vehicles, (f)(5), (f)(7), (f)(9), and (f)(13) since the fault memory was last cleared. All components or systems that are monitored continuously shall always indicate "complete". Those components or systems that are not subject to continuous monitoring shall immediately indicate "complete" upon the respective diagnostic(s) being fully executed and determining that the component or system is not malfunctioning. A component or system shall also indicate "complete" if after the requisite number of decisions necessary for determining MIL status have been fully executed, the monitor indicates a malfunction for the component or system. The status for each of the monitored components or systems shall indicate "not complete" whenever fault memory has been cleared or erased by a means other than that allowed in section (d)(2). Normal vehicle shut down (i.e., key off, engine off) may not cause the status to indicate "not complete".

(4.1.1) Subject to Executive Officer approval, if monitoring is disabled for a multiple number of driving cycles due to the continued presence of extreme operating conditions (e.g., cold ambient temperatures, high altitudes, etc), readiness status for the subject monitoring system may be set to indicate "complete" without monitoring having been completed. Executive Officer approval shall be based on the conditions for monitoring system disablement and the number of driving cycles specified without completion of monitoring before readiness is indicated as "complete".

(4.1.2) For the evaporative system monitor:

(A) Except as provided below in section ~~(f)~~(g)(4.1.2)(B), the readiness status shall be set in accordance with section ~~(f)~~(g)(4.1) when both the functional check of the purge valve and the leak detection monitor of the orifice size specified in either section (e)(4.2.2)(B) or (C) (e.g., 0.040 inch or 0.020 inch) indicate that they are complete.

(B) For vehicles that utilize a 0.090 inch (in lieu of 0.040 inch) leak detection monitor in accordance with section (e)(4.2.5), the readiness status shall be set in accordance with section ~~(f)~~(g)(4.1) when both the functional check of the purge valve and the leak detection monitor of the orifice size specified in section (e)(4.2.2)(C) (e.g., 0.020 inch) indicate that they are complete.

(4.1.3) If the manufacturer elects to additionally indicate readiness status through the MIL in the key on, engine off position as provided for in section (d)(2.1.43), the readiness status shall be indicated in the following manner: If the readiness status for all monitored components or systems is "complete", the MIL shall remain continuously illuminated in the key on, engine off position for at least 15-20 seconds. If the readiness status for one or more of the monitored components or systems is "not complete", after 15-20 seconds of operation in the key on, engine off position with the MIL illuminated continuously, the MIL shall blink once per second for 5-10 seconds. The data stream value for MIL status (section ~~(f)~~(g)(4.2)) shall indicate "commanded off" during this sequence unless the MIL has also been "commanded on" for a detected fault.

(4.2) Data Stream: The following signals shall be made available on demand through the standardized data link connector in accordance with SAE J1979 specifications. The actual signal value shall always be used instead of a default or limp home value.

(4.2.1) For all vehicles: calculated load value, number of stored confirmed fault codes, engine coolant temperature, engine speed, absolute throttle position (if equipped with a throttle), vehicle speed, OBD requirements to which the engine is certified (e.g., California OBD II, EPA OBD, European OBD, non-OBD) and MIL status (i.e., commanded-on or commanded-off).

(4.2.2) For all vehicles so equipped: fuel control system status (e.g., open loop, closed loop, etc.), fuel trim, fuel pressure, ignition timing advance, intake air temperature, manifold absolute pressure, air flow rate from mass air flow sensor, secondary air status (upstream, downstream, or atmosphere), oxygen sensor output, air/fuel ratio sensor output.

(4.2.3) For all 2005 and subsequent model year vehicles using the ISO 15765-4 protocol for the standardized functions required in section ~~(f)~~(g), the following signals shall also be made available: absolute load, fuel level (if used to enable or disable any other diagnostics), relative throttle position (if equipped with a throttle), barometric pressure (directly measured or estimated), engine control module system voltage, commanded equivalence ratio, catalyst temperature (if directly measured or estimated for purposes of enabling the catalyst monitor(s)), monitor status (i.e., disabled for the rest of this driving cycle, complete this driving cycle, or not complete this driving cycle) since last engine shut-off for each monitor used for readiness status, time elapsed since engine start, distance traveled while MIL activated, distance traveled since fault memory last cleared, and number of warm-up cycles since fault memory last cleared.

(4.2.4) For all 2005 and subsequent model year vehicles so equipped and using the ISO 15765-4 protocol for the standardized functions required in section ~~(f)~~(g): ambient air temperature, evaporative system vapor pressure, commanded purge valve duty cycle/position, commanded EGR valve duty cycle/position, EGR error between actual and commanded, PTO status (active or not active), redundant absolute throttle position (for electronic throttle or other systems that utilize two or more sensors), absolute pedal position, redundant absolute pedal position, and commanded throttle motor position.

(4.2.5) Additionally, for all 2010 and subsequent model year vehicles with a diesel engine:

(A) Calculated load (engine torque as a percentage of maximum torque available at the current engine speed), driver's demand engine torque (as a percentage of maximum engine torque), actual engine torque (as a percentage of maximum engine torque), engine oil temperature (if used for emission control or any OBD diagnostics), time elapsed since engine start; and

(B) Fuel level (if used to enable or disable any other diagnostics), barometric pressure (directly measured or estimated), engine control module system voltage; and

(C) Monitor status (i.e., disabled for the rest of this driving cycle, complete this driving cycle, or not complete this driving cycle) since last engine shut-off for each monitor used for readiness status, distance traveled (or engine run time for engines not utilizing vehicle speed information) while MIL activated, distance traveled (or engine run time for engines not utilizing vehicle speed information) since fault memory last cleared, and number of warm-up cycles since fault memory last cleared; and

(D) For all engines so equipped: absolute throttle position, relative throttle position, fuel injection timing, intake manifold temperature, intercooler temperature, ambient air temperature, commanded EGR valve duty cycle/position, actual EGR valve duty cycle/position, EGR error between actual and commanded, PTO status (active or not active), absolute pedal position, redundant absolute pedal position, commanded throttle motor position, fuel rate, boost pressure, commanded/target boost pressure, turbo inlet air temperature, fuel rail pressure, commanded fuel rail pressure, PM filter inlet pressure, PM filter inlet temperature, PM filter outlet pressure, PM filter outlet temperature, PM filter delta pressure, exhaust pressure sensor output, exhaust gas temperature sensor output, injection control pressure, commanded injection control pressure, turbocharger/turbine speed, variable geometry turbo position, commanded variable geometry turbo position, turbocharger compressor inlet temperature, turbocharger compressor inlet pressure, turbocharger turbine inlet temperature, turbocharger turbine outlet temperature, wastegate valve position, glow plug lamp status, PM sensor output, and NOx sensor output;

(E) Additionally, for all 2010 and subsequent model year medium-duty vehicles with a diesel engine certified on an engine dynamometer: NOx NTE control area status (i.e., inside control area, outside control area, inside manufacturer-specific NOx NTE carve-out area, or NTE deficiency for NOx active area) and PM NTE control area status (i.e., inside control area, outside control area, inside manufacturer-specific PM NTE carve-out area, or NTE deficiency for PM active area).

(4.3) Freeze Frame.

(4.3.1) "Freeze frame" information required to be stored pursuant to sections (d)(2.2.46), (e)(3.4.3), ~~and~~ (e)(6.4.4), (f)(3.4.2)(B), and (f)(4.4.2)(D) shall be made available on demand through the standardized data link connector in accordance with SAE J1979 specifications.

(4.3.2) "Freeze frame" conditions must include the fault code which caused the data to be stored and all of the signals required in section ~~(f)~~(g)(4.2.1) except number of stored confirmed fault codes, OBD requirements to which the engine is certified, ~~and~~ MIL status, and absolute throttle position in accordance with (g)(4.3.3). Freeze frame conditions shall also include all of the signals required on the vehicle in sections ~~(f)~~(g)(4.2.2) through (g)(4.2.54)(D) that are used for diagnostic or control purposes in the specific diagnostic or emission-critical powertrain control unit that stored the fault code except: oxygen sensor output, air/fuel ratio sensor output, catalyst temperature, evaporative system vapor pressure, glow plug lamp status, PM sensor output, NOx sensor output, monitor status since last engine shut off, distance traveled while MIL activated, distance traveled since fault memory last cleared, and number of warm-up cycles since fault memory last cleared.

(4.3.3) In lieu of including the absolute throttle position data specified in (g)(4.2.1) in the freeze frame data, diagnostic or emission-critical powertrain control units that do not use the absolute throttle position data may include the relative throttle position data specified in (g)(4.2.3) or pedal position data specified in (g)(4.2.4).

~~(4.3.3)~~(4.3.4) Only one frame of data is required to be recorded. Manufacturers may choose to store additional frames provided that at least the required frame can be read by a scan tool meeting SAE J1978 specifications.

(4.4) Fault Codes

(4.4.1) For all monitored components and systems, stored pending, ~~and~~ confirmed, and permanent fault codes shall be made available through the diagnostic connector in accordance with SAE J1979 specifications. Standardized fault codes conforming to SAE J2012 shall be employed.

(4.4.2) The stored fault code shall, to the fullest extent possible, pinpoint the likely cause of the malfunction. To the extent feasible on all 2005 and subsequent model year vehicles, manufacturers shall use separate fault codes for every diagnostic where the diagnostic and repair procedure or likely cause of the failure is different. In general, rationality and functional diagnostics shall use different fault codes than the respective circuit continuity diagnostics. Additionally, input component circuit continuity diagnostics shall use different fault codes for distinct malfunctions (e.g., out-of-range low, out-of-range high, open circuit, etc.).

(4.4.3) Manufacturers shall use appropriate SAE-defined fault codes of SAE J2012 (e.g., P0xxx, P2xxx) whenever possible. With Executive Officer approval, manufacturers may use manufacturer-defined fault codes in accordance with SAE J2012 specifications (e.g., P1xxx). Factors to be considered by the Executive Officer for approval shall include the lack of available SAE-defined fault codes, uniqueness of the diagnostic or monitored component, expected future usage of the diagnostic or component, and estimated usefulness in providing additional diagnostic and repair information to service technicians. Manufacturer-defined fault codes shall be used consistently (i.e., the same fault code may not be used to represent two different failure modes) across a manufacturer's entire product line.

(4.4.4) A fault code (pending and/or confirmed, as required in sections (d) ~~and~~ (e), and (f)) shall be stored and available to an SAE J1978 scan tool within 10 seconds after a diagnostic has determined that a malfunction has occurred. A permanent fault code shall be stored and available to an SAE J1978 scan tool no later than the end of an ignition cycle (including electronic control unit shutdown) in which the corresponding confirmed fault code causing the MIL to be illuminated has been stored.

(4.4.5) Pending fault codes:

(A) On all 2005 and subsequent model year vehicles, pending fault codes for all components and systems (including continuously and non-continuously monitored components) shall be made available through the diagnostic connector in accordance with SAE J1979 specifications (e.g., Mode/Service $07).

(B) On all 2005 and subsequent model year vehicles, a pending fault code(s) shall be stored and available through the diagnostic connector for all currently malfunctioning monitored component(s) or system(s), regardless of the MIL illumination status or confirmed fault code status (e.g., even after a pending fault has matured to a confirmed fault code and the MIL is illuminated, a pending fault code shall be stored and available if the most recent monitoring event indicates the component is malfunctioning).

(C) Manufacturers using alternate statistical protocols for MIL illumination as allowed in section (d)(2.2.36) shall submit to the Executive Officer a protocol for setting pending fault codes. The Executive Officer shall approve the proposed protocol upon determining that, overall, it is equivalent to the requirements in sections (f)(g)(4.4.5)(A) and (B) and that it effectively provides service technicians with a quick and accurate indication of a pending failure.

(4.4.6) Permanent fault codes:

(A) Permanent fault codes for all components and systems shall be made available through the diagnostic connector in a standardized format that distinguishes permanent fault codes from both pending fault codes and confirmed fault codes.

(B) A confirmed fault code shall be stored as a permanent fault code no later than the end of the ignition cycle and subsequently at all times that the confirmed fault code is commanding the MIL on (e.g., for currently failing systems but not during the 40 warm-up cycle self-healing process described in section (d)(2.4)).

(C) Permanent fault codes shall be stored in NVRAM and may not be erasable by any scan tool command (generic or enhanced) or by disconnecting power to the on-board computer.

(D) Permanent fault codes may not be erased when the control module containing the permanent fault codes is reprogrammed unless the readiness status (refer to section (g)(4.1)) for all monitored components and systems is set to "not complete" in conjunction with the reprogramming event.

(E) The OBD system shall have the ability to store a minimum of four current confirmed fault codes as permanent fault codes in NVRAM. If the number of confirmed fault codes currently commanding the MIL on exceeds the maximum number of permanent fault codes that can be stored, the OBD system shall store the earliest detected confirmed fault codes as permanent fault codes. If additional confirmed fault codes are stored when the maximum number of permanent fault codes is already stored in

NVRAM, the OBD system may not replace any existing permanent fault code with the additional confirmed fault codes.

(4.5) Test Results

(4.5.1) For all monitored components and systems for gasoline engine vehicles identified in sections (e)(1) through (e)(8) except misfire detection, ~~and~~ fuel system monitoring, and oxygen sensor circuit and out-of-range monitoring, and for all monitored components and systems for diesel engine vehicles identified in sections (f)(1) through (f)(9) except those required to be monitored continuously, results of the most recent monitoring of the components and systems and the test limits established for monitoring the respective components and systems shall be stored and available through the data link in accordance with SAE J1979 specifications.

(4.5.2) The test results shall be reported such that properly functioning components and systems (e.g., "passing" systems) do not store test values outside of the established test limits.

(4.5.3) The test results shall be stored until updated by a more recent valid test result or the fault memory of the OBD II system computer is cleared. Upon fault memory being cleared, test results reported for monitors that have not yet completed since the last time the fault memory was cleared shall report values that do not indicate a failure (i.e., a test value which is outside of the test limits).

(4.5.4) Additionally, for vehicles using ISO 15765-4 (see section ~~(f)~~(g)(3.4)) as the communication protocol:

(A) The test results and limits shall be made available in the standardized format specified in SAE J1979 for the ISO 15765-4 protocol. Test results using vehicle manufacturer-defined monitor identifications (i.e., SAE J1979 OBDMIDs in the range of $E1-$FF) may not be used.

(B) Test limits shall include both minimum and maximum acceptable values and shall be reported for all ~~monitored components and systems~~test results required ~~identified~~ in section (g)(4.5.1)~~s (e)(1) through (e)(8)~~, ~~except fuel system monitoring~~. The test limits shall be defined so that a test result equal to either test limit is a "passing" value, not a "failing" value.

(C) For 2005 and subsequent model year vehicles, misfire monitoring test results shall be calculated and reported in the standardized format specified in SAE J1979. For 25 percent of 2009, 50 percent of 2010, and 100 percent of 2011 and subsequent model year vehicles equipped with VVT systems, VVT monitoring test results and limits shall be stored and available in the standardized format specified in SAE J1979.

(D) Monitors that have not yet completed since the last time the fault memory was cleared shall report values of zero for the test result and test limits.

(E) All test results and test limits shall always be reported and the test results shall be stored until updated by a more recent valid test result or the fault memory of the OBD II system computer is cleared. For monitors with multiple pass/fail criteria (e.g., a purge flow diagnostic that can pass upon seeing a rich shift, lean shift, or engine speed change), only the test results used in the most recent decision shall be reported with valid results and limits while test results not used in the most recent decision shall report values of zero for the test results and limits (e.g., a purge flow monitoring event that passed based on seeing a rich shift shall report the results and the limits of the rich shift test and shall report values of zero for the results and limits of the lean shift and engine speed change tests).

(F) The OBD II system shall store and report unique test results for each separate diagnostic (e.g., an OBD II system with individual evaporative system diagnostics for 0.040 inch and 0.020 inch leaks shall separately report 0.040 inch and 0.020 inch test results).

(4.6) Software Calibration Identification:

(4.6.1) On all vehicles, a software calibration identification number (CAL ID) for the diagnostic or emission critical powertrain control unit(s) shall be made available through the standardized data link connector in accordance with the SAE J1979 specifications. Except as provided for in section (g)(4.6.3), for 2009 and subsequent model year vehicles, the OBD II system shall use a single software calibration identification number (CAL ID) for each diagnostic or emission critical powertrain control unit(s) that replies to a generic scan tool with a unique module address.

(4.6.2) A unique CAL ID shall be used for every emission-related calibration and/or software set having at least one bit of different data from any other emission-related calibration and/or software set. Control units coded with multiple emission or diagnostic calibrations and/or software sets shall indicate a unique CAL ID for each variant in a manner that enables an off-board device to determine which variant is being used by the vehicle. Control units that utilize a strategy that will result in MIL illumination if the incorrect variant is used (e.g., control units that contain variants for manual and automatic transmissions but will illuminate the MIL if the variant selected does not match the type of transmission on the vehicle) are not required to use unique CAL IDs.

(4.6.3) For 2009 and subsequent model year vehicles, manufacturers may request Executive Officer approval to respond with more than one CAL ID per diagnostic or emission critical powertrain control unit. Executive Officer approval of the request shall be based on the method used by the manufacturer to ensure each control unit will respond to a SAE J1978 scan tool with the CAL IDs in order of highest to lowest priority with regards to areas of the software most critical to emission and OBD II system performance.

(4.7) Software Calibration Verification Number

(4.7.1) All 2005[2] and subsequent model year vehicles shall use an algorithm to calculate a calibration verification number (CVN) that verifies the on-board computer software integrity in diagnostic or emission critical electronically reprogrammable powertrain control units. The CVN shall be made available through the standardized data link connector in accordance with the SAE J1979 specifications. The CVN shall be capable of being used to determine if the emission-related software and/or calibration data are valid

2 The requirements of section (fg)(4.7) shall supercede the requirements set forth in title 13, CCR section 1968.1(l)(4.0).

and applicable for that vehicle and CAL ID. For 2010 and subsequent model year vehicles, one CVN shall be made available for each CAL ID made available and each CVN shall be output to a generic scan tool in the same order as the CAL IDs are output to the scan tool to allow the scan tool to match each CVN to the corresponding CAL ID.

(4.7.2) Manufacturers shall request Executive Officer approval of the algorithm used to calculate the CVN. Executive Officer approval of the algorithm shall be based on the complexity of the algorithm and the difficulty in achieving the same CVN with modified calibration values.

(4.7.3) The CVN shall be calculated at least once per driving cycle and stored until the CVN is subsequently updated. Except for immediately after a reprogramming event or a non-volatile memory clear or for the first 30 seconds of engine operation after a volatile memory clear or battery disconnect, the stored value shall be made available through the data link connector to a generic scan tool in accordance with SAE J1979 specifications. The stored CVN value may not be erased when fault memory is erased by a generic scan tool in accordance with SAE J1979 specifications or during normal vehicle shut down (i.e., key off, engine off).

(4.7.4) For purposes of Inspection and Maintenance (I/M) testing, manufacturers shall make the CVN and CAL ID combination information available for all 2005 and subsequent model year vehicles in a standardized electronic format that allows for off-board verification that the CVN is valid and appropriate for a specific vehicle and CAL ID. The standardized electronic format is detailed in Attachment XXX of ARB Mail-Out #XX-XX, Month Date, Year, incorporated by reference.

(4.8) Vehicle Identification Number: All 2005 and subsequent model year vehicles shall have the vehicle identification number (VIN) available in a standardized format through the standardized data link connector in accordance with SAE J1979 specifications. Only one electronic control unit per vehicle shall report the VIN to an SAE J1978 scan tool.

(4.9) ECU Name: For all 2010 and subsequent model year vehicles, the name of each electronic control unit that responds to an SAE J1978 scan tool with a unique address or identifier shall be communicated in a standardized format in accordance with SAE J1979 (i.e., ECUNAME in Service/Mode $09, InfoType $0A).

(5) In-use Performance Ratio Tracking Requirements:

(5.1) For each monitor required in section (e) to separately report an in-use performance ratio, manufacturers shall implement software algorithms to report a numerator and denominator in the standardized format specified below and in accordance with the SAE J1979 specifications.

(5.2) Numerical Value Specifications:

(5.2.1) For the numerator, denominator, general denominator, and ignition cycle counter:

(A) Each number shall have a minimum value of zero and a maximum value of 65,535 with a resolution of one.

(B) Each number shall be reset to zero only when a non-volatile memory reset occurs (e.g., reprogramming event, etc.) or, if the numbers are stored in keep-alive memory (KAM), when KAM is lost due to an interruption in electrical power to the control module (e.g., battery disconnect, etc.). Numbers may not be reset to zero under any other circumstances including when a scan tool command to clear fault codes or reset KAM is received.

(C) If either the numerator or denominator for a specific component reaches the maximum value of 65,535 ±2, both numbers shall be divided by two before either is incremented again to avoid overflow problems.

(D) If the ignition cycle counter reaches the maximum value of 65,535 ±2, the ignition cycle counter shall rollover and increment to zero on the next ignition cycle to avoid overflow problems.

(E) If the general denominator reaches the maximum value of 65,535 ±2, the general denominator shall rollover and increment to zero on the next driving cycle that meets the general denominator definition to avoid overflow problems.

(F) If a vehicle is not equipped with a component (e.g., oxygen sensor bank 2, secondary air system), the corresponding numerator and denominator for that specific component shall always be reported as zero.

(5.2.2) For the ratio:

(A) The ratio shall have a minimum value of zero and a maximum value of 7.99527 with a resolution of 0.000122.

(B) A ratio for a specific component shall be considered to be zero whenever the corresponding numerator is equal to zero and the corresponding denominator is not zero.

(C) A ratio for a specific component shall be considered to be the maximum value of 7.99527 if the corresponding denominator is zero or if the actual value of the numerator divided by the denominator exceeds the maximum value of 7.99527.

(6) Engine Run Time Tracking Requirements:

(6.1) For all 2010 and subsequent model year medium-duty vehicles equipped with diesel engines, manufacturers shall implement software algorithms to individually track and report in a standardized format the engine run time while being operated in the following conditions:

(6.1.1) Total engine run time;

(6.1.2) Total idle run time (with "idle" defined as accelerator pedal released by driver, vehicle speed less than or equal to one mile per hour, and PTO not active);

(6.1.3) Total run time with PTO active.

(6.1.4) Total run time with EI-AECD #1active;

(6.1.5) Total run time with EI-AECD #2 active; and so on up to

(6.1.6) Total run time with EI-AECD #n active.

(6.2) For all 2010 and subsequent model year light-duty vehicles equipped with diesel engines, manufacturers shall implement software algorithms to individually track and report in a standardized format the engine run time while being operated in the following conditions:

(6.2.1) Total engine run time;

(6.2.2) Total run time with EI-AECD #1active;
(6.2.3) Total run time with EI-AECD #2 active; and so on up to
(6.2.4) Total run time with EI-AECD #n active.

(6.3) Numerical Value Specifications:

(6.3.1) For each counter specified in section (g)(6):

(A) Each number shall be a four-byte value with a minimum value of zero with a resolution of one minute per bit.

(B) Each number shall be reset to zero only when a non-volatile memory reset occurs (e.g., reprogramming event). Numbers may not be reset to zero under any other circumstances including when a scan tool (generic or enhanced) command to clear fault codes or reset KAM is received.

(C) If any of the individual counters reach the maximum value, all counters shall be divided by two before any are incremented again to avoid overflow problems.

(6.4) Separation of EI-AECDs

(6.4.1) Each EI-AECD shall be tracked individually and increment the counters at all times the conditions necessary to activate the EI-AECD are present.

(6.4.2) For EI-AECDs that have variable actions or degrees of action (e.g., derate EGR more aggressively as engine oil temperature continues to increase), the EI-AECD shall be tracked as two separate EI-AECDs and increment two counters.

(A) The first of the two counters shall be incremented whenever the EI-AECD is commanding some amount of reduced emission control effectiveness up to but not including 75 percent of the maximum reduced emission control effectiveness that the EI-AECD is capable of commanding during in-use vehicle or engine operation. For example, an overheat protection strategy that progressively derates EGR and eventually shuts off EGR as oil temperature increases would accumulate time for the first counter from the time derating of EGR begins up to the time that EGR is derated 75 percent. As a second example, an overheat protection strategy that advances fuel injection timing progressively up to a maximum advance of 15 degrees crank angle as the engine coolant temperature increases would accumulate time for the first counter from the time advance is applied up to the time that advance reaches 11.25 degrees (75 percent of the maximum 15 degrees).

(B) The second of the two counters shall be incremented whenever the EI-AECD is commanding 75 percent or more of the maximum reduced emission control effectiveness that the EI-AECD is capable of commanding during in-use vehicle or engine operation. For example, the second counter for the first example EI-AECD identified in section (g)(6.4.2.)(A) would accumulate time from the time that EGR is derated 75 percent up to and including when EGR is completely shut off. For the second example EI-AECD identified in section (g)(6.4.2)(A), the second counter would accumulate time from the time fuel injection timing advance is at 11.25 degrees up to and including the maximum advance of 15 degrees.

(6.4.3) If more than one EI-AECD is currently active, the counters for both EI-AECDs shall accumulate time, regardless if there is overlap or redundancy in the commanded action (e.g., two different EI-AECDs independently but simultaneously commanding EGR off shall both accumulate time in their respective counters).

(6) Service Information:

(6.1) Motor vehicle manufacturers shall provide the aftermarket service and repair industry emission-related service information for all 1994 and subsequent model year vehicles equipped with OBD II systems as set forth in sections (f)(6.3) through (6.5). The requirements of section (f)(6) shall supersede the service information requirements set forth in title 13, CCR section 1968.1.

(6.2) The Executive Officer shall waive the requirements of sections (f)(6.3) through (6.5) upon determining that the ARB or U.S. EPA has adopted a service information regulation or rule that is in effect and operative and requires motor vehicle manufacturers to provide emission-related service information:

(A) of comparable or greater scope than required under these provisions;

(B) in an easily accessible format and in a timeframe that is equivalent to or exceeds the timeframes set forth below; and

(C) at fair and reasonable cost.

(6.3) For all 1994 and subsequent model year vehicles equipped with an OBD II system, manufacturers shall make readily available, at a fair and reasonable price to the automotive repair industry, vehicle repair procedures which allow effective emission-related diagnosis and repairs to be performed using only the SAE J1978 generic scan tool and commonly available, non-microprocessor based tools.

(6.4) As an alternative to publishing repair procedures required under section (f)(6.3), a manufacturer may publish repair procedures referencing the use of manufacturer-specific or enhanced equipment provided the manufacturer makes available to the aftermarket scan tool industry the information needed to manufacture scan tools to perform the same emission-related diagnosis and repair procedures (excluding any reprogramming) in a comparable manner as the manufacturer-specific diagnostic scan tool.

(6.5) For all 1996 and subsequent model year vehicles, manufacturers shall make available:

(A) Information to utilize the test results reported as required in section (f)(4.5) (or title 13, CCR section 1968.1 (l)(3.0) for 1996 through 2002 model year vehicles). The information must include a description of the test and test result, associated fault codes with the test result, and scaling, units, and conversion factors necessary to convert the results to engineering units.

(B) A generic description of each of the diagnostics used to meet the requirements of this regulation. The generic description must include a text description of how the diagnostic is performed, typical enable conditions, typical malfunction thresholds, typical monitoring time, fault codes associated with the diagnostic, and test results (section (f)(4.5)) associated with the diagnostic. Vehicles that have diagnostics not adequately represented by the typical values identified above shall be specifically identified along with the appropriate typical values.

(C) Information necessary to execute each of the diagnostics used to meet the requirements of sections (e)(1) through (e)(8). The information must

~~include either a description of sample driving patterns designed to be operated in-use or a written description of the conditions the vehicle needs to operate in to execute each of the diagnostics necessary to change the readiness status from "not complete" to "complete" for all monitors. The information shall be able to be used to exercise all necessary monitors in a single driving cycle as well as be able to be used to exercise the monitors to individually change the readiness status for each specific monitor from "not complete" to "complete".~~

(7) Exceptions to Standardization Requirements.

(7.1) For medium-duty vehicles equipped with a diesel engine~~s~~ certified on an engine dynamometer, a manufacturer may request Executive Officer approval to use both: (1) an alternate diagnostic connector, and emission-related message structure and format in lieu of the standardization requirements in sections ~~(f)~~(g)(2) and (4) that refer to SAE J1962, SAE J1978, and SAE J1979, and (2) an alternate communication protocol in lieu of the identified protocols in section ~~(f)~~(g)(3). The Executive Officer shall approve the request if the alternate diagnostic connector, communication protocol, and emission-related message format and structure requested by the manufacturer meet the standardization requirements in title 13, CCR section 1971.1 applicable for 2013 and subsequent model year heavy-duty diesel engines and the information required to be made available in section (g)(4.1) through (g)(6) (e.g., readiness status, data stream parameters, permanent fault codes, engine run time tracking data) is available in a standardized format through the alternate emission-related message format.~~:~~

~~(A)The ARB has adopted an on-board diagnostic regulation for heavy-duty vehicles and the alternate diagnostic connector, communication protocol, and emission-related message format and structure requested by the manufacturer meets the standardization requirements in the on-board diagnostic regulation for heavy-duty vehicles; or~~

~~(B)For 2004 and 2005 model year vehicles only, the alternate diagnostic connector, communication protocol, and emission-related message format and structure requested by the manufacturer meet the standardization requirements of SAE J1939 and the manufacturer has implemented features (e.g., readiness code indication via the MIL pursuant to section (f)(4.1.3)) that will allow the vehicle to be tested in a California Inspection and Maintenance test facility. If the ARB has not adopted a heavy-duty vehicle on-board diagnostic regulation by July 1, 2004, the Executive Officer shall extend the provisions of this section through the 2006 model year. The Executive Officer shall extend the provisions of this section one additional model year on each subsequent July 1 if the ARB has not adopted a heavy-duty vehicle on-board diagnostic regulation by that date.~~

(7.2) For 2004 model year vehicles only, wherever the requirements of sections ~~(f)~~(g)(2) and ~~(f)~~(g)(4) reflect a substantive change from the requirements of title 13, CCR sections 1968.1(e), (f), (k), or (l) for the 2003 model year vehicles, the manufacturer may request Executive Officer approval to continue to use the requirements of section 1968.1 in lieu of the requirements of sections ~~(f)~~(g)(2) and ~~(f)~~(g)(4). The Executive Officer shall approve the request upon determining that the manufacturer has submitted data and/or engineering evaluation that demonstrate that software or hardware changes would be required to comply with the requirements of sections ~~(f)~~(g)(2) and ~~(f)~~(g)(4) and that the system complies with the requirements of sections 1968.1(e), (f), (k), and (l).

~~(g)~~(h) .... *MONITORING SYSTEM DEMONSTRATION REQUIREMENTS FOR CERTIFICATION*

(1) General.

(1.1) Certification requires that manufacturers submit emission test data from one or more durability demonstration test vehicles (test vehicles). For applications certified on engine dynamometers, engines may be used instead of vehicles.

(1.2) The Executive Officer may approve other demonstration protocols if the manufacturer can provide comparable assurance that the malfunction criteria are chosen based on meeting emission requirements and that the timeliness of malfunction detection is within the constraints of the applicable monitoring requirements.

(1.3) For flexible fuel vehicles capable of operating on more than one fuel or fuel combinations, the manufacturer shall submit a plan for providing emission test data to the Executive Officer for approval. The Executive Officer shall approve the plan if it is determined to be representative of expected in-use fuel or fuel combinations and provides accurate and timely evaluation of the monitored systems.

(2) Selection of Test Vehicles:

~~(2.1.1)~~(2.1) Prior to submitting any applications for certification for a model year, a manufacturer shall notify the Executive Officer of the test groups planned for that model year. The Executive Officer will then select the test group(s) that the manufacturer shall use as demonstration test vehicles to provide emission test data. The selection of test vehicles for production vehicle evaluation, as specified in section (j), may take place during this selection process.

~~(2.1.2)~~(2.2) A manufacturer certifying one to five test groups in a model year shall provide emission test data from a test vehicle from one test group. A manufacturer certifying six to ~~ten~~ fifteen test groups in a model year shall provide emission test data from test vehicles from two test groups. A manufacturer certifying ~~eleven~~ sixteen or more test groups in a model year shall provide emission test data from test vehicles from three test groups. The Executive Officer may waive the requirement for submittal of data from one or more of the test groups if data have been previously submitted for all of the test groups.

~~(2.1.3)~~(2.3) For the test vehicle(s), a manufacturer shall use a certification emission durability test vehicle(s), a representative high mileage vehicle(s), or a vehicle(s) aged to the end of the full useful life using an ARB-approved alternative durability procedure (ADP).

(3) Required Testing for Gasoline/Spark-ignited vehicles:

Except as provided below, the manufacturer shall perform single-fault testing based on the applicable FTP test with the following components/systems set at their malfunction criteria limits as determined by the manufacturer for meeting the requirements of section (e):

(3.1) ~~Oxygen~~Exhaust Gas Sensors:

(3.1.1) The manufacturer shall perform a test with all primary oxygen sensors (conventional switching sensors and wide range or universal sensors) used for fuel control simultaneously possessing a response rate deteriorated to the malfunction criteria limit. Manufacturers shall also perform a test for any other oxygen sensor parameter that can cause vehicle emissions to exceed the malfunction threshold (e.g., 1.5 times the applicable standards)~~(e.g.~~ due to a~~,~~ shift in air/fuel ratio at which oxygen sensor switches, decreased amplitude, etc.). When performing additional test(s), all primary and secondary (if applicable) oxygen sensors used for fuel control shall be operating at the malfunction criteria limit for the applicable parameter only. All other primary and secondary oxygen sensor parameters shall be with normal characteristics.

(3.1.2) For vehicles utilizing sensors other than oxygen sensors for primary fuel control (e.g., ~~linear air-fuel ratio sensors, universal sensors~~hydrocarbon sensors, etc.), the manufacturer shall submit, for Executive Officer approval, a demonstration test plan for performing testing of all of the sensor parameters that can cause vehicle emissions to exceed the malfunction threshold (e.g., 1.5 times the applicable standards). The Executive Officer shall approve the plan if it is determined that it will provide data that will assure proper performance of the diagnostics of the sensors, consistent with the intent of section ~~(g)~~(h).

(3.2) EGR System: The manufacturer shall perform a test at the low flow limit.

(3.3) VVT System: For 2006 ~~and subsequent~~ through 2008 model year Low Emission II applications and all 2009 and subsequent model year vehicles, the manufacturer shall perform a test at each target error limit and slow response limit calibrated to the malfunction criteria (e.g., 1.5 times the FTP standard) in sections (e)(13.2.1) and (13.2.2). In conducting the VVT system demonstration tests, the manufacturer may use computer modifications to cause the VVT system to operate at the malfunction limit if the manufacturer can demonstrate that the computer modifications produce test results equivalent to an induced hardware malfunction.

(3.4) Fuel System:

(3.4.1) For vehicles with adaptive feedback based on the primary fuel control sensor(s), the manufacturer shall perform a test with the adaptive feedback based on the primary fuel control sensor(s) at the rich limit(s) and a test at the lean limit(s) established by the manufacturer in section (e)(6.2.1) to detect a malfunction before emissions exceed the malfunction threshold (e.g., 1.5 times the applicable standards).

(3.4.2) For vehicles with feedback based on a secondary fuel control sensor(s) and subject to the malfunction criteria in section (e)(6.2.1), the manufacturer shall perform a test with the feedback based on the secondary fuel control sensor(s) at the rich limit(s) and a test at the lean limit(s) established by the manufacturer in section (e)(6.2.1) to detect a malfunction before emissions exceed the malfunction threshold (e.g., 1.5 times the applicable standards).

(3.4.3) For other fuel metering or control systems, the manufacturer shall perform a test at the criteria limit(s).

(3.4.4) For purposes of fuel system testing, the fault(s) induced may result in a uniform distribution of fuel and air among the cylinders. Non-uniform distribution of fuel and air used to induce a fault may not cause misfire. In conducting the fuel system demonstration tests, the manufacturer may use computer modifications to cause the fuel system to operate at the malfunction limit if the manufacturer can demonstrate that the computer modifications produce test results equivalent to an induced hardware malfunction.

(3.5) Misfire: The manufacturer shall perform a test at the malfunction criteria limit specified in section (e)(3.2.2). The testing is not required for diesel applications.

(3.6) Secondary Air System: The manufacturer shall perform a test at the low flow limit. Manufacturers performing only a functional check in accordance with the provisions of section (e)(5.2.2)(B) or (e)(5.2.4) shall perform a test at the functional check flow malfunction criteria.

(3.7) Catalyst System: The manufacturer shall perform a test using a catalyst system deteriorated to the malfunction criteria using methods established by the manufacturer in accordance with sections (e)(1.2.6) and (1.2.7). For diesel vehicles, the manufacturer shall perform a test using a catalyst system deteriorated to the malfunction criteria in sections (e)(1.5.2)(A)(i), (B)(i), or (C)(i). For diesel vehicles with catalyst systems not subject to the malfunction criteria in section (e)(1.5.2)(A)(i), (B)(i), or (C)(i), manufacturers are not required to perform a catalyst demonstration test.

(3.8) Heated Catalyst Systems: The manufacturer shall perform a test at the malfunction criteria limit established by the manufacturer in section (e)(2.2).

(3.9) PM Trap: The manufacturer shall perform a test using a PM trap(s) deteriorated to the malfunction criteria in sections (e)(15.2.1) or (15.2.3). For diesel vehicles with a PM trap(s) not subject to the malfunction criteria in section (e)(15.2.1) or (15.2.3), manufacturers are not required to perform a PM trap(s) demonstration test.

(3.10)(3.9) Other systems: The manufacturer shall conduct demonstration tests for all other emission control components designed and calibrated to an emission threshold malfunction criteria (e.g., 1.5 times any of the applicable emission standards) (e.g., hydrocarbon traps, adsorbers, etc.) under the provisions of section (e)(176).

(3.11)(3.10) The manufacturer may electronically simulate deteriorated components but may not make any vehicle control unit modifications (unless otherwise excepted above) when performing demonstration tests. All equipment necessary to duplicate the demonstration test must be made available to the ARB upon request.

(4) Required Testing for Diesel/Compression-ignition vehicles:

Except as provided below, the manufacturer shall perform single-fault testing based on the applicable test with the following components/systems set at their malfunction criteria limits as determined by the manufacturer for meeting the requirements of section (f).

(4.1) NMHC Catalyst: The manufacturer shall perform a separate test for each monitored NMHC catalyst(s) (e.g., oxidation catalyst). The catalyst(s) being evaluated shall be deteriorated to the applicable malfunction criteria established by the manufacturer in section (f)(1.2.2) using methods established by the manufacturer in accordance with section (f)(1.2.4). For each monitored NMHC catalyst(s), the manufacturer shall also demonstrate that the OBD II system will detect a catalyst malfunction with the catalyst at its maximum level of deterioration (i.e., the substrate(s) completely removed from the catalyst container or "empty" can). Emission data are not required for the empty can demonstration.

(4.2) NOx Catalyst: The manufacturer shall perform a separate test for each monitored NOx catalyst(s) (e.g., SCR catalyst). The catalyst(s) being evaluated shall be deteriorated to the applicable malfunction criteria established by the manufacturer in sections (f)(2.2.2)(A) and (f)(2.2.3)(A) using methods established by the manufacturer in accordance with section (f)(2.2.4). For each monitored NOx catalyst(s), the manufacturer shall also demonstrate that the OBD II system will detect a catalyst malfunction with the catalyst at its maximum level of deterioration (i.e., the substrate(s) completely removed from the catalyst container or "empty" can). Emission data are not required for the empty can demonstration.

(4.3) Misfire Monitoring: For 2010 and subsequent model year vehicles subject to section (f)(3.2.2), the manufacturer shall perform a test at the malfunction criteria limit specified in section (f)(3.2.2). A misfire monitor demonstration test is not required for vehicles not subject to section (f)(3.2.2).

(4.4) Fuel System: The manufacturer shall perform a separate test for each applicable malfunction limit established by the manufacturer for the fuel system parameters (e.g., fuel pressure, injection timing, injection quantity) specified in sections (f)(4.2.1) through (f)(4.2.3). When performing a test for a specific parameter, the fuel system shall be operating at the malfunction criteria limit for the applicable parameter only. All other parameters shall be with normal characteristics. In conducting the fuel system demonstration tests, the manufacturer may use computer modifications to cause the fuel system to operate at the malfunction limit if the manufacturer can demonstrate to the Executive Officer that the computer modifications produce test results equivalent to an induced hardware malfunction.

(4.5) Exhaust Gas Sensor: The manufacturer shall perform a test for each exhaust gas sensor parameter calibrated to the malfunction criteria in sections (f)(5.2.1)(A)(i), (f)(5.2.1)(B)(i), and (f)(5.2.2)(A). When performing a test, all exhaust gas sensors used for the same purpose (e.g., for the same feedback control loop, for the same control feature on parallel exhaust banks) shall be operating at the malfunction criteria limit for the applicable parameter only. All other exhaust gas sensor parameters shall be with normal characteristics.

(4.6) EGR System: The manufacturer shall perform a test at each flow, slow response, and cooling limit calibrated to the malfunction criteria in sections (f)(6.2.1) through (f)(6.2.3) and (f)(6.2.5). In conducting the EGR system slow response demonstration tests, the manufacturer may use computer modifications to cause the EGR system to operate at the malfunction limit if the manufacturer can demonstrate to the Executive Officer that the computer modifications produce test results equivalent to an induced hardware malfunction.

(4.7) Boost Pressure Control System: The manufacturer shall perform a test at each boost, response, and cooling limit calibrated to the malfunction criteria in sections (f)(7.2.1) through (f)(7.2.4).

(4.8) NOx Adsorber: The manufacturer shall perform a test using a NOx adsorber(s) deteriorated to the malfunction criteria in section (f)(8.2.1). The manufacturer shall also demonstrate that the OBD II system will detect a NOx adsorber malfunction with the NOx adsorber at its maximum level of deterioration (i.e., the substrate(s) completely removed from the container or "empty" can). Emission data are not required for the empty can demonstration.

(4.9) PM Filter: The manufacturer shall perform a test using a PM filter(s) deteriorated to each applicable malfunction criteria in sections (f)(9.2.1), (f)(9.2.2), and (f)(9.2.4). The manufacturer shall also demonstrate that the OBD II system will detect a PM filter malfunction with the filter at its maximum level of deterioration (i.e., the filter(s) completely removed from the filter container or "empty" can). Emission data are not required for the empty can demonstration.

(4.10) VVT System: The manufacturer shall perform a test at each target error limit and slow response limit calibrated to the malfunction criteria in sections (f)(13.2.1) and (f)(13.2.2). In conducting the VVT system demonstration tests, the manufacturer may use computer modifications to cause the VVT system to operate at the malfunction limit if the manufacturer can demonstrate to the Executive Officer that the computer modifications produce test results equivalent to an induced hardware malfunction.

(4.11) For each of the testing requirements of section (h)(4), if the manufacturer has established that only a functional check is required because no failure or deterioration of the specific tested system could result in an engine's emissions exceeding the emission malfunction criteria, the manufacturer is not required to perform a demonstration test; however the manufacturer is required to provide the data and/or engineering analysis used to determine that only a functional test of the system(s) is required.

~~(4)~~(5) Testing Protocol:

~~(4.1)~~(5.1) Preconditioning: The manufacturer shall use an applicable ~~FTP~~ cycle (FTP, SET, or Unified Cycle, if approved) for preconditioning test vehicles prior to conducting each of the above emission tests. Upon determining that a manufacturer has provided data and/or an engineering evaluation that demonstrate that additional preconditioning is necessary to stabilize the emission control system, the Executive Officer shall allow the manufacturer to perform a single additional preconditioning cycle, identical to the initial preconditioning cycle, or a Federal Highway Fuel Economy Driving Cycle, following a ten minute (20 minutes for medium duty engines certified on an engine dynamometer) hot soak after the initial preconditioning cycle. The manufacturer may not require the test vehicle to be cold soaked prior to conducting preconditioning cycles in order for the monitoring system testing to be successful.

~~(4.2)~~(5.2) Test Sequence:

~~(4.2.1)~~(5.2.1) The manufacturer shall set the system or component on the test vehicle for which detection is to be tested at the criteria limit(s) prior to conducting the applicable preconditioning cycle(s). If a second preconditioning cycle is permitted in accordance with section ~~(g)~~(h)(4~~5~~.1) above, the manufacturer may adjust the system or component to be tested before conducting the second preconditioning cycle. The manufacturer may not replace, modify, or adjust the system or component after the last preconditioning cycle has taken place.

~~(4.2.2)~~(5.2.2) After preconditioning, the test vehicle shall be operated over the applicable ~~FTP~~ cycle ~~(or Unified Cycle, if approved)~~ to allow for the initial detection of the tested system or component malfunction. This ~~driving~~ test cycle may be omitted from the testing protocol if it is unnecessary. If required by the designated monitoring strategy, a cold soak may be performed prior to conducting this driving cycle.

~~(4.2.3)~~(5.2.3) The test vehicle shall then be operated over the ~~cold start and hot start exhaust tests of the~~ applicable exhaust emission ~~FTP~~ test. If monitoring during the Unified Cycle is approved, a second Unified Cycle may be conducted prior to the ~~FTP~~ exhaust emission test.

~~(4.3)~~(5.3) A manufacturer required to test more than one test vehicle (section ~~(g)~~(h)(2.~~1.~~2)) may utilize internal calibration sign-off test procedures (e.g., forced cool downs, less frequently calibrated emission analyzers, etc.) instead of official ~~FTP~~ exhaust emission test procedures to obtain the emission test data required in section ~~(g)~~(h) for all but one of the required test vehicles. The manufacturer may elect this option if the data from the alternative test procedure are representative of official ~~FTP~~ exhaust emission test results. Manufacturers using this option are still responsible for meeting the malfunction criteria specified in sections (e) and (f) when emission tests are performed in accordance with official ~~FTP~~ exhaust emission test procedures.

(5.4) For medium-duty vehicles certified to an engine dynamometer exhaust emission standard, a manufacturer may request Executive Officer approval to utilize an alternate testing protocol for demonstration of MIL illumination if the engine dynamometer emission test cycle does not allow all of a monitor's enable conditions to be satisfied. A manufacturer may request the use of an alternate engine dynamometer test cycle or the use of chassis testing to demonstrate proper MIL illumination. In evaluating the manufacturer's request, the Executive Officer shall consider the technical necessity for using an alternate test cycle and the degree to which the alternate test cycle demonstrates that in-use operation with the malfunctioning component will properly result in MIL illumination.

~~(5)~~(6) Evaluation Protocol:

~~(5.1.1)~~(6.1) For all tests conducted under section ~~(g)~~(h), the MIL shall be illuminated upon detection of the tested system or component malfunction before the ~~hot start exhaust test~~ end of the ~~complete FTP~~ first engine start portion of the exhaust emission test (or before the hot start portion of the last Unified Cycle, if applicable) in accordance with requirements of sections (e) and (f).

~~(5.1.2)~~(6.2) For all tests conducted under section ~~(g)~~(h), manufacturers may use Non-Methane Hydrocarbon (NMHC) emission results in lieu of Non-

Methane Organic Gas (NMOG) emission results for comparison to the applicable FTP standards or malfunction criteria (e.g., 1.5 times the FTP standards). If NMHC emission results are used in lieu of NMOG, the emission result shall be multiplied by 1.04 to generate an equivalent NMOG result before comparison to the applicable FTP standards.

(5.1.3)(6.3) If the MIL illuminates prior to emissions exceeding the applicable malfunction criteria specified in sections (e) and (f), no further demonstration is required. With respect to the misfire monitor demonstration test, if a manufacturer has elected to use the minimum misfire malfunction criteria of one percent as allowed in sections (e)(3.2.2)(A) and (f)(3.2.2)(B), no further demonstration is required if the MIL illuminates with misfire implanted at the malfunction criteria limit.

(5.1.4)(6.4) If the MIL does not illuminate when the systems or components are set at their limit(s), the criteria limit or the OBD II system is not acceptable.

(A)(6.4.1) Except for testing of the catalyst (i.e., components monitored under (e)(1), (f)(2) or (f)(8)) or PM filter system, if the MIL first illuminates after emissions exceed the applicable malfunction criteria specified in sections (e) and (f), the test vehicle shall be retested with the tested system or component adjusted so that the MIL will illuminate before emissions exceed the applicable malfunction criteria specified in sections (e) and (f). If the component cannot be adjusted to meet this criterion because a default fuel or emission control strategy is used when a malfunction is detected (e.g., open loop fuel control used after an O2 sensor malfunction is determined, etc.), the test vehicle shall be retested with the component adjusted to the worst acceptable limit (i.e., the applicable monitor indicates the component is performing at or slightly better than the malfunction criteria). For the OBD II system to be approved, the MIL must not illuminate during this test and the vehicle emissions must be below the applicable malfunction criteria specified in sections (e) and (f).

(B)(6.4.2) In testing the catalyst (i.e., components monitored under (e)(1), (f)(2) or (f)(8)) or PM filter system, if the MIL first illuminates after emissions exceed the applicable emission threshold(s) specified in sections (e) and (f), the tested vehicle shall be retested with a less deteriorated catalyst or PM filter system (i.e., more of the applicable engine out pollutants are converted or trapped). For the OBD II system to be approved, testing shall be continued until either of the following conditions are satisfied:

(i)(A) The MIL is illuminated and emissions do not exceed the thresholds specified in sections (e) and (f); or

(ii)(B) The manufacturer demonstrates that the MIL illuminates within acceptable upper and lower limits of the threshold specified in sections (e) and (f) for MIL illumination. The manufacturer shall demonstrate acceptable limits by continuing testing until the test results show:

a.(i) The MIL is illuminated and emissions exceed the thresholds specified in sections (e) and (f) by 10 25 percent or less of the applicable standard (e.g., emissions are less than 1.85 2.0 times the applicable standard for a malfunction criterion of 1.75 times the standard); and

b.(ii) The MIL is not illuminated and emissions are below the thresholds specified in sections (e) and (f) by no more than 20 25 percent of the standard (e.g., emissions are between 1.55 and 1.75 times the applicable standard for a malfunction criterion of 1.75 times the standard).

~~(5.1.5)~~(6.5) If an OBD II system is determined unacceptable by the above criteria, the manufacturer may recalibrate and retest the system on the same test vehicle. In such a case, the manufacturer must confirm, by retesting, that all systems and components that were tested prior to recalibration and are affected by the recalibration function properly under the OBD II system as recalibrated.

(6.6) Where applicable for diesel vehicles, the emission test results shall be adjusted as required under sections (d)(6.2)~~, d)(6.2.1), d)(6.2.2), and d)(6.2.3)~~.

~~(6)~~(7) Confirmatory Testing:

~~(6.1)~~(7.1) The ARB may perform confirmatory testing to verify the emission test data submitted by the manufacturer under the requirements of section ~~(g)~~(h) comply with the requirements of section ~~(g)~~(h) and the malfunction criteria identified in sections (e) and (f). This confirmatory testing is limited to the vehicle configuration represented by the demonstration vehicle(s). For purposes of section ~~(g)~~(h)(~~6~~7), vehicle configuration shall have the same meaning as the term used in 40 CFR 86.082-2.

~~(6.2)~~(7.2) The ARB or its designee may install appropriately deteriorated or malfunctioning components in an otherwise properly functioning test vehicle of a test group represented by the demonstration test vehicle(s) (or simulate a deteriorated or malfunctioning component) in order to test any of the components or systems required to be tested in section ~~(g)~~(h). Upon request by the Executive Officer, the manufacturer shall make available a vehicle and all test equipment (e.g., malfunction simulators, deteriorated components, etc.) necessary to duplicate the manufacturer's testing. The Executive Officer shall make the request within six months of reviewing and approving the demonstration test vehicle data submitted by the manufacturer for the specific test group.

~~(6.3)~~(7.3) Vehicles with OBD II systems represented by the demonstration vehicle(s) may be recalled for corrective action if a representative sample of vehicles uniformly fails to meet the requirements of section ~~(g)~~(h).

~~(h)~~(i).. *CERTIFICATION DOCUMENTATION*

(1) When submitting an application for certification of a test group, the manufacturer shall submit the following documentation. If any of the items listed below are standardized for all of a manufacturer's test groups, the manufacturer may, for each model year, submit one set of documents covering the standardized items for all of its test groups.

(1.1) For the required documentation not standardized across all test groups, the manufacturer may propose to the Executive Officer that documentation covering a specified combination of test groups be used. These combinations shall be known as "OBD II groups". Executive Officer approval shall be granted for those groupings that include test groups using the same OBD II strategies and similar calibrations. If approved by the Executive

Officer, the manufacturer may submit one set of documentation from one or more representative test group(s) that are a part of the OBD II group. The Executive Officer shall determine whether a selected test group(s) is representative of the OBD II group as a whole. To be approved as representative, the test group(s) must possess the most stringent emission standards and OBD II monitoring requirements and cover all of the emission control devices within the OBD II group.

(1.2) With Executive Officer approval, one or more of the documentation requirements of section ~~(h)~~(i) may be waived or modified if the information required would be redundant or unnecessarily burdensome to generate.

(1.3) To the extent possible, the certification documentation shall use SAE J1930 terms, abbreviations, and acronyms.

(2) The following information shall be submitted as "Part 1" of the certification application. Except as provided below for demonstration data, the Executive Officer will not issue an Executive Order certifying the covered vehicles without the information having been provided. The information must include:

(2.1) A description of the functional operation of the OBD II system including a complete written description for each monitoring strategy that outlines every step in the decision making process of the monitor. Algorithms, diagrams, samples of data, and/or other graphical representations of the monitoring strategy shall be included where necessary to adequately describe the information.

(2.2) A table, in the standardized format detailed in Attachment A of ARB Mail-Out #95-20, May 22, 1995, incorporated by reference.

(2.2.1) The table must include the following information for each monitored component or system (either computer-sensed or -controlled) of the emission control system:

(A) corresponding fault code
(B) monitoring method or procedure for malfunction detection
(C) primary malfunction detection parameter and its type of output signal
(D) fault criteria limits used to evaluate output signal of primary parameter
(E) other monitored secondary parameters and conditions (in engineering units) necessary for malfunction detection
(F) monitoring time length and frequency of checks
(G) criteria for storing fault code
(H) criteria for illuminating malfunction indicator light
(I) criteria used for determining out of range values and input component rationality checks

(2.2.2) Wherever possible, the table shall use the following engineering units:

(A) Degrees Celsius (°C) for all temperature criteria
(B) KiloPascals (KPa) for all pressure criteria related to manifold or atmospheric pressure
(C) Grams (g) for all intake air mass criteria
(D) Pascals (Pa) for all pressure criteria related to evaporative system vapor pressure
(E) Miles per hour (mph) for all vehicle speed criteria

(F) Relative percent (%) for all relative throttle position criteria (as defined in SAE J1979)
(G) Voltage (V) for all absolute throttle position criteria (as defined in SAE J1979)
(H) Per crankshaft revolution (/rev) for all changes per ignition event based criteria (e.g., g/rev instead of g/stroke or g/firing)
(I) Per second (/sec) for all changes per time based criteria (e.g., g/sec)
(J) Percent of nominal tank volume (%) for all fuel tank level criteria

(2.3) A logic flowchart describing the step by step evaluation of the enable criteria and malfunction criteria for each monitored emission-related component or system.

(2.4) Emission test data, a description of the testing sequence (e.g., the number and types of preconditioning cycles), approximate time (in seconds) of MIL illumination during the test, fault code(s) and freeze frame information stored at the time of detection, corresponding SAE J1979 test results (e.g. Mode/Service $06) stored during the test, and a description of the modified or deteriorated components used for fault simulation with respect to the demonstration tests specified in section ~~(g)~~(h). The Executive Officer may approve conditional certification of a test group prior to the submittal of this data for ARB review and approval. Factors to be considered by the Executive Officer in approving the late submission of information identified in section ~~(h)~~(i)(2.4) shall include the reason for the delay in the data collection, the length of time until data will be available, and the demonstrated previous success of the manufacturer in submitting the data prior to certification.

(2.5) For gasoline vehicles, ~~D~~data supporting the misfire monitor, including:

(2.5.1) The established percentage of misfire that can be tolerated without damaging the catalyst over the full range of engine speed and load conditions.

(2.5.2) Data demonstrating the probability of detection of misfire events of the misfire monitoring system over the full engine speed and load operating range for the following misfire patterns: random cylinders misfiring at the malfunction criteria established in section (e)(3.2.2), one cylinder continuously misfiring, and paired cylinders continuously misfiring.

(2.5.3) Data identifying all disablement of misfire monitoring that occurs during the FTP and US06 cycles. For every disablement that occurs during the cycles, the data should identify: when the disablement occurred relative to the driver's trace, the number of engine revolutions that each disablement was present for, and which disable condition documented in the certification application caused the disablement. The data shall be submitted in the standardized format detailed in Attachment XXX of ARB Mail-Out #XX-XX, Month Date, Year, incorporated by reference.

(2.5.4) Manufacturers are not required to use the durability demonstration vehicle to collect the misfire data for sections ~~(h)~~(i)(2.5.1) though (2.5.3).

(2.6) Data supporting the limit for the time between engine starting and attaining the designated heating temperature for after-start heated catalyst systems.

(2.7) For diesel vehicle monitors in section (f) that are required to indicate a malfunction before emissions exceed an emission threshold based on any applicable standard (e.g., 1.5 times any of the applicable standards), the test cycle and standard determined by the manufacturer to be the most stringent for each applicable monitor in accordance with section (d)(6.1)

~~(2.7)~~(2.8) A listing of all electronic powertrain input and output signals (including those not monitored by the OBD II system) that identifies which signals are monitored by the OBD II system.

~~(2.8)~~(2.9) A written description of all parameters and conditions necessary to begin closed loop operation.

~~(2.9)~~(2.10) A summary table identifying every test group and each of the OBD II phase-in requirements that apply to each test group.

~~(2.10)~~(2.11) A written identification of the communication protocol utilized by each test group for communication with an SAE J1978 scan tool.

~~(2.11)~~(2.12) A pictorial representation or written description of the diagnostic connector location including any covers or labels.

~~(2.12)~~(2.13) A written description of the method used by the manufacturer to meet the requirements of sections (e)(9) and (f)(10) for PCV and CV system monitoring including diagrams or pictures of valve and/or hose connections.

(2.14) A cover letter identifying all concerns and deficiencies applicable to the equivalent previous model year test group and the changes and/or resolution of each concern or deficiency for the current model year test group.

(2.15) For diesel engine vehicles, a written description of each AECD utilized by the manufacturer including the identification of each EI-AECD relative to the data required to be tracked and reported in the standardized format specified in section (g)(6) (e.g., EI-AECD #1 is "engine overheat protection as determined by coolant temperature greater than…"), the sensor signals and/or calculated values used to invoke each AECD, the engineering data and/or analysis demonstrating the need for such an AECD, the actions taken when each AECD is activated, the expected in-use frequency of operation of each AECD, and the expected emission impact from each AECD activation.

~~(2.13)~~(2.16) Any other information determined by the Executive Officer to be necessary to demonstrate compliance with the requirements of this regulation.

(3) "Part 2". The following information shall be submitted by January 1st of the applicable model year:

(3.1) A listing and block diagram of the input parameters used to calculate or determine calculated load values and the input parameters used to calculate or determine fuel trim values.

(3.2) A scale drawing of the MIL and the fuel cap indicator light, if present, which specifies location in the instrument panel, wording, color, and intensity.

(4) "Part 3". The following information shall be submitted upon request of the Executive Officer:

(4.1) Data supporting the criteria used to detect a malfunction when catalyst deterioration causes emissions to exceed the applicable malfunction criteria specified in sections (e) and (f).

(4.2) Data supporting the criteria used to detect evaporative system leaks.

(4.3) Any other information determined by the Executive Officer to be necessary to demonstrate compliance with the requirements of this regulation.

(i)**DEFICIENCIES**

(1)For 2004 and subsequent model year vehicles, the Executive Officer, upon receipt of an application from the manufacturer, may certify vehicles even though said vehicles may not comply with one or more of the requirements of title 13, CCR section 1968.2. In granting the certification, the Executive Officer shall consider the following factors: the extent to which the requirements of section 1968.2 are satisfied overall based on a review of the vehicle applications in question, the relative performance of the resultant OBD II system compared to systems fully compliant with the requirements of title 13, CCR section 1968.2, and a demonstrated good-faith effort on the part of the manufacturer to: (1) meet the requirements in full by evaluating and considering the best available monitoring technology; and (2) come into compliance as expeditiously as possible. The Executive Officer may not grant certification to a vehicle in which the reported noncompliance for which a deficiency is sought would be subject to ordered recall pursuant to section 1968.5 (c)(3)(A).

(2)Manufacturers of non-complying systems are subject to fines pursuant to section 43016 of the California Health and Safety Code. The specified fines apply to the third and subsequently identified deficiencies, with the exception that fines shall apply to all monitoring system deficiencies wherein a required monitoring strategy is completely absent from the OBD system.

(3)The fines are in the amount of $50 per deficiency per vehicle for non-compliance with any of the monitoring requirements specified in sections (e)(1) through (e)(8), (e)(11), (e)(13) through (e)(15), and (e)(17), and $25 per deficiency per vehicle for non-compliance with any other requirement of section 1968.2. In determining the identified order of deficiencies, deficiencies subject to a $50 fine are identified first. Total fines per vehicle under section (i) may not exceed $500 per vehicle and are payable to the State Treasurer for deposit in the Air Pollution Control Fund.

(4)Manufacturers must re-apply for Executive Officer approval of a deficiency each model year. In considering the request to carry-over a deficiency, the Executive Officer shall consider the factors identified in section (i)(1) including the manufacturer's progress towards correcting the deficiency. The Executive Officer may not allow manufacturers to carry over monitoring system deficiencies for more than two model years unless it can be demonstrated that substantial vehicle hardware modifications and additional lead time beyond two years would be necessary to correct the deficiency, in which case the Executive Officer shall allow the deficiency to be carried over for three model years.

(5)Except as allowed in section (i)(6), deficiencies may not be retroactively granted after certification.

~~(6)Request for retroactive deficiencies~~

~~(6.1)Manufacturers may request that the Executive Officer grant a deficiency and amend a vehicle's certification to conform to the granting of the deficiencies during the first 6 months after commencement of normal production for each aspect of the monitoring system: (a) identified by the manufacturer (during testing required by section (j)(2) or any other testing) to be functioning different than the certified system or otherwise not meeting the requirements of any aspect of section 1968.2; and (b) reported to the Executive Officer. If the Executive Officer grants the deficiencies and amended certification, their approval would be retroactive to the start of production.~~

~~(6.2)Executive Officer approval of the request for a retroactive deficiency shall be granted provided that the conditions necessary for a pre-certification deficiency determination are satisfied (see section (i)(1)) and the manufacturer could not have reasonably anticipated the identified problem before commencement of production.~~

~~(6.3)In granting the amended certification, the Executive Officer shall include any approved post-production deficiencies together with all previously approved deficiencies in computing fines in accordance with section (i)(2).~~

~~(7)Any OBD II system installed on a production vehicle that fails to conform with the certified OBD II system for that vehicle or otherwise fails to meet the requirements of section 1968.2 and has not been granted a deficiency pursuant to the provisions of section (i)(1) through (i)(6) are considered non-compliant. The vehicles are subject to enforcement pursuant to applicable provisions of the Health and Safety Code and title 13, CCR section 1968.5.~~

(j) *PRODUCTION VEHICLE EVALUATION TESTING*

(1) Verification of Standardized Requirements.

(1.1) Requirement: For 2005 and subsequent model year vehicles, manufacturers shall perform testing to verify that all vehicles meet the requirements of section ~~(f)~~(g)(3) and ~~(f)~~(g)(4) relevant to proper communication of required emission-related messages to an SAE J1978 scan tool.

(1.2) Selection of Test Vehicles: Manufacturers shall perform this testing every model year on one production vehicle from every unique calibration within ~~one~~ two months of the start of normal production for that calibration. Manufacturers may request Executive Officer approval to group multiple calibrations together and test one representative calibration per group. The Executive Officer shall approve the request upon finding that the software designed to comply with the standardization requirements of section ~~(f)~~(g) in the representative calibration vehicle is identical (e.g., communication protocol message timing, number of supported data stream parameters, etc.) to all others in the group and that any differences in the calibrations are not relevant with respect to meeting the criteria in section (j)(1.4).

(1.3) Test Equipment: For the testing required in section (j)(1), manufacturers shall utilize an off-board device to conduct the testing. Prior to conducting testing, manufacturers are required to request and receive Executive Officer approval of the off-board device that the manufacturer will use to perform the testing. The Executive Officer shall approve the request upon determining that the manufacturer has submitted data, specifications, and/or engineering analysis that demonstrate that the off-board device ~~will verify vehicles will be able to perform all of the required functions in section (j)(1.4) with any other off-board device designed and built in accordance with the SAE J1978 generic scan tool specifications~~meets the minimum requirements to conduct testing according to SAE J1699-3 using the software developed and maintained for the SAE J1699-3 committee and available through www.sourceforge.net and SAE J2534 compliant hardware configured specifically for SAE J1699-3 testing.

(1.4) Required Testing (i.e., "static" testing portion of SAE J1699-3):

(1.4.1) The testing shall verify that the vehicle can properly establish communications between all emission-related on-board computers and any SAE J1978 scan tool designed to adhere strictly to the communication protocols allowed in section ~~(f)~~(g)(3);

(1.4.2) The testing shall further verify that the vehicle can properly communicate to any SAE J1978 scan tool:

(A) The current readiness status from all on-board computers required to support readiness status in accordance with SAE J1979 and section ~~(f)~~(g)(4.1) while the engine is running;

(B) The MIL command status while the MIL is commanded off and while the MIL is commanded on in accordance with SAE J1979 and section ~~(f)~~(g)(4.2) while the engine is running, and in accordance with SAE J1979 and sections (d)(2.1.2) during the MIL functional check and, if applicable, ~~(f)~~(g)(4.1.3) during the MIL readiness status check while the engine is off;

(C) All data stream parameters required in section ~~(f)~~(g)(4.2) in accordance with SAE J1979 including the identification of each data stream parameter as supported in SAE J1979 (e.g., Mode/Service $01, PID $00);

(D) The CAL ID, CVN, and VIN (if applicable) in accordance with SAE J1979 and sections ~~(f)~~(g)(4.6) through (4.8);

(E) An emission-related fault code (permanent, ~~both~~ confirmed, and pending) in accordance with SAE J1979 (including correctly indicating the number of stored fault codes (e.g., Mode/Service $01, PID $01, Data A)) and section ~~(f)~~(g)(4.4);

(1.4.3) The testing shall also verify that the vehicle can properly respond to any SAE J1978 scan tool request to clear emission-related fault codes and reset readiness status.

(1.5) Reporting of Results:

(1.5.1) The manufacturer shall notify the Executive Officer within one month of identifying any vehicle that does not meet the requirements of section (j)(1.4). The manufacturer shall submit a written report of the problem(s) identified and propose corrective action (if any) to remedy the problem(s) to the Executive Officer for approval. Factors to be considered by the Executive Officer in approving the proposed corrective action shall include the severity of the problem(s), the ability of the vehicle to be tested in an I/M program, the ability of service technicians to access the required diagnostic information, the impact on equipment and tool manufacturers, and the amount of time prior to implementation of the proposed corrective action.

(1.5.2) ~~Upon request of the Executive Officer~~Within three months of ~~,~~any passing testing conducted pursuant to section (j)(1), a manufacturer shall submit a report of the results ~~of any testing conducted pursuant to section (j)(1)~~ to the Executive Officer for review.

(1.5.3) In accordance with section ~~(i)~~ (k)(6), manufacturers may request Executive Officer approval for a retroactive deficiency to be granted for items identified during this testing.

(2) Verification of Monitoring Requirements.

(2.1) For 2004 and subsequent model year vehicles, within the first six months after normal production begins, manufacturers shall conduct a complete evaluation of the OBD II system of one or more production vehicles (test vehicles) and submit the results of the evaluation to the Executive Officer.

(2.2) Selection of test vehicles:

(2.2.1) Prior to submitting any applications for certification for a model year, a manufacturer shall notify the Executive Officer of the test groups planned for that model year. The Executive Officer will then select the test group(s), in accordance with sections (j)(2.2.2) and (j)(2.2.3) below, that the manufacturer shall use as test vehicles to provide evaluation test results. This selection process may take place during durability demonstration test vehicle selection specified in section ~~(g)~~(h).

(2.2.2) A manufacturer shall evaluate one production vehicle per test group selected for monitoring system demonstration in section ~~(g)~~(h).

(2.2.3) In addition to the vehicles selected in section (j)(2.2.2) above, a manufacturer shall evaluate vehicles chosen from test groups that are not selected for monitoring system demonstration testing under section ~~(g)~~(h). The number of additional vehicles to be tested shall be equal to the number of vehicles selected for monitoring system demonstration in section ~~(g)~~(h).

(2.2.4) The Executive Officer may waive the requirements for submittal of evaluation results from one or more of the test groups if data has been previously submitted for all of the test groups.

(2.3) Evaluation requirements:

(2.3.1) The evaluation shall demonstrate the ability of the OBD II system on the selected production vehicle to detect a malfunction, illuminate the MIL, and store a confirmed fault code when a malfunction is present and the monitoring conditions have been satisfied for each individual diagnostic required by title 13, CCR section 1968.2.

(2.3.2) The evaluation shall verify that malfunctions detected by non-MIL illuminating diagnostics of components used to enable any other OBD II system diagnostic (e.g., fuel level sensor) will not inhibit the ability of other OBD II system diagnostics to properly detect malfunctions.

(2.3.3) On vehicles so equipped, the evaluation shall verify that the software used to track the numerator and denominator for purposes of determining in-use monitoring frequency correctly increments as required in section (d)(4)(i.e., the "dynamic" testing portion of SAE J1699-3).

(2.3.4) Malfunctions may be mechanically implanted or electronically simulated but internal on-board computer hardware or software changes may not be used to simulate malfunctions. Emission testing to confirm that the malfunction is detected before the appropriate emission standards are exceeded is not required.

(2.3.5) Manufacturers shall submit a proposed test plan for Executive Officer approval prior to evaluation testing being performed. The test plan shall identify the method used to induce a malfunction in each diagnostic. If the Executive Officer determines that the requirements of section (j)(2) are satisfied, the proposed test plan shall be approved.

(2.3.6) Subject to Executive Officer approval, manufacturers may omit demonstration of specific diagnostics. The Executive Officer shall approve a manufacturer's request if the demonstration cannot be reasonably performed without causing physical damage to the vehicle (e.g., on-board computer internal circuit faults).

(2.3.7) For evaluation of test vehicles selected in accordance with section (j)(2.2.2), manufacturers are not required to demonstrate diagnostics that were previously demonstrated prior to certification as required in section ~~(g)~~(h).

(2.4) Manufacturers shall submit a report of the results of all testing conducted pursuant to section (j)(2) to the Executive Officer for review. This report shall identify the method used to induce a malfunction in each diagnostic, the MIL illumination status, and the confirmed fault code(s) stored.

(2.5) In accordance with section ~~(i)~~ (k)(6), manufacturers may request Executive Officer approval for a retroactive deficiency to be granted for items identified during this testing.

(3) Verification and Reporting of In-use Monitoring Performance.

(3.1) Manufacturers are required to collect and report in-use monitoring performance data representative of every test group certified by the manufacturer and equipped with in-use monitoring performance tracking software in accordance with section (d)(4) to the ARB within ~~six~~ twelve months from either the time vehicles in the test group were first introduced into commerce or the start of normal production for such vehicles, whichever is later. The manufacturer may propose to the Executive Officer that multiple test groups be combined to collect representative data. Executive Officer approval shall be granted upon determining that the proposed groupings include test groups using the same OBD II strategies and similar calibrations and that are expected to have similar in-use monitoring performance. If approved by the Executive Officer, the manufacturer may submit one set of data for each of the approved groupings.

(3.2) For each test group or combination of test groups, the data must include all of the in-use performance tracking data reported through SAE J1979 (i.e., all numerators, denominators, and the ignition cycle counter), the date the data was collected, the odometer reading, the vehicle VIN, and the ECM software calibration identification number and be in the standardized format detailed in Attachment XXX of ARB Mail-Out #XX-XX, Month Date, Year, incorporated by reference.

§ 1968.5. Enforcement of Malfunction and Diagnostic System Requirements for 2004 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles and Engines.

(a) *General*

(1) Applicability.

(A) These procedures shall be used to assure compliance with the requirements of title 13, California Code of Regulations (CCR) section 1968.2 for all 2004 and subsequent model year ~~vehicles~~ passenger cars, light-duty trucks, medium-duty vehicles, and engines certified on an engine dynamometer for use in medium-duty vehicles (the classifications of which shall jointly be referred to for purposes of this regulation as vehicles) equipped with OBD II systems that have been certified for sale in California.

(B) Vehicles manufactured prior to the 2004 model year are covered by the general enforcement and penalty provisions of the Health and Safety Code, and the specific provisions of title 13, CCR sections 1968.1 and 2111 through 2149.

(2) Purpose.

The purpose of this section is to establish the enforcement protocol that shall be used by the ARB to assure that vehicles certified for sale in California are equipped with OBD II systems that properly function and meet the purposes and requirements of title 13, CCR section 1968.2.

(3) Definitions.

The definitions applicable to these rules include those set forth in Health and Safety Code section 39010 et seq. and in title 13, CCR sections 1900(b) and 1968.2(~~b~~c), which are incorporated by reference herein. The following definitions are specifically applicable to section 1968.5 and take precedence over any contrary definitions.

~~(A)~~ *"Days"*, when computing any period of time, unless otherwise noted, means normal working days that a manufacturer is open for business.

~~(B)~~ *"Executive Officer"* means the Executive Officer of the Air Resources Board or his or her authorized representative.

~~(C)~~ *"Influenced OBD II-Related Recall"* means an inspection, repair, adjustment, or modification program initiated and conducted by a manufacturer as a result of enforcement testing conducted by the ARB or any other information for the purpose of correcting any nonconforming OBD II system for which direct notification of vehicle ~~or engine~~ owners is necessary.

~~(D)~~ *"Major Monitor"* means those monitors covered by the requirements set forth in title 13, CCR sections 1968.2(e)(1.0) through (e)(8.0), (e)(11.0) through (e)(1~~5~~4.0), ~~and~~ (e)(1~~7~~6.0), (f)(1.0) through (f)(9), (f)(12), (f)(13), and (f)(16).

~~(E)~~ *"Motor Vehicle Class"* means a group or set of vehicles ~~or engines~~ subject to enforcement testing that have been determined by the

Executive Officer to share common or similar hardware, software, OBD II monitoring strategy, or emission control strategy.

~~(F)~~ *"Motor Vehicle Manufacturer"* means the manufacturer granted certification to sell motor vehicles in the State of California.

~~(G)~~ *"Nonconforming OBD II System"* means an OBD II system on a production vehicle that has been determined not to comply with the requirements of title 13, CCR section 1968.2. For purposes of section 1968.5, a motor vehicle class shall be considered nonconforming irrespective of whether vehicles in the motor vehicle class, on average, meet applicable tailpipe or evaporative emission standards.

~~(H)~~ *"OBD II Emission Testing"* refers to testing conducted to determine compliance with the malfunction criteria in title 13, CCR sections 1968.2(e) and (f) that are based on a multiple of, or an additive to, a tailpipe emission standard or an absolute measurement from an applicable emission test cycle (e.g., 1.5 times the applicable FTP emission standards, PM standard plus 0.02 g/bhp-hr, PM level of 0.03 g/bhp-hr as measured from an applicable emission test cycle).

~~(I)~~ *"OBD II Ratio Testing"* refers to testing conducted to determine compliance with the required in-use monitor performance ratio in title 13, CCR section 1968.2(d)(3.2.1).

~~(J)~~ *"Ordered OBD II-Related Recall"* means an inspection, repair, adjustment, or modification program required by the ARB to be conducted by the manufacturer to correct any nonconforming OBD II system for which direct notification of vehicle ~~or engine~~ owners is necessary.

~~(K)~~ *"Quarterly Reports"* refer to the following calendar periods: January 1 – March 31; April 1 – June 30; July 1 – September 30; October 1 – December 31.

~~(L)~~ *"Test Sample Group"* means a group of production vehicles in a designated motor vehicle class that are equipped with OBD II systems and are selected and tested as part of the ARB enforcement testing program set forth in section (b).

~~(M)~~ *"Voluntary OBD II-Related Recall"* means an inspection, repair, adjustment, or modification program voluntarily initiated and conducted by a manufacturer to correct any nonconforming OBD II system for which direct notification of vehicle ~~or engine~~ owners is necessary.

(b) *Testing Procedures*

(1) Purpose.

To assure that OBD II systems on production motor vehicles ~~and engines~~ comply with the requirements of title 13, CCR section 1968.2, the ARB may periodically evaluate vehicles ~~and engines~~ from a motor vehicle class.

(2) Preliminary Testing and Evaluation.

(A) As part of his or her evaluation of vehicles to determine compliance with the requirements of title 13, CCR section 1968.2, the Executive

Officer may routinely conduct testing on any production vehicles that have been certified for sale in California.

(B) Based upon such testing or any other information, including data from California or other State Inspection and Maintenance (I&M) stations, warranty information reports, and field information reports, the Executive Officer may conduct enforcement testing pursuant to sections (b)(3) through (5) below.

(3) Vehicle Selection for Enforcement Testing.

(A) Determining the Motor Vehicle Class.

(i) Upon deciding to conduct enforcement testing, the Executive Officer shall determine the motor vehicle class to be tested. In determining the scope of the motor vehicle class to be tested, the Executive Officer shall consider the similarities and differences in the OBD II systems of potentially affected vehicles. Among other things, the Executive Officer shall consider whether vehicles share similar computer hardware and software, calibrations, or OBD II monitoring and emission control strategies.

(ii) The default motor vehicle class is the test group or OBD II group used by the manufacturer to certify the vehicles to be tested. However, upon concluding that a subgroup of vehicles differs from other vehicles in the identified test group or OBD II group and that a reasonable basis exists to believe that the differences may directly impact the type of testing that will be performed, the Executive Officer may determine that a subgroup of the test group or OBD II group is the appropriate motor vehicle class for testing.

(iii) Similarly, upon concluding that vehicles from several OBD II groups (which may include OBD II groups from different model years) share such common characteristics that a reasonable basis exists to believe that results of enforcement testing may be applicable to a motor vehicle class larger than a specific test group or OBD II group, the Executive Officer may determine that the appropriate motor vehicle class includes more than one test group or OBD II group.

(iv) Except for testing to determine if an OBD II system has been designed to deactivate based on age and/or mileage (title 13, CCR section 1968.2 (d)(1.3)), the Executive Officer may not conduct testing of a motor vehicle class whose vehicles, on average, exceed the defined full useful life of the motor vehicle class. For purposes of the determination of this average, the Executive Officer shall use the accrual rates appropriate for vehicles in the motor vehicle class as defined in EMFAC2000 "Public Meeting to Consider Approval of Revisions to the State's On-Road Motor Vehicle Emissions Inventory: Technical Support Document, Section 7.1, 'Estimation of Average Mileage Accrual Rates from Smog Check Data,'" May 2000, incorporated by reference.

(B) Size of Test Sample Group.

After determining the motor vehicle class to be tested, the Executive Officer shall determine the appropriate number of vehicles to include in the test sample group for enforcement testing in accordance with the following guidelines:

(i) For OBD II emission testing, the Executive Officer shall follow the provisions of title 13, CCR section 2137 regarding test sample size. In accordance with section 2137, the Executive Officer shall test 10 vehicles that have been procured following the protocol of section (b)(3)(C) below and meet the selection criteria of section (b)(3)(D)(i) below to determine the emissions characteristics of the motor vehicle class being tested.

(ii) For OBD II ratio testing, the Executive Officer shall collect data from a test sample group of 30 vehicles that have been procured following the protocol of section (b)(3)(C) below and meet the selection criteria of section (b)(3)(D)(ii) below to determine the in-use OBD II monitoring performance of the motor vehicle class being tested.

(iii) In determining compliance with any other requirements of title 13, CCR section 1968.2 (e.g., diagnostic connector location, communication protocol standards, MIL illumination protocol, evaporative system diagnostics, etc.), the Executive Officer shall determine, on a case by case basis, the number of vehicles meeting the selection criteria of section (b)(3)(D)(iii) needed to assure that the results of such testing may be reasonably inferred to the motor vehicle class. The Executive Officer's determination shall be based upon the nature of the noncompliance and the scope of the motor vehicle class. The test sample group could be as few as two test vehicles.

(C) Protocol for Procuring Vehicles for Test Sample Group.

(i) For OBD II emission and ratio testing, the Executive Officer shall procure vehicles consistent with the procurement process followed by the Executive Officer under title 13, CCR section 2137 (e.g., obtaining lists of all vehicles in the motor vehicle class within a specified geographical area, mailing postcards soliciting participation of vehicles within the specified area, selecting vehicles from those that responded to the solicitation, inspecting selected vehicles to determine whether appropriate to include in sample group, etc.). In selecting vehicles for OBD II emission testing, the Executive Officer shall include only vehicles meeting the criteria set forth in section (b)(3)(D)(i) below. For OBD II ratio testing, the Executive Officer shall include only vehicles meeting the criteria set forth in section (b)(3)(D)(ii) below.

(ii) For all other testing, the Executive Officer shall, on a case by case basis, determine the appropriate manner for procuring vehicles. In making his or her determination, the Executive Officer shall consider the nature of the noncompliance and the scope of the motor vehicle class. If the Executive Officer concludes that a reasonable basis exists to believe that a vehicle operator's driving or maintenance habits would not substantially impact test results to determine noncompliance, he or she may procure vehicle(s) by any means that assures effective collection and testing of vehicles (e.g., rental car agencies, fleet vehicles, etc.). In all cases, however, the selection process must ensure proper selection of vehicles in accord with section (b)(3)(D)(iii) below.

(D) Vehicles to be included in a Test Sample Group.

(i) In selecting vehicles to be included in a test sample group for enforcement OBD II emission testing, the Executive Officer shall include only vehicles that:

a. Are certified to the requirements of title 13, CCR section 1968.2 and California exhaust emission standards.
b. Are registered for operation in California.
c. Have mileage that is equal to or less than 75 percent of the certified full useful life mileage and have an age of less than the certified full useful life age for the subject vehicles.
d. Have not been tampered with or equipped with add-on or modified parts that would cause the OBD II system not to comply with the requirements of title 13, CCR section 1968.2 or would have a permanent effect on exhaust emission performance.
e. Have not been subjected to abuse (e.g., racing, overloading, misfueling) neglect, improper maintenance, or other factors that would cause the OBD II system not to comply with the requirements of title 13, CCR section 1968.2 or would have a permanent effect on exhaust emission performance.
f. Have no detected or known malfunction(s) that would affect the performance of the OBD II system and are unrelated to the monitor or system being evaluated. At its discretion, the ARB may elect to repair a vehicle with a detected or known malfunction and then include the vehicle in the test sample group.
g. Have had no major repair to the engine or major repair of the vehicle resulting from a collision.
h. Have no problem that might jeopardize the safety of laboratory personnel.

(ii) In selecting vehicles to be included in a test sample group for enforcement OBD II ratio testing, the Executive Officer shall include only vehicles that:

a. Are certified to the requirements of title 13, CCR section 1968.2.
b. Have collected sufficient vehicle operation data for the monitor to be tested. For monitors required to meet the in-use monitor performance ratio and to track and report ratio data pursuant to title 13, CCR section 1968.2(d)(3.2), sufficient vehicle operation

data shall mean the denominator meets the criteria set forth in ~~paragraphs~~ sections (b)(3)(D)(ii)1. ~~and~~ through ~~2~~3. below. For monitors required to meet the in-use monitor performance ratio but not required to track and report ratio data pursuant to title 13, CCR section 1968.2(d)(3.2), sufficient vehicle operation data shall mean that vehicles that have a denominator that meets the criteria set forth in ~~paragraphs~~ sections (b)(3)(D)(ii)1. ~~and~~ through ~~2~~3. below after undergoing testing as set forth in section (b)(4)(C)(ii) below. Specifically, the denominator, as defined in title 13, CCR section 1968.2(d)(4.3), for the monitor to be tested must have a value equal to or greater than:

1. 150 for evaporative system monitors, secondary air system monitors, and monitors utilizing a denominator incremented in accordance with title 13, CCR sections 1968.2(d)(4.3.2)(E) or (F) (e.g., cold start monitors, air conditioning system monitors, etc.), or
2. 50 for PM filter monitors and oxidation catalyst monitors utilizing a denominator incremented in accordance with title 13, CCR section 1968.2(d)(4.3.2)(G), or
~~2.~~3. 300 for catalyst, oxygen sensor, EGR, VVT, and all other component monitors.

c. Have not been tampered with or equipped with add-on or modified parts that would cause the OBD II system not to comply with the requirements of title 13, CCR section 1968.2.
d. Have mileage and age that are less than or equal to the certified full useful life mileage and age for the subject vehicles.

(iii) In selecting vehicles to be included in a test sample group for enforcement testing of any other requirement of title 13, CCR section 1968.2 (not covered by sections (b)(3)(D)(i) or (ii) above), the Executive Officer shall include only vehicles that:

a. Are certified to the requirements of title 13, CCR section 1968.2.
b. Have not been tampered with or equipped with add-on or modified parts that would cause the OBD II system not to comply with the requirements of title 13, CCR section 1968.2.
c. Have no detected or known malfunction(s) that would affect the performance of the OBD II system and are unrelated to the monitor or system being evaluated. At its discretion, the ARB may elect to repair a vehicle with a detected or known malfunction and then include the vehicle in the test sample group.
d. Have mileage and age that are less than or equal to the certified full useful life mileage and age for the subject vehicles.

(iv) If the Executive Officer discovers, by either evidence presented by the manufacturer as provided in section (b)(7) or on his or her own, that a vehicle fails to meet one or more of the applicable criteria of section (b)(3)(D)(i) through (iii), the Executive Officer shall remove vehicles in the test sample do not properly illuminate the MIL when emissions exceed:

a. 2.0 times the FTP standards for malfunction criteria defined in title 13, CCR section 1968.2(e) that require MIL illumination at 1.5 or 1.75 times the FTP standards;
b. 3.5 times the FTP standards for malfunction criteria defined in title 13, CCR section 1968.2(e) that require MIL illumination at 2.5 times the FTP standards; or
c. 4.5 times the FTP standards for malfunction criteria defined in title 13, CCR section 1968.2(e) that require MIL illumination at 3.5 times the FTP standards.

(ii) Intermediate In-Use Diesel Thresholds.

a. For 2007 through 2012 model year vehicles subject to diesel/compression-ignition monitoring requirements in title 13, CCR section 1968.2(f) , the results of the OBD II emission tests indicate that 50 percent or more of the vehicles in the test sample do not properly illuminate the MIL when emissions exceed:
   1. an additional 1.0 times the applicable standards above the malfunction criteria for malfunction criteria defined in title 13, CCR section 1968.2(f) that require MIL illumination at less than 3.5 times the applicable standards (e.g., 3.5 times the applicable standards for a malfunction criteria of 2.5 times the applicable standards); or
   2. an additional 1.5 times the applicable standards above the malfunction criteria for malfunction criteria defined in title 13, CCR section 1968.2(f) that require MIL illumination at greater than or equal to 3.5 times the applicable standards (e.g., 6.5 times the applicable standards for a malfunction criteria o f 5.0 times the applicable standards); or
   3. an additional 1.0 times the applicable standards above the malfunction criteria for malfunction criteria defined in title 13, CCR section 1968.2(f) that require MIL illumination at an additive threshold of less than or equal to 0.3 g/bhp-hr NOx, an additive threshold of less than or equal to 0.02 g/bhp-hr PM, or an absolute threshold of less than or equal to 0.03 g/bhp-hr (e.g., 0.07 g/bhp-hr PM for an additive malfunction criteria of 0.03 g/bhp-hr with a standard of 0.02 g/bhp-hr); or
   4. an additional 1.5 times the applicable standards above the malfunction criteria for malfunction criteria defined in title 13, CCR section 1968.2(f) that require MIL illumination at an additive threshold of greater than 0.3 g/bhp-hr NOx, an additive threshold of greater than 0.02 g/bhp-hr PM, or an absolute threshold of greater than 0.03 g/bhp-hr PM (e.g., 1.0 g/bhp-hr NOx for an additive malfunction criteria of 0.5 g/bhp-hr with a standard of 0.2 g/bhp-hr).

b. For 2010 through 2012 model year medium-duty vehicles certified to an engine dynamometer standard, the "applicable standards" used in section (b)(6)(A)(ii) shall be limited to the emission test cycle and standard (i.e., FTP or SET) determined by the manufacturer to be more stringent and documented as such in the certification application in accordance with title 13, CCR section 1968.2(d)(6.1).

c. For 2007 through 2009 model year vehicles subject to adjustment for infrequent regeneration events in accordance with title 13, CCR section 1968.2(d)(6.2), OBD II emission enforcement testing for monitors using the provisions of title 13, CCR section 1968.2(d)(6.2.3) (baseline-derived adjustment factors instead of malfunction threshold component-specific adjustment factors) shall be limited to using emission test results without the infrequent regeneration event occurring and applying the same baseline-derived adjustment factors used by the manufacturer at the time of certification.

~~(ii)~~(iii) Final In-Use Thresholds. For 2009 and subsequent model year vehicles subject to the gasoline/spark-ignited requirements of title 13, CCR section 1968.2(e) and 2013 and subsequent model year vehicles subject to the diesel/compression-ignition requirements of title 13, CCR section 1968.2(f), the results of the OBD II emission tests indicate that 50 percent or more of the vehicles in the test sample do not properly illuminate the MIL when the emission malfunction criteria defined in title 13, CCR sections 1968.2(e) or (f) are exceeded.

(B) OBD II Ratio Testing.

(i) For monitors on 2004 through ~~2008~~ 2014 model year vehicles certified to a ratio of 0.100 in accordance with title 13, CCR section 1968.2(d)(3.2.1)(D), the data collected from the vehicles in the test sample indicate either that the average in-use monitor performance ratio for one or more of the monitors in the test sample group is less than 0.100 or that 66.0 percent or more of the vehicles in the test sample group have an in-use monitor performance ratio of less than 0.100 for the same monitor.

(ii) For monitors on ~~2006~~ 2007 and subsequent model year vehicles certified to the ratios in title 13, CCR sections 1968.2(d)(3.2.1)(A) through (C), the data collected from the vehicles in the test sample indicate either that 66.0 percent or more of the vehicles in the test sample group have an in-use monitor performance ratio of less than the required minimum ratio defined in title 13, CCR section 1968.2(d)(3.2.1) for the same monitor or that the average in-use monitor performance ratio for one or more of the monitors in the motor vehicle class is less than the required minimum ratio defined in title 13, CCR section 1968.2(d)(3.2.1) as defined by determining the average in-use monitor performance ratio for one or more of the monitors in the test sample group is less than:

a. 0.230 for secondary air system monitors and other cold start related monitors utilizing a denominator incremented in accordance with title 13, CCR section 1968.2(d)(4.3.2)(E) (e.g., cold start strategy monitors, etc.);

b. For evaporative system monitors:

   1. 0.230 for monitors designed to detect malfunctions identified in title 13, CCR section 1968.2(e)(4.2.2)(C) (i.e., 0.020 inch leak detection);

   2. 0.460 for monitors designed to detect malfunctions identified in title 13, CCR section 1968.2(e)(4.2.2)(A) and (B) (i.e., purge flow and 0.040 inch leak detection);

c. 0.297 for catalyst, oxygen sensor, EGR, VVT system, and all other monitors specifically required in section title 13, CCR sections 1968.2(e) and (f) to meet the monitoring condition requirements of title 13, CCR section 1968.2(d)(3.2).

(C) All Other OBD II Testing.

(i) The results of the testing indicate that at least 30 percent of the vehicles in the test sample do not comply with the same requirement of title 13, CCR section 1968.2.

(ii) The results of the testing indicate that at least 30 percent of the vehicles in the test sample do not comply with one or more of the requirements of title 13, CCR section 1968.2 while the engine is running and while in the key on, engine off position such that Inspection and Maintenance or scan tool equipment designed to access the following parameters via the standards referenced in title 13, CCR section 1968.2 cannot obtain valid and correct data for the following parameters:

a. The current readiness status from all on-board computers required to support readiness status in accordance with Society of Automotive Engineers J1979 (SAE J1979) as incorporated by reference in title 13, CCR section 1968.2(g)(1) and section 1968.2(g)(4.1);

b. The current MIL command status while the MIL is commanded off and while the MIL is commanded on in accordance with SAE J1979 and title 13, CCR section 1968.2(g)(4.2), and in accordance with SAE J1979 and title 13, CCR sections 1968.2(d)(2.1.2) during the MIL functional check and, if applicable, title 13, CCR 1968.2(g)(4.1.3) during the MIL readiness status check;

c. The current permanent fault code(s) in accordance with SAE J1979 and section title 13, CCR 1968.2(g)(4.4);

d. The data stream parameters (Mode/Service $01) for: engine speed (PID $0C) and OBD requirements to which the vehicle or engine is certified (PID $1C); and for 2008 and subsequent model year vehicles using the ISO 15765-4 protocol that have not implemented permanent fault codes subject to (b)(6)(C)(ii)c., number of warm-up cycles since codes cleared (PID $30), distance since codes cleared (PID $31), and engine run time since codes cleared (PID $4E); as required in title 13, CCR section 1968.2(g)(4.2) and in accordance with SAE J1979;

e. The CAL ID, CVN, and VIN (Mode $09 PIDs $01 through $06) as required in title 13, CCR sections 1968.2(g)(4.6), (g)(4.7.1), (g)(4.7.3), and (g)(4.8) and in accordance with SAE J1979;

f. The proper identification of all data identified in (b)(6)(C)(ii)a. through (b)(6)(C)(ii)e. as supported or unsupported as required in title 13, CCR section 1968.2(g)(4) and in accordance with SAE J1979 (e.g., Mode/Service $01, PIDs $00, $20, $40; Mode/Service $09, PID $00, etc.); or

g. For vehicles using an alternate connector and communication protocol (e.g., SAE J1939) as provided for in title 13, CCR section 1968.2(g)(7.1), the parameters and data identified in sections (b)(6)(C)(ii)a. through f. in accordance with title 13, CCR section 1968.2(g)(4) and with the specified alternate connector and communication protocol in lieu of in accordance with SAE J1979.

~~(ii)~~(iii) If the finding of nonconformance under section (b)(6)(C)(i) above concerns vehicles that do not comply with the requirements of title 13, CCR section 1968.2(d)(4) or (5) (e.g., numerators or denominators are not properly being incremented), it shall be presumed that the nonconformance would result in an OBD II ratio enforcement test result that would be subject to an ordered OBD II-related recall in accord with the criterion in section (c)(3)(A)(i). The manufacturer may rebut such a presumption by presenting evidence in accord with section (b)(7)(C)(iii) below that demonstrates to the satisfaction of the Executive Officer that the identified nonconformance would not result in an ordered OBD II-related recall under section (c)(3)(A)(i).

(7) Executive Officer Notification to the Manufacturer Regarding Determination of Nonconformance.

(A) Upon making the determination of nonconformance in section (b)(6) above, the Executive Officer shall notify the manufacturer in writing.

(B) The Executive Officer shall include in the notice:

(i) a description of each group or set of vehicles ~~or engines~~ in the motor vehicle class covered by the determination;

(ii) the factual basis for the determination, including a summary of the test results relied upon for the determination;

(iii) a statement that the Executive Officer shall provide to the manufacturer, upon request and consistent with the California Public Records Act, Government Code section 6250 et seq., all records material to the Executive Officer's determination;

(iv) a provision allowing the manufacturer no less than 90 days from the date of issuance of the notice to provide the Executive Officer with any information contesting the findings set forth in the notice; and

(v) a statement that if a final determination is made that the motor vehicle class is equipped with a nonconforming OBD II system, the manufacturer may be subject to appropriate remedial action, including recall and monetary penalties.

(C) Within the time period set by the Executive Officer in section (b)(7)(B)(iv) and any extensions of time granted under section (b)(7)(H), the manufacturer shall provide the Executive Officer, consistent with paragraphs (i) through (iii) below, with any test results, data, or other information derived from vehicle testing that may rebut or mitigate the results of the ARB testing, including any evidence that a motor vehicle class, if determined to be nonconforming, should be exempted from mandatory recall. (See section (c)(3)(B) below.).

(i) For OBD II emission testing and OBD II ratio testing:

a. The manufacturer may submit evidence to demonstrate that vehicles in the test sample group used by the Executive Officer were inappropriately selected, procured, or tested in support of a request to have vehicles excluded from the test sample group in accordance with section (b)(3)(D)(iv).

b. If the manufacturer elects to conduct additional testing of vehicles ~~or engines~~ in the motor vehicle class and submit the results of such testing to the Executive Officer, the manufacturer shall:

1. Present evidence that it has followed the vehicle procurement and test procedures set forth in sections (b)(3) and (4) above, or

2. If the manufacturer elects to use different procurement and testing procedures, submit a detailed description of the procedures used and evidence that such procedures provide an equivalent level of assurance that the results are representative of the motor vehicle class.

(ii) If the manufacturer objects to the size of the test sample group or the method used to procure vehicles in the test sample group used by the Executive Officer pursuant to section (b)(3)(B)(iii) or (b)(3)(C)(ii), the manufacturer shall set forth what it considers to be the appropriate size and procurement method, the reasons therefore, and test data from vehicles that confirm the manufacturer's position.

(iii) If the manufacturer elects to present evidence to overcome the presumption of nonconformance in section (b)(6)(C)(iii) above, the manufacturer shall demonstrate that the vehicles in the motor vehicle class comply with in-use monitor performance ratio requirements of title 13, CCR section 1968.2(d)(3.2) by presenting:

a. Evidence in accord with the procurement and testing requirements of sections (b)(3) and (4).
b. Any other evidence that provides an equivalent level of proof that vehicles operated in California comply with the in-use monitor performance ratio requirements.

(D) The Executive Officer may, but is not required to, accept any information submitted by a manufacturer pursuant to section (b)(7)(C) above after the time established for submission of such information has passed unless the manufacturer could not have reasonably foreseen the need for providing the information within the time period provided. In determining whether to accept late information, the Executive Officer will consider the lateness of the submission, the manufacturer's reasons for why such information was not timely presented, the materiality of the information to the Executive Officer's final determination, and what effect any delay may have on effective enforcement and the health and welfare of the State.

(E) The requirements of section (b)(7) shall not be construed to abridge the manufacturer's right to assert any privilege or right provided under California law.

(F) After receipt of any information submitted by the manufacturer pursuant to section (b)(7)(C) above, the Executive Officer shall consider all information submitted by the manufacturer and may conduct any additional testing that he or she believes is necessary.

(G) Final Determination.

(i) Within 60 days after completing any additional testing that the Executive Officer deemed necessary under section (b)(7)(F) above, the Executive Officer shall notify the manufacturer of his or her final determination regarding the finding of nonconformity of the OBD II system in the motor vehicle class. The determination shall be made after considering all of the information collected and received, including all information that has been received from the manufacturer.

(ii) The notice must include a description of each test group(s), OBD II group(s), or subgroups thereof, that has been determined to have a nonconforming OBD II system and set forth the factual bases for the determination.

(H) Extensions. The Executive Officer may for good cause extend the time requirements set forth in section (b)(7). In granting additional time to a manufacturer, the Executive Officer shall consider, among other things, any documentation submitted by the manufacturer regarding the time that it reasonably believes is necessary to conduct its own testing, why such information could not have been more expeditiously presented, and what effect any delay caused by granting the extension may have on effective enforcement and the health and welfare of the State. The Executive Officer shall grant a manufacturer a reasonable extension of time upon the manufacturer demonstrating that despite the exercise of reasonable diligence, the manufacturer has been unable to produce relevant evidence in the time initially provided.

(c) *Remedial Action*

(1) Voluntary OBD II-Related Recalls.

If a manufacturer initiates a voluntary OBD II-related recall campaign, the manufacturer shall notify the Executive Officer of the recall at least 45 days before owner notification is to begin. The manufacturer shall also submit a voluntary OBD II-related recall plan for approval, as prescribed under section (d)(1) below. A voluntary recall plan shall be deemed approved unless disapproved by the Executive Officer within 30 days after receipt of the recall plan.

(2) Influenced OBD II-Related Recalls.

(A) Upon being notified by the Executive Officer, pursuant to section (b)(7)(G), that a motor vehicle class is equipped with a nonconforming OBD II system, the manufacturer may, within 45 days from the date of service of such notification, elect to conduct an influenced OBD II-related recall of all vehicles within the motor vehicle class for the purpose of correcting the nonconforming OBD II systems. Upon such an election, the manufacturer shall submit an influenced OBD II-related recall plan for approval, as prescribed under section (d)(1) below.

(B) If a manufacturer does not elect to conduct an influenced OBD II-related recall under section (c)(2)(A) above, the Executive Officer may order the manufacturer to undertake appropriate remedial action, up to and including the recall and repair of the nonconforming OBD II systems.

(3) Ordered Remedial Action-Mandatory Recall.

(A) Except as provided in sections (c)(3)(B) below, the Executive Officer shall order the recall and repair of all vehicles ~~and engines~~ in a motor vehicle class that have been determined to be equipped with a nonconforming OBD II system if enforcement testing conducted pursuant to section (b) above or information received from the manufacturer indicates that:

(i) For monitors on ~~2006~~ 2007 and subsequent model year vehicles certified to the ratios in title 13, CCR sections 1968.2-(d)(3.2.1)(A) through (C), the average in-use monitor performance ratio for one or more of the major monitors in the test sample group is less than or equal to 33.0 percent of the applicable required minimum ratio established in title 13, CCR section 1968.2(d)(3.2.1) (e.g., if the required ratio is 0.336, less than or equal to a ratio of 0.111) or 66.0 percent or more of the vehicles in the test sample group have an in-use monitor performance ratio of less than or equal to 33.0 percent of the applicable required minimum ratio established in title 13, CCR section 1968.2(d)(3.2.1) for the same major monitor. For monitors on 2004 through ~~2008~~ 2014 model year vehicles certified to the 0.100 ratio in title 13, CCR section 1968.2-(d)(3.2.1)(D), the

Executive Officer shall determine the remedial action for nonconformances regarding the in-use monitor performance ratio in accordance with section (c)(4) below.

(ii) When the vehicle is tested on-road and driven so as to reasonably encounter all monitoring conditions disclosed in the manufacturer's certification application, the OBD II system is unable to detect and illuminate the MIL for a malfunction of a component/system monitored by a major monitor (other than the monitors for misfire causing catalyst damage and the evaporative system) prior to emissions exceeding two times the malfunction criteria of title 13, CCR sections 1968.2(e) and (f) (e.g., if the malfunction criteria is 1.75 times the applicable FTP standard, recall would be required when emissions exceed 3.5 times the applicable FTP standard or if the malfunction criteria is the PM standard plus 0.02 g/bhp-hr and the PM standard is 0.01 g/bhp-hr, recall would be required when emissions exceed 0.06 g/bhp-hr). Additionally, for the first two years that a new major monitor is required in title 13, CCR section 1968.2(e) (e.g., 2006 and 2007 model year for cold start strategy monitoring in title 13, CCR section 1968.2(e)(11)), the Executive Officer shall use three times the malfunction criteria in lieu of two times the malfunction criteria (e.g., if the malfunction criterion is 1.5 times the applicable FTP standard, recall would be required when emissions exceed 4.5 times the applicable FTP standard). Additionally, for major monitors on 2007 through 2009 model year vehicles certified to the monitoring requirements in title 13, CCR section 1968.2(f), the Executive Officer shall determine the remedial action for nonconformances regarding emission exceedance in accordance with section (c)(4) below in lieu of the criteria in section (c)(3)(ii). For purposes of the emission exceedance determination, carbon monoxide (CO) emissions are not considered.

(iii) The monitor for misfire causing catalyst damage is unable to properly detect and illuminate the MIL for misfire rates that are more than 20 percentage points greater than the misfire rates disclosed by the manufacturer in its certification application as causing catalyst damage (e.g., if the disclosed misfire rate is 12 percent, recall would be required if the misfire rate is greater than 32 percent without proper detection).

(iv) When the vehicle is tested on-road and driven so as to reasonably encounter all monitoring conditions disclosed in the manufacturer's certification application, the evaporative system monitor is unable to detect and illuminate the MIL for a cumulative leak or leaks in the evaporative system equivalent to that caused by an orifice with a diameter of at least 1.5 times the diameter of the required orifice in title 13, CCR section 1968.2(e)(4.2.2)(C).

(v) When the vehicle is tested on-road and driven so as to reasonably encounter all monitoring conditions disclosed in the manufacturer's certification application, the OBD II system cannot detect and illuminate the MIL for a malfunction of a ~~non-major monitor~~ component that effectively disables a major monitor and the major monitor, by being disabled, meets the criteria for recall identified in sections (c)(3)(A)(ii) or (iv) above (e.g. is unable to detect and illuminate the MIL for malfunctions that cause FTP emissions to exceed two times the malfunction criteria).

(vi) The motor vehicle class cannot be tested so as to obtain valid test results in accordance with the ~~procedures~~ criteria identified in ~~of the California Inspection & Maintenance (I/M) program applicable at the time of vehicle certification~~ section (b)(6)(C)(ii) due to the nonconforming OBD II system. ~~If the I/M test procedures have been amended within two years prior to the time of certification, the motor vehicle manufacturer may elect to use the preceding procedures.~~

(B) A motor vehicle class shall not be subject to mandatory recall if the Executive Officer determines that, even though a monitor meets a criterion set forth in section (c)(3)(A)(i)-(vi) for mandatory recall:

(i) The OBD II system can still detect and illuminate the MIL for all malfunctions monitored by the nonconforming monitor (e.g., monitor "A" is non-functional but monitor "B" is able to detect all malfunctions of the component(s) monitored by monitor "A").

(ii) The monitor meets the criterion solely due to a failure or deterioration mode of a monitored component or system that could not have been reasonably foreseen to occur by the manufacturer.

(iii) The failure or deterioration of the monitored component or system that cannot be properly detected causes the vehicle to be undriveable (e.g., vehicle stalls continuously or the transmission will not shift out of first gear, etc.) or causes an overt indication such that the driver is certain to respond and have the problem corrected (e.g., illumination of an over-temperature warning light or charging system light that uncorrected will result in an undriveable vehicle, etc.).

(C) A motor vehicle class that is not subject to mandatory recall pursuant to paragraph (B) above may still be subject to remedial action pursuant to section (c)(4) below.

(4) Other Ordered Remedial Action.

(A) If the Executive Officer has determined based upon enforcement testing conducted pursuant to section (b) above or information received from the manufacturer that a motor vehicle class is equipped with a nonconforming OBD II system and the nonconformance does not fall within the provisions of section (c)(3)(A) above, he or she may require the manufacturer to undertake remedial action up to and including recall of the affected motor vehicle class.

(B) In making his or her findings regarding remedial action, the Executive Officer shall consider the capability of the OBD II system to properly function. This determination shall be based upon consideration of all relevant circumstances including, but not limited to, those set forth below.

(i) Whether the manufacturer identified and informed the ARB about the nonconformance(s) or whether the ARB identified the nonconformance(s) prior to being informed by the manufacturer.

(ii) The number of nonconformances.

(iii) If the identified nonconformance(s) is with a major monitor(s), the nature and extent of the nonconformance(s), including:

a. the degree to which the in-use monitor performance ratio(s) is below the required ratio(s) specified in title 13, CCR section 1968.2(d)(3.2.1), and

b. the amount of the emission exceedance(s) over the established malfunction criteria set forth in title 13, CCR sections 1968.2(e) and (f) before a malfunction is detected and the MIL is illuminated.

(iv) If the identified nonconformance(s) is with a non-major monitor the nature and extent of the nonconformance(s), including:

a. the degree to which the in-use monitor performance ratio(s) (where applicable) is below the required ratio(s) specified in title 13, CCR section 1968.2(d)(3.2.1),

b. the degree to which the monitored component must be malfunctioning or exceed the established malfunction criteria set forth in title 13, CCR sections 1968.2(e) and (f) before a malfunction is detected and the MIL is illuminated, and

c. the effect that the nonconformance(s) has on the operation of a major monitor(s).

(v) The impact of the nonconformance on vehicle owners (e.g., cost of future repairs, driveability, etc.) and the ability of the service and repair industry to make effective repairs (e.g., difficulty in accessing fault information, diagnosing the root cause of a failure, etc.).

(vi) The degree to which the identified nonconformance(s) complicates, interferes with, disrupts, or hampers a service technician's ability to follow California I/M testing protocol when performing a California I/M inspection.

(vii) The failure of the data link connector of the motor vehicle class to meet the requirements of title 13, CCR section 1968.2(~~f~~g)(2).

(viii) The failure of the ~~PCV~~ crankcase ventilation system in a motor vehicle class to comply with the requirements of title 13, CCR sections 1968.2(e)(9) or (f)(10).

(ix) The failure of the cooling system monitor in a motor vehicle class to properly verify that the cooling system reaches the highest enable temperature used for any other monitor when the vehicle is operated in the monitoring conditions disclosed in the manufacturer's certification application, or failure to comply with any requirement in title 13, CCR sections 1968.2(e)(10) or (f)(11).

(x) The estimated frequency that a monitor detects a malfunction and illuminates the MIL when no component malfunction is present (i.e., false MILs).

(xi) The estimated frequency that a monitor fails to detect a malfunction and illuminate the MIL when the monitoring conditions, as set forth in the manufacturer's approved certification application, have been satisfied and a faulty or deteriorated monitored component is present (i.e., false passes).

(xii) Whether the manufacturer submitted false, inaccurate, or incomplete documentation regarding the identified nonconformance at the time of certification pursuant to title 13, CCR section 1968.2(hi) and the extent to which the false, inaccurate, or incomplete documentation was material to the granting of certification.

(C) In making the determination, the average tailpipe and evaporative emissions of vehicles within the affected motor vehicle class shall not be considered.

(5) Assessment of Monetary Penalties.

The Executive Officer may seek penalties pursuant to the applicable provisions of the Health and Safety Code for violations of the requirements of title 13, CCR section 1968.2 or for production vehicles otherwise failing to be equipped with OBD II systems that have been certified by the ARB. In determining the penalty amounts that the ARB may seek, the Executive Officer shall consider all relevant circumstances including the factors set forth below:

(A) Whether the manufacturer self-reported the nonconformity or the ARB discovered the nonconformity independent of the manufacturer.

(B) The nature and degree of the nonconformity and whether the manufacturer should reasonably have discovered the nonconformity and taken corrective action by voluntary OBD II-related recall or running changes during the production year.

(C) The economic benefits, if any, gained by the manufacturer from not complying with the provisions of title 13, CCR section 1968.2.

(D) The manufacturer's history of compliance with the OBD II requirements.

(E) The preventative efforts taken by the manufacturer to avoid noncompliance, including any programs followed by the manufacturer to ensure compliance.

(F) The manufacturer's efforts to correct the nonconformity once it was identified.

(G) The innovative nature and magnitude of effort, including the cost of any other proposed remedial action, necessary to correct the nonconformity.

(H) The deterrent effect of the penalty.

(I) Whether the manufacturer has failed to provide complete and accurate information required to be submitted at the time of certification pursuant to title 13, CCR section 1968.2(~~h~~i).

(J) The nature and degree that OBD II systems on production vehicles differ from the systems that have been certified by the ARB.

(6) Notice to Manufacturer for an Ordered Remedial Action.

(A) The Executive Officer shall immediately notify the manufacturer upon the Executive Officer determining the type of remedial action to be taken.

(B) For remedial actions other than the assessment of monetary penalties, the notice must:

(i) specifically set forth the remedial action that is being ordered,

(ii) include a description of the test group(s), OBD II group(s), or subgroup(s) thereof, that has been determined to have a nonconforming OBD II system,

(iii) set forth the factual bases for the determination, and

(iv) designate a date at least 45 days from the date of receipt of such notice by which the manufacturer shall submit a plan, pursuant to section (d)(1) below, outlining the remedial action to be undertaken consistent with the Executive Officer's order. Except as provided in section (c)(7)(C) below, all plans shall be submitted to the Chief, Mobile Source Operations Division, 9528 Telstar Avenue, El Monte, California 91731, within the time limit specified in the notice. The Executive Officer may grant the manufacturer an extension of time for good cause.

(C) For cases in which the ARB elects to seek monetary penalties pursuant to authority granted under the Health and Safety Code, the Executive Officer shall issue a notice to the manufacturer that he or she will be filing a complaint in the appropriate administrative or civil court forum seeking penalties against the manufacturer for violations of title 13, CCR section 1968.2. The notice must include a description of the test group(s), OBD II group(s), or subgroup(s) thereof, that have been determined to have a nonconforming OBD II system and set forth the factual bases for the determination.

(7) Availability of Public Hearing to Contest Remedial Actions Other than Determination to Seek Monetary Penalties.

(A) Within 45 days from the date of receipt of the notice that is required under section (c)(6) above, the manufacturer may request a public hearing pursuant to the procedures set forth in title 17, CCR section 60055.1, et seq., to contest the findings of nonconformity, the necessity for, or the scope of any ordered remedial action. Pursuant to those procedures, the Executive Officer has the initial burden of presenting evidence that those parts of the Executive Officer's determination specifically challenged are supported by the facts and applicable law. (Title 17, CCR section 60055.32(d)(1).) Each issue of controversy shall be decided based upon the preponderance of the evidence presented at the hearing. (Title 17, CCR section 60055.32(h).)

(B) Notwithstanding the provisions of title 17, CCR section 60055.17(a)(1), administrative hearings conducted pursuant to a request filed under section (c)(7)(A) above shall be referred to the Office of Administrative Hearings, which shall otherwise follow the procedures established in title 17, CCR section 60055.1 et seq.

(C) If a manufacturer requests a public hearing pursuant to section (c)(7)(A) above and if the Executive Officer's determination of nonconformity is confirmed at the hearing, the manufacturer shall submit the required remedial action plan in accordance with section (d)(1) below within 30 days after receipt of the Board's decision.

(d) *Requirements for Implementing Remedial Actions*

(1) Remedial Action Plans.

(A) A manufacturer initiating a remedial action (voluntary, influenced, or ordered), other than payment of monetary penalties, shall develop a remedial action plan that contains the following information, unless otherwise specified:

(i) A description of each test group, OBD II group, or subgroup thereof covered by the remedial action, including the number of vehicles~~ or engines~~, the engine families, test groups, or subgroups within the identified class(es), the make(s), model(s), and model years of the covered vehicles~~ and engines~~, and such other information as may be required to identify the covered vehicles~~ or engines~~.

(ii) A description of the nonconforming OBD II system and, in the case of a recall (whether voluntary, influenced, or ordered), the specific modifications, alterations, repairs, adjustments, or other changes to correct the nonconforming OBD II system, including data and/or engineering evaluation supporting the specific corrections.

(iii) A description of the method that the manufacturer will use to determine the names and addresses of vehicle~~ or engine~~ owners and the manufacturer's method and schedule for notifying the service facilities and vehicle ~~or engine~~ owners of the remedial action.

(iv) A copy of all instructions that the manufacturer will use to notify service facilities about the required remedial action and the specific corrections, if any, that will be required to be made to the nonconforming OBD II systems.

(v) A description of the procedure to be followed by vehicle ~~or engine~~ owners to obtain remedial action for the nonconforming OBD II system. This must include the date, on or after which the owner can have required remedial action performed, the time reasonably necessary to perform the labor to remedy the nonconformity, and the designation of facilities at which the nonconformity can be remedied.

(vi) If some or all of the nonconforming OBD II systems are to be remedied by persons other than dealers or authorized warranty agents of the manufacturer, a description of such class of service agents and what steps, including a copy of all instructions mailed to such service agents, the manufacturer will take to assure that such agents are prepared and equipped to perform the proposed remedial action.

(vii) A copy of the letter of notification to be sent to vehicle ~~or engine~~ owners.

(viii) A proposed schedule for implementing the remedial action, including identified increments of progress towards full implementation.

(ix) A description of the method that the manufacturer will use to assure that an adequate supply of parts will be available to initiate the remedial action campaign on the date set by the manufacturer and that an adequate supply of parts will continue to be available throughout the campaign.

(x) A description and test data of the emission impact, if any, that the proposed remedial action may cause to a representative vehicle ~~or engine~~ from the motor vehicle class to be remedied.

(xi) A description of the impact, if any, and supporting data and/or engineering evaluation, that the proposed remedial action will have on fuel economy, driveability, performance, and safety of the motor vehicle class covered by the remedial action.

(xii) Any other information, reports, or data which the Executive Officer may reasonably determine to be necessary to evaluate the remedial action plan.

(B) Approval and Implementation of Remedial Action Plans.

(i) If the Executive Officer finds that the remedial action plan is designed effectively to address the required remedial action and complies with the provisions in section (d)(1)(A) above, he or she shall notify the manufacturer in writing within 30 days of receipt of the plan that the plan has been approved.

(ii) The Executive Officer shall approve a voluntary, influenced, or ordered remedial action plan if the plan contains the information specified in section (d)(1)(A) above and is designed to notify the vehicle ~~or engine~~ owner and implement the remedial action in an expeditious manner.

(iii) In disapproving an ordered remedial action plan, the Executive Officer shall notify the manufacturer in writing of the disapproval and the reasons for the determination. The manufacturer shall resubmit a revised remedial action plan that fully addresses the reasons for the Executive Officer's disapproval within 10 days of receipt of the disapproval notice.

(iv) Upon receipt of the approval notice of the ordered remedial action plan from the Executive Officer, the manufacturer shall, within 45 days of receipt of the notice, begin to notify vehicle ~~or engine~~ owners and implement the remedial action campaign.

(v) If the Executive Officer disapproves a voluntary or influenced remedial action plan, the manufacturer shall either accept the proposed modifications to the plan as suggested by the Executive Officer, resubmit a revised remedial action plan that fully addresses the reasons for the Executive Officer's disapproval within 30 days, or be subject to an Executive Officer order that the manufacturer undertake appropriate remedial action pursuant to section (c)(2)(B) above.

(vi) Upon receipt of the voluntary or influenced remedial action approval notice from the Executive Officer, the manufacturer shall begin to notify vehicle ~~or engine~~ owners and implement the remedial action campaign according to the schedule indicated in the remedial action plan.

(2) Eligibility for Remedial Action.

(A) The manufacturer may not condition a vehicle ~~or engine~~ owner's eligibility for remedial action required under section 1968.5 on the proper maintenance or use of the vehicle ~~or engine~~.

(B) The manufacturer shall not be obligated to repair a component which has been modified or altered such that the remedial action cannot be performed without additional cost.

(3) Notice to Owners.

(A) The manufacturer shall notify owners of vehicles ~~or engines~~ in the motor vehicle class covered by the remedial order. The notice must be made by first-class mail or by such other means as approved by the Executive Officer. When necessary, the Executive Officer may require the use of certified mail for ordered remedial actions to assure effective notification.

(B) The manufacturer shall use all reasonable means necessary to locate vehicle ~~or engine~~ owners, including motor vehicle registration lists available from the California Department of Motor Vehicles and commercial sources such as R.L. Polk & Co.

(C) The notice must contain the following:

(i) For ordered remedial actions, a statement: "The California Air Resources Board has determined that your (vehicle or engine) (is or may be) equipped with an improperly functioning on-board emission-related diagnostic system that violates established standards and regulations that were adopted to protect your health and welfare from the dangers of air pollution."

(ii) For voluntary and influenced remedial actions, a statement: "Your (vehicle or engine) (is or may be) equipped with an improperly functioning on-board emission-related diagnostic system that violates (California or California and Federal) standards and regulations" if applicable as determined by the Executive Officer.

(iii) A statement that the nonconformity of any such vehicles ~~or engines~~ will be remedied at the expense of the manufacturer.

(iv) A statement that eligibility for remedial action may not be denied solely on the basis that the vehicle ~~or engine~~ owner used parts not manufactured by the original equipment vehicle manufacturer, or had repairs performed by outlets other than the vehicle ~~or engine~~ manufacturer's franchised dealers.

(v) Instructions to the vehicle ~~or engine~~ owners on how to obtain remedial action, including instructions on whom to contact (i.e., a description of the facilities where the vehicles ~~or engines~~ should be taken for the remedial action), the first date that a vehicle ~~or engine~~ may be brought in for remedial action, and the time that it will reasonably take to correct the nonconformity.

(vi) The statement: "In order to assure your full protection under the emission warranty provisions, it is recommended that you have your (vehicle or engine) serviced as soon as possible. Failure to do so could be determined as lack of proper maintenance of your (vehicle or engine)."

(vii) A telephone number for vehicle ~~and engine~~ owners to call to report difficulty in obtaining remedial action.

(viii) A card to be used by a vehicle ~~or engine~~ owner in the event the vehicle ~~or engine~~ to be recalled has been sold. Such card should be addressed to the manufacturer, have postage paid, and shall provide a space in which the owner may indicate the name and address of the person to whom the vehicle ~~or engine~~ was sold or transferred.

(ix) If the remedial action involves recall, the notice must also provide:

a. A clear description of the components that will be affected by the remedial action and a general statement of the measures to be taken to correct the nonconformity.

b. A statement that such nonconformity, if not corrected, may cause the vehicle ~~or engine~~ to fail an emission inspection or I/M smog check test.

c. A statement describing the adverse effects, if any, of an uncorrected nonconforming OBD II system on the performance, fuel economy, or durability of the vehicle ~~or engine~~.

d. A statement that after remedial action has been taken, the manufacturer will have the service facility issue a certificate showing that a vehicle has been corrected under the recall program, and that such a certificate will be required to be provided to the Department of Motor Vehicles as a condition for vehicle registration.

(D) A notice sent pursuant to this section or any other communication sent to vehicle ~~or engine~~ owners or dealers may not contain any statement, expressed or implied, that the OBD II system is compliant or that the OBD II system will not degrade air quality.

(E) The Executive Officer shall inform the manufacturer of any other requirements pertaining to the notification under section (d)(3) which the Executive Officer has determined as reasonable and necessary to assure the effectiveness of the recall campaign.

(4) Label Indicating that Recall Repairs Have Been Performed.

(A) If the required remedial action involves recall of a test group(s), OBD II group(s), or subgroup(s) thereof, the manufacturer shall require those who perform inspections and/or recall repairs to affix a label to each vehicle ~~or engine~~ that has been inspected and/or repaired.

(B) The label must be placed in a location approved by the Executive Officer and must be fabricated of a material suitable for such location in which it is installed and which is not readily removable.

(C) The label must contain the remedial action campaign number and a code designating the facility at which the remedial action or inspection to determine the need for remedial action was performed.

(5) Proof of Performance of Remedial Action Certificate.

If the required remedial action involves a recall, the manufacturer shall provide, through its service agents, to owners of vehicles ~~or engines~~ that have had the remedial action performed a certificate that confirms that the vehicle has been recalled and that required inspection and/or repairs have been performed. The certificate must be in a format prescribed by the Executive Officer, however, the Executive Officer may not require a format different in any way from the format of the certificate required in title 13, CCR sections 2117 and 2129.

(6) Record Keeping and Reporting Requirements.

(A) The manufacturer shall maintain sufficient records to enable the Executive Officer to conduct an analysis of the adequacy of the remedial action.

(B) Unless otherwise specified by the Executive Officer, the manufacturer shall report on the progress of the remedial action campaign by submitting reports for eight consecutive quarters commencing with the quarter immediately after the recall campaign begins. The reports shall be submitted no later than 25 days after the close of each calendar quarter to: Chief, Mobile Source Operations Division, 9528 Telstar Avenue, El Monte, California 91731. For each recall campaign, the quarterly report must contain the following:

(i) The test group and the remedial action campaign number designated by the manufacturer and a brief description of the nature of the campaign.

(ii) The date owner notifications began and date completed.

(iii) The number of vehicles ~~or engines~~ involved in the remedial action campaign.

(iv) The number of vehicles ~~or engines~~ known or estimated to be equipped with the nonconforming OBD II system and an explanation of the means by which this number was determined.

(v) The number of vehicles ~~or engines~~ inspected during the campaign since its inception.
(vi) The number of vehicles ~~or engines~~ found to be affected by the nonconformity during the campaign since its inception.
(vii) The number of vehicles ~~or engines~~ receiving remedial action during the campaign since its inception.
(viii) The number of vehicles ~~or engines~~ determined to be unavailable for inspection or remedial action, during the campaign since its inception, due to exportation, theft, scrapping, or other reasons (specify).
(ix) The number of vehicles ~~or engines~~, during the campaign since its inception, determined to be ineligible for remedial action under section (d)(2)(B).
(x) An initial list, using the following data elements and designated positions, indicating all vehicles ~~or engines~~ subject to recall that the manufacturer has not been invoiced for, or a subsequent list indicating all vehicles subject to the recall that the manufacturer has been invoiced for since the previous report. The list must be supplied in a standardized computer format to be specified by the Executive Officer. The ~~date~~ data elements must be written in "ASCII" code without a comma separating each element. For example: XTY32A71234E-9456123408-25-91A. The add flag (see below) should reflect the vehicles ~~or engines~~ for which the manufacturer has not been invoiced and the delete flag should reflect changes since the previous report. The Executive Officer may change the frequency of this submittal depending on the needs of enforcement. The Executive Officer may not, however, require a frequency or format for this submittal that is different in any way from the frequency or format determined by the Executive Officer as required for reporting of data in title 13, CCR sections 2119(a)(10) and 2133(a)(10).

Data Elements	Positions
• File Code (designated by DMV)	1
• License Plate Number	2-8
• Last three VIN positions	9-11
• Recall ID Number	12-17
• Mfg. ID Number (Mfg. Occupational License Number)	18-22
• Recall Start Date (mmddyyyy)	23-30
• Add or Delete Flag (A/D)	31
• Complete VIN if personalized license plate (File Code "L" or "S")	32-48

(xi) A copy of any service bulletins issued during the reporting period by the manufacturer to franchised dealerships or other service agents that relate to the nonconforming OBD II system and the remedial action and have not previously been reported to the Executive Officer.

(xii) A copy of all communications transmitted to vehicle ~~or engine~~ owners that relate to the nonconforming OBD II systems and the required remedial action and have not been previously reported to the Executive Officer.

(C) If the manufacturer determines that any of the information submitted to the Executive Officer pursuant to section (d) has changed or is incorrect, the manufacturer shall submit the revised information, with an explanation.

(D) The manufacturer shall maintain in a form suitable for inspection, such as computer information, storage devices, or card files, and shall make available to the Executive Officer or his or her authorized representative upon request, the names and addresses of vehicle ~~or engine~~ owners:

(i) To whom notification was sent;

(ii) Whose vehicles ~~or engines~~ were repaired or inspected under the recall campaign;

(iii) Whose vehicles ~~or engines~~ were determined not to be eligible for remedial action because the vehicles ~~or engines~~ were modified, altered, or unavailable due to exportation, theft, scrapping, or other reason specified in the answer to sections (d)(6)(B)(viii) and (ix).

(E) The information gathered by the manufacturer to compile the reports required by these procedures must be retained for no less than one year beyond the useful life of the vehicles ~~or engines~~ and must be made available to authorized personnel of the ARB upon request.

(F) The filing of any report under the provisions of these procedures must not affect the manufacturer's responsibility to file reports or applications, obtain approval, or give notice under any other provisions of law.

(7) Extension of Time.

Upon request of the manufacturer, the Executive Officer may extend any deadline set forth in section 1968.5(d) upon finding that the manufacturer has demonstrated good cause for the requested extension.

(e) *Penalties for Failing to Comply with the Requirements of Section (d)*

(1) In addition to the penalties that may be assessed by the Executive Officer pursuant to section (c) because of a manufacturer's failure to comply with the requirements of title 13, CCR section 1968.2, a manufacturer may be subject to penalties pursuant to section 43016, Health and Safety Code for failing to comply with the requirements of section (d).

(2) If a manufacturer fails to comply with a voluntary or influenced remedial action plan, the Executive Officer may order remedial action pursuant to section (c) above.

NOTE: Authority cited: Sections 39600, 39601, 43000.5, 43013, 43016, 43018, 43100, 43101, 43104, 43105, 43105.5, 43106, 43154, 43211, and 43212, Health and Safety Code. Reference: Sections 39002, 39003, 39010, 39018, 39021.5, 39024, 39024.5, 39027, 39027.3, 39028, 39029, 39031, 39032, 39032.5, 39033, 39035, 39037.05, 39037.5, 39038, 39039, 39040, 39042, 39042.5, 39046, 39047, 39053, 39054, 39058, 39059, 39060, 39515, 39600-39601, 43000, 43000.5, 43004, 43006, 43013, 43016, 43018, 43100, 43101, 43102, 43104, 43105, 43105.5, 43106, 43150, 43151, 43152, 43153, 43154, 43155, 43156, 43204, 43211, and 43212, Health and Safety Code.

Attachment C

Title 13, California Code of Regulations, Sections 2035, 2037, and 2038, Emission Control System Warranty Requirements for 1990 and Subsequent Model Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles and Engines

Article 6. Emission Control System Warranty

§2035. Purpose, Applicability, and Definitions.

(a) Purpose.
The purpose of this article is to interpret and make specific the statutory emissions warranty set forth in Health and Safety Code sections 43205, and 43205.5 by clarifying the rights and responsibilities of individual motor vehicle and motor vehicle engine owners, motor vehicle and motor vehicle engine manufacturers, and the service industry.

(b) Applicability.
This article shall apply to:

(1) ~~(a)~~ California-certified 1979 and subsequent model motorcycles, passenger cars, light-duty trucks, medium-duty vehicles, and heavy-duty vehicles, registered in California, regardless of their original point of registration; and

(2) California certified motor vehicle engines used in such vehicles.

(c) Definitions.
For the purposes of this article, the following definitions shall apply:

(1) "Warrantable condition" means any condition of a vehicle or engine which triggers the responsibility of the manufacturer to take corrective action pursuant to sections 2036, 2037, or 2038.

(2) "Warranted Part" means:

(A) ~~(a)~~ in the case of ~~1.~~ 1979 through 1989 model year passenger cars, light-duty trucks, and medium-duty vehicles, ~~and 2.~~ 1979 and later model year motorcycles and heavy-duty vehicles, and ~~3.~~ 1990 and subsequent model year passenger cars, light-duty trucks, and medium duty vehicles produced before January 24, 1991, any emission~~s~~-related part installed on a motor vehicle or motor vehicle engine by the vehicle or engine manufacturer, or installed in a warranty repair, which is included on the "Emissions Warranty Parts List" required by section 2036(f) and approved for the vehicle or engine by the ~~e~~Executive ~~o~~Officer; and

(B) ~~(b)~~ in the case of 1990 and subsequent model year passenger cars, light-duty trucks, and medium-duty vehicles~~,~~ other than those identified in subparagraph (A)~~(a)~~ of this definition, any part installed on a motor vehicle or motor vehicle engine by the vehicle or engine manufacturer, or installed in a warranty repair, which affects any regulated emission from a motor vehicle or engine which is subject to California emission standards.

(3) "Warranty period" means the period of time and mileage that the vehicle, engine, or part are covered by the warranty provisions.

(4) "Warranty station" means a service facility authorized by the vehicle or engine manufacturer to perform warranty repairs. This shall include all of the manufacturer's dealerships which are franchised to service the subject vehicles or engines.

(5) "Vehicle or engine manufacturer" means the manufacturer granted certification for a motor vehicle or motor vehicle engine. In the case of motor vehicles for which certification of the exhaust and evaporative emissions control systems is granted to different manufacturers, the warranty responsibility shall be assigned accordingly.

NOTE

Authority cited: Sections 39600 and 39601 and 39601, Health and Safety Code. Reference: Sections 43106, 43204, 43205, and 43205.5, Health and Safety Code.

HISTORY

1. New section filed 1-16-79; effective thirtieth day thereafter (Register 79, No. 3).
2. Amendment of subsection (c) filed 12-27-83; effective thirtieth day thereafter (Register 83, No. 53).
3. Amendment filed 3-26-85; effective thirtieth day thereafter (Register 85, No. 13).
4. Amendment filed 11-26-90; operative 12-26-90 (Register 91, No. 3).

§2037. Defects Warranty Requirements for 1990 and Subsequent Model Passenger Cars. Light-Duty Trucks, Medium-Duty Vehicles, and Motor Vehicle Engines Used in Such Vehicles.

(a) Applicability.
This section shall apply to 1990 and subsequent model passenger cars, light-duty trucks, medium-duty vehicles, and motor vehicle engines used in such vehicles. The warranty period shall begin on the date the vehicle is delivered to an ultimate purchaser, or if the vehicle is first placed in service as a "demonstrator" or "company" car prior to delivery, on the date it is first placed in service.

(b) General Emissions Warranty Coverage.
The manufacturer of each motor vehicle or motor vehicle engine shall warrant to the ultimate purchaser and each subsequent purchaser that the vehicle or engine is:

(1) Designed, built, and equipped so as to conform with all applicable regulations adopted by the Air Resources Board pursuant to its authority in chapters 1 and 2, part 5, division 26 of the Health and Safety Code; and

(2) Free from defects in materials and workmanship which cause the failure of a warranted part to be identical in all material respects to the part as described in the vehicle or engine manufacturer's application for certification, including any defect in materials or workmanship which would cause the vehicle's on-board diagnostic malfunction indicator light to illuminate, for a period of three years or 50,000 miles, whichever first occurs; and

(3) Free from defects in materials and workmanship which cause the failure of a warranted part described in ~~sub~~section (c) below for seven years or 70,000 miles, whichever first occurs.

(c) "High-Priced" Warranted Parts

(1) Each manufacturer shall identify in its application for certification the "high-priced" warranted parts which ~~[i]~~ are:

(A) For 1990 through 2007 model year vehicles: [i] included on the Board's "Emissions Warranty Parts List" as last amended February 22, 1985, incorporated herein by reference, and; [ii] have an individual replacement cost~~,~~ at the time of certification~~,~~ exceeding the cost limit defined in ~~sub~~section (c)(~~1~~3);~~.~~

(B) For 2008 and subsequent model year vehicles: [i] subject to coverage as a warranted part in section (b)(2) above, and; [ii] have an individual replacement cost at the time of certification exceeding the cost limit defined in section (c)(3).

(2) The replacement cost shall be the retail cost to a vehicle owner and include the cost of the part, labor, and standard diagnosis. The costs shall be those of the highest-cost metropolitan area of California.

~~(1)~~(3) The cost limit shall be calculated using the following equation:

$$\text{Cost limit}_n = \$300 \times (CPI_{n-2} / 118.3)$$

Cost $limit_n$ is the cost limit for the applicable model year of the vehicle rounded to the nearest ten dollars.
n is the model year of the new vehicles.
n-2 is the calendar year two years prior to the model year of the new vehicles.
CPI is the annual average nationwide urban consumer price index published by the United States Bureau of Labor Statistics.

~~(2)~~(4) The cost limit shall be revised annually by the Executive Officer. The highest-cost metropolitan area in California shall be identified by the Executive Officer for use in this ~~sub~~section. If a manufacturer seeks certification of a vehicle before the applicable annual average CPI is available, the cost limit shall be calculated using the average of the monthly nationwide urban CPI figures for the most recent twelve month period for which figures have been published by the United States Bureau of Labor Statistics.

~~(3)~~(5) Each manufacturer shall submit to the Executive Officer the documentation used to identify the "high-priced" warranted parts required in this ~~sub~~section. The documentation shall include the estimated retail parts costs, labor rates in dollars per hour, and the labor hours necessary to diagnose and replace the parts. The documentation is not required for vehicles certified before January 24, 1991.

(6) The Executive Officer may reject or require modification of the manufacturer's list of "high-priced" warranted parts to ensure that such list includes all emission-related parts whose replacement cost exceeds the cost limit defined in section (c)(3)

(d) Subject to the conditions ~~s~~and exclusions of ~~sub~~section (i), the warranty on emission~~s~~-related parts shall be interpreted as follows:

(1) Any warranted part which is not scheduled for replacement as required maintenance in the written instructions required by ~~sub~~section (e) shall be warranted for the applicable warranty period defined in ~~sub~~section (b)(2) or (3). If any such part fails during the period of warranty coverage, it shall be repaired or replaced by the vehicle or engine manufacturer according to ~~sub~~section (d)(4) below. Any such part repaired or replaced under the warranty shall be warranted for the remaining warranty period.

(2) Any warranted part which is scheduled only for regular inspection in the written instructions required by ~~sub~~section (e) shall be warranted for the applicable warranty period defined in ~~sub~~section (b)(2) or (3). A statement in such written instructions to the effect of "repair or replace as necessary" shall not reduce the period of warranty coverage. Any such part required or replaced under warranty shall be warranted for the remaining warranty period.

(3) Any warranted part which is scheduled for replacement as required maintenance in the written instructions required by ~~sub~~section (~~3~~e) shall be warranted for the period of time or mileage, whichever first occurs, prior to the first scheduled replacement point for that part. If the part fails prior to the first scheduled replacement, the part shall be repaired or replaced by the vehicle or engine manufacturer according to ~~sub~~section (d)(4) below. Any such part required or

replaced under warranty shall be warranted for the remainder of the period prior to the first scheduled replacement point for the part.

(4) Repair or replacement of any warranted part under the warranty provisions of this article shall be performed at no charge to the vehicle or engine owner at a warranty station, except in the case of an emergency when a warranted part or a warranty station is not reasonably available to the vehicle or engine owner. In an emergency, repairs may be performed at any available service establishment, or by the owner, using any replacement part. The manufacturer shall reimburse the owner for his or her expenses including diagnostic charges for such emergency repair or replacement, not to exceed the manufacturer's suggested retail price for all warranted parts replaced and labor charges based on the manufacturer's recommended time allowance for the warranty repair and the geographically appropriate hourly labor rate. A vehicle or engine owner may reasonably be required to keep receipts and failed parts in order to receive compensation for warranted repairs reimbursable due to an emergency, provided the manufacturer's written instructions required by section (e) advise the owner of this obligation.

(5) Notwithstanding the provisions of subsection (d)(4) above, warranty services or repairs shall be provided at all of a manufacturer's dealerships which are franchised to service the subject vehicles or engines.

(6) The vehicle or engine owner shall not be charged for diagnostic labor which leads to the determination that a warranted part is ~~in fact~~ defective, provided that such diagnostic work is performed at a warranty station.

(7) The vehicle or engine manufacturer shall be liable for damages to other vehicle components proximately caused by a failure under warranty of any warranted part.

(8) Throughout the vehicle or engine's warranty period defined in ~~sub~~section (b)(2) ~~or~~ and (b)(3), the vehicle or engine manufacturer shall maintain a supply of warranted parts sufficient to meet the expected demand for such parts. The lack of availability of such parts or the incompleteness of repairs within a reasonable time period, not to exceed 30 days from the time the vehicle or engine is initially presented to the warranty station for repair, shall constitute an emergency for purposes of ~~sub~~section (d)(4) above.

(9) Any replacement part may be used in the performance of any maintenance or repairs. Any replacement part designated by a manufacturer may be used in warranty repairs provided without charge to the vehicle owner. Such use shall not reduce the warranty obligations of the vehicle or engine manufacturer, except that the vehicle or engine manufacturer shall not be liable under this article for repair or replacement of any replacement part which is not a warranted part (except as provided under ~~sub~~section (d)(7) above).

(10) Any add-on or modified part exempted by the Air Resources Board from the prohibitions of Vehicle Code section 27156 may be used on a vehicle or engine. Such use, in and of itself, shall not be grounds for disallowing a warranty claim made in accordance with this article. The vehicle or engine manufacturer shall not be liable under this article to warrant failures of warranted parts caused by the use of such an add-on or modified part.

(11) The Executive Officer may request and, in such case, the vehicle or engine manufacture shall provide, any documents which describe ~~that~~ the manufacturer's warranty procedures or policies.

(e) Each manufacturer shall furnish with each new vehicle or engine, written instructions for the maintenance and use of the vehicle or engine by the owner~~, which~~ and the instructions shall be consistent with this article and applicable regulations in article 2 of this subchapter.

(f) Each manufacturer shall furnish with each new vehicle or engine a list of the "high-priced" warranted parts established by ~~sub~~section (c).

(g) Prior to the 2001 model year, each manufacturer shall submit the documents required by ~~sub~~sections (c)(~~3~~5), (e), and (f) with the manufacturer's preliminary application for new ~~-~~vehicle or engine certification for approval by the Executive Officer. For 2001 and subsequent model years, each manufacturer shall submit the documents required by ~~sub~~section ~~2037~~(c)(5~~3~~), (e), and (f) with the Part 2 Application for Certification pursuant to the "California Exhaust Emission Standards and Test Procedures for 2001 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles," incorporated by reference in title 13, CCR ~~sub~~section 1961(d). The Executive Officer may reject or require modification ~~of the manufacturer's list of "high-priced" warranted parts to ensure that each such list includes all emission-related parts whose replacement cost exceeds the cost limit defined in subsection (c)(1) and also may reject or require modification~~ of any of the documents required by ~~sub~~sections (c), (e), and (f) for, among other reasons, incompleteness and lack of clarity. Approval by the Executive Officer of the documents required by ~~sub~~sections (c), (e), and (f) shall be a condition of certification. The Executive Officer shall approve or disapprove the documents required by ~~sub~~sections (c), (e), and (f) within 90 days of the date such documents are received from the manufacturer. Any disapproval shall be accompanied by a statement of the reasons thereof. In the event of disapproval, the manufacturer may petition the Board to review the decision of the Executive Officer.

(h) Vehicle Inspection Program.

(1) This ~~sub~~section applies to 1990 and subsequent model passenger cars, light-duty trucks, and medium-duty vehicles which fail to pass a smog check inspection ~~test~~ pursuant to Health and Safety Code section 44012 after ~~a~~ the warranty period of ~~use of~~ three years or~~f~~ 50,000 miles, whichever occurs first, has expired, but before ~~a~~ the warranty period ~~of use~~ of seven years or 70,000 miles, whichever occurs first, has expired. The provisions of this section shall be contained in the warranty statement required pursuant to title 13, CCR section 2039.

(2) The owner of a vehicle which fails ~~in the~~ an inspection during the period described in ~~sub~~section (h)(1) may choose to have the vehicle repaired at a warranty station.

(A) If the warranty station identifies that the ~~smog check~~ inspection failure was caused by the failure or malfunction of a "high-priced" part defined in ~~sub~~section (c), then the vehicle manufacturer shall be liable for expenses involved in detecting and correcting the part failure or malfunction, unless the warranty station demonstrates that the part failure or malfunction was caused by abuse, neglect, or improper maintenance as specified in ~~sub~~section (i).

(B) If the warranty station demonstrates that the ~~smog check~~ inspection failure was caused by one or more conditions excluded from warranty coverage pursuant to ~~sub~~section (i), the vehicle owner shall be liable for all diagnostic and repair expenses. Such expenses shall not exceed the maximum repair costs permissible under the inspection program.

(C) If the warranty station determines that the ~~smog check~~ inspection failure was caused by one or more defects covered under warranty pursuant to these regulations and in combination with one or more conditions excluded from warranty coverage pursuant to ~~sub~~section (i), then the vehicle owner shall not be charged for the diagnostic and repair costs related to detecting and repairing the warrantable defects.

(3) In the alternative, the owner of a vehicle which fails the ~~smog check~~ inspection may choose to have the vehicle repaired at other than a warranty station. If a warrantable defect is found, the vehicle owner may deliver the vehicle to a warranty station and have the defect corrected free of charge. The vehicle manufacturer shall not be liable for any expenses incurred at a service establishment not authorized to perform warranty repairs, except in the case of an emergency as ~~specified~~ defined in ~~sub~~section (d)(4). If the vehicle owner chooses to have ~~the~~ a warrantable defect repaired at other than a warranty station, the upper cost limit pursuant to Health and Safety Code section 44017 shall not apply to the repair.

(i) Exclusions.

The repair or replacement of any warranted part otherwise eligible for warranty coverage under ~~sub~~sections (d) and (h)~~,~~ shall be excluded from such warranty coverage if the vehicle or engine manufacturer demonstrates that the vehicle or engine has been abused, neglected, or improperly maintained, and that such abuse, neglect, or improper maintenance was the direct cause of the need for the repair or replacement of the part.

NOTE

Authority cited: Sections 39600 and 39601, Health and Safety Code. Reference: Sections 43106, 43204, 43205, 44004, 44010, 44011, 44012, 44015, and 44017, Health and Safety Code.

HISTORY

1. New section filed 1-16-79; effective thirtieth day thereafter (Register 79, No. 3).
2. Amendment filed 11-26-90; operative 12-26-90 (Register 91, No. 3).
3. Amendment of section heading, subsection (g) and NOTE filed 10-28-99; operative 11-27-99 (Register 99, No. 44).

§2038. Performance Warranty Requirements for 1990 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles, and Motor Vehicle Engines Used in Such Vehicles.

(a) Applicability.
This section shall apply to 1990 and subsequent model passenger cars, light-duty trucks, and medium-duty vehicles, and motor vehicle engines used in such vehicles required to be inspected under any California statutorily authorized motor vehicle emissions inspection and maintenance program. The warranty period shall begin on the date the vehicle is delivered to an ultimate purchaser, or if the vehicle is first placed in service as a "demonstrator" or "company" car prior to delivery, on the date it is first placed in service.

(b) General Emissions Warranty Coverage.
The manufacturer of each passenger car, light-duty truck, and medium-duty vehicle shall warrant to the ultimate purchaser and each subsequent purchaser that the vehicle or engine:

(1) Is designed, built, and equipped so as to conform with all applicable regulations adopted by the Air Resources Board pursuant to its authority in chapters 1 and 2, part 5, division 26 of the Health and Safety Code; and

(2) Will, for a period of three years or 50,000 miles, whichever first occurs, pass an inspection ~~test~~ established under section 44012 of the Health and Safety Code ("inspection").

(c) ~~Proper Use and Maintenance~~Written Instructions.

(1) Each vehicle or engine manufacturer shall furnish with each new vehicle or engine, written instructions for the required maintenance and use of this vehicle or engine by the vehicle owner (written instructions)~~, which~~ and the written instructions shall be consistent with this article and applicable regulations in article 2 of this subchapter.

(2) Prior to the 2001 model year, each vehicle or engine manufacturer shall submit the documents required by section (c)(1) with the vehicle or engine manufacturer's preliminary application for new vehicle or engine certification for approval by the Executive Officer.

(3) For 2001 and subsequent model years, each vehicle or engine manufacturer shall submit the documents required by section (c)(1) with the Part 2 Application for Certification pursuant to the "California Exhaust Emission Standards and Test Procedures for 2001 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles," incorporated by reference in title 13, CCR section 1961(d).

(4) The Executive Officer may reject or require modification of written instructions for, among other reasons, incompleteness or lack of clarity. Approval by the Executive Officer of the written instructions shall be a condition of certification. The Executive Officer shall approve or disapprove the written instructions within 90 days of the date such documents are received from the vehicle or engine manufacturer. Any disapproval shall be accompanied by a statement of the

reasons therefore. In the event of disapproval, the engine or vehicle manufacturer may petition the Board to review the decision of the Executive Officer.

(d) Proper Use and Maintenance

(2)(1) An emission performance warranty claim may be denied if the vehicle or engine manufacturer demonstrates that the vehicle or engine's failure of the test inspection established under 44012 of the Health and Safety Code was directly caused by abuse, neglect, or improper maintenance as reflected by a failure to maintain or use the vehicle or engine in accordance with the written instructions for the required maintenance and use of the vehicle or engine furnished in conformance with subsection (1) above.

(3)(2) Except as provided in subsection (d)(65), a vehicle or engine manufacturer may deny an emission performance warranty claim on the basis of noncompliance with the written instructions for required maintenance and use only if:

(A) An owner is not able to comply with a request by a manufacturer for evidence pursuant to subsection (d)(54); or

(B) Notwithstanding the evidence presented pursuant to subsection (d)(54), the vehicle or engine manufacturer is able to prove that the vehicle failed an emission test established under section 44012 of the Health and Safety Code inspection because the vehicle was abused, or the required maintenance and use was performed in a manner resulting in a component's being improperly installed or a component or related parameter's being adjusted substantially outside of the vehicle or engine manufacturer's specifications, or maintenance was performed on a vehicle which resulted in the removing or rendering inoperative of any component affecting the vehicle's emissions.

(4)(3) When determining whether an owner has complied with the written instructions for required maintenance and use, a vehicle or engine manufacturer may require a owner to submit evidence of compliance only with those written instructions for which the vehicle or engine manufacturer has an objective reason for believing:

(A) Were not performed, and;

(B) If not performed, could be the cause of the particular vehicle's exceeding applicable emission standardsfailed inspection.

(5)(4) Evidence of compliance with a maintenance instruction may consist of:

(A) A maintenance log book which has been validated at the approximate time or mileage intervals specified in the written instructions for service by someone who regularly engages in the business of servicing automobiles for the relevant maintenance instruction(s); or

(B) A repair order, sales receipt, or similar evidence showing that the vehicle has been submitted for scheduled maintenance servicing at the approximate time or mileage intervals specified in the written instructionsfor service to someone who regularly engages in the business of servicing automobiles for the purpose of performing the relevant maintenance; or

(C) A statement by the vehicle owner that the maintenance was performed at the approximate time or mileage interval specified in the written instructions using proper replacement parts.

~~(6)~~(5) In no case may a vehicle or engine manufacturer deny an emission performance warranty claim on the basis of:

(A) Warranty work or predelivery service performed by any facility authorized by the vehicle or engine manufacturer to perform such work or service; or

(B) Work performed in an emergency situation to rectify an unsafe condition, including an unsafe driveability condition, attributable to the vehicle or engine manufacturer, provided the vehicle owner has taken steps to put the vehicle back in a conforming condition in a timely manner; or

(C) Any cause attributable to the vehicle or engine manufacturer; or

(D) The use of any fuel which is commonly available in the geographical area in which the vehicle or engine is located, unless the written instructions ~~for required maintenance and use~~ specify that the use of that fuel would adversely affect the emission control devices and systems of the vehicle, and there is commonly available information for the vehicle owner to identify the proper fuel to be used.

~~(7)~~(6) The vehicle owner may perform maintenance or have maintenance performed more frequently than required in the ~~maintenance~~ written instructions.

~~(8)~~(7) Except as specified in ~~sub~~section (d)(~~3~~2)(B) above, failure of the vehicle or engine owner to ensure the performance of such scheduled maintenance or to keep maintenance records shall not, per se, be grounds for disallowing a warranty claim.

~~(d)~~(e) Repair, adjustment, or replacement of any part under the warranty provisions of this article shall be performed at no charge to the vehicle or engine owner at a warranty station, except where a warranted part is not available to the vehicle or engine owner within a reasonable time (in no case more than 30 days) after the vehicle or engine is initially presented to the warranty station for repair. In case of such unavailability, repairs may be performed at any available service establishment, or by the owner, using any replacement part. The manufacturer shall reimburse the owner for his or her expenses including diagnostic charges for such repair or replacement, not to exceed the manufacturer's suggested retail price for all warranted parts replaced and labor charges based on the manufacturer's recommended time allowance for the warranty repair and the geographically appropriate hourly labor rate. A vehicle or engine owner may reasonably be required to keep receipts and failed parts in order to receive ~~compensation for warranted reprise~~ reimbursement~~able~~ due to such unavailability, provided the manufacturer's written instructions advise the owner of this obligation.

~~(e)~~(f) The vehicle or engine manufacturer shall be liable for damages to other vehicle components proximately caused by a failure under warranty of any warranted part.

~~(f)~~(g) Any replacement part may be used in the performance of any maintenance or repairs. Any replacement part designated by a vehicle or engine manufacturer may be used in warranty repairs provided without charge to the vehicle owner. Such use shall not reduce the warranty obligations of the vehicle or engine manufacturer, except that the vehicle or engine manufacturer shall not be liable under this article for repair or replacement of any replacement part which is not a warranted part (except as provided under ~~sub~~section (~~e~~d) above).

~~(g)~~(h) Any add-on or modified part exempted by the Air Resources Board from the prohibitions of Vehicle Code section 27156 may be used on a vehicle or engine. Such use, in and of itself, shall not be grounds for disallowing a warranty claim made in accordance with this article. The vehicle or engine manufacturer shall not be liable under this article to warrant failures of warranted parts caused by the use of such an add-on or modified part.

~~(h)~~(i) Warranty Claim Procedures.

(1) A warranty claim may be submitted by bringing a vehicle to any repair facility authorized by the vehicle or engine manufacturer to service that ~~model~~ vehicle.

(2) The manufacturer of each vehicle or engine to which the warranty is applicable shall establish procedures as to the manner in which a claim under the emission performance warranty is to be processed. The procedures shall provide for a final decision and repair of a warrantable condition by the vehicle or engine manufacturer within a reasonable time, not to exceed 30 days from the time at which the vehicle is initially presented for repair, or unless a delay:

(A) is requested by the vehicle owner, or

(B) is caused by an event not attributable to the vehicle or engine manufacturer or the warranty station.

(3) Within the time period specified in ~~sub~~section (i)(2), the manufacturer shall provide the owner, in writing, with an explanation as to why the claim is being denied.~~:~~

~~(A)Notify the owner, in writing, an explanation why the claim is being denied.~~

(4) Failure to notify a~~n~~ vehicle owner that a warrantable condition does not exist within the required time period ~~(under~~ of ~~sub~~section (i)(2)~~-above)~~, for reasons ~~that are not attributable to the vehicle owner or events which are not beyond the control of the vehicle manufacturer or the warranty station~~other than those provided for in sections (i)(2)(A) and (B), shall result in the vehicle or engine manufacturer being responsible for repairing the vehicle free of charge to the vehicle owner.

(5) The vehicle or engine manufacturer shall incur all costs associated with a determination that an emission performance warranty claim is valid.

~~(i)~~(j) Warranty services or repairs shall be provided at all of a vehicle or engine manufacturer's dealerships which are franchised to service the subject vehicles or engines.

~~(j)~~(k) The vehicle ~~or engine~~ owner shall not be charged for diagnostic labor which leads to the determination of a warrantable condition provided that such diagnostic work is performed at a warranty station.

~~(k)~~(l) Throughout the vehicle or engine's warranty period defined in ~~sub~~section (b), the vehicle or engine manufacturer shall maintain a supply of warranted parts sufficient to meet the expected demand for such parts. The lack of availability of such parts or the incompleteness of the repairs within a reasonable time period, not to exceed 30 days from the time the vehicle or engine is initially presented to the warranty station for repair, shall constitute an unavailability of parts for purposes of ~~sub~~section (~~d~~e).

~~(l)~~(m) The Executive Officer may request and, in such case, the vehicle or engine manufacturer shall provide, any documents which describe ~~that~~ the vehicle or engine manufacturer's warranty procedures or policies.

~~(m)Prior to the 2001 model year, each manufacturer shall submit the documents required by subsection (c)(1) with the manufacturer's preliminary application for new vehicle or engine certification for approval by the Executive Officer. For 2001 and subsequent model years, each manufacturer shall submit the documents required by subsection (c)(1) with the Part 2 Application for Certification pursuant to the "California Exhaust Emission Standards and Test Procedures for 2001 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles," incorporated by reference in section 1961(d). The Executive Officer may reject or require modification of the documents required by subsection (c)(1). Approval by the Executive Officer of the documents required by subsection (c)(1) shall be a condition of certification. The Executive Officer shall approve or disapprove the documents required by subsection (c)(1) within 90 days of the date such documents are received from the manufacturer. Any disapproval shall be accompanied by a statement of the reasons therefore. In the event of disapproval, the manufacturer may petition the Board to review the decision of the Executive Officer.~~

NOTE

Authority cited: Sections 39600 and 39601, Health and Safety Code. Reference: Sections 43106, 43204, 43205, 44004, 44010, 44011, 44012, 44014, and 44015, Health and Safety Code.

HISTORY

1. New section filed 1-16-79; effective thirtieth day thereafter (Register 79, No. 3).
2. Amendment filed 11-26-90; operative 12-26-90 (Register 91, No. 3).
3. Amendment of subsection (m) filed 10-28-99; operative 11-27-99 (Register 99, No. 44).

TITLE 13. CALIFORNIA AIR RESOURCES BOARD

NOTICE OF PUBLIC HEARING TO CONSIDER ADOPTION OF CALIFORNIA'S HEAVY-DUTY DIESEL IN-USE COMPLIANCE REGULATION

The Air Resources Board (the Board or ARB) will conduct a public hearing at the time and place noted below to consider adoption of amendments to California's heavy-duty diesel engine (HDDE) regulations and test procedures. The proposed amendments would create an in-use compliance program for HDDEs conducted by the engine manufacturers. The proposed program is essentially identical to that of the United States Environmental Protection Agency (U.S. EPA).

DATE: September 28, 2006

TIME: 9:00 a.m.

PLACE: California Environmental Protection Agency
Air Resources Board
Byron Sher Auditorium
1001 I Street
Sacramento, CA 95814

This item will be considered at a two-day meeting of the Board, which will commence at 9:00 a.m., September 28, 2006, and may continue at 8:30 a.m., September 29, 2006. This item may not be considered until September 29, 2006. Please consult the agenda for the meeting, which will be available at least 10 days before September 28, 2006, to determine the day on which this item will be considered.

For individuals with sensory disabilities, this document is available in Braille, large print, audiocassette or computer disk. Please contact ARB's Disability Coordinator at 916-323-4916 by voice or through the California Relay Services at 711, to place your request for disability services. If you are a person with limited English and would like to request interpreter services, please contact ARB's Bilingual Manager at 916-323-7053.

INFORMATIVE DIGEST OF PROPOSED ACTION AND POLICY STATEMENT OVERVIEW

Sections Affected: Proposed amendments to title 13, California Code of Regulations (CCR), sections 1956.1 and 1956.8, and the following documents incorporated by reference therein: "California Exhaust Emission Standards and Test Procedures for 2004 and Subsequent Model Heavy-Duty Diesel Engines and Vehicles," as last amended July 24, 2003, and "California Exhaust Emission Standards and Test Procedures for 2004 and Subsequent Model Heavy-Duty Otto-Cycle Engines and Vehicles," as last amended December 12, 2002.

Background: Health and Safety Code section 43104 directs ARB to adopt test procedures to ensure compliance with emission standards for new heavy-duty motor vehicles. Test procedures for in-use compliance of emission standards are contained in title 13, California Code of Regulations, sections 2111-2140. According to these procedures, for HDDEs, a minimum of ten engines must be emission-tested on a stationary engine dynamometer, and the emission results are then compared to the applicable emission standards to determine compliance. Conducting in-use testing with a stationary engine dynamometer is both time-consuming and expensive because it requires that engines be removed from the vehicles to be tested and then reinstalled once testing has been completed. As a result, ARB has not utilized these test procedures to conduct compliance testing for HDDEs. The proposed amendments would streamline in-use compliance testing of HDDEs in California by making California's testing requirements consistent with more flexible federal requirements.

In the 1990s, seven of the largest engine manufacturers were alleged to have violated state and federal emissions laws by disabling emission control devices on HDDEs during in-use, on-highway driving. These cases were resolved through enforcement actions which were concluded when settlement agreements were reached with the manufacturers in question. To ensure that exhaust emissions were controlled under virtually all driving conditions, most of the settling manufacturers were required to produce engines that comply with supplemental certification test procedures known as the Not-To-Exceed (NTE) test and the EURO III European Stationary Cycle (ESC) test. However, these supplemental test procedure requirements imposed by the settlement agreements expired on January 1, 2005. To ensure that HDDEs continued to be certified to the supplemental procedures, in December 2000, ARB adopted the NTE and ESC tests as part of the HDDE regulations, applicable to all 2005 and subsequent model year engines.

The NTE test procedure allows testing on an engine dynamometer, a chassis dynamometer in laboratory conditions, or with on-board portable emission measurement systems (PEMS) during on-road operation. This means that engines certified to the NTE requirements can be tested in-use and in the vehicle using PEMS, avoiding the high costs associated with engine removal and dynamometer testing.

Beginning in 2001, ARB staff started working collaboratively with U.S.EPA and engine manufacturers to develop an in-use testing and compliance program based on performing the NTE test with PEMS. In May 2003, the general structure of such a program was developed and agreed-upon by all parties. Based upon this collaborative work, in June 2005, the U.S. EPA adopted a manufacturer-run in-use testing program, which all manufacturers of HDDEs sold elsewhere in the United States must comply with. The proposed amendments would make California requirements consistent with the federal requirements in this area.

Proposed Action: The proposed amendments would implement a manufacturer-run in-use compliance program for HDDEs. In this proposed program, PEMS would be utilized to conduct on-road, in-use emission testing of heavy-duty diesel vehicles. Emission results from PEMS would be used to determine compliance with the NTE emission limits within the engines' useful lives. The proposed program would start in 2007 for gaseous emissions and in 2008 for particulate matter emissions. In order to be familiarized with in-use testing of HDDEs with PEMS and NTE data collection, engine manufacturers initiated a pilot HDDE testing program which began in 2005 and will continue until the start of the enforceable compliance program, if it is adopted by the Board.

Under the proposed amendments, each year, ARB and U.S. EPA would jointly designate up to 25 percent of a manufacturer's total number of HDDE families for testing. The engine families selected for testing could include any 2007 and later model year medium-duty diesel engine and HDDE used in vehicles with gross vehicle weight ratings above 8,500 pounds. Manufacturers would screen, procure and test vehicles that use the designated engines. The vehicles would be tested under real-world driving conditions, within the engines' useful lives. ARB personnel would have the right to be present during PEMS installation and on-road testing. Pollutants that would be measured to determine compliance are: oxides of nitrogen, particulate matter, non-methane hydrocarbon, and carbon monoxide.

The proposed test program would have two phases. The first phase of testing, Phase 1, is intended to screen a designated engine family for conformity with the applicable NTE emission limits. Under Phase 1, the manufacturer would test a minimum of 5 and a maximum of 10 vehicles per engine family during normal over-the-road vehicle operation. If the engine family does not pass the Phase I requirements, then Phase 2 testing may be required. In Phase 2, ten additional vehicles are tested under more narrowly-defined test conditions to specifically target non-complying operating conditions. Failure of the Phase 1 or Phase 2 requirements may result in ARB requiring some form of remedial action. In determining whether to pursue remedial action following Phase 1 or Phase 2 testing, ARB would consider other test data obtained separately by staff or submitted by the manufacturer.

Since the proposed NTE testing would be conducted on-road instead of in an environmentally-controlled laboratory as manufacturers must do to obtain certification of new motor vehicle engine families to ARB's emission standards, an "accuracy margin" is proposed to be incorporated in the NTE testing to account for potential differences in emission measurements between the laboratory equipment and PEMS. In 2005, a Memorandum of Agreement was signed between ARB, U.S. EPA, and the engine manufacturers to establish a test program for determining measurement accuracy margins to be used in the proposed amendments. The test program is currently on-going. In the meantime, the proposed amendments contain interim accuracy margins that have been agreed upon by the same parties. Once the final accuracy margins are determined, they will be presented to the Board for adoption in a subsequent rulemaking.

COMPARABLE FEDERAL REGULATIONS

On June 14, 2005, U.S. EPA adopted a manufacturer-run in-use testing and compliance program. The details of the federal program were based on the collaborative efforts between ARB, U.S. EPA, and the engine manufacturers. The proposed amendments are essentially identical to the U.S. EPA's program.

AVAILABILITY OF DOCUMENTS AND AGENCY CONTACT PERSONS

The Board staff has prepared a Staff Report: Initial Statement of Reasons (ISOR) for the proposed regulatory action, which includes a summary of the environmental and economic impacts of the proposal. The report is entitled: "Staff Report: Initial Statement of Reasons for the Proposed Rulemaking – Public Hearing to Adopt California's Heavy-Duty Diesel In-Use Compliance Regulation."

Copies of the ISOR and the full text of the proposed regulatory language, in underline and strikeout format to allow for comparison with the existing regulations, may be accessed on the ARB's web site listed below, or may be obtained from the Public Information Office, Air Resources Board, 1001 I Street, Visitors and Environmental Services Center, 1st Floor, Sacramento, CA 95814, (916) 322-2990 at least 45 days prior to the scheduled hearing on September 28, 2006.

Upon its completion, the Final Statement of Reasons (FSOR) will be available and copies may be requested from the agency contact persons in this notice, or may be accessed on the ARB's web site listed below.

Inquiries concerning the substance of the proposed regulation may be directed to the designated agency contact persons: Mr. Stephan Lemieux, Manager, On-Road Heavy Duty Diesel Section, at (626) 450-6162 or slemieux@arb.ca.gov, or Mr. Dipak Bishnu, Air Resources Engineer, On-Road Heavy Duty Diesel Section, at (626) 575-6696 or dbishnu@arb.ca.gov .

Further, the agency representative and designated back-up contact persons to whom non-substantive inquiries concerning the proposed administrative action may be directed are Artavia Edwards, Manager, Board Administration & Regulatory Coordination Unit, (916) 322-6070, or Alexa Malik, Regulations Coordinator, (916) 322-4011. The Board has compiled a record for this rulemaking action, which includes all the information upon which the proposal is based. This material is available for inspection upon request to the contact persons.

This notice, the ISOR and all subsequent regulatory documents, including the FSOR, when completed, are available on the ARB Internet site for this rulemaking at www.arb.ca.gov/regact/inuse06/inuse06.htm

COSTS TO PUBLIC AGENCIES AND TO BUSINESSES AND PERSONS AFFECTED

The determinations of the Board's Executive Officer concerning the costs or savings necessarily incurred by public agencies, private persons and businesses in reasonable compliance with the proposed regulations are presented below.

Pursuant to Government Code sections 11346.5(a)(5) and 11346.5(a)(6), the Executive Officer has determined that the proposed regulatory action will not create costs or savings to any state agency or in federal funding to the state, costs or mandate to any local agency or school district whether or not reimbursable by the state pursuant to part 7 (commencing with section 17500), division 4, title 2 of the Government Code, or other nondiscretionary cost or savings to state or local agencies. The proposed amendments affect manufacturers of HDDEs, not state or local agencies.

In developing this regulatory proposal, the ARB staff evaluated the potential economic impacts on representative private persons or businesses. The ARB is not aware of any cost impacts that a representative private person or business would necessarily incur in reasonable compliance with the proposed action. The proposed amendment would make California requirements for in-use testing of HDDEs consistent with federal requirements. Inasmuch as the proposed amendments could be said to have economic impacts, these impacts are expected to be slight and absorbable by the manufacturers of HDDEs. Any impacts on the manufacturers of PEMs are expected to be positive.

The Executive Officer has made an initial determination that the proposed regulatory action will not have a significant statewide adverse economic impact directly affecting businesses, including the ability of California businesses to compete with businesses in other states, or on representative private persons. Any cost impacts are expected to be slight and absorbable by the businesses affected. The amendments would apply to all manufacturers of HDDEs and make California requirements consistent with federal law. None of the manufacturers of HDDEs is located in California. There may be a slight positive economic impact on the manufacturer of PEMS that is located in California.

In accordance with Government Code section 11346.3, the Executive Officer has determined that the proposed regulatory action will not affect the creation or elimination of jobs within the State of California, the creation of new businesses or elimination of existing businesses within the State of California, or the expansion of businesses currently doing business within the State of California. Any impact on businesses in California is expected to be slight and positive. A detailed assessment of the economic impacts of the proposed regulatory action can be found in the ISOR.

The Executive Officer has also determined, pursuant to title 1, CCR, section 4, that the proposed regulatory action will not affect small businesses. There will be no incremental costs associated with staff's proposal in addition to those already needed to comply with the federal regulation. Any impact on businesses in California is expected to be slight and positive.

In accordance with Government Code sections 11346.3(c) and 11346.5(a)(11), the Executive Officer has found that the reporting requirements of the regulation which apply to businesses are necessary for the health, safety, and welfare of the people of the State of California.

Before taking final action on the proposed regulatory action, the Board must determine that no reasonable alternative considered by the board or that has otherwise been identified and brought to the attention of the board would be more effective in carrying out the purpose for which the action is proposed or would be as effective and less burdensome to affected private persons than the proposed action.

SUBMITTAL OF COMMENTS

The public may present comments relating to this matter orally or in writing at the Hearing, and in writing or by e-mail before the hearing. To be considered by the Board, written submissions not physically submitted at the hearing must be received **no later than 12:00 noon, September 27, 2006**, and addressed to the following:

Postal mail: Clerk of the Board, Air Resources Board
1001 I Street, Sacramento, California 95814

Electronic submittal : http://www.arb.ca.gov/lispub/comm/bclist.php

Facsimile submittal: (916) 322-3928

The Board requests but does not require that 30 copies of any written statement be submitted and that all written statements be filed at least 10 days prior to the hearing so that ARB staff and Board Members have time to fully consider each comment. The board encourages members of the public to bring to the attention of staff in advance of the hearing any suggestions for modification of the proposed regulatory action.

STATUTORY AUTHORITY AND REFERENCES

This regulatory action is proposed under that authority granted in Health and Safety Code, sections 39600, 39601, 43013, 43018, 43100, 43101, 43104, 43105, and 43806; and Vehicle Code section 28114. This action is proposed to implement, interpret and make specific Health and Safety Code sections 39002, 39003, 39500, 43000, 43013, 43018, 43100, 43101, 43102, 43104, 43106, 43202, 43204, 43206, 43210, 43211, 43212, 43213, and 43806; and Vehicle Code section 28114.

HEARING PROCEDURES

The public hearing will be conducted in accordance with the California Administrative Procedure Act, title 2, division 3, part 1, chapter 3.5 (commencing with section 11340) of the Government Code.

Following the public hearing, the Board may adopt the regulatory language as originally proposed, or with non substantial or grammatical modifications. The Board may also adopt the proposed regulatory language with other modifications if the text as modified is sufficiently related to the originally proposed text that the public was adequately placed on notice that the regulatory language as modified could result from the proposed regulatory action; in such event the full regulatory text, with the modifications clearly indicated, will be made available to the public, for written comment, at least 15 days before it is adopted.

The public may request a copy of the modified regulatory text from the ARB's Public Information Office, Air Resources Board, 1001 I Street, Visitors and Environmental Services Center, 1st Floor, Sacramento, CA 95814, (916) 322-2990.

CALIFORNIA AIR RESOURCES BOARD

Catherine Witherspoon
Executive Officer

Date: 7/31/06

The energy challenge facing California is real. Every Californian needs to take immediate action to reduce energy consumption. For a list of simple ways you can reduce demand and cut your energy costs see our Web –site at www.arb.ca.gov.

California Environmental Protection Agency

Air Resources Board

STAFF REPORT: INITIAL STATEMENT OF REASONS

PUBLIC HEARING TO ADOPT CALIFORNIA'S HEAVY-DUTY DIESEL IN-USE COMPLIANCE REGULATION

Date of Release: August 11, 2006
Scheduled for Consideration: September 28, 2006

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

In the 1990s, seven of the largest heavy-duty diesel engine (HDDE) manufacturers (herein referred to as the "settling manufacturers") were alleged to have violated state and federal emission laws by disabling emission control devices on HDDEs during in-use, on highway driving. These cases were resolved through enforcement actions which were concluded when settlement agreements were reached with the settling manufacturers.

In these settlement agreements, the settling manufacturers were required, among other things, to produce HDDEs meeting the 2004 standards earlier, no later than October 1, 2002. It was also determined that the certification test procedure, the Federal Test Procedure, was not comprehensive enough to ensure that exhaust emissions were controlled under all driving conditions. Thus, the majority of these settling manufacturers were also required to produce engines that comply with supplemental test procedures, including the Not-To-Exceed (NTE) requirements and the EURO III European Stationary Cycle (ESC) test. However, the supplemental test procedures, under the Settlement agreement, sunsetted on January 1, 2005.

Existing Regulations

In December 2000, the ARB adopted the NTE and ESC supplemental test procedures as part of the HDDE regulations, applicable to HDDEs produced on or after January 1, 2005. In October 2001, the ARB adopted more stringent emission standards and made minor modifications to the supplemental test procedures for 2007 and subsequent model year HDDEs, aligning the California and federal HDDE emission requirements. The 2007 emission standards represent a 90% reduction of oxides of nitrogen (NOx), 72% reduction of non-methane hydrocarbons (NMHC), and 90% reduction of particulate matter (PM) emissions compared to the 2004 emission standards.

Currently, the California Code of Regulations, title 13, sections 2111-2140, grants ARB the authority to conduct in-use compliance testing of HDDEs to ensure compliance with the applicable emission standards throughout their useful life. According to the existing in-use compliance testing procedures, a minimum of ten engines must be tested on an engine dynamometer. To show compliance, the testing must satisfy two criteria: (a) the engine family must meet the engine certification emission standards based on the average emissions of the ten engines tested, and (b) no more than two defects of the same emission related component can occur. The existing procedures require that trucks be taken out of service, have their engines removed, and then be installed on an engine dynamometer. It is a time consuming and costly process (roughly costing $250,000 per engine family). Primarily for this reason, ARB has not conducted any in-use compliance testing on HDDEs.

Proposed Regulation
The proposed regulation would implement a manufacturer-run in-use compliance program for HDDEs, based on an agreement among ARB, U.S. EPA, and engine manufacturers in May 2003 (ARB, U.S. EPA, EMA, 2003). Specifically, the engine manufacturers would be responsible for screening, procuring and testing heavy-duty diesel vehicles. Portable emission measurement systems (PEMS) would be utilized to conduct over-the-road emission measurement testing of HDDEs. The proposed program would assess NTE compliance of 2007 and newer HDDEs in-use, and would help ensure overall compliance with the 2007 emission standards throughout the engine's useful life. Currently, a non-enforceable pilot program is being conducted to gain experience with in-use NTE testing utilizing PEMS. Starting in 2007, a federal enforcement program for gaseous emissions will begin, followed by an enforcement program for PM in 2008. The federal program is essentially identical to staff's proposal.

The proposed program would apply to all 2007 and subsequent model year engine dynamometer certified diesel engines to be installed in vehicles with gross vehicle weight ratings greater than 8,500 pounds. Each year, ARB and U.S. EPA would designate for testing up to 25% of a manufacturer's total number of medium- and heavy-duty diesel engine families, combined. The proposed test program has two phases. The first phase, Phase 1, would involve testing a designated engine family for conformity with the applicable NTE requirements. If the engine family does not pass the Phase 1 requirements, then Phase 2 testing, under more narrowly defined test conditions, may be required. Emissions that would be measured for compliance are: NOx, NMHC, carbon monoxide (CO), and PM.

Compliance Determination
To show compliance with the proposed requirements, 90 percent of the average emissions of all time-weighted NTE sampling events must be below the NTE threshold for each pollutant. The NTE threshold is comprised of the NTE emission limit, plus a measurement accuracy margin and an in-use compliance margin. In addition, for model years 2007 through 2009, each sampling event must not be greater than 2 times the NTE threshold, regardless of whether the 90 percent pass criteria was met. A valid NTE sampling event consists of 30 seconds or more of continuous operation in the NTE control area.

The engine manufacturer would likely be required to test between 5 and 20 vehicles per engine family, depending on whether Phase 1 only or Phase 1 and Phase 2 testing was completed, and the number of test vehicles that failed to comply. After evaluating all test data, ARB staff would determine whether that engine family meets the emission requirements for that year's testing or whether remedial action is warranted.

Reporting Requirements
The engine manufacturers would report test data and other relevant in-use test information, with a comprehensive report using a standardized, electronic reporting format on a quarterly basis, no later than 30 days after the quarter ends. The report

must include all measured emissions test data, engine operating parameters, test conditions, test equipment specifications, vehicle and engine information.

Technological Feasibility
The success of the proposed program would depend on ensuring that the PEMS can correctly measure the exhaust emissions from heavy-duty diesel vehicles in the field. Because testing would be conducted in the field instead of an environmentally controlled laboratory environment, ARB, U.S. EPA and the engine manufacturers have agreed to determine a measurement "accuracy margin" for each pollutant to account for any potential difference in measurement accuracy. The accuracy margins are currently being determined by an independent contractor, Southwest Research Institute.

Economic Impacts to Business
The proposed regulation would affect about 13 medium- and heavy-duty engine manufacturers who certify their engines for sale in California and a few PEMS manufacturers. None of the engine manufacturers is located in California, and none is considered to be a small business. One PEMS manufacturer is located in California and is considered a small business. The proposed regulation poses no additional costs to engine manufacturers since the manufacturers are already subjected to an identical rule adopted by U.S. EPA in June 2005. The total per manufacturer cost consists of fixed and variable cost components. When combining the fixed and variable costs together, the average annual cost per manufacturer ranges from $123,884 to $163,927. The actual cost to a specific manufacturer will vary depending on how many engine families it certifies in a year, how many vehicles are tested in Phase 1 for a given engine family, whether Phase 2 testing occurs for a given engine family, and on other variables. The total cost to conduct the proposed program nationwide is estimated to range from $1.6 to $2.1 million per year for the 13 engine manufacturers. The proposed program, implemented on a nationwide basis, would potentially result in the average annual sale of $1.3 million in PEMS units, and thus provide an economic benefit to PEMS manufacturers. The proposed regulation would not adversely impact California business competitiveness, creation, elimination or expansion of jobs and businesses in California. Also, there would be no additional net costs accrued by local and state agencies as a result of the proposed regulation.

Air Quality Impacts
By enforcing emission requirements adopted for 2007 and newer HDDEs, the proposed regulation would ensure that the original emission benefits claimed through the adoption of lower emission standards are obtained. The proposed regulation would achieve benefits in two ways. First, the heavy-duty diesel vehicles would be tested in the field, and violations of the emission requirements within the regulatory useful life would be detected and remedied. The proposed program can potentially cover all engine models within a four year period (up to 25 percent tested per year).

The second mechanism is by encouraging the design of robust and durable engine and emission control systems in order to avoid failure of in-use compliance testing and to prevent potentially costly recalls or extended parts warranties. The effectiveness of in-use compliance programs in encouraging durable emission control components have been demonstrated in the light-duty vehicle program. The initial years of the light-duty in-use compliance program showed high engine family failure or defect rates. After about ten years of routine compliance testing the failure rate decreased to about ten percent or less of the total engine families tested.

I. INTRODUCTION

Despite significant improvements in California's air quality over the last forty years, more must be done to improve air quality and protect public health. California is currently in non-attainment with the federal ambient ozone and particulate matter (PM) standards over many areas throughout the state. Reductions in mobile source emissions are essential for the attainment of state and federal ozone and PM standards. Diesel engines used in heavy-duty on-road vehicles and off-road equipment are the largest source of ozone-forming nitrogen oxides (NOx), and PM emissions.

Both NOx and PM contribute to serious health problems including premature mortality, aggravation of respiratory and cardiovascular disease, aggravation of existing asthma, acute respiratory symptoms, chronic bronchitis, and decreased lung function. In addition, in 1998 the Air Resources Board (ARB) identified diesel PM as a toxic air contaminant. Compared to other air toxics, diesel PM emissions are responsible for 70% of the total ambient air toxics risk. To address this concern, in 2000 ARB adopted the "California Diesel Risk Reduction Plan." [1] This plan has an aggressive goal of reducing diesel PM levels by 75% and 85% from the 2000 baseline in 2010 and 2020, respectively. The Diesel Risk Reduction Plan has four basic strategies to accomplish these goals: (a) adoption of stringent standards for new heavy-duty diesel engines (HDDE), (b) use of low sulfur clean diesel fuels, (c) aggressive retrofitting of in-use engines with new engines, and (d) ensuring in-use performance of engines to certified standards.

In addition to the California Diesel Risk Reduction Plan, California's 2003 State and Federal Strategy for the California State Implementation Plan (2003 SIP) also outlines measures to reduce ozone forming emissions, including both NOx and reactive organic gases (ROG). One on-road heavy-duty vehicle measure contained in the 2003 SIP is measure "ON-RD HVY-DUTY-3." This measure consists of several regulatory programs such as PM In-Use Emission Control, Engine Software Upgrade, On-Board Diagnostics, Manufacturers' In-Use Compliance, and Reduced Idling. It commits to achieve between 1.4 and 4.5 tons per day (tpd) of ROG and between 8 and 11 tpd of NOx emission reductions in the South Coast Air Basin in 2010. Staff's proposal will help fulfill the fourth goal in the Diesel Risk Reduction Plan; ensuring in-use performance of HDDEs to certified standards.

The federal Clean Air Act grants California the authority to adopt and enforce rules to control mobile source emissions within California. In doing so, however, ARB is required to adopt State requirements that are as stringent, or more stringent, than the federal requirements. Currently, according to the California Code of Regulations,

---

[1] California Diesel Risk Reduction Program
http://www.arb.ca.gov/diesel/dieselrrp.htm

title 13, sections 2111-2140, the ARB has the authority to conduct in-use compliance testing of HDDEs to ensure compliance with the applicable emission standards throughout their useful life. The California Clean Air Act (CCAA), as codified in the Health and Safety Code sections 43104, also granted ARB the authority to adopt test procedures. Staff's proposal is within the authority granted under the CCAA.

II. BACKGROUND

On-road heavy-duty vehicles play an important role in both California's and the national economy. Unfortunately, they have also contributed to a significant portion of California's air pollution problems.

A. EMISSIONS CONTRIBUTION

The primary pollutants of concern from diesel engines are NOx and PM emissions. The high temperatures experienced during the diesel combustion cycle, along with excess air containing oxygen and nitrogen form NOx emissions. PM emissions can be significant under certain operating conditions, caused by incomplete fuel combustion. Lubrication oil and other additives that engines consume also contribute to PM emissions. Because of the presence of excess air (and thus oxygen), hydrocarbon (HC) and carbon monoxide (CO) emissions are relatively low. Fuel evaporative emissions from diesel engines are also relatively low due to the low evaporation rate of diesel fuel.

It is projected that in 2010, on-road HDDEs will contribute approximately 30 percent, or 582 tpd, of the total statewide mobile source NOx emission inventory[2] (see Figure 1). About 20 percent, or 12 tpd, of the projected 2010 statewide diesel PM inventory will be produced by on-road HDDEs (see Figure 2). Note that NOx and PM control for the majority of new off-road diesel engines will be fully implemented by 2015. Measures to clean up existing off-road equipment are under development and slated for Board Consideration around December 2006.

[2] Emission Inventory Data-Almanac Emission Projection Data (Published in 2005) http://www.arb.ca.gov/ei/emsmain/reportform.htm

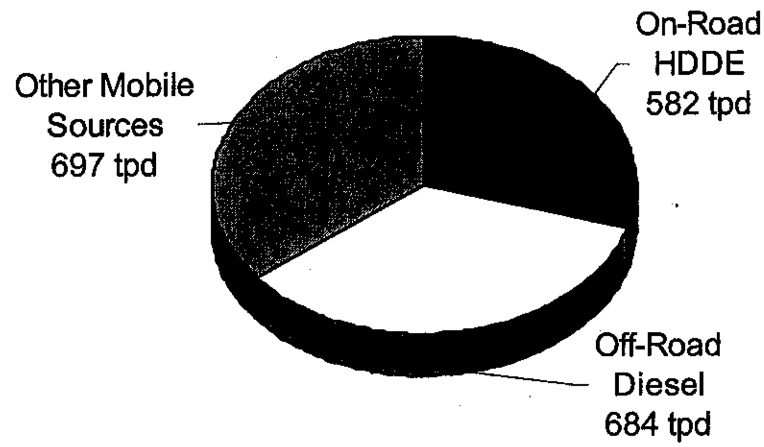


Figure 1 - 2010 Statewide Mobile Source NOx Emission Inventory ~ 1963 tpd

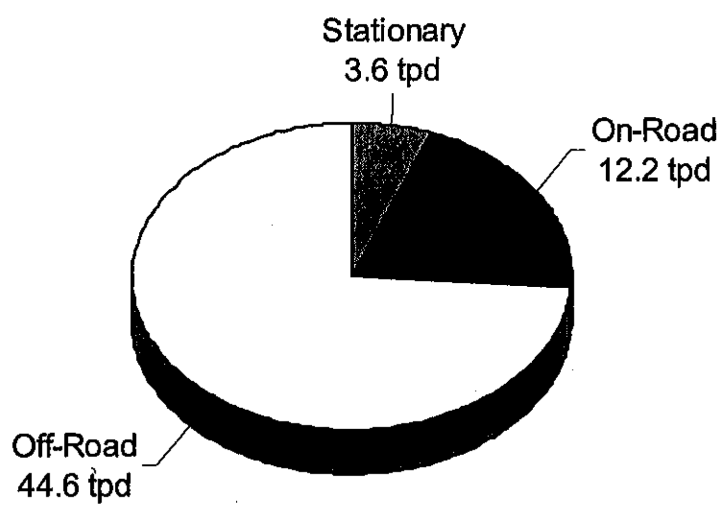


Figure 2 - 2010 Statewide Diesel PM Emission Inventory ~ 61 tpd

B. CERTIFICATION EMISSION STANDARDS

Since 1990, the ARB and the United States Environmental Protection Agency (U.S. EPA) have worked together to harmonize emission control requirements for HDDEs. Consequently, the California and federal emission standards for HDDEs are aligned (see Table 1). In October 1997, U.S. EPA adopted new emission standards for 2004 and subsequent model year HDDEs. The ARB subsequently adopted the same standards in April 1998 that significantly reduced both the HC and NOx emission standards from 1.3 HC and 4.0 NOx to a combined 2.4 non-methane hydrocarbons (NMHC) plus NOx grams per brake horsepower-hour emission standard.

In the mid to late 1990s, with the advent of electronically controlled engines, seven of the largest HDDE manufacturers (herein referred to as the "settling manufacturers") were alleged to have violated state and federal emission laws by designing their engines to turn off emission control devices during sustained highway driving. These cases were resolved through enforcement actions which were concluded when settlement agreements were reached with the settling manufacturers. In these settlement agreements, the settling manufacturers were required, among other things, to produce HDDEs that meet the adopted 2004 2.4 NMHC plus NOx emission standard early, no later than October 1, 2002 (15 months ahead of the regulatory requirements). Also the settling manufacturers agreed to meet supplemental test procedures including Not-To-Exceed (NTE) requirements and the EURO III European Stationary Cycle (ESC) test, starting with 1998 through 2004 model year engines. However, these supplemental test procedure requirements sunsetted with 2004 model year engines. (The NTE and ESC test procedure requirements are discussed in greater detail in section "C." below).

To prevent "backsliding" of the supplemental test procedure requirements after 2004, in December 2000, ARB adopted NTE and ESC supplemental test procedures, applicable to all California certified HDDEs beginning with 2005 model year engines. In addition to preventing backsliding, the adopted regulations also ensure that all other ("non-settling") manufacturers comply beginning with 2005 model year engines.

In January 2001, the U.S. EPA adopted new HDDE emission standards, along with modified NTE and ESC test requirements for 2007 and subsequent model years. These emission standards represent a 90% reduction of NOx, 72% reduction of NMHC, and a 90% reduction of PM emissions compared to the 2004 emission standards. In October 2001, the ARB harmonized with the federal program by adopting identical 2007 HDDE emission standards and NTE and ESC test requirements.

Table 1 - CA and Federal Heavy-Duty Diesel Engine Certification Emission Standards

Model Year	HC (g/bhp-hr)	CO (g/bhp-hr)	NMHC + NOx (g/bhp-hr)	NOx (g/bhp-hr)	PM (g/bhp-hr)
1990	1.3	15.5	-	6.0	0.60
1991	1.3	15.5	-	5.0	0.25
1994	1.3	15.5	-	5.0	0.10
1998	1.3	15.5	-	4.0	0.10
2004[1]	-	15.5	2.4[2]	-	0.10
2007	0.14[3][4]	15.5	-	0.2[3]	0.01

1 October 1, 2002, for ARB Settlement agreement signers
2 2.5 g/bhp-hr if NMHC is below 0.50 g/bhp-hr
3 Phase in schedule , 50% from 2007 to 2009, 100% in 2010
4 Non methane hydrocarbons (NMHC)

C. CERTIFICATION TEST PROCEDURES

New motor vehicles and engines are certified by ARB for emission compliance before they are legal for sale, use, or registration in California. Certification is granted annually to individual engine families and is good for one model year. An engine family is a grouping of vehicles or engine models that are similar in design and have similar emission characteristics (e.g., common engine parameters, fuel system, and emission control systems).

For HDDE certification, a representative engine of a specific engine family is tested on an engine dynamometer by the manufacturer under a prescribed test protocol. The testing protocol specifies the test fuel, temperature of the fuel, the different testing cycles to be employed during engine dynamometer testing, and the emissions that are to be measured. The main test cycle that is used for certification is the Federal Test Procedure (FTP). In addition, as previously mentioned, manufacturers must also comply with the NTE and ESC test requirements. The exhaust emissions that are measured during certification testing are NOx, NMHC, CO, and PM.

1. Federal Test Procedure

The FTP is a heavy-duty transient cycle currently used for emission testing of on-road heavy-duty engines. This transient test was developed with real world test data collected on heavy-duty trucks and buses, representing the majority of real world driving conditions, simulating stop and go traffic, idling, and limited freeway driving. The average load factor on the engine is about 20 to 25% of the maximum horsepower available at a given speed. The equivalent average speed of the FTP is about 18.6 miles per hour and the equivalent distance traveled is 6.4 miles with a total run time of 1200 seconds.

2. European Stationary Cycle

The ESC is a 13-mode, steady state test procedure, introduced in Europe in 2000 for emission certification testing of HDDEs. Emissions are measured during each mode and averaged over the cycle using a set of weighting factors. PM emissions are sampled on one filter over the 13 modes. This test cycle covers a larger range of engine loads, up to 100% of available engine horsepower. In addition, manufacturers are required to test at three additional test points (or 'mystery points') to ensure compliance under a full range of steady state operating conditions.

3. Not-To-Exceed Testing

The NTE requirements were designed to help ensure that HDDE emissions are properly controlled over a large range of speed and load combinations and typical environmental conditions commonly experienced during everyday use of the vehicle. The NTE protocol allows testing on an engine dynamometer, chassis dynamometer, or with on-board portable emission measurement systems (PEMS) during over-the-road operation. The maximum allowable NTE emissions, when averaged over a minimum time of 30 seconds, must not exceed an emission limit that is a multiple of the FTP standards.

NTE establishes an area (NTE control area)[3] under the engine's torque versus speed curve where emissions must not exceed a specified value for any of the regulated pollutants. It also broadens the applicable ambient conditions in which the emission limits must be met including a temperature range of 55-95 degrees Fahrenheit, an altitude range up to 5,500 feet above sea level, and a humidity range from 50 to 75 grains of water per pound of dry air. The test itself does not involve a prescribed driving cycle of any given length (mileage or time); rather it involves any drive cycle that could occur within the bounds of the NTE control area.

The NTE control area includes three basic boundaries on the engine's torque and speed map (see Figure 3). The first is the upper boundary that represents the engine's maximum torque at a given speed. The lower boundary is 30% of

[3] For details see 40 CFR 86.1370-2007(b)

an engine's maximum torque and power. The third boundary is operation above 15% of the ESC speed range. During certification, the HDDE manufacturer does not need to submit NTE test data but must make a statement in their certification application that the engine complies with the NTE requirements.

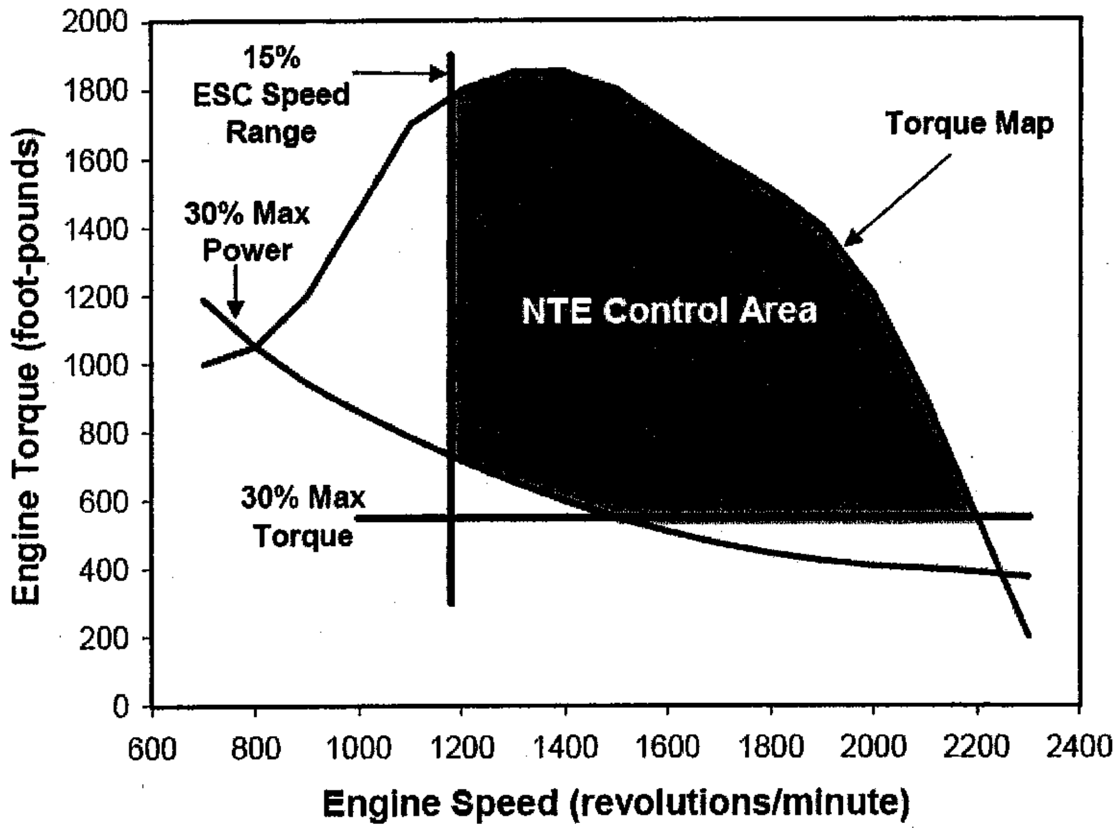


Figure 3 - Sample NTE Control Area for Heavy-Duty Diesel Engines

D. IN-USE COMPLIANCE REGULATIONS

As previously mentioned, California's current authority to conduct compliance testing is found in the California Code of Regulations, title 13, sections 2111-2140. The ARB has the authority to conduct in-use compliance testing of HDDEs to ensure compliance with the applicable emission standards throughout the engine's useful life. According to the current in-use compliance testing procedures, a minimum of ten engines must be tested on an engine dynamometer. To demonstrate compliance, two criteria must be met: 1) the engine family complies with the engine certification emission standards based on the average emissions of the ten engines tested, and 2) after testing is completed, no more than two defects of the same emission related component can occur.

Despite California's authority to conduct in-use compliance testing on HDDEs, to date no such testing has been performed. This is because it is very time consuming, requiring removal of the engine from the truck (typically requiring one to two weeks per truck/engine). Thus, truck operators are reluctant to volunteer their truck since it is their main source of income, and consequently any downtime would have a significant economic impact. In addition, the testing itself is very costly. Staff estimates that testing an engine family (ten engines minimum) would cost roughly $250,000.[4]

Staff's proposal addresses a long standing need to assess the emissions performance of HDDEs installed in vehicles when operated under a wide range of real-world driving conditions. The proposal is specifically intended to assess compliance with the NTE requirements and to help ensure that HDDEs will comply with all applicable emission standards throughout their useful lives. This proposed program would, for the first time, require engine manufacturers to measure and report in-use exhaust emissions from heavy-duty vehicles using onboard portable emissions measurement systems (PEMS) during typical over-the-road operation. PEMS are miniature versions of analyzers with the same measurement technology used for laboratory testing and can be mounted on the vehicle to conduct field exhaust emissions testing.

E. COMPARABLE FEDERAL REGULATIONS

Staff's proposal is based on a cooperative effort that began in 2001, with the U.S. EPA and engine manufacturers. Based on this collaborative work, in June 2005, the U.S. EPA adopted a manufacturer-run in-use testing program, titled 'In-Use Testing Program for Heavy-Duty Diesel Engines and Vehicles'. Staff's proposed program is essentially identical to the U.S. EPA's program (U.S. EPA, 2005a, pp 34594 – 34626).

In July 2005, U.S. EPA also modified and consolidated the test procedures for testing both on-road, and off-road diesel engines in 40 CFR, part 1065 (U.S. EPA, 2005b, pp 40420 – 40468). Staff's proposed program will also include those modifications to the 'California Exhaust Emission Standards and Test Procedures for 2004 and Subsequent Model Heavy-Duty Diesel Engines and Vehicles' (see Appendix B).

[4] Federal Register, June 14, 2005, page 34616 (40 CFR Parts 9 and 86, Part III), 'each engine test could cost $25,000 if the vehicle could be procured from an in-use fleet.'

III. SUMMARY OF PROPOSAL

A. APPLICABILITY

The proposed program would apply to all 2007 and subsequent model year engine dynamometer certified diesel engines to be installed in vehicles with gross vehicle weight ratings greater than 8,500 pounds. A non-enforceable 2-year pilot program began in 2005 to assess data collection issues associated with gaseous emissions and a 2-year pilot program for PM will begin in late 2006 to assess data collection issues associated with PM emissions.

B. PROGRAM OVERVIEW

The key elements of proposed program are as follows:

- Each year, ARB and U.S. EPA would designate for testing up to 25% of a manufacturer's total number of medium- and heavy-duty diesel engine families, combined. Testing would be conducted under real-world driving conditions, within the engine's useful life period.
- The engine manufacturers would screen, procure, and test vehicles received either from fleets or individual customers. For details see the vehicle screening guidance document (U.S. EPA, 2006a).
- The proposed program would have two phases. The first phase of testing, Phase 1, is intended to evaluate a designated engine family for conformity with the applicable NTE requirements. If the engine family does not pass the Phase 1 requirements, then Phase 2 testing may be required. Phase 2 testing may be conducted under more defined and narrow test conditions to target specific non-complying operating conditions.
- Emissions that would be measured for compliance are: NOx, NMHC, CO, and PM. Measuring carbon dioxide and oxygen would also be required as a means of verifying fuel consumption and work output (i.e., torque) of the engine.
- Measurement "accuracy" margins would be established to account for the emissions measurement variability associated with the use of PEMS during over-the-road testing, compared to certification testing performed in a laboratory environment (ARB, U.S. EPA, EMA, 2005a).

   - During the pilot program years, 2005 through 2007, manufacturers would use interim additive accuracy margins of 0.17 g/bhp-hr for NMHC; 0.50 g/bhp-hr for NOx; 0.60 g/bhp-hr for CO, and 0.10 g/bhp-hr for PM.
   - Accuracy margins for the enforceable program are currently being developed through a joint ARB, U.S. EPA, and engine manufacturer sponsored research program.

- ARB personnel may be present during PEMS installation and over-the-road testing.
- Manufacturers are to report test data and other relevant in-use test information to ARB on a quarterly basis, for all engines tested during that quarter, no later than 30 days after the quarter ends.
- Both test data and test reports would be comprehensive in nature and would be submitted in an electronic format jointly developed by ARB, U.S. EPA, and the engine manufacturers.

C. ENGINE FAMILY AND VEHICLE SELECTION

The ARB estimates that there are about 75 medium- and heavy-duty diesel engine families certified each year by about 13 manufacturers. Because it would be overly burdensome for most manufacturers to test all of their engine families in a single year, the proposal would spread this testing burden out over a four-year period. To accomplish this, most manufacturers would need to test one to two engine families per year. Some manufacturers would need to test up to four engine families per year. Each year, by June 1st, ARB, and U.S. EPA would designate up to 25% of a manufacturer's total number of HDDEs for testing. For the purpose of calculating the number of engine families to be tested in a given year, only engine families with nationwide sales over 1500 engines annually would be used, with a minimum of one engine family per year per manufacturer. However, engine manufacturers would not be required to test over the course of any four-year period, a number of engine families that exceeds the manufacturer's total number of engine families certified unless there is clear evidence of nonconformity with respect to a specific engine family that was tested.

Test vehicles would be obtained from at least two sources and the vehicles would be screened for proper use and maintenance. The vehicles selected for testing would be representative of how the engines are typically used in-use, and there would have to be assurance that they would operate for at least three hours in non-idle operation over a complete shift-day.

Test vehicle engines would be calibrated and set to the manufacturer's original settings, and the manufacturer would verify that the test vehicles have only been operated on commercially available ultra low sulfur diesel fuel or a fuel approved for use by the manufacturer. Manufacturers would verify, remedy, or reject from the program vehicles with an illuminated malfunction indicator light or stored on-board diagnostic trouble code. Manufacturers would not be allowed to screen-out test vehicles for high mileage except for those vehicles that exceed their regulatory useful life.

D. COMPLIANCE MARGINS

As previously mentioned, using PEMS to assess in-use compliance of HDDEs has many advantages compared to traditional engine dynamometer testing. However, the use of PEMS under various environmental conditions could impact the accuracy of the test results. In order to account for this additional variability, the proposal would allow for the use of an accuracy margin that would be included in the calculations for each pollutant to determine compliance. Measurement accuracy margin development is discussed further in section V, Portable Emission Measurement Systems.

In addition to the measurement accuracy margin, another in-use compliance margin, adopted as per the 2007 HDDE rule, would be applied. It is based on mileage of the engine and is only applicable to NOx and PM emissions for 2007 through 2011 model year HDDEs. For NOx, this compliance margin varies from 0.10 to 0.20 g/bhp-hr, depending on vehicle/engine mileage. The NOx in-use compliance margin is applicable for engines certified to a family engine limit no higher than 1.3 g/bhp-hr. For PM, the in-use compliance margin is 0.01 g/bhp-hr regardless of the mileage. See 40 CFR 86.007-11(h) for more details.

As previously mentioned, the ARB, U.S. EPA, and the engine manufacturers are currently engaged in developing measurement accuracy margins for gaseous emissions which will be used for the enforceable program beginning in 2007. Another test program will be developed to determine a measurement accuracy margin for PM, using it for the enforceable program for PM, beginning in 2008.

E. VEHICLE PASS CRITERIA

Under staff's proposed program vehicle pass criteria would be used to determine whether an engine meets the NTE requirements it was certified to. In order for an engine to meet the vehicle pass criteria, 90 percent of each NTE sampling event must be below an "NTE threshold." The NTE threshold is comprised of adding the NTE limit, the in-use compliance margin, and the measurement accuracy margin. In addition, for model years 2007 through 2009, each sampling event must not be greater than two times the NTE threshold, regardless of whether the 90 percent pass criteria are met.[5]

A valid NTE sampling event consists of 30 or more seconds of continuous operation in the NTE control area. Some NTE sampling events may be excluded or limited depending on whether the engine manufacturer, during the time of certification, requested exemptions under certain operating conditions, or was able to show that the engine rarely operates under a certain speed and load.

The average emission level for each pollutant over each valid NTE sampling event would be calculated.[6] Each NTE event would be time weighted, based on the shortest and longest NTE sample collected. The time weighting would be limited to ten times the shortest sample event time or 600 seconds, whichever is less.

After each NTE event has been time weighted, these data will be used to determine whether the vehicle meets the 90 percent requirement under the vehicle pass criteria. To do this, all time weighted NTE sampling events that are below the NTE threshold will be compared with all the NTE sampling events, including events that were above the NTE threshold. If 90 percent or more of the time weighted samples are below the threshold and none of the events were above two times the NTE threshold, then the vehicle would have met the vehicle pass criteria. A comparison would be done for each pollutant and the vehicle must comply with each one to receive a vehicle pass determination.

Table 2 below is an example of how NTE sampling event durations would be evaluated for each pollutant. In the example, six valid NTE samples are collected of different durations, ranging from 40 seconds (sample 1) to 630 seconds (sample 3). Since the smallest sample was 40 seconds, the maximum allowed time weighting is ten times that amount, or 400 seconds. Each sample is then evaluated to determine whether the time interval for each sample needs to be adjusted.

[5] Some exceptions apply. See CFR §86.1912
[6] For details see CFR parts 1065, subpart G

Table 2 - Illustration of NTE Sampling Events for Calculation

NTE sample	Duration of NTE sample (seconds)	Duration Limit Applied?	Duration used in Calculations (seconds)	Below NTE threshold
1	40	No	40	No
2	165	No	165	Yes
3	630	Yes. Use ten times shortest valid NTE.	400	Yes
4	470	Yes. Use ten times shortest valid NTE.	400	Yes
5	78	No	78	No
6	237	No	237	Yes
			Total NTE time = 1320 seconds	

Table 2 above is an example of how NTE sampling event durations would be evaluated for each pollutant. In the example, six valid NTE samples are collected of different durations, ranging from 40 seconds (sample 1) to 630 seconds (sample 3). Since the smallest sample was 40 seconds, the maximum allowed time weighting is ten times that amount, or 400 seconds. Each sample is then evaluated to determine whether the time interval for each sample needs to be adjusted.

Once the weighting has been done, the average emission result for each NTE sampling event for each pollutant can be compared with the NTE threshold value for that pollutant to determine whether the NTE sampling event is in compliance. The results of all the sampling events are then compared to determine whether the vehicle met the vehicle pass criteria. In the example above, the vehicle spent a total of 1320 seconds in six different NTE events. The total time the vehicle spent in NTE events that were below the NTE threshold is 1320-(40+78) = 1202 seconds. The ratio of time of complying NTE events to the total NTE events is 1202/1320 = 0.91 or 91%. Thus, the vehicle passes the vehicle pass criteria (assuming that the NTE sampling events 1 and 5 are below two times the NTE threshold value).

F. 2005 AND 2006 PILOT PROGRAM

The proposed program is unique, in that it would be the first of its kind to require compliance with emission requirements outside of a test laboratory environment using PEMS. Indeed, because it is unique, the ARB, U.S. EPA, and engine manufacturers have already agreed to launch a pilot program in calendar years 2005 and 2006 to gain experience with in-use testing utilizing PEMS. The pilot program will measure gaseous emissions (i.e., NMHC, CO, and NOx) and will prepare both the manufacturers and ARB for the fully enforceable program, beginning in calendar year 2007. Similarly, a pilot program measuring PM will take place in 2006 and 2007, preceding a fully enforceable program for PM beginning in 2008.

Under the pilot program, engines meeting the 2004 HDDE standards and NTE requirements will be selected for testing. Manufacturers will conduct in-use testing under the Phase 1 test criteria (discussed below in section G.) and will test up to ten vehicles per designated engine family.

The pilot program test data will be used to help refine the program and address testing and reporting issues before the enforceable program begins. There will not be any follow-up remedial actions based solely on the test results of pilot program. However, ARB may utilize pilot program test results, in conjunction with its own test data and other information, to assess or pursue any appropriate remedial or enforcement action.

G. PHASE 1 TESTING

Figure 4, below, is a flow chart illustrating the compliance determination process for Phase 1 and Phase 2 of the program.

Under Phase 1 testing, test vehicles are to be operated over normal driving routes, carrying their routine loads during typical environmental conditions. The driver normally assigned to the vehicle would be used. The intent of this phase of the program is to assess the emissions from heavy-duty vehicles as they are used and operated on a normal day-to-day basis. Manufacturers would be required to test a minimum of five and a maximum of ten different vehicles within a designated engine family. If five out of five or five out of six vehicles meet the vehicle pass criteria the manufacturer would then be allowed to terminate Phase 1 testing. The manufacturer would not be required to take any further action or submit any further data to ARB for that engine family during that year's testing.

If two out of six vehicles in Phase 1 testing do not meet the vehicle pass criteria, four additional vehicles of the same engine family will be procured and tested. If these additional four vehicles meet the vehicle pass criteria, resulting in eight out of ten vehicles passing, the manufacturer would then be allowed to terminate Phase 1 testing, with no further action required.

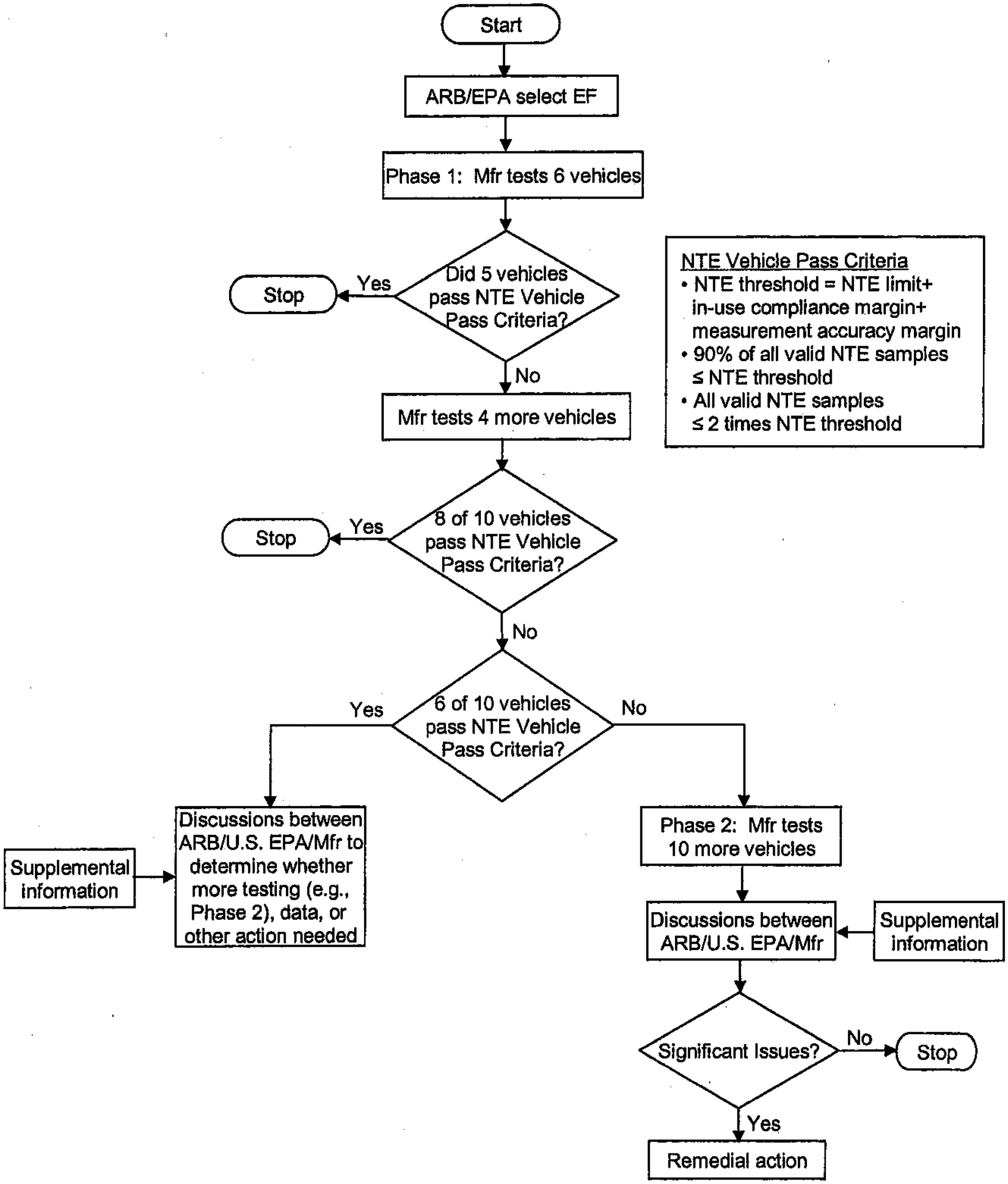


Figure 4 - Flow Chart of HDDE In-Use Testing Compliance Determination

If less than eight out of ten vehicles pass, one of two potential follow-up options would be undertaken:

1. If three or four vehicles fail the vehicle pass criteria, the manufacturer would then engage in follow-up discussions with ARB to determine whether any further testing, data submissions or other actions may be warranted. Other actions may include seeking some form of remedial action from the manufacturer.

2. If five or more vehicles fail the vehicle pass criteria, the manufacturer would be required to conduct some form of additional testing, investigation, or other action. The ARB would have the discretion to require the manufacturer to undertake Phase 2 testing unless the manufacturer agrees with ARB that some form of remedial action is warranted.

H. PHASE 2 TESTING

The primary purpose of Phase 2 testing is to gain further information regarding the extent to which, and under what conditions, the vehicles from the designated engine family failed to pass the vehicle pass criteria during Phase 1 testing (see Figure 4, above). If the manufacturer is required to conduct Phase 2 testing, ten additional vehicles would be selected of the same engine family tested during Phase 1. The ten test vehicles would go through the same vehicle screening protocol used for Phase 1 testing. ARB could require a subclass of engines within the engine family, if the data generated under Phase 1 or other test data indicate possible non-compliance with the emission standards. Additionally, ARB could also specify certain driving routes or other driving conditions (e.g., temperatures, altitudes, geographic locations, or time of year), if it is suspected that these conditions are associated with non-compliance. At any point during Phase 2 testing, ARB and the manufacturer could agree to stop testing and settle on some form of remedial action prior to the completion of testing the additional ten vehicles.

In determining whether to pursue some form of remedial action following Phase 1 or Phase 2 testing, ARB would consider several factors including additional test data submitted by the manufacturer. Such data may be based on tests conducted using PEMS, engine dynamometers, or chassis dynamometers. Other factors staff would consider include, among other things: the margin by which any exceedance(s) were above the NTE threshold; the number of engines that showed an exceedance; the frequency and duration of any exceedance as compared with the aggregate amount of time that all of the test vehicles were operated within the NTE control area; the emissions of the test vehicles over the entire test route, including average(s); the projected emissions impact of the exceedance and; the relationship of the exceedance at issue to the engine family's ability to comply with the applicable emission requirements.

I. REPORTING REQUIREMENTS

Under the proposed manufacturer-run compliance program, engine manufacturers would be required to submit test data, and other relevant in-use test information to ARB for each vehicle tested. Manufacturers would be required to submit these data and information on a quarterly basis, no later than 30 days after the quarter ends.

The engine manufacturers' reports would be submitted using a standardized, electronic reporting format. The report would include all measured emissions test data, engine operating parameters, test conditions, test equipment specifications, vehicle and engine information generated during the manufacturer test program (e.g., information on vehicle maintenance and usage history with reasons for rejected vehicles, restorative maintenance performed prior to testing), vehicle pass results, etc. The engine operating parameters that would be reported are engine speed, engine torque or brake specific fuel consumption, engine coolant temperature, intake manifold temperature, intake manifold pressure, and any parameter sensed or controlled that modulates engine operation and emissions. For further details on the manufacturers' reports see the reporting guidance document (U.S. EPA, 2006b).

J. DETERIORATION FACTOR GENERATION

Currently, manufacturers of HDDEs have considerable flexibility in the generation of deterioration factors (DFs) in the laboratory using an engine dynamometer. The engine is run over a durability driving cycle for a period of time or simulated mileage and emissions are measured over this cycle at intervals specified by the engine manufacturer. The measured emissions are plotted as a function of time or simulated mileage and a statistical curve fitting method is used to calculate emissions deterioration over time. Since the emission tests are not typically performed at the end of an engine's useful life, the curve-fit is extrapolated out to estimate useful life emissions. Once a useful life DF has been determined, the test results and the DF are used in comparison to the standards to determine compliance at time of certification.

During the development of the proposed program, engine manufacturers have requested that they be allowed to use the in-use test data to generate their DFs. Since the manufacturers would be conducting these tests every year and cover most of the engine families they certify within four years, staff concurs that this "real world" methodology to calculate DFs may be a better approach compared to engine dynamometer laboratory testing. ARB intends to assess the generation of DFs based on the proposed 2005 and 2006 pilot program and may approve the use of in-use data to develop DFs in the future.

K. ARB'S CONFIRMATORY TESTING

Under staff's proposed program, manufacturers would be procuring, screening, and testing engines that they have previously certified. One of the greatest benefits of this proposed program is the number of engine families that would be tested for compliance, compared to the number of compliance tests that have been conducted in the past. However, because there would be a vested interest for the manufacturers to successfully complete and pass testing of their engine families with a minimum number of engines tested, the ARB would likely perform its own confirmatory testing on selected engine families using the same testing protocol contained in the proposal. This testing would not be meant to duplicate the manufacturers' testing but instead help assure that the manufacturers will select, screen, and conduct the testing appropriately.

L. OTHER PROPOSED CHANGES

In addition to the proposed in-use compliance program, staff proposes five minor non-substantive modifications. The first proposed amendment corrects the 2007 and later model year NOx emission standard applicable to medium- and heavy-duty diesel engines, and urban buses. When the NOx standard was adopted by the Board in the original rulemaking in 2001, it was staff's intent to propose a 2007 and later model year NOx emission standard that was identical to the applicable federal standard, which is 0.20 g/bhp-hr. When the regulations and the incorporated test procedures were amended, the second decimal place of the NOx emission standard was inadvertently omitted (i.e., it should read 0.20 g/bhp-hr, not 0.2 g/bhp-hr).

The second proposed amendment allows manufacturers to optionally certify medium-duty diesel vehicles under 14,000 pounds gross vehicle weight rating to count towards the phase-in calculations for the 2007 HDDE standards. This allowance was unintentionally overlooked when the 2007 HDDE standards were adopted. This proposed correction would align California's program with the federal program.

The third proposed amendment corrects the formaldehyde standards and the 2007 and later model year Ultra-Low Emission Vehicle standards for medium-duty diesel engines in the "California Exhaust Emission Standards and Test Procedures for 2004 and Subsequent Model Heavy-Duty Diesel Engines and Vehicles." These standards were incorrectly transcribed when the format of the

"California Exhaust Emission Standards and Test Procedures for 2004 and Subsequent Model Heavy-Duty Diesel Engines and Vehicles" was reorganized and updated in December 12, 2002. The corrected amendment makes these emission standards consistent with those in the existing California Code of Regulations.

The fourth proposed amendment aligns the emission DF methodology for HDDEs with the approach currently used by ARB and U.S. EPA for off-road diesel engines. To determine if the emission levels from the emission data engine comply with the applicable emission standards at useful life, DFs, either additive or multiplicative, are applied to the measured emission levels for each pollutant. The proposed amendment harmonizes the approach to determine whether an additive or multiplicative DF is appropriate for on- and off-road diesel engines.

The last proposed amendment updates the labeling requirements for heavy-duty otto-cycle engines. On December 8, 2005, U.S. EPA finalized technical amendments related to streamline evaporative emission testing, in which one of the technical amendments allowed for alternative labeling requirements for 2007 and later model year engines, with advance Administrator approval. Staff also proposes the same alternative labeling allowance for these model year engines.

IV. DIFFERENCES AND SIMILARITIES BETWEEN CALIFORNIA AND FEDERAL REGULATIONS

Staff's proposed manufacturer-run compliance program is intended to be identical to the program adopted by the U.S. EPA in June 2005. This program would ensure emission compliance from a group of vehicles that affect California's clean air attainment goals and would harmonize both California and federal requirements. For example, engine family and vehicle selection, in-use testing protocol using PEMS, test data and results reporting, and vehicle pass determination are all identical to those adopted by the U.S. EPA in their rule. Only the following element of staff's proposal differ slightly with the federal program.

One of the elements of staff's proposal that may differ with the federal program is how ARB would evaluate the test data for determining compliance. Both U.S. EPA and ARB would coordinate engine family selection and receive the same test data and test results submitted by manufacturers after testing is completed. ARB would make its own interpretation and determination of test results based on the data submitted by manufacturers or in conjunction with other data generated by ARB from its own in-use testing. Thus, ARB's interpretation of manufacturer test results and pursuit of remedial action may be different from actions taken by the U.S. EPA.

V. PORTABLE EMISSION MEASUREMENT SYSTEMS

The proposal would require engine manufacturers to use PEMS to conduct in-use testing of heavy-duty diesel vehicles. The emission standards for 2007 HDDEs are expressed as mass of pollutant per unit amount of work per unit time. Therefore, at a minimum, the PEMS must be capable of measuring (a) exhaust concentrations of NOx, CO, NMHC, and PM, (b) exhaust flow rate, (c) engine operating speed, torque, coolant temperature, intake manifold temperature, pressure, and (d) ambient conditions such as temperature, dew point, altitude. The success of the program will depend on the availability and reliability of PEMS.

A. COMMERCIAL AVAILABILITY

The use of PEMS for over-the-road emissions measurement has been under development for the past decade. Testing conducted in the past few years has shown that PEMS technologies have performed well and accurately in measuring gaseous emissions from heavy-duty diesel vehicles under different driving conditions. PEMS emission analyzers used for measuring gaseous pollutants use the same technology used in larger laboratory instruments. On the other hand, the development of the PEMS for PM measurement has been challenging and slower; the technology used for measuring PM with PEMS is completely different than the technology used in a laboratory.

1. Gaseous Emissions

Engine manufacturers are likely to certify most of their 2007 through 2010 model year engines at around a 1.1 to 1.3 g/bhp-hr NOx emission level. The corresponding NTE emission limit would be about 2.0 g/bhp-hr, depending upon vehicle mileage and other NTE flexibilities found in the 2007 HDDE rule. Since 2002, there are several commercially available PEMS capable of measuring NOx, CO, CO_2, and NMHC at the exhaust concentration levels associated with 2007 and later model year NTE limits. Most analyzers used in PEMS for gaseous measurement are essentially miniature versions of the same instrument used by laboratories. The measurement technology used in PEMs include: a Chemiluminescence detector, zirconia oxide sensor, or non-dispersive ultraviolet (NDUV) detector for NOx; non-dispersive infrared detector for CO and CO_2; and a dual flame ionization detector to calculate NMHC. Some of the engine manufacturers are already using PEMS with these technologies to assess emissions compliance with their prototype 2007 model year engines.

2. Particulate Matter Emissions

PM measurement has been traditionally conducted by sampling diluted engine exhaust on a filter and then weighing the filter before and after testing to determine the net mass gain due to PM emissions over a test cycle. The same measurement technology can not be applied while testing heavy-duty diesel vehicles over-the-road when using PEMS because real time, second-by-second measurement capability is necessary to satisfy the requirements of the proposed program. Recently, real time PM measurement technologies have been developed and successfully tested in the laboratory. These technologies detect the inertia of collected PM and determine its mass based on the frequency of the vibrating mass rather than collecting PM on a filter and weighing its mass. Technologies using the inertial weight of PM include the tapered element oscillating microbalance and the quartz-crystal microbalance. Recent studies have verified the capabilities of the quartz-crystal microbalance, showing reasonably good measurement accuracy compared to the traditional filter weight based method.

PEMS capable of measuring PM with the above technologies are commercially available today. However, further development work is needed to resolve a few key challenges, such as (a) quantifying semi-volatile hydrocarbons and dilute sulfuric acid PM for every NTE event, (b) matching partial flow dilution of the raw sample in PEMS to match conditions with a typical laboratory's constant volume dilution system, and (c) measuring "nano-gram" levels of PM in 30-second NTE samples.

B. ACCURACY MARGIN DETERMINATION

There are fundamental differences when exhaust emission measurements are made with stationary analyzers in a controlled laboratory environment compared to emission measurements done with portable emission analyzers in an uncontrolled open environment, subjected to road vibration and other electro-magnetic, and radio-frequency interferences. To account for these factors, in May 2005, ARB, U.S. EPA, and the engine manufacturers agreed to jointly fund and develop a data-driven, research, development, and demonstration project to determine emission measurement "accuracy margins" for gaseous and PM emissions (Memorandum of Agreement, Program to Develop Emission Measurement Accuracy Margins for Heavy-Duty In-Use Testing, May 2005). For a detailed description of the research program, currently underway at the Southwest Research Institute in San Antonio, Texas, see the "test plan" for further details (ARB, U.S. EPA, EMA, 2005b).

VI. ECONOMIC IMPACTS

A. LEGAL REQUIREMENTS

Government Code sections 11346.3 and 11346.5(a) require state agencies adopting and amending any administrative regulations to identify and assess the potential for adverse economic impacts on California businesses and individuals. State agencies are also required to estimate the cost or savings to any state or local agency and school districts. The assessment shall include a consideration of the impact of the proposed regulation on California jobs, business expansion, elimination or creation, and the ability of California business to compete with business in other states.

State agencies are also required to estimate the cost or savings to any State or local agency and school district in accordance with instructions adopted by the Department of Finance. The estimate shall include any non-discretionary cost or saving to the local agencies and the cost or saving in federal funding to the State.

B. AFFECTED BUSINESSES

The proposed regulation will affect businesses that manufacturer on-road HDDEs and PEMS units. Based on 2005 California certification data, 13 heavy-duty engine manufacturers certified their engines for sale in California. None of these manufacturers is located in California, and none is considered to be a small business. The total number of affected PEMS manufacturers is difficult to determine at this time because some manufacturers are still developing their products. Currently, at least four manufacturers have offered for sale PEMS that measure gaseous emissions. One of these manufacturers is located in California and is a small business.

C. POTENTIAL COSTS TO ENGINE MANUFACTURERS

From one perspective, the proposed regulation poses no additional costs to engine manufacturers who certify in California since the manufacturers are already subject to an identical nationwide rule adopted by U.S. EPA on June 14, 2005 (i.e., no additional testing beyond what is required by the federal rule). Nevertheless, the proposed regulation can be viewed as imposing new testing costs on manufacturers when compared to current California law which does not impose any in-use testing cost on them. These new in-use testing costs would be identical to the estimated nationwide costs since it imposes about the same number of tests and requirements as the nationwide program.

Inasmuch as the proposed amendments could be said to have economic impacts, these impacts are expected to be slight and absorbable by the manufacturers of HDDEs.

The U.S.EPA cost estimate to conduct the manufacturer-run in-use compliance program nationwide ranges from $1.6 to $2.1 million per year for the entire industry (U.S. EPA, 2005c)(Table 3). The total cost consists of fixed and variable cost components. In this program, the fixed costs are the direct expense of purchasing PEMS units. U.S. EPA has estimated that the annualized cost per PEMS unit is $34,145 [7] and that each manufacturer, on average, will purchase 3 units. Assuming 13 affected engine manufacturers, the total annualized fixed cost of the program is $1,331,655. The variable costs are dependent on the number of engine families tested and the numbers of tests performed, and include costs for direct labor, other direct costs, labor overhead, vehicle incentives, travel, and administrative overhead. The variable cost for each engine family is estimated to range from $15,491 to $44,411. Assuming 18 engine families (25 percent of 71 engine families certified federally in the 2005 model year) are tested per year, the total annualized variable cost of the program is estimated to range from $278,838 to $799,398. When combining the fixed and variable costs together, the average cost per manufacturer ranges from $123,884 to $163,927. The actual cost to a specific manufacturer will vary depending on how many engine families it certifies, how many vehicles are tested in Phase 1 for a given engine family, whether Phase 2 testing occurs for a given engine family, and other variables.

Table 3 - Total Annualized Cost for the Nationwide Program

Costs	Minimum	Maximum
Fixed Annualized Costs	$1,331,655	$1,331,655
Variable Annualized Costs	$278,838	$799,398
Total Annualized Costs	$1,610,493	$2,131,053
Average Cost Per Manufacturer	**$123,884**	**$163,927**

D. POTENTIAL IMPACTS ON PEMS MANUFACTURERS

The proposed regulation imposes technical specifications on PEMS for use in the proposed program. However, there is no certification process to qualify PEMS for use in the proposed regulations and thus; heavy-duty engine

[7] This annualized PEMS cost assumes the capital cost for a unit that measures both gaseous and PM emissions of $140,000, a product life of five years, and a capital recovery rate of seven percent per annum.

manufacturers will be responsible to ensure that the PEMS used in the proposed program meet the required specifications. Businesses that manufacture PEMS may incur additional cost to further develop their systems to meet the engine manufacturer needs under this program, but that cost can be recovered during the sale of other PEMS and they should not be adversely impacted by the proposed regulations. Rather, the proposed regulations, along with the national rule, should increase the sale of PEMS due to the market demand for this technology under this program. This program, implemented on a nationwide basis, will potentially result in the average annual sale of $1.3 million in PEMS (based on fixed costs noted above). Therefore, the economic impact on the manufacturer of PEMS that is located in California may be slight and positive.

E. POTENTIAL IMPACTS ON BUSINESS COMPETITIVENESS

The proposed regulation is not expected to adversely impact the ability of California businesses to compete with similar businesses in other states. As noted earlier, the U.S. EPA has already adopted this program on a nationwide basis and thus, businesses in all states will be subjected to identical requirements.

F. POTENTIAL IMPACTS ON JOBS AND BUSINESS CREATION, ELIMINATION, OR EXPANSION

The proposed regulation is not expected to significantly impact the creation, elimination or expansion of jobs and businesses in California. Any effect on employment, business creation or expansion is expected to be slight but positive. Engine manufacturers may hire additional personnel to perform tasks in the proposed program but this impact will not likely be realized in California since none of the manufacturers are located in California. If an engine manufacturer were to test vehicles in California, there could potentially be an increase in jobs or the creation of businesses to test HDDVs. However, this is also unlikely because the manufacturer is expected to utilize its own staff rather than outsourcing the testing. In addition, although one PEMS manufacturer is located in California and staff's proposal may expand that business, it is unknown whether engine manufacturers will purchase PEMS from this California business and how many units may be purchased.

G. POTENTIAL COSTS TO LOCAL AND STATE AGENCIES

The proposed amendments to the Procedure will not create costs or savings, as defined in Government Code section 11346.5 (a)(6), to any State agency or in federal funding to the State, costs or mandate to any local agency or school district whether or not reimbursable by the State pursuant to part 7 (commencing with section 17500, division 4, title 2 of the Government Code), or other non-discretionary savings to local agencies. The staff has not encountered information that indicates that any of these impacts is to be expected.

No additional net costs for local and state agencies will be accrued as a result of the proposed regulation. If an engine manufacturer chooses to procure vehicles for the proposed program through a local or state agency, participation is strictly voluntary, and the agency will be provided an incentive for the use of the vehicles. In addition, the cost for ARB to enforce the proposed program should be absorbed within the existing ARB programs and budget, and thus no additional costs are anticipated.

VII. ENVIRONMENTAL IMPACTS

A. AIR QUALITY IMPACTS

By enforcing emission limits adopted for HDDEs, the proposed regulation would ensure that the original emission benefits claimed through the adoption of lower emission standards are obtained. The next phase of HDDE emission standards will require a 90 percent reduction in NOx and PM emissions compared to today's standards, and will start in 2007 and be fully phased-in by 2010. Vehicles certified to these standards will have added complexity compared to today's vehicles due to the use of advanced aftertreatment systems and feedback controls to enhance emission control effectiveness. The proposed enforcement program will ensure that the emission control systems on HDDEs are properly designed and sufficiently durable to comply with the emission requirements during their useful life.

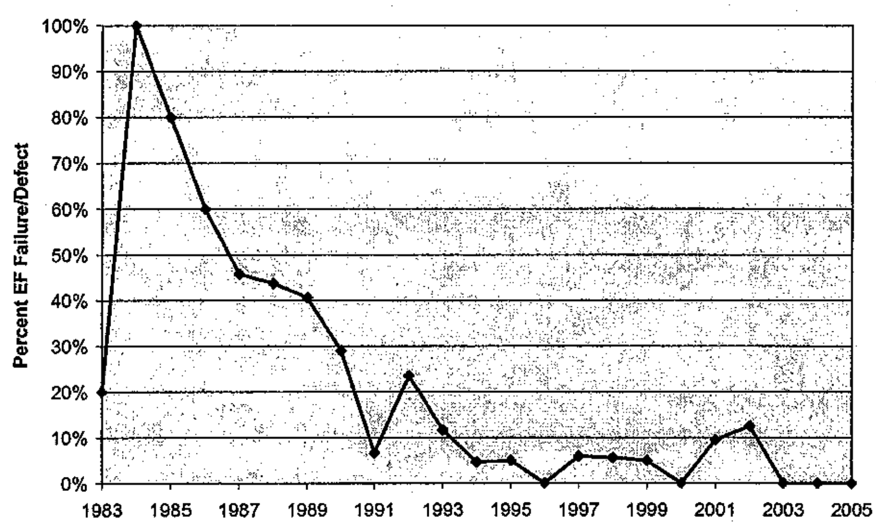
The proposed regulation will achieve benefits by routinely testing heavy-duty diesel vehicles in-use to ensure compliance with emission requirements as well as providing manufacturers an incentive for improved engine designs. With regard to in-use compliance, heavy-duty diesel vehicles will be tested in the field, and violations of the emission requirements within the regulatory useful life will be detected. The proposed program can potentially cover all engine models within a four year period (up to 25 percent tested per year). However, it is unknown how to quantify the actual environmental benefits because the number of vehicles failing the proposed program and their failed emission rate compared to a properly operating vehicle must be first determined in order to calculate the emission benefit. These two factors cannot be estimated at this time.

With regard to an incentive for improving designs, staff's proposal will encourage the design of robust and durable engines and emission control systems in order to avoid failure of in-use compliance testing and to prevent potentially costly recalls or extended parts warranties. It is also uncertain how to quantitatively calculate this emission benefit at this time, but the effectiveness of in-use compliance programs in encouraging durable emission control components have been demonstrated in the light-duty vehicle program. The light-duty vehicle in-use compliance program, which is operated by ARB rather than by manufacturers as in the proposed program, began in 1983. The initial years of the light-duty in-use compliance program showed high engine family failure or defect rates (Figure 5). After about ten years of routine compliance testing the failure rate decreased to about ten percent or less of the total engine families tested. In fact, in the last three years, no engine families have failed light-duty in-use compliance testing. The In-Use Verification Program, another enforcement program for light-duty vehicles that began in 2001, is manufacturer-run, similar to the proposed regulations. Since its initiation, no engine families have failed.

The current low failure rate is evidence of the success of these and other light-duty enforcement programs, most notably the on-board diagnostics program. In addition, in 2001, ARB introduced another light duty vehicle enforcement program, the in-use volunteer program that requires the manufacturers to test their in-use vehicles, similar to the proposed regulation for HDDEs.

As mentioned earlier, the proposed manufacturer-run in-use testing and compliance program is part of Measure ON-RD HVY-DUTY-3 in the 2003 SIP. This measure describes various approaches to clean up the existing and new truck fleet. Since the environmental benefits of the proposed regulation are not quantifiable, no SIP emission benefits will be claimed through the proposed regulation. Note that the SIP emission reduction commitments for Measure ON-RD HVY-DUTY-3 have already been met by other adopted approaches contained in the Measure.

Figure 5 - Light-Duty Vehicle In-Use Compliance Testing Engine Family Failure/Defects from 1983 to 2005



B. ENVIRONMENTAL JUSTICE

State law defines environmental justice as the fair treatment of people of all races, cultures, and incomes with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies. The Board has established a framework for incorporating environmental justice into ARB's programs consistent with the directives of State law. The proposed regulation would benefit all Californians by ensuring that

HDDEs comply with certification emission standards throughout their useful life. Communities located in proximity to ports, distribution centers, and other areas with high heavy-duty diesel vehicle activity would particularly benefit from the proposed regulation.

VIII. REGULATORY ALTERNATIVES

Several alternatives to the proposed requirements have been evaluated, as described below. After careful consideration of each alternative, the proposed regulation was determined to be the best option. A description of each alternative and the rationale for rejection are described as follows.

A. NO ACTION

If ARB did not take any action to adopt the proposed requirements, it will still have the authority to conduct in-use compliance testing under its current in-use compliance regulations. Under these regulations, we would perform engine dynamometer testing. If ARB would test the same annual number of engine families as in the proposed program, staff estimates the annual costs would be $4.5 million. In addition, since U.S. EPA has already adopted this program on a nationwide basis, vehicles in California would be subjected to the federal in-use compliance program. The main disadvantage of not taking any action is that California would not be able to enforce its own regulations through the convenience of a manufacturer-run in-use compliance program. Due to its severe air pollution problem, California is the only state given the authority to adopt its own emission standards, and the ability to enforce the standards is a critical component to the effectiveness of the regulations. While the proposed program is identical to the federal program in practically all aspects, retaining ARB's authority to enforce the HDDE regulations through the proposed manufacturer-run program would allow it to specify engine families to be tested, interpret the generated emission data to determine appropriate next steps, and make key decisions regarding the consequences of engine families failing to meet the requirements of the proposed program. In addition, many of the elements of the proposed rulemaking resolve concerns that engine manufacturers had regarding the NTE test, such as how the NTE emissions would be calculated and what would constitute a failed NTE test. By not taking any action, manufacturer concerns regarding the NTE test would not be addressed.

B. OPERATE THE PROPOSED IN-USE TESTING AND COMPLIANCE PROGRAM WITHOUT MANUFACTURER INVOLVEMENT

In this alternative, the proposed in-use testing and compliance program would be performed by ARB instead of the manufacturer. In this case, ARB would have full control over the program and would be able to procure vehicles from anywhere within the state and to test vehicles under whatever representative ambient conditions that it deemed necessary. The main disadvantage to this alternative is the difficulty in procuring vehicles to participate in the program. On-road heavy-duty trucks are mostly used for business purposes, and truck owners are typically not willing to allow government representatives to modify their vehicles to install a PEMS, potentially disrupting their work day. Engine manufacturers, however, have established working relationships with many truck fleet owners and have extensive knowledge of their engines such that any potential disruption to the use of the vehicle is minimal, if any. Also, the engine manufacturer can assure the owner that the engine warranty would not be voided because of any modifications and provide appealing incentives for participation in the program. Although HDDEs can be obtained through government agencies in California, the available selection of the manufacturer and model of the engines is limited. Also, California is not precluded from conducting its own in-use testing if information regarding a possible non-complying engine family is reported. Assuming that ARB can procure and test HDDEs using PEMS at the same cost as the engine manufacturers, the cost that would be incurred to test the same number of families would be $1.8 million per year. Thus, by considering the advantages and disadvantages of this alternative, conducting the proposed in-use testing and compliance program by ARB would result in only limited test capability, whereas manufacturer involvement would provide greater effectiveness in potentially testing the full range of engine families certified.

C. REQUIRE THE USE OF CHASSIS DYNAMOMETER FOR IN-USE TESTING AND COMPLIANCE

Another alternative to the proposed regulations is to require the use of a chassis dynamometer for testing rather than the use of PEMS and testing would be conducted under ARB's current regulation. ARB owns and operates a heavy-duty chassis dynamometer in Los Angeles. Testing on a chassis dynamometer would require the generation of representative test cycles and correlation of measured emissions to the NTE emission limits. One of the main advantages of a chassis dynamometer is the quality of the emission analyzers, which are certification-grade and thus, correlates well with the equipment used by the engine manufacturers during certification. In addition, repeat tests of a given driving cycle can be performed for a more precise understanding of the emission performance of an engine, as compared to a single and unique test run on an engine using PEMS. The major disadvantage of the use of a chassis dynamometer, compared to PEMS, is its inability to generate emission data during real-world driving and under diverse ambient conditions experienced by a vehicle in the field. Another disadvantage is the need to generate representative driving cycles to test on a chassis dynamometer since the NTE requirement specifies testing under representative driving conditions. In addition, relative to PEMS, chassis testing is more expensive and time-consuming. Assuming that ARB would test the same number of engine families as the proposed program, staff estimates the annual costs to conduct such a chassis-dynamometer based program would be $3.6 million. Therefore, at this time, the use of PEMS for in-use compliance testing is the preferred option over the use of a chassis dynamometer.

IX. REMAINING NON-CONTROVERSIAL ISSUES

A. PEMS SUPPLIER

As indicated in section V, the success of the proposed manufacturer-run in-use compliance program would greatly depend on the commercial availability of PEMS capable of measuring both gaseous and PM emissions from HDDEs. There are several commercial PEMS suppliers that can effectively measure the gaseous emissions during over-the-road testing. However, more development is needed to improve PM measurement capabilities.

B. ENFORCEABLE PROGRAM IMPLEMENTATION

The proposed program would be enforceable beginning with 2007 model year HDDEs. But this assumes that the measurement accuracy margins have been determined and the two pilot programs for both gaseous and PM are either completed or at least underway to gain necessary experience before the start of the enforceable program. Thus, if major milestones slip, the enforceable program could be delayed. The timeline for the manufacturer-run in-use compliance program is indicated below in Table 4.

Table 4 - Time Line for Manufacturer-Run In-Use Compliance Program

Program Name	ARB/U.S. EPA Engine Family Selection date, by	Manufacturer test completion and reporting date, by
2005 Gaseous Pilot	June 2005	November 2007
2006 Gaseous Pilot	December 2006	June 2008
2006 PM Pilot	December 2006	June 2008
2007 PM Pilot	December 2007	December 2009
2007 Gaseous Enforceable	December 2007	December 2009
2008 Gaseous & PM Enforceable	October 2008	April 2010
2009 Gaseous & PM Enforceable	June 2009	December 2010

X. SUMMARY AND STAFF RECOMMENDATIONS

The proposed manufacturer-run in-use compliance program addresses a long standing need to monitor the emission performance of HDDEs installed in on-highway vehicles when they are operated over a wide range of real-world conditions. It is specifically intended to monitor compliance with NTE requirements and to help ensure that HDDEs will comply with all applicable emission standards throughout their useful lives. The proposed regulation is also necessary to help meet clean air goals as specified in the 2003 SIP. The following specific benefits would be gained with the adoption of staff's proposal

- The use of commercially available PEMS would significantly reduce the testing cost and time of testing HDDEs.
- The proposed requirements would result in a cost savings to the engine manufacturers by aligning California and federal compliance programs, resulting in testing fewer HDDEs than they would otherwise be required to do if two separate compliance programs were in place.
- The proposed testing program would generate a huge amount of HDDE in-use test data that can be used effectively both by the manufacturers and ARB.
- The manufacturers would be able to evaluate the performance of the HDDEs and emission control systems under real world operating conditions and use. The test data could be used to create cleaner and more durable engine designs.
- ARB would be able to use HDDE in-use test data to make an independent evaluation regarding the need for any further testing of an engine family when some of the test data show possible non-conformity. In the future, ARB may also use the HDDE in-use test data to develop in-use emission factors for emissions and air quality modeling.

Staff therefore recommends that the Board adopt the proposed manufacturer-run in-use compliance regulation. The staff also recommends that the Board amend sections 1956.1, 1956.8, title 13, CCR, and the incorporated "California Exhaust Emission Standard and Test Procedures for 2004 and Subsequent Model Heavy-Duty diesel Engines and Otto-Cycle Engines and Vehicles" as set forth in Appendices A, B and C. The proposed regulatory language for California's manufacturer-run in-use compliance program is essentially identical to the requirements adopted by the U.S. EPA.

XI. REFERENCES

ARB, U.S. EPA, Engine Manufacturers Association (EMA) (2003). Outline of Regulatory Proposal (NPRM) for Manufacturer-Run In-Use Heavy-Duty Vehicle NTE Testing Program, May 9, 2003 (http://www.epa.gov/otaq/hd-hwy.htm)

U.S. EPA (2005a). Control of Emissions of Air Pollution from New Motor Vehicles: In-Use Testing for Heavy-Duty Diesel Engines and Vehicles, Final Rule, (Federal Register, Vol. 70, No. 113, PP 34594 – 34626, Tuesday, June 14, 2005) (http://www.epa.gov/otaq/hd-hwy.htm)

U.S. EPA (2005b). Test Procedures for Testing Highway and Nonroad Engines and Omnibus Technical Amendments, (Federal Register, Vol. 70, No. 133, PP 40420 – 40468, Wednesday, July 13, 2005) (http://www.epa.gov/otaq/hd-hwy.htm)

U.S. EPA (2006a). Manufacturer-run Heavy-Duty In-Use Testing Program: Vehicle Screening Guidance, (CISD-06-010 (HD), May 5, 2006) (http://www.epa.gov/otaq/cert/dearmfr/cisd06010.pdf)

ARB, U.S. EPA, EMA (2005a). Memorandum of Agreement, Program to Develop Emission Measurement Accuracy Margins for Heavy-Duty In-Use Testing, May 2005 (http://www.epa.gov/otaq/hd-hwy.htm)

U.S. EPA (2006b). Manufacturer-run Heavy-Duty In-Use Testing Program: Reporting Guidance, (CISD-06-011 (HD), May 5, 2006) (http://www.epa.gov/otaq/cert/dearmfr/cisd06011.pdf)

ARB, U.S. EPA, EMA (2005b).Test Plan to Determine PEMS Measurement Allowances for the Gaseous Emissions Regulated under the Manufacturer-Run Heavy-Duty Diesel Engine In-Use Testing Program, October 25, 2005 (http://www.epa.gov/otaq/hd-hwy.htm)

U.S. EPA (2005c). Technical Support Document, In-Use Testing Program for Heavy-Duty Diesel Engines and Vehicles, (EPA420-R-05-006, June 2005) (http://www.epa.gov/otaq/hd-hwy.htm)

APPENDIX A

PROPOSED REGULATION ORDER

Amend the following section of Title 13, California Code of Regulations, to read as set forth in the following pages:

§1956.1	Exhaust Emission Standards and Test Procedures – 1985 and Subsequent Model Heavy-Duty Urban Bus Engines and Vehicles
§1956.8	Exhaust Emission Standards and Test Procedures for 1985 and Subsequent Model Year Heavy-Duty Engines and Vehicles

Note: This Document is printed in a style to indicate changes from the existing provisions. All existing language is indicated by plain type. All additions to the existing language are indicated by underline. All deletions to the existing language are indicated by ~~strikeout~~.

Amend Title 13, California Code of Regulations, section 1956.1, to read:

§ 1956.1. Exhaust Emissions Standards and Test Procedures - 1985 and Subsequent Model Heavy-Duty Urban Bus Engines and Vehicles.

(a)(1) through (a)(11) [No change.]

(a)(12) 2007 and subsequent – 0.20 g/bhp-hr NOx, 0.01 g/bhp-hr PM, 0.05 g/bhp-hr NMHC, 5.0 g/bhp-hr CO, and 0.01 g/bhp-hr formaldehyde.

(b) [No change.]

(c) The test procedures for determining compliance with standards applicable to 1985 and subsequent model heavy-duty diesel cycle urban bus engines and vehicles and the requirements for participation in the averaging, banking and trading programs, are set forth in the "California Exhaust Emission Standards and Test Procedures for 1985 through 2003 Model Heavy-Duty Diesel Engines and Vehicles, " adopted April 8, 1985, as last amended December 12, 2002, the "California Exhaust Emission Standards and Test Procedures for 2004 and Subsequent Model Heavy-Duty Diesel Engines and Vehicles," adopted December 12, 2002, as last amended [*insert amendment date once regulations are finalized*], and the "California Interim Certification Procedures for 2004 and Subsequent Model Hybrid-Electric Vehicles, in the Urban Bus and Heavy-Duty Vehicle Classes," adopted October 24, 2002, which are incorporated by reference herein.

Note: Authority cited: Sections 39600, 39601, 43013, 43018, 43100, 43101, 43104 and 43806, Health and Safety Code; and Section 28114, Vehicle Code. Reference: Sections 39002, 39003, 39017, 39033, 39500, 39650, 39657, 39667, 39701, 40000, 43000, 43000.5, 43009, 43013, 43018, 43102 and 43806, Health and Safety Code; and Section 28114, Vehicle Code.

Amend Title 13, California Code of Regulations, section 1956.8, to read:

§ 1956.8. Exhaust Emissions Standards and Test Procedures - 1985 and Subsequent Model Heavy-Duty Engines and Vehicles.

(a)(1) [No change.]

(a)(2)(A) The exhaust emissions from new 2004 and subsequent model heavy-duty diesel engines, heavy-duty natural gas-fueled and liquefied-petroleum-gas-fueled engines derived from diesel-cycle engines, and heavy-duty methanol-fueled diesel engines, and the optional, reduced-emission standards for 2002 and subsequent model engines produced beginning October 1, 2002, except in all cases engines used in medium-duty vehicles, shall not exceed:

Exhaust Emission Standards for 2004 and Subsequent Model Heavy-Duty Engines, and Optional, Reduced Emission Standards for 2002 and Subsequent Model Heavy-Duty Engines Produced Beginning October 1, 2002, Other than Urban Bus Engines (grams per brake horsepower-hour [g/bhp-hr])

Model Year	Oxides of Nitrogen Plus Non-methane Hydrocarbons	Optional Oxides of Nitrogen Plus Non-methane Hydrocarbons	Oxides of Nitrogen	Non-methane Hydrocarbons	Carbon Monoxide	Particulates
2004-2006[H],	2.4 [A,C,E,J]	2.5 [B,C,E,J]	n/a	n/a	15.5	0.10 [C]
October 1, 2002 – 2006	n/a	1.8 to 0.3 [A,D,F]	n/a	n/a	15.5	0.03 to 0.01 [G]
2007 and subsequent	n/a	n/a	0.20 [I]	0.14	15.5	0.01 [K]

(a)(2)(A) footnotes [A] through [K] [No change.]

(a)(2)(B) through (a)(5) [No change.]

(b) The test procedures for determining compliance with standards applicable to 1985 and subsequent model heavy-duty diesel engines and vehicles and the requirements for participating in the averaging, banking and trading programs, are set forth in the "California Exhaust Emission Standards and Test Procedures for 1985 through 2003 Model Heavy-Duty Diesel Engines and Vehicles," adopted April 8, 1985, as last amended December 12, 2002, the "California Exhaust Emission Standards and Test Procedures for 2004 and Subsequent Model Heavy-Duty Diesel Engines and Vehicles," adopted December 12, 2002, as last amended *[insert amendment date once regulations are finalized]*, and the "California Interim Certification Procedures for 2004 and Subsequent Model Hybrid-Electric Vehicles, in the Urban Bus and Heavy-Duty Vehicle Classes,"~~,~~ adopted October 24, 2002, which are incorporated by reference herein.

(c) [No change]

(d) The test procedures for determining compliance with standards applicable to 1987 and subsequent model heavy-duty Otto-cycle engines and vehicles are set forth in the "California Exhaust Emission Standards and Test Procedures for 1987 through 2003 Model Heavy-Duty Otto-Cycle Engines and Vehicles," adopted April 25, 1986, as last amended December 27, 2000, the "California Exhaust Emission Standards and Test Procedures for 2004 and Subsequent Model Heavy-Duty Otto-Cycle Engines," adopted December 27, 2000, as last amended ~~December 12, 2002~~ [*insert amendment date once regulations are finalized*], the "California Non-Methane Organic Gas Test Procedures," adopted July 12, 1991, as last amended July 30, 2002, and the "California Interim Certification Procedures for 2004 and Subsequent Model Hybrid-Electric Vehicles, in the Urban Bus and Heavy-Duty Vehicle Classes," adopted October 24, 2002, which are incorporated by reference herein.

(e) through (g) [No change]

(h) The exhaust emissions from new:
(1) 1992 through 2004 model-year Otto-cycle engines used in incomplete medium-duty low-emission vehicles, ultra-low-emission vehicles, and super-ultra-low-emission vehicles, and
(2) 1992 and subsequent model diesel engines used in medium-duty low-emission vehicles, ultra-low-emission vehicles and super-ultra-low-emission vehicles shall not exceed:

Exhaust Emission Standards for Engines Used in Incomplete Otto-Cycle Medium-Duty Low-Emission Vehicles, Ultra-Low-Emission Vehicles, and Super Ultra-Low-Emission Vehicles, and for Diesel Engines Used in Medium-Duty Low-Emission Vehicles, Ultra-Low-Emission Vehicles, and Super Ultra-Low-Emission Vehicles[A,F]

(grams per brake horsepower-hour)

Model Year	Vehicle Emissions Category[B]	Carbon Monoxide	NMHC + NOx [C]	Non-Methane Hydrocarbons	Oxides of Nitrogen	Formaldehyde	Particulates[D]
1992[E] - 2001	LEV	14.4	3.5 [K]	n/a	n/a	0.050	0.10 [K]
2002-2003[E]	LEV	14.4	3.0 [K]	n/a	n/a	0.050	0.10 [K]
1992-2003[E,H]	ULEV	14.4	2.5[K]	n/a	n/a	0.050	0.10 [K]
2004 and subsequent [L]	ULEV - Opt A	14.4	2.5 [I,J,K]	n/a	n/a	0.050	0.10 [J,K]
2004 and subsequent [L]	ULEV - Opt. B	14.4	2.4 [I,J,K]	n/a	n/a	0.050	0.10 [J,K]
2007 and subsequent [D]	ULEV	15.5	n/a	0.14	0.20	0.050	0.01
1992 and subsequent [L]	SULEV	7.2	2.0 [K]	n/a	n/a	0.025	0.05 [K]
2007 and subsequent [D]	SULEV	7.7	n/a	0.07	0.10	0.025	0.005

(h)(1) and (h)(2) footnotes [A] through [L] [No change.]

NOTE: Authority cited: Sections 39600, 39601, 43013, 43018, 43100, 43101, 43104, 43105 and 43806, Health and Safety Code; and Section 28114, Vehicle Code. Reference: Sections 39002, 39003, 39500, 43000, 43013, 43018, 43100, 43101, 43102, 43104, 43106, 43202, 43204, 43206, 43210, 43211, 43212, 43213, and 43806, Health and Safety Code; and Section 28114, Vehicle Code.

APPENDIX B

PROPOSED AMENDMENTS TO THE CALIFORNIA EXHAUST EMISSION STANDARDS AND TEST PROCEDURES FOR 2004 AND SUBSEQUENT MODEL HEAVY-DUTY DIESEL-CYCLE ENGINES AND VEHICLES

45-Day Notice Version
Date of Release: August 11, 2006
Board Hearing Date: September 28, 2006

PROPOSED

State of California
AIR RESOURCES BOARD

CALIFORNIA EXHAUST EMISSION STANDARDS AND TEST PROCEDURES FOR 2004 AND SUBSEQUENT MODEL HEAVY-DUTY DIESEL ENGINES AND VEHICLES

Adopted: December 12, 2002
Amended: July 24, 2003
Amended: [Requirements to Reduce Idling Emissions adopted by the Board on October 20, 2005, and currently being finalized. These amendments are not included in this version. For more information, see http://www.arb.ca.gov/regact/hdvidle/hdvidle.htm]
Amended: (Insert date of finalized amendment)

NOTE: Proposed amendments in this document are printed in a style to indicate changes from existing provisions (July 24, 2003 amendments.) All existing language is indicated by plain type. All additions to the existing language are indicated by underline. All deletions to the existing language are indicated by ~~strikeout~~. Only those portions of the existing language containing the proposed modifications are included. All other portions remain unchanged and are indicated by the symbol "* * * * *" for reference. A complete set of the test procedures, adopted on December 12, 2002, is available at http://www.arb.ca.gov/msprog/onroadhd/2004hddtps_levhdg02_clean_11-13.pdf .

CALIFORNIA EXHAUST EMISSION STANDARDS AND TEST PROCEDURES FOR 2004 AND SUBSEQUENT MODEL HEAVY-DUTY DIESEL ENGINES AND VEHICLES

The following provisions of Subparts A, I, ~~and~~ N, S, and T, Part 86, and of Subparts A through K, Part 1065, Title 40, Code of Federal Regulations, as adopted or amended by the U.S. Environmental Protection Agency on the date set forth next to the ~~40 CFR Part 86~~ applicable section listed below, and only to the extent they pertain to the testing and compliance of exhaust emissions from heavy-duty diesel engines and vehicles, are adopted and incorporated herein by this reference as the "California Exhaust Emission Standards and Test Procedures for 2004 and Subsequent Model Heavy-Duty Diesel Engines and Vehicles," except as altered or replaced by the provisions set forth below.

PART 86 – CONTROL OF EMISSIONS FROM NEW AND IN-USE HIGHWAY VEHICLES AND ENGINES

~~PART~~ I. GENERAL PROVISIONS FOR CERTIFICATION AND IN-USE VERIFICATION OF EMISSIONS.

§86.1 **Reference materials**. June 14, 2005.

1 Delete subparagraph (a).

2 Amend subparagraph (b) as follows:

2.1 Delete subparagraphs (b)(1) through (b)(5).

2.2 Subparagraph (b)(6) [No change.]

Subpart A - General Provisions for Emission Regulations for 1977 and Later Model Year New Light-Duty Vehicles, Light-Duty Trucks, and Heavy-Duty Engines, and for 1985 and Later Model Year New Gasoline-Fueled, Natural Gas-Fueled, Liquefied Petroleum Gas-Fueled and Methanol-Fueled Heavy-Duty Vehicles.

1. General Applicability. [§86.xxx-1]

* * * * *

2. Definitions. [§86.xxx-2]

A. Federal Provisions.

1. **§86.004-2** January 18, 2001. [All federal definitions apply, except as otherwise noted below. Definitions specific to other requirements are contained in separate documents.]

B. California Provisions.

"Administrator" means the Executive Officer of the Air Resources Board.
"Certificate of Conformity" means "Executive Order" certifying vehicles for sale in California.
"Certification" means certification as defined in Section 39018 of the Health and Safety Code.
"**EPA**" shall also mean Air Resources Board or Executive Officer of the Air Resources Board
"EPA Enforcement Officer" means the Executive Officer or his delegate.
"Medium-duty engine" means a heavy-duty engine that is used to propel a medium-duty vehicle.
"Medium-duty vehicle" means 2004 through 2006 model year heavy-duty low-emission vehicle, ultra-low-emission vehicle, super-ultra-low-emission vehicle or zero-emission vehicle certified to the standards in title 13, CCR, section 1960.1(h)(2) having a manufacturer's gross vehicle weight rating of 14,000 pounds or less; and any 2004 and subsequent model heavy-duty low-emission, ultra-low-emission, super-ultra-low-emission or zero-emission vehicle certified to the standards in title 13, CCR section 1956.8(h), having a manufacturer's gross vehicle weight rating between 8,501 and 14,000 pounds.
"NTE standard" means NTE emission limit.
"**Warranty period**" [For guidance see title 13, CCR, §2036].

* * * * *

11. Emission standards for diesel heavy-duty engines and vehicles. [§86.xxx-11]

A. Federal provisions.

1. **§86.004-11 Emission standards for 2004 and later model year diesel heavy-duty engines and vehicles.** October 6, 2000.

* * * * *

2. **§86.007-11 Emission standards and supplemental requirements for 2007 and later model year diesel heavy-duty engines and vehicles.** ~~January 18, 2001~~ July 13, 2005.

2.1. Add the following sentence to the introductory paragraph: Except as otherwise noted, references in this subsection to heavy-duty engines or HDEs shall include medium-duty engines as defined in Section I.2.B of these test procedures.

2.2 Subparagraphs (a) and (a)(1). [No change.]

2.2.1 Amend subparagraph (a)(2) as follows: The standards set forth in paragraph (a)(1) of this section refer to the exhaust emitted over the operating schedule set forth in paragraph (f)(2) of appendix I to this part, and measured and calculated in accordance with the procedures set forth in subpart N of this part as amended in part II of these test procedures, except as noted in §86.007-23(c)(2) or superseding sections.

2.2.2. Delete subparagraph (a)(3). [For guidance see Subpart N, §86.1360-2007 of these test procedures].

2.2.3. Delete subparagraph (a)(4)(i) through (a)(4)(~~v~~ vi). [For guidance see Subpart N, §86.1370-2007 of these test procedures]

2.3 Subparagraphs (b)(1)(i) through (b)(1)(iii). [No change.]

2.3.1 Delete subparagraph (b)(1)(iv). [For guidance see Subpart N, §86.1370-2007 of these test procedures]

2.3.2 Subparagraphs (b)(2)(i). [No change.]

2.3.3 Delete subparagraph (b)(2)(ii). [For guidance see Subpart N, §86.1370-2007 of these test procedures]

2.3.4 Subparagraph (b)(3) and (b)(4). [No change.]

2.4 Subparagraph (c). [No change.]

2.5. Amend subparagraph (d) as follows: Every manufacturer of new motor vehicle engines subject to the standards prescribed in title 13, CCR, §1956.8 (a), §1956.8 (h), and this section shall, prior to taking any of the actions prohibited by California Health & Safety Code section 43211 or as specified in section 203(a)(1) of the Act, test or cause to be tested motor vehicle engines in accordance with applicable procedures in subpart I or N as amended in part II of these test procedures to ascertain that such test engines meet the requirements of paragraphs (a), (b), (c), and (d) of this section.

2.6 Subparagraphs (e) through (h). [No change.]

B. California provisions.

1. Urban Bus Standards.

1.1 The exhaust emissions from new 2004 through 2006 model year heavy-duty engines (other than diesel-fueled, dual-fuel and bi-fuel heavy-duty engines) used in urban buses shall not exceed the standards set forth in 40 CFR §86.004-11(a)(1), above.

1.2 The exhaust emissions, as measured under transient operating conditions, from 2004 through 2006 model year diesel-fueled, dual-fuel and bi-fuel heavy-duty engines used in urban buses shall not exceed:

2004 – 2006 Heavy-Duty Diesel-Fuel, Dual Fuel, and Bi-Fuel Urban Bus Engine Exhaust Emission Standards* (grams per brake horsepower-hour or g/bhp-hr)				
NOx[1]	**NMHC or NMHCE**	**CO[3]**	**PM[2]**	**HCHO[4]**
0.5 (0.2 g/megajoule)	0.05 (0.02 g/megajoule)	5.0 (1.9 g/megajoule); [7.0 (2.6 g/megajoule)]	0.01 (0.004 g/megajoule)	0.01 (0.004 g/megajoule)

1 Oxides of Nitrogen (NOx). This standard is for certification testing and selective enforcement audit

testing. As an option, manufacturers may choose to meet the NOx standard with a base engine that is certified to the standards in §86.004-11(a)(1), (October 6, 2000), equipped with an aftertreatment system that reduces NOx to 0.5 g/bhp-hr and PM to 0.01 g/bhp-hr. The NMHC, CO, and formaldehyde standards above shall still apply. Manufacturers shall be responsible for full certification, durability, testing, and warranty and other requirements for the base engine. For the aftertreatment system, manufacturers shall not be subject to the certification durability requirements, or in-use recall and enforcement provisions, but are subject to warranty provisions for functionality.

2 Particulates. This standard is for certification testing, selective enforcement audit testing, and in-use testing. As an option, manufacturers may choose to meet the PM standard with an aftertreatment system that reduces PM to 0.01 g/bhp-hr. Manufacturers shall be responsible for full certification, durability, testing, and warranty and other requirements for the base engine. For the aftertreatment system, manufacturers shall not be subject to the certification durability requirements, or in-use recall and enforcement provisions, but are subject to warranty provisions for functionality.

3 Carbon monoxide. The 5.0 g/bhp-hr (1.9 grams per megajoule) standard is for certification testing and selective enforcement audit testing, and the 7.0 g/bhp-hr (2.6 grams per megajoule) standard is for in-use testing.

4 Formaldehyde. This standard is for certification testing, selective enforcement audit testing and in-use testing.

1.3 The exhaust emissions from new 2007 and subsequent model year heavy-duty engines used in urban buses shall not exceed the following standards:

2007 and Subsequent Heavy-Duty Diesel Urban Bus Engine Exhaust Emission Standards* (grams per brake-horsepower-hour or g/bhp-hr)				
NOx	**NMHC or NMHCE**	**CO**	**PM**	**HCHO**
0.20 (0.075 g/megajoule)	0.05 (0.02 g/megajoule)	5.0 (1.9 g/megajoule)	0.01 (0.004 g/megajoule)	0.01 (0.004 g/megajoule)

* * * * *

5. **Standards for Medium-Duty Engines.** A manufacturer of heavy-duty engines used in medium-duty vehicles may choose to comply with the following standards as an alternative to the primary emission standards and test procedures specified in title 13, CCR, §1961. A manufacturer that chooses to comply with these optional heavy-duty standards and test procedures shall specify, in the application for certification, an in-use compliance test procedure, as provided in title 13, CCR, §2139(c).

The exhaust emissions from new 2004 and subsequent model heavy-duty diesel engines used in ultra-low emission and super-ultra-low emission medium-duty diesel vehicles shall not exceed:

Exhaust Emission Standards for 2004 – 2006 Model Medium-Duty ULEVs and SULEVs

Vehicle Emission Category	NOx + NMHC		CO	PM	HCHO
ULEV[1] Option A	2.5 (with a 0.5 cap on NMHC)		14.4	0.10	0.050
ULEV[1]; Option B	2.4		14~~,~~.4	0.10	0.050
Exhaust Emission Standards for 2007 and Subsequent Model Medium-Duty ULEVs and SULEVs					
Vehicle Emission Category	NOx	NMHC or NMHCE	CO	PM	HCHO
ULEV[1]	~~See 40 CFR §86.007-11(a)(1)(i)~~ 0.20	~~See 40 CFR §86.007-11(a)(1)(ii)~~ 0.14	~~See 40 CFR §86.007-11(a)(1)(iii)~~ 15.5	~~See 40 CFR §86.007-11(a)(1)(iv)~~ 0.01	~~0.01~~ 0.050
SULEV[1]	0.10	0.07	7.7	0.005	~~0.005~~ 0.025

[1] Emissions averaging may be used to meet these standards using the requirements for participation averaging, banking and trading programs, as set forth in Section I.15 of these test procedures.

* * * * *

16. Prohibition of defeat devices. §86.00~~0~~4-16 ~~January 18, 2001~~ July 13, 2005. [No change.]

* * * * *

21. Application for certification. [§86.xxx-21]

A. Federal provisions.

1. **§86.004-21** October 6, 2000. Amend as follows:
   1.1 Subparagraphs (a) through (l). [No change.]
   1.2 Delete subparagraph (m).
   1.2 Subparagraph (n). [No change.]

2. **§86.007-21** ~~October 6, 2000~~ July 13, 2005. Amend as follows:
   2.1 Subparagraphs (a) through (l). [No change.]
   2.2 Delete subparagraph (m).
   2.3 Subparagraph (n). [No change.]
   2.4 Amend subparagraph (o) as follows: For 2005 and subsequent model year diesel heavy-duty engines, the manufacturer must provide the following additional information pertaining to the supplemental steady-state test conducted

under § 86.1360-2007:

2.4.1 ~~Amend s~~ Subparagraph (o)(1) ~~as follows: Weighted brake-specific emissions data (i.e., in units of g/bhp-hr), calculated according to § 86.1360-2007(e)(5) and (6), for all pollutants for which an emission standard is established in § 86.004-11(a);~~ [No change]

2.4.2 Amend ~~S~~ subparagraph~~s~~ (o)(2) ~~through (o)(6). [No change.]~~ as follows: For engines subject to the MAEL (see §86.1360-2007B.1), brake specific gaseous emission data for each of the 12 non-idle test points (identified under §86.1360-2007(b)(1)) and the 3 selected test points (identified under §86.1360-2007(b)(2));

2.4.3 Amend subparagraph (o)(3) as follows: For engines subject to the MAEL (see §86.1360-2007B.1), concentrations and mass flow rates of all regulated gaseous emissions plus carbon dioxide;

2.4.4 Subparagraph (o)(4) and (o)(5). [No change.]

2.4.~~3~~ 5 Amend subparagraph (o)(~~7~~ 6) as follows: For engines subject to the MAEL (see §86.1360-2007B.1), ~~A~~ a statement that the engines will comply with the weighted average emissions cap and interpolated values comply with the emission testing caps specified in §86.1360-2007B.1 for the useful life of the engine. The manufacturer also must maintain records at the manufacturer's facility which contain a detailed description of all test data, engineering analyses, and other information which provides the basis for this statement, where such information exists. The manufacturer must provide such information to the Executive Officer upon request.

2.4.6 Subparagraph (o)(7). [Reserve.]

2.5 Amend subparagraph (p) as follows:

2.5.1. (1) The manufacturer must provide a statement in the application for certification that the diesel heavy-duty engine for which certification is being requested will comply with the applicable Not-To-Exceed Limits specified in §86.1370-2007A.1.4 when operated under all conditions which may reasonably be expected to be encountered in normal vehicle operation and use. The manufacturer also must maintain records at the manufacturer's facility which contain all test data, engineering analyses, and other information which provides the basis for this statement, where such information exists. The manufacturer must provide such information to the Executive Officer upon request.

2.5.2. Subparagraph (p)(2). [No change.]

2.5.3. Amend subparagraph (p)(3) as follows: For each engine model and/or horsepower rating within an engine family for which a manufacturer is applying for a NTE deficiency(ies) under the provisions of §86.1370-2007B.3, the manufacturer's application for an NTE deficiency(ies) must include a complete description of the deficiency, including but not limited to: the specific description of the deficiency; what pollutant the deficiency is being applied for, all engineering efforts the manufacturer has made to overcome the deficiency, what specific operating conditions the deficiency is being requested for (i.e., temperature ranges, humidity ranges, altitude ranges, etc.), a full description of the auxiliary emission control device(s) which will be used to maintain emissions to the lowest practical level; and what the lowest practical emission level will be.

* * * * *

28. Compliance with emission standards. §86.xxx-28 January 18, 2001.

A. Federal provisions.

1. **§86.004-28.** January 18, 2001. Amend as follows:

1.1 Subparagraphs (a) through (c)(4)(i) [No change.]

1.2 Amend subparagraph (c)(4)(ii) as follows: [No change, except that diesel-cycle smoke testing shall only apply to petroleum-fueled diesel-cycle engines.]

1.3. Subparagraph (c)(4)(iii)(A) [n/a; Otto-cycle engines.]

1.4 Subparagraph (c)(4)(iii)(B): [No change, except that the exhaust emission results for formaldehyde exhaust emission results for methanol-fueled engines and vehicles, ultra-low emission vehicles and super-ultra-low emission vehicles shall also be adjusted by the appropriate deterioration factor (through addition or multiplication as the case may be.]

1.5 Amend subparagraph (c)(4)(iii)(B)(*3*) as follows: For petroleum-fueled diesel cycle HDEs only: [No change to remainder of paragraph.]

1.6 Subparagraphs (c)(iv) through (i). [No change.]

B. California provisions.

1. Deterioration factor for exhaust emissions.

1.1 **Additive deterioration factor.** Except as specified in paragraph B.1.2 of this section, use an additive deterioration factor for exhaust emissions. An additive deterioration factor for a pollutant is the difference between exhaust emissions at the end of the useful life and exhaust emissions at the low-hour test point. In these cases, adjust the official emission results for each tested engine at the selected test point by adding the factor to the measured emissions. If the factor is less than zero, use zero. Additive deterioration factors must be specified to one more decimal place than the applicable standard.

1.2 **Multiplicative deterioration factor.** Use a multiplicative deterioration factor if good engineering judgment calls for the deterioration factor for a pollutant to be the ratio of exhaust emissions at the end of the useful life to exhaust emissions at the low-hour test point. For example, if you use aftertreatment technology that controls emissions of a pollutant proportionally to engine-out emissions, it is often appropriate to use a multiplicative deterioration factor. Adjust the official emission results for each tested engine at the selected test point by multiplying the measured emissions by the deterioration factor. If the factor is less than one, use one. A multiplicative deterioration factor may not be appropriate in cases where testing variability is significantly greater than engine-to-engine variability.

Multiplicative deterioration factors must be specified to one more significant figure than the applicable standard.

* * * * *

35. Labeling. §86.xxx-35.

A. **Federal Provisions**

1. **§86.001-35** ~~January 18, 2001~~ April 6, 1994.

* * * * *

2. **§86.007-35** ~~January 18, 2001~~ July 13, 2005.

* * * * *

~~PART~~ II. TEST PROCEDURES

Subpart I - Emission Regulations for New Diesel-Fueled Heavy-Duty Engines; Smoke Exhaust Test Procedure

* * * * *

Subpart N - Emission Regulations for New Otto-Cycle and Diesel Heavy-Duty Engines; Gaseous and Particulate Exhaust Test Procedures

86.1301-~~90~~	Scope; applicability. ~~April 11, 1989~~ July 13, 2005.
86.1302-84	Definitions. November 16, 1983.
86.1303-84	Abbreviations. November 16, 1983.
86.1304-~~90~~	Section numbering; construction. ~~October 6, 2000~~ July 13, 2005.
86.1305-2004	Introduction; structure of subpart. October 6, 2000.
86.1305-2010	Introduction; structure of subpart. July 13, 2005.

* * * * *

86.1313-98 Fuel specifications. February 18, 2000.

1. Subparagraph (a) [n/a]

2. Amend subparagraph (b) Diesel test fuel as follows:

   2.1 Subparagraph (b)(1) [No change.]

   2.2 Add the following language to subparagraph (b)(2): For 2004 through 2005 model-year medium-duty diesel-fueled engines, the petroleum fuel used in exhaust emissions testing may meet the specifications listed below, or substantially equivalent specifications approved by the Executive Officer, as an option to the specifications in Table N90-2. Where a manufacturer elects pursuant to this subparagraph to conduct exhaust emission testing using the specifications in Table N98-2, or the specifications listed below, the Executive Officer shall conduct exhaust emission testing with the diesel fuel meeting the specifications elected by the manufacturer. The manufacturer shall submit evidence to the Executive Officer demonstrating to the Executive Officer's satisfaction that the test fuel will be the predominant in-use fuel. Such evidence could include such things as copies of signed contracts from customers indicating the intent to purchase and use the test fuel as the primary fuel for use in the engines or other evidence acceptable to the Executive Officer.

Fuel Property	Limit	Test Method [a]
Natural Cetane Number	47-55	D613-86
Distillation Range, °F		Title 13 CCR, §2282(g)(3)
IBP	340-420	
10% point	400-490	
50% point	470-560	
90% point	550-610	
EP	580-660	
API Gravity, degrees	33-39	D287-82
Total Sulfur, wt. %	0.01-0.05	Title 13 CCR, §2282(g)(3)
Nitrogen Content, ppmw	100-500	Title 13 CCR, §2282(g)(3)
Total Aromatic Hydrocarbons, vol.%	8-12	Title 13 CCR, §2282(g)(3)
Polycyclic Aromatic Hydrocarbons, wt. % (max.)	1.4	Title 13 CCR, §2282(g)(3)
Flashpoint, °F (max)	130	D 93-80
Viscosity @ 40°~~F~~ C, centistokes	2.0-4.1	D 445-83

[a] ASTM specifications unless otherwise noted. A reference to a subsection of Title 13, CCR, §2282 means the test method identified in that subsection for the particular property. A test method other than that specified may be used following a determination by the Executive Officer that the other method produces results equivalent to the results of the specified method.

2.3 (3) Add the following language to subparagraph (b)(3): For 2004 and 2005 model-year medium-duty diesel-fueled engines, diesel fuel representative of commercial diesel fuel which will be generally available through retail outlets shall be used in service accumulation.

3. Subparagraphs (c), (d) and (e). [For guidance see §86.1313-94, above.]

86.1313-04 Fuel specifications. January 18, 2001. [n/a]

86.1313-2007 Fuel specifications. January 18, 2001.

1. Subparagraph (a) [n/a]
2. Subparagraph (b) heading and (b)(1) [No change]
3. Reletter subparagraph §86.1313-2007(b)(2) as (b)(2)(A) and add the following:

(b)(2)(B) Diesel fuel having the specifications listed below may be used in exhaust emission testing as an option to the specifications in Table N07-2. If a manufacturer elects to use this option, the Executive Officer shall conduct exhaust emission testing with diesel fuel having the specifications listed below.

Fuel Property	Limit	Test Method [a]
Natural Cetane Number	47-55	D613-86
Distillation Range, °F		Title 13 CCR, §2282(g)(3)
IBP	340-420	
10% point	400-490	
50% point	470-560	
90% point	550-610	
EP	580-660	
API Gravity, degrees	33-39	D287-82
Total Sulfur, ppm	7-15	Title 13 CCR, §2282(g)(3)
Nitrogen Content, ppmw	100-500	Title 13 CCR, §2282(g)(3)
Total Aromatic Hydrocarbons, vol.%	8-12	Title 13 CCR, §2282(g)(3)
Polycyclic Aromatic Hydrocarbons, wt. % (max.)	1.4	Title 13 CCR, §2282(g)(3)
Flashpoint, °F (max)	130	D 93-80
Viscosity @ 40°~~F~~ C, centistokes	2.0-4.1	D 445-83

[a] ASTM specifications unless otherwise noted. A reference to a subsection of Title 13, CCR, §2282 means the test method identified in that subsection for the particular property. A test method other than that specified may be used following a determination by the Executive Officer that the other method produces results equivalent to the results of the specified method.

4. Subparagraph (b)(3) [No change]

* * * * *

86.1321-90 Hydrocarbon analyzer calibration. July 13, 2005.
86.1321-94 Hydrocarbon analyzer calibration. ~~September 5, 1997~~ July 13, 2005.

* * * * *

86.1333-2010 Transient test cycle generation. July 13, 2005.

* * * * *

86.1360-2007 Supplemental ~~steady-state~~ emission test; test cycle and procedures.

~~January 18, 2001~~ July 13, 2005.

A. Federal provisions

1. Introductory paragraph. [No change.]

2. Amend subparagraph (a) as follows: Applicability. This section applies to 2005 and subsequent model year heavy duty diesel engines.

3. Amend subparagraph (b) as follows:

3.1 Amend ~~S~~ subparagraph (b)(1) as follows: The ramped-modal procedures described in §86.1362-2007 apply to 2007 and subsequent model year heavy duty diesel engines. See B.1. of this section for the procedures applicable to 2005 and 2006 model year engines.

~~3.1.1 (b)(1)(i). Test cycle. [No change.]~~

~~3.1.2. Add subparagraph (b)(1)(ii) as follows: For 2007 and subsequent model years, upon Executive Officer approval, the manufacturer may use mode lengths other than those listed in subparagraph (b)(1)(i) of this section.~~

3.2. Subparagraph (b)(2): [No change.]

4. ~~Amend s~~Subparagraph (c) ~~as follows: Determining engine speeds. (1) The engine speeds A, B, and C, referenced in the table in paragraph (b)(1) of this section, and speeds D and E must be determined as follows: [No change to remainder of subparagraph.]~~ [Reserve.]

5. Subparagraph (d) Determining the control area. [No change.]

6. Subparagraph (e) ~~Test requirements.~~ [~~No change~~ Reserve.]

7. Amend subparagraph (f) as follows: Maximum allowable emission limits.

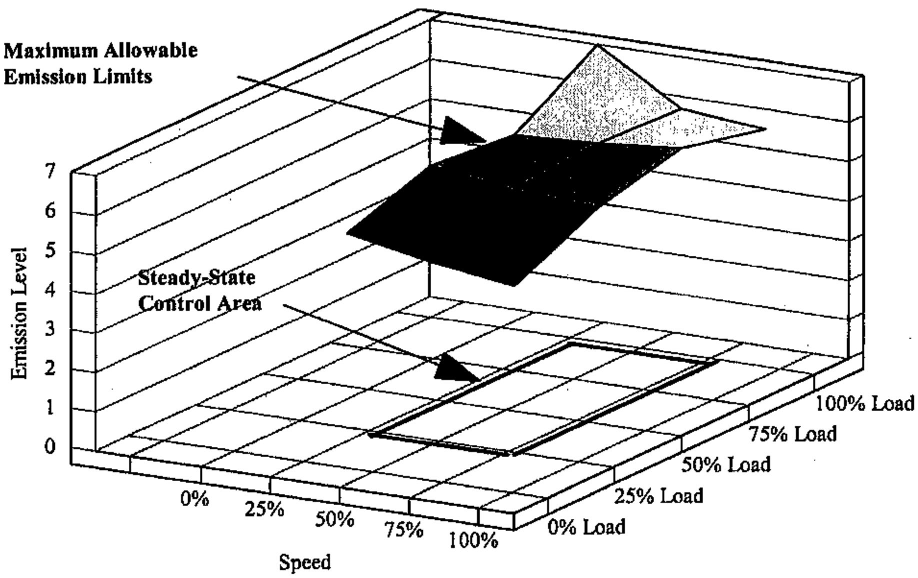
(1) For gaseous emissions, the 12 non-idle test point results and the four-point linear interpolation procedure specified in paragraph (g) of this section for intermediate conditions, shall define Maximum Allowable Emission Limits for purposes of paragraph B.1 of this section except as modified under paragraph (f)(3) of this section. [No change to remainder of paragraph.]

45-Day Notice Version
Date of Release: August 11, 2006
Board Hearing Date: September 28, 2006

Figure 1

Maximum Allowable Emission Limits

Sample - For Illustration Only



(2) If the weighted average emissions, calculated according to paragraph (e)(6) of this section, for any gaseous pollutant is equal to or lower than required by paragraph B.1 of this section, each of the 13 test values for that pollutant shall first be multiplied by the ratio of the applicable emission standard (under paragraph B.1 of this section) to the weighted average emissions value, and then by 1.10 for interpolation allowance, before determining the Maximum Allowable Emission Limits under paragraph (g)(2) of this section.

(3) [No change.]

8. Subparagraph (g) Calculating intermediate test points. [No change.]

~~9. Subparagraph (h): Test fuel specifications. [No change.]~~

~~10. Subparagraph (i) General requirements: [No change.]~~

B. California provisions

1. **Emission testing caps and procedures for the 2005 and subsequent model years.**

1.1 Testing to determine whether an engine meets the applicable emission limits when measured over the supplemental emission test is performed according to section 86.1363-2007. The weighted average exhaust emissions, as determined according to 86.1363-2007(g) under paragraph (e)(5) and (6) of this section pertaining to the supplemental steady-state test cycle, for each regulated pollutant shall not exceed 1.0 times the applicable emission standards specified in Part I.11 of these test procedures or FELs specified in §86.007-11(a)(1).

1.2 For engines not having a NOx FEL less than 1.5 g/bhp-hr, gaseous exhaust emissions shall not exceed the steady-state interpolated values determined by the Maximum Allowable Emission Limits (for the corresponding speed and load), as determined under subparagraph (g) of this section, when the engine is operated in the steady-state control area defined under subparagraph (d) of this section, during steady-state engine operation.

1.3 For engines with a NOx FEL less than 1.5 g/bhp-hr, the Maximum Allowable Emission Limit requirements, as determined under Sec. 86.1360-2007(f), do not apply.

1.4 The emission caps specified in this section shall be rounded to the same number of significant figures as the applicable standards in Part I.11 of these test procedures using ASTM E29-93a.

* * * * *

86.1362-2007 Steady-state testing with a ramped-modal cycle. July 13, 2005.

86.1363-2007 Steady-state testing with a discrete-mode cycle. July 13, 2005.

86.1370-2007 Not-To-Exceed test procedures. January 18, 2001 July 13, 2005.

A. Federal provisions.

1. Amend subparagraph (a) as follows: General. The purpose of this test procedure is to measure in-use emissions of 2005 and subsequent model year heavy-duty diesel engines while operating within a broad range of speed and load points (the Not-To-Exceed Control Area) and under conditions which can reasonably be expected to be encountered in normal vehicle operation and use. Emission results from this test procedure are to be compared to the Not-To-Exceed Limits specified in paragraph (d)(1) of this section. The Not-To-Exceed Limits specified in paragraph (d)(1) of this section do not apply for engine starting conditions specified in subparagraph A.1.7 of this section. Tests conducted using the procedures specified in §1901 are considered valid Not-to-

45-Day Notice Version
Date of Release: August 11, 2006
Board Hearing Date: September 28, 2006

Exceed tests (Note: duty cycles and limits on ambient conditions do not apply for Not-To-Exceed tests).

* * * * *

B. California provisions.

1. Ambient operating regions.

* * * * *

5. Submission of NTE deficiencies and limited testing region information. Manufacturers are not required to provide engine information exclusively related to in-use testing as part of initial certification. However, upon request from ARB, the manufacturers must provide the information which clearly identifies parameters defining all NTE deficiencies described under subparagraph B.3. of this section and parameters defining all NTE limited testing regions described under 86.1370-07(b)(6) and (7) that are requested. When requested, deficiencies and limited testing regions must be reported for all engine families and power ratings in English with sufficient detail for us to determine if a particular deficiency or limited testing region will be encountered in the emission test data from the portable emission-sampling equipment and field-testing procedures referenced in 86.1375. Such information is to be provided within 60 days of the request from ARB.

86.1372-2007 Measuring smoke emissions within the NTE zone. October 6, 2000.

This section contains the measurement techniques to be used for determining compliance with the filter smoke limit or opacity limits in §86.1370-2007 (d)(3)(i). [No change to remainder of section.]

86.1375-2007 Equipment Specifications for Field Testing. June 14, 2005. [No change.]

86.1380-2004 Load response test. October 6, 2000. [Delete]

Subpart S – General Compliance Provisions for Control of Air Pollution From New and In-Use Light-Duty Vehicles, Light-Duty Trucks, and Complete Otto-Cycle Heavy-Duty Vehicles.

86.1863-07 Optional chassis certification for diesel vehicles. June 17, 2003.

1. Amend subparagraph (a) as follows: A manufacturer may optionally certify heavy-duty diesel vehicles weighing 14,000 pounds GVWR or less to the emission standards specified in title 13, CCR, §1961. Such vehicles must meet all applicable requirements of the "California Exhaust Emission Standards and Test Procedures for 2001 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles," as incorporated by reference in title 13, CCR, §1961 (d).

2. Amend subparagraph (b) as follows: Diesel vehicles optionally certified under this section are subject to the OBD requirements of title 13, CCR, §1968.2.

3. Subparagraphs (c) to (g). [No change.]

Subpart T - Manufacturer-Run In-Use Testing Program for Heavy-Duty Diesel Engines

86.1901 What testing requirements apply to my engines that have gone into service? June 14, 2005.

86.1905 How does this program work? June 14, 2005.

1. Subparagraphs (a) through (f). [No change.]

2. Amend subparagraph (g) as follows: For any communication related to this subpart, contact the On-Road Heavy-Duty Diesel Section Manager, Mobile Source Control Division, Air Resources Board, 9528 Telstar Avenue, El Monte, CA 91731.

86.1908 How must I select and screen my in-use engines? June 14, 2005.

1. Amend subparagraph (a) as follows:
 1.1 Subparagraph (a)(1) through (a)(8). [No change.]
 1.2 Amend subparagraph (a)(9) as follows: The vehicles have not exceeded the applicable useful life, in miles or years as defined in title 13, CCR, section 2112; you may otherwise not exclude engines from testing based on their age or mileage.
 1.3 Subparagraph (a)(10). [No change.]

2. Subparagraph (b) through (d). [No change.]

86.1910 How must I prepare and test my in-use engines? June 14, 2005.

86.1912 How do I determine whether an engine meets the vehicle-pass criteria? June 14, 2005.

86.1915 What are the requirements for Phase 1 and Phase 2 testing? June 14, 2005.

86.1917 How does in-use testing under this subpart relate to the emission-related warranty in Section 207(a)(1) of the Clean Air Act? June 14, 2005.

1. Amend subparagraph (a) as follows: An exceedance of the NTE found through the in-use testing program under this subpart is not by itself sufficient to show a breach of warranty under title 13, CCR, section 2036. [No change to remainder of paragraph.]

2. Amend subparagraph (b) as follows: To the extent that in-use NTE testing does not reveal such a material deficiency at the time of sale in the design or manufacture of an engine compared with the certified engine, or a defect in the

materials and workmanship of a component or part, test results showing an exceedance of the NTE by itself would not show a breach of warranty under title 13, CCR, section 2036.

86.1920 What in-use testing information must I report to EPA? June 14, 2005.

1. Amend subparagraph (a) as follows: Send us electronic reports using an approved information format to Chief, Emission Research and Regulatory Development Branch, Mobile Source Control Division, Air Resources Board, 9528 Telstar Avenue, El Monte, California, 91731. If you want to use a different format, send us a written request with justification.

2. Subparagraphs (b) to (c). [No change.]

3. Amend subparagraph (d) as follows: Send us an electronic notification at inuse@arb.ca.gov describing any voluntary vehicle/engine emission evaluation test you intend to conduct ... [No change to remainder of paragraph.]

4. Amend subparagraph (e) as follows: Send us an electronic notification at inuse@arb.ca.gov within 15 days after your initial review of the test data for a selected engine family indicates that three engines in Phase 1 testing have failed to comply with the vehicle-pass criteria. [No change to remainder of paragraph.]

5. Subparagraphs (f) and (g). [No change.]

86.1925 What records must I keep? June 14, 2005.

86.1930 What special provisions apply from 2005 through 2007? June 14, 2005.

86.1935 What special provisions may apply as a consequence of a delay in the accuracy margin report for portable emission measurement systems? June 14, 2005.

Appendix I to Part 86 - Urban Dynamometer Schedules.

(f)(2) EPA Engine Dynamometer Schedule for Heavy-Duty Diesel Engines. December 10, 1984.

Appendix I to Subpart T – Sample Graphical Summary of NTE Emission Results

PART 1065 – ENGINE-TESTING PROCEDURES.

Subpart A – Applicability and General Provisions

1065.1 Applicability. July 13, 2005.

1. Amend subparagraph (a) as follows:
   1.1. Introductory paragraph. [No change.]
   1.2. Amend subparagraph (a)(1) as follows: Model year 2010 and later heavy-duty highway engines we regulate under title 13, CCR, §1956.8. For earlier model years, manufacturers may use the test procedures in this part or those specified in 40 CFR part 86, subpart N, according to §1065.10, as modified by these test procedures.
   1.3. Subparagraphs (a)(2) through (a)(4). [n/a]

2. Subparagraph (b). [n/a]

3. Subparagraph (c) through (g). [No change.]

1065.2 Submitting information to EPA under this part. July 13, 2005.

1. Subparagraphs (a) through (d). [No change.]

2. Amend subparagraph (e) as follows: See title 13, CCR, section 91011 for provisions related to confidential information. Note that according to this section, emission data shall not be identified as confidential.

1065.5 Overview of this part 1065 and its relationship to the standard-setting part. July 13, 2005.
1065.10 Other procedures. July 13, 2005.
1065.12 Approval of alternate procedures. July 13, 2005.
1065.15 Overview of procedures for laboratory and field testing. July 13, 2005.
1065.20 Units of measure and overview of calculations. July 13, 2005.
1065.25 Recordkeeping. July 13, 2005.

Subpart B – Equipment Specifications

1065.101 Overview. July 13, 2005.
1065.110 Work inputs and outputs, accessory work, and operator demand. July 13, 2005.
1065.120 Fuel properties and fuel temperature and pressure. July 13, 2005.
1065.122 Engine cooling and lubrication. July 13, 2005.
1065.125 Engine intake air. July 13, 2005.
1065.127 Exhaust gas recirculation. July 13, 2005.

Subpart C – Measurement Instruments

Measurement of Engine Parameters and Ambient Conditions

Flow-Related Measurements

CO and CO_2 Measurements

Hydrocarbon Measurements

NOx Measurements

July 13, 2005.

Hydrocarbon Measurements

1065.360 FID optimization and verification. July 13, 2005.
1065.362 Non-stoichiometric raw exhaust FID O_2 interference verification. July 13, 2005.
1065.365 Nonmethane cutter penetration fractions. July 13, 2005.

NOx Measurements

1065.370 CLD CO_2 and H_2O quench verification. July 13, 2005.
1065.372 NDUV analyzer HC and H_2O interference verification. July 13, 2005.
1065.376 Chiller NO_2 penetration. July 13, 2005.
1065.378 NO_2-to-NO converter conversion verification. July 13, 2005.

PM Measurements

1065.390 PM balance verifications and weighing process verification. July 13, 2005.
1065.395 Inertial PM balance verifications. July 13, 2005.

Subpart E – Engine Selection, Preparation, and Maintenance

1065.401 Test engine selection. July 13, 2005.
1065.405 Test engine preparation and maintenance. July 13, 2005.
1065.410 Maintenance limits for stabilized test engines. July 13, 2005.
1065.415 Durability demonstration. July 13, 2005.

Subpart F – Performing an Emission Test in the Laboratory

1065.501 Overview. July 13, 2005.
1065.510 Engine mapping. July 13, 2005.
1065.512 Duty cycle generation. July 13, 2005.
1065.514 Cycle-validation criteria. July 13, 2005.
1065.520 Pre-test verification procedures and pre-test data collection. July 13, 2005.
1065.525 Engine starting, restarting, and shutdown. July 13, 2005.
1065.530 Emission test sequence. July 13, 2005.
1065.545 Validation of proportional flow control for batch sampling. July 13, 2005.

Subpart G – Calculations and Data Requirements

Subpart H – Engine Fluids, Test Fuels, Analytical Gases and Other Calibration Standards

1065.701 General requirements for test fuels. July 13, 2005.

A. Federal provisions.

1. Subparagraph (a) [No change.]

2. Amend subparagraph (b) as follows: *Fuels meeting alternative specifications.* We may allow you to use a different test fuel if you show us and we find that using it does not affect your ability to comply with all applicable emission standards using commercially available fuels.

3. Subparagraph (c) [No change.]

4. Amend subparagraph (d) as follows: *Fuel specifications.* The fuel parameters specified in this subpart depend on measurement procedures

that are incorporated by reference.

5. Subparagraph (e) [No change.]

B. California provisions.

1. Methanol Fuel.

1.1 **Exhaust emission test fuel.** For diesel alcohol vehicles and hybrid electric vehicles which use diesel alcohol engines, methanol or ethanol fuel used for exhaust and evaporative emission testing shall meet the specifications set forth in title 13, CCR, section 2292.1 (Specifications for M-100 Fuel Methanol) or section 2292.3 (Specification for E-100 Fuel Ethanol) as modified by the following:

Specification	**Limit**
M-100 Fuel Methanol	
Methanol	98.0 ± 0.5 vol. percent
Ethanol	1.0 vol. Percent (max.)
Petroleum fuel meeting the specifications of 40 CFR 86.1313-98	1.0 ± 0.1 vol. percent
E-100 Fuel Ethanol	
Ethanol	98.0 ± 0.5 vol. percent
Methanol	1.0 vol. Percent (max.)
Petroleum fuel meeting the specifications of 40 CFR 86.1313-98	1.0 ± 0.1 vol. percent

1.2 **Mileage accumulation fuel.** For diesel alcohol vehicles and hybrid electric vehicles which use diesel alcohol engines, methanol or ethanol fuel used for service accumulation shall meet the applicable specifications set forth in title 13, CCR, section 2292.1 (Specifications for M-100 Fuel Methanol) or section 2292.3 (Specification for E-100 Fuel Ethanol).

1.3 The specification range of the fuels to be used under this section 1 shall be reported in accordance with §86.094-21.

1.4 Fuel additives and ignition improvers intended for use in alcohol test fuels shall be subject to the approval of the Executive Officer. In order for such approval to be granted, a manufacturer must demonstrate that emissions will not be adversely affected by the use of the fuel additive or ignition improver.

2. Mixtures Of Petroleum and Methanol Fuels for Flexible Fuel Vehicles.

2.1 Exhaust emission test fuel for emission-data and durability-data vehicles. For diesel alcohol vehicles and hybrid electric vehicles which use diesel alcohol engines, methanol or ethanol fuel used for exhaust emission testing shall meet the applicable specifications set forth in title 13, CCR, section 2292.2 (Specifications for M-85 Fuel Methanol) or section 2292.4 (Specifications for E-85 Fuel Ethanol) as modified by the following:

Specification	Limit
M-85 Fuel Methanol	
Petroleum fuel meeting the specifications of 40 CFR §86.1313-98	13-16 vol. percent
Reid vapor pressure	8.0-8.5 psi, using common blending components from the gasoline stream.
E-85 Fuel Ethanol	
Petroleum fuel meeting the specifications of 40 CFR §86.1313-98	15-21 vol. percent
Reid vapor pressure	8.0-8.5 psi, using common blending components from the gasoline stream.

2.2 Mileage accumulation fuel. For flexible fuel diesel alcohol vehicles and hybrid electric vehicles that use diesel alcohol engines, petroleum fuel shall meet the applicable specifications in §86.1313-98(a) or (b), as modified by these test procedures, and methanol or ethanol fuel shall meet the applicable specifications set forth in title 13, CCR, section 2292.2 (Specifications for M-85 Fuel Methanol) or section 2292.4 (Specification for E-85 Fuel Ethanol). Mileage accumulation procedures shall be subject to the requirements set forth in §§ 86.001-26 and 86.1831-01(a) and (b) and are subject to the prior approval of the Executive Officer. A manufacturer shall consider expected customer fuel usage as well as emission deterioration when developing its durability demonstration.

2.3 **Evaporative emission test fuel for emission-data and durability-data vehicles.** For diesel alcohol vehicles and hybrid electric vehicles which use diesel alcohol engines, a blend of methanol or ethanol fuel used for evaporative emission testing shall meet the applicable specifications set forth in title 13, CCR, section 2292.2 (Specifications for M-85 Fuel Methanol) or section 2292.4 (Specifications for E-85 Fuel Ethanol) and gasoline meeting the specifications of 86.1313-94 (a)(1), as modified by these test procedures, such that the final blend is composed of either 35 volume percent methanol (1.0 volume percent of total blend) for methanol-fueled vehicles or 10 volume percent ethanol (1.0 volume percent of total blend) for ethanol-fueled vehicles. Alternative alcohol-gasoline blends may be used in place of M35 or E10 if demonstrated to result in equivalent or higher evaporative emissions, subject to prior approval of the Executive Officer.

2.4 The specification range of the fuels to be used in this section 2 shall be reported in accordance with §86.094-21.

2.5 Fuel additives and ignition improvers intended for use in alcohol test fuels shall be subject to the approval of the Executive Officer. In order for such approval to be granted, a manufacturer must demonstrate that emissions will not be adversely affected by the use of the fuel additive or ignition improver.

3. **Identification of New Clean Fuels to be Used in Certification Testing.** Any person may petition the state board to establish by regulation certification testing specifications for a new clean fuel for which specifications for the new clean fuel are not specifically set forth in paragraph §86.1313-98 as amended herein. Prior to adopting such specifications, the state board shall consider the relative cost-effectiveness of use of the fuel in reducing emissions compared to the use of other fuels. Whenever the state board adopts specifications for a new clean fuel for certification testing, it shall also establish by regulation specifications for the fuel as it is sold commercially to the public.

(a) If the proposed new clean fuel may be used to fuel existing motor vehicles, the state board shall not establish certification specifications for the fuel unless the petitioner has demonstrated that:

(1) Use of the new clean fuel in such existing motor vehicles would not increase emissions of NMHC, NOx, and CO, and the potential risk associated with toxic air contaminants, as determined pursuant to the procedures set forth in the "California Test Procedures for Evaluating Substitute Fuels and New Clean Fuels," as adopted September 17, 1993. In the case of fuel-flexible vehicles or dual-fuel vehicles that were not certified on the new clean fuel but are capable of being operated on it, exhaust and evaporative emissions

from the use of the new clean fuel shall not increase compared to exhaust and evaporative emissions from the use of gasoline that complies with Title 13, Division 3, Chapter 5, Article 1, California Code of Regulations.

(2) Use of the new clean fuel in such existing motor vehicles would not result in increased deterioration of the vehicle and would not void the warranties of any such vehicles.

(b) Whenever the state board designates a new clean fuel pursuant to this section, the state board shall also establish by regulation required specifications for the new clean fuel sold commercially in California.

1065.703 Distillate diesel fuel. July 13, 2005.

1. Subparagraph (a) [No change.]

2. Delete subparagraph (b) and replace with the following:
(b)(1) Use the ultra low sulfur grade test fuel as specified in Table 1 of §1065.703.
(b)(2) Diesel test fuel having the specifications listed below in the table may be used in exhaust emission testing as an option to the specifications in Table 1 of §1065.703. If a manufacturer elects to use this option, the Executive Officer shall conduct exhaust emission testing with diesel fuel having the specifications listed below.

Diesel Fuel Specification	**Limit**	**Test Method** [a]
Natural Cetane Number	47-55	D613-86
Distillation Range, °F		Title 13 CCR, §2282(g)(3)
IBP	340-420	
10% point	400-490	
50% point	470-560	
90% point	550-610	
EP	580-660	
API Gravity, degrees	33-39	D287-82
Total Sulfur, ppm	7-15	Title 13 CCR, §2282(g)(3)
Nitrogen Content, ppmw	100-500	Title 13 CCR, §2282(g)(3)
Total Aromatic Hydrocarbons, vol.%	8-12	Title 13 CCR, §2282(g)(3)

Polycyclic Aromatic Hydrocarbons, wt.% (max.)	1.4	Title 13 CCR, §2282(g)(3)
Flashpoint, °F (max)	130	D 93-80
Viscosity @ 40°C, centistokes	2.0-4.1	D 445-83

[a] ASTM specifications unless otherwise noted. A reference to a subsection of title 13, CCR, §2282 means the test method identified in that subsection for the particular property. A test method other than that specified may be used following a determination by the Executive Officer that the other method produces results equivalent to the results of the specified method.

3. Subparagraph (c) [No change.]

1065.705 Residual fuel. [Reserved]
1065.710 Gasoline. July 13, 2005. [n/a]

1065.715 Natural gas. July 13, 2005.

1. Delete subparagraph (a) and replace with the following:
(a)(1) **Exhaust emission test fuel.** For dedicated, dual-fueled or hybrid electric vehicles which use natural gas, fuel used for exhaust and evaporative emission testing shall meet the specifications listed in title 13, CCR, section 2292.5 (Specifications for Compressed Natural Gas) as modified by the following:

Specification	**Limit**
Compressed Natural Gas Certification Test Fuel	
Methane	90.0 ± 1.0 mole percent
Ethane	4.0 ± 0.5 mole percent
C_3 and higher hydrocarbon content	2.0 ± 0.3 mole percent
Oxygen	0.5 mole percent maximum
Inert gases (CO_2 + N_2)	3.5 ± 0.5 vol. percent

(a)(2) **Mileage accumulation fuel.** For dedicated, dual-fueled or hybrid electric vehicles which use natural gas, fuel used for service accumulation shall meet the specifications listed in title 13, CCR, section 2292.5 (Specifications for Compressed Natural Gas).

(a)(3) The specification range of the fuels to be used in this section (a) shall be reported in accordance with §86.094-21.

2. Subparargraph (b) [No change.]

1065.720 Liquefied petroleum gas. July 13, 2005.

1. Delete subparagraph (a) and replace with the following:
(a)(1) **Evaporative and exhaust emission test fuel.** For dedicated, dual-fueled or hybrid electric vehicles which use liquefied petroleum gas, fuel used for exhaust and evaporative emission testing shall meet the specifications listed in title 13, CCR, section 2292.6 (Specifications for Liquefied Petroleum Gas) as modified by the following:

Specification	**Limit**
Liquefied Petroleum Gas Certification Test Fuel	
Propane	93.5 ± 1.0 volume percent
Propene	3.8 ± 0.5 volume percent
Butane and heavier components	1.9 ± 0.3 volume percent

(a)(2) **Mileage accumulation fuel.** For dedicated, dual-fueled or hybrid electric vehicles which use liquefied petroleum gas, fuel used for service accumulation shall meet the specifications listed in title 13, CCR, section 2292.6 (Specifications for Liquefied Petroleum Gas).
(a)(3) The specification range of the fuels to be used in this section (a) shall be measured in accordance with ASTM D2163-91 and reported in accordance with §86.094-21.

2. Subparagraph (b) [No change.]

1065.740 Lubricants. July 13, 2005.
1065.745 Coolants. July 13, 2005.
1065.750 Analytical gases. July 13, 2005.
1065.790 Mass standards. July 13, 2005.

Subpart I –Testing with Oxygenated Fuels

45-Day Notice Version
Date of Release: August 11, 2006
Board Hearing Date: September 28, 2006

1065.801 Applicability. July 13, 2005.
1065.805 Sampling system. July 13, 2005.
1065.845 Response factor determination. July 13, 2005.
1065.850 Calculations. July 13, 2005.

Subpart J – Field Testing and Portable Emission Measurement Systems

1065.901 Applicability. July 13, 2005.
1065.905 General provisions. July 13, 2005.
1065.910 PEMS auxiliary equipment for field testing. July 13, 2005.
1065.915 PEMS instruments. July 13, 2005.
1065.920 PEMS calibrations and verifications. July 13, 2005.
1065.925 PEMS preparation for field testing. July 13, 2005.
1065.930 Engine starting, restarting, and shutdown. July 13, 2005.
1065.935 Emission test sequence for field testing. July 13, 2005.
1065.940 Emission calculations. July 13, 2005.

Subpart K – Definitions and Other Reference Information

1065.1001 Definitions. July 13, 2005.

1. Amend the definition of "Designated Compliance Officer" as follows: *Designated Compliance Officer* means the Executive Officer of the Air Resources Board or a designee of the Executive Officer.

1065.1005 Symbols, abbreviations, acronyms, and units of measure. July 13, 2005.
1065.1010 Reference materials. July 13, 2005.

APPENDIX C

PROPOSED AMENDMENTS TO THE CALIFORNIA EXHAUST EMISSION STANDARDS AND TEST PROCEDURES FOR 2004 AND SUBSEQUENT MODEL HEAVY-DUTY OTTO-CYCLE ENGINES AND VEHICLES

PROPOSED

State of California
AIR RESOURCES BOARD

CALIFORNIA EXHAUST EMISSION STANDARDS AND TEST PROCEDURES FOR 2004 AND SUBSEQUENT MODEL HEAVY-DUTY OTTO-CYCLE ENGINES

Adopted: December 27, 2000
Amended: December 12, 2002
Amended: ____________

NOTE: Proposed amendments in this document are printed in a style to indicate changes from existing provisions (December 12, 2002, amendments.) All existing language is indicated by plain type. All additions to the existing language are indicated by underline. All deletions to the existing language are indicated by strikeout. Only those portions of the existing language containing the proposed modifications are included. All other portions remain unchanged and are indicated by the symbol "* * * * *" for reference. A complete set of the test procedures, amended on December 12, 2002, is available at http://www.arb.ca.gov/msprog/onroadhd/hdoetps_levhdg02_clean_11-14.pdf.

NOTE: This document is incorporated by reference in section 1956.8(d), title 13, California Code of Regulations ("CCR") and also incorporates by reference various sections of Title 40, Part 86 of the Code of Federal Regulations, with some modifications. It contains the majority of the requirements necessary for certification of heavy-duty Otto-cycle engines for sale in California, in addition to containing the exhaust emissions standards and test procedures for these Otto-cycle engines.[1] The section numbering conventions for this document are set forth in subparagraph 4 on page 4. Reference is also made in this document to other California-specific requirements that are necessary to complete an application for certification. These other documents are designed to be used in conjunction with this document. They include:

1. "California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles" (incorporated by reference in section 1976, title 13, CCR.

2. Warranty requirements (sections 2035, et seq., title 13, CCR).

3. OBDII (section 1968, et seq., title 13, CCR, as applicable).

---

1 The requirements for Otto-cycle engines used in complete vehicles up to 14,000 pounds GVW are contained in the "California Exhaust Emission Standards and Test Procedures for 2001 and Subsequent Model Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles," incorporated by reference in §1961(d), title 13, CCR.

CALIFORNIA EXHAUST EMISSION STANDARDS AND TEST PROCEDURES FOR 2004 AND SUBSEQUENT MODEL HEAVY-DUTY OTTO-CYCLE ENGINES

The following provisions of Subparts A, N, and P, Part 86, Title 40, Code of Federal Regulations ("CFR"), as adopted or amended by the U.S. Environmental Protection Agency on the date set forth next to the 40 CFR Part 86 section listed below, and only to the extent they pertain to the testing and compliance of exhaust emissions from heavy-duty Otto-cycle engines, are adopted and incorporated herein by this reference as the "California Exhaust Emission Standards and Test Procedures for 2004 and Subsequent Model Heavy-Duty Otto-Cycle Engines," with the following exceptions and additions.

Part I. GENERAL PROVISIONS FOR CERTIFICATION AND IN-USE VERIFICATION OF EMISSIONS

Subpart A - General Provisions for Emission Regulations for 1977 and Later Model Year New Light-Duty Vehicles, Light-Duty Trucks and Heavy-Duty Engines, and for 1985 and Later Model Year New Gasoline-Fueled, Natural Gas-Fueled, Liquefied Petroleum Gas-Fueled and Methanol-Fueled Heavy Duty Vehicles

1. **General Applicability.** [§86.xxx-1]

* * * * *

35. **Labeling.** [§86.xxx-35]

A. Federal provisions.

1. §86.001-35. April 6, 1994.

1.1 Add the following sentence to the introductory paragraph: The labeling requirements of this section shall apply to all new motor vehicle engines certified according to the provisions of California Health and Safety Code Section 43100.

2. §86.007-35. ~~January 18, 2001~~ June 29, 2004. [No change, except as noted above for §86.001-35.]

B. California Provisions

1. For 2004 through 2007 model year engines certified to the optional standards in §86.005-10(f) the following statement shall also be printed on the label, "This engine conforms to the California ULEV standards applicable to 20XX model year Heavy-Duty Otto-Cycle Engines."

2. For 2007 and later model year engines, the Executive Officer may approve in advance other label content and formats provided the alternative label contains information consistent with this section 35.

* * * * *