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ABSTRACT

Heavy-duty vehicles account for approximately 30 percent of the oxides of nitrogen (NOx) and 65 percent of the particulate matter (PM) emissions fiom the entire California on-road fleet, despite the fact that these vehicles comprise only 2 percent of the same. To meet legislative mandates to reduce excess smoke emissions fiom in-use heavy-duty diesel-powered vehicles, the Air Resources Board (ARB or Board) adopted, in December 1997, amendments to the regulations governing the operation and enforcement of the Heavy-Duty Vehicle Inspection Program (HDVIP or the "roadside" program) and the Periodic Smoke Inspection Program (PSIP or the "fleet" program).

The initial roadside program was adopted in November 1990 in response to Senate Bill (SB) 1997 (stat. 1988, ch. 1544, Presley), and enforced fiom 1991 to 1993. It was suspended in October 1993, when the Board redirected staff to investigate reformulated fuels issues. The Board adopted the fleet program in December 1992, but until recently it had not been enforced. Enforcement of these amended programs commenced in the Spring/Summer of 1998.

Compared to having no heavy-duty vehicle inspection programs, the roadside and fleet programs with the amendments are expected to achieve the following emission reductions (in tons per day) of reactive organic gases (ROG), NOx and P M

	ROG	NOx	PM-10
1999	6.37	12.24	5.24
2010	5.30	14.03	3.19

Diesel fuel consumption will be reduced by approximately 16.7 and 19.2 million gallons annually in 1999 and 2010, respectively. This represents a savings over the 12-year period of approximately 250 million gallons of fuel or over $212 million (at current fuel prices.)

INTRODUCTION

To meet legislative mandates to reduce excess smoke emissions from in-use heavy-duty diesel-powered vehicles, the ARB adopted, in December 1997, amendments to the regulations governing the operation of the HDVIP and the PSIP. Both of these programs are enforcement programs designed to reduce excessive smoke emissions fiom mal-maintained and tampered heavy-duty diesel-powered vehicles. These amendments modify existing program regulations.

The initial HDVIP was enforced from November 25, 1991 to October 15, 1993 when it was suspended and staff was redirected by the Board to investigate reformulated fuels issues. Also in 1993, the California Legislature enacted a new statute, Assembly Bill (AB) 584 (Statutes of 1993, Chapter 570, Cortese), which directed the Board to make additional changes to the programs. The Board adopted the fleet program regulations on December 9, 1992. Due to the redirection of the staff and program technical issues, enforcement of the fleet program was never implemented. Both programs were administered on a voluntary compliance basis from October 1993. Enforcement of the HDVIP was reinstated on June 1, 1998 and enforcement of th PSP began on July 1, 1998.

The regulatory amendments to the existing programs were designed to comply fully with the mandates of AB 584 and AB 1460 (Statutes of 1996, Chapter 292, Morrissey). Assembly Bill 584 requires that the smoke test procedures used for both the roadside and fleet programs produce consistent and repeatable results. Pursuant to AB 584, these requirements are met with the adoption of the Society of Automotive Engineers (SAE) J1667 test procedure[1] into the programs' regulations. Assembly Bill 584 also requires that the HDVIP's inspection procedures produce "no false failures". Should false failures occur, they must be remedied without penalty to the vehicle owner. The amendments have provisions that meet these requirements. Assembly Bill 1460 requires limited additional changess to the statute authorizing the HDVIP. The most

[1] The SAE J1667 test procedure is entitled: "Snap Acceleration Smoke Test Procedure for Heavy Duty Powered Vehicles

significant requirement under AB 1460 is that "excessive smoke" must be defined in the regulations governing the HDVIP; a definition that ties excessive smoke emissions to the regulations' opacity cutpoints was proposed and adopted in December 1997.

BACKGROUND

Emissions from Heavy-Duty Vehicles

Emissions from heavy-duty diesel trucks and buses are well known to seriously impact California's air quality. Heavy-duty vehicles account for approximately 30 percent of the NOx and 65 percent of the PM emissions from the entire California on-road fleet, even though these vehicles comprise only approximately 2 percent of that fleet. The NOx emissions, when combined with various hydrocarbon (HC) emissions and sunlight, form ozone, commonly referred to as "smog". Consequently, NOx, and to a lesser degree, HC exhaust emissions from heavy-duty trucks and buses significantly contribute to violations of the state and federal ambient air quality standards for ozone. Diesel exhaust particulate emissions consist of fine particles designated as PM-10, most of which are designated as PM-2.5[2]. The NOx emissions also contribute to PM pollution by forming nitrates in the atmosphere. These particulate emissions contribute to violations of the state and federal ambient air quality standards for particulate matter and contribute to reduced visibility. The HDVIP and PSIP are designed to reduce the excessive in-use emissions that result from improper vehicle maintenance practices and tampering.

Ozone and particulate matter pollution are of great concern because of their adverse effects on human health. Ozone is a known respiratory irritant that harms lung tissue and reduces breathing capacity. Its effects are strongest in sensitive individuals such as asthmatics, the elderly, and children. Based on recent epidemiological studies[3], particulate matter pollution has been consistently related to premature mortalities. According to a recent Natural Resource Defense Council study[4] particulate matter pollution causes between 8,600 and 19,400 premature deaths in California every year. In response to evidence relating ozone and particulate matter pollution to these and other health effects, the United States Environmental Protection Agency recently tightened both the federal ozone and particulate standards.

Constituents of diesel exhaust have been identified as toxic air contaminants under the ARB's Toxic Air Contaminant Program, and whole diesel exhaust is currently under review for identification. The International Agency for Research on Cancer has identified diesel exhaust as a probable human carcinogen[5]. Diesel exhaust was identified in 1990 under California's Proposition 65 as a chemical known to cause cancer. Also excessive exhaust emissions (black smoke) from on-road heavy-duty vehicles continue to be the number one target of public complaints regarding air pollution.

History and Legal Bias for the HDVIP and PSIP

In response to these environmental and public health impacts, SB 1997 was enacted in 1988 directing the ARB to design and enforce an effective in-use heavy-duty vehicle smoke enforcement program. The regulations governing this program, the HDVIP, were adopted by the ARB on November 8, 1990 and became operative on November 21, 1991.

Under the HDVIP, heavy-duty diesel-powered trucks and buses are tested for excessive smoke emissions, and heavy-duty diesel- and gasoline-powered trucks and buses are inspected for tampering. Intrastate, interstate, and international[6] heavy-duty vehicles are tested statewide by ARB inspectors at California Highway Patrol (CHP) inspection facilities and weigh stations, and at random roadside locations. The owners of vehicles failing prescribed test procedures[7] are issued citations which require the prompt repair (within 45 days) of the vehicle and carry civil penalties ranging from $300 to $1800 per violation. Failure to clear citations can result in vehicles being removed from service by the CHP, at the request of the ARB (Health and Safety Code section 44011.6 (j) and Vehicle Code section 27159). Vehicle owners may appeal citations through the ARB's Administrative Hearing Program[8].

In concert with the HDVIP, regulations for a companion enforcement program requiring California fleet owners to self-inspect their vehicles for excessive smoke emissions were adopted in 1992 in accordance with SB 2330 (Statutes of 1990, Chapter 1453, Killea). This program, the PSIP, and the HDVIP use the same smoke test procedure as required under their governing statutes and regulations. With the adoption of the PSIP, the Legislature's mandate to control excessive smoke emissions from heavy-duty diesel vehicles was enhanced.

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[2] PM-10 is particulate matter less than or equal to 10 microns in size, and PM-2.5 is particulate matter less than or equal to 2.5 microns in size. Studies show that diesel exhaust is primarily, PM-2.5.

[3] Dockery, Douglas W. et al. "An Association Between Air Pollution and Mortality in Six U.S. Cities." New Engand Journal of Medicine, Vol 329, No. 24, pp. 1753-9.

[4] Shprentz, Deborah Sheiman,, et al. Breath-Taking: Premature mortality due to Particulate Air Pollution in 239 American Cities. Natural Resource Defense Council. May 1996.

[5] The Toxic Air Contaminant Process: Diesel Exhaust. California Environmental Protection Agency, Air Resources Board, June 1994.

[6] With the adoption of the North American Free Trade Agreement, NAFTA, commercial trucks and buses will be permitted to operate beyond the 25 mile commercial zone in the states bordering Mexico resulting in increased truck and bus activity in California and the other border states.

[7] The test procedure consists of a "map-acceleration" vehicle test utilizing an electronic smokemeter and an engine and emissions controls system tampering inspection.

[8] The hearing procedures are established in sections 60075.1 through 60075.47, title 17, California Code of Regulations, pursuant to Health and Safety Code section 44011.6(m).

Under the PSIP, California-based truck and bus fleet owners with two or more vehicles are required to conduct annual smoke opacity and tampering self-inspections for all of their vehicles. To ensure program compliance, ARB inspectors are required to audit fleet maintenance and inspection records and test a representative sample of vehicles. The PSIP includes fleet vehicles that would normally not be captured by the HDVIP roadside enforcement operations (i.e., local service and delivery vehicles).

The regulations governing the PSIP were originally scheduled to become effective on January 1, 1995. Due to delays in the completion of the SAE J1667 test procedure, these regulations were amended to postpone their effective date to January 1, 1996. In a March 1996 notice, the ARB staff advised fleet operators that the PSIP would be administered on a voluntary basis, pending adoption of the SAE J1667 procedure into the program's governing regulations.

Presently, several states have enforcement programs for in-use heavy-duty diesel vehicles. Arizona was the first to implement such a program in 1970, and four other states have active programs in effect today. Other states have regulations in place but to date have not enforced their programs. California's HDVIP has been recognized as the nation's most comprehensive and effective enforcement program. The HDVIP proved very effective for the two years (1991 - 1993) it was enforced. During this time, the overall program failure rate was reduced from 34 percent to 21 percent, resulting in an estimated 38 percent reduction in the number of heavy-duty smoking trucks and buses operating in California.

Issues Associated with the Programs and Compliance with AB 584

Although the HDVIP has been effective in reducing emissions and the number of smoking heavy-duty vehicles, its "snap-acceleration" test (previously referred to as the "snap-idle" test) has been the focus of controversy[9]. The California Trucking Association (CTA) has argued that the test can be unreliable and can fail "clean" trucks. This debate has been ongoing since the program's implementation in 1991, and has led to litigation four times. In all cases, the test has been upheld by the California courts, including two decisions from the Third District Court of Appeals that were left standing by the California Supreme Court.

To resolve this lingering controversy, in 1993, the Legislature enacted AB 584 that was sponsored by the trucking industry. As discussed earlier, AB 584 requires that the smoke test procedure used in the HDV must produce "consistent and repeatable" results. This requirement is satisfied with the adoption of the SAE J1667 smoke test procedure into the HDVP's and PSIP's governing regulations. The SAE J1667 test procedure was adopted by the SAE in February of 1996.

[9] **In developing both the existing and proposed HDVIP and PSIP regulations, the ARB worked within a statutorily required (SB 1997 of 1988, AB 584 of 1983 and AB 1460 of 1996) Ad-Hoc Advisory Committee that includes, among others, the California Trucking Association and the Engine Manufacturers Association.**

Subsequent to the SAE's adoption of the J1667 test procedure, the ARB staff, in consultation with the regulated industries, designed two studies to assess the effectiveness of the J1667 test procedure, and to determine the smoke opacity cutpoints for inclusion in the regulations.

These wo studies, the Random Truck Opacity Survey (RTOS) and the Truck Repair Study (TRS) were conducted in late 1996 and in 1997. The data from these studies served as the technical basis for staff's proposed regulatory amendments.

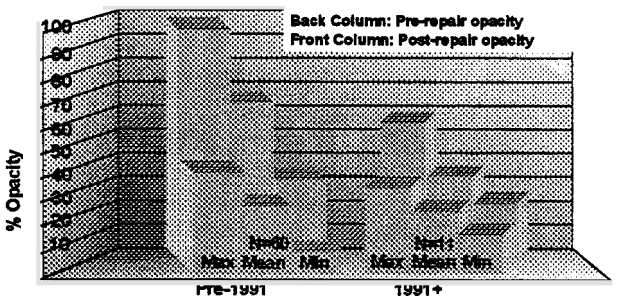

Figure 1
Summary of Truck Repair Opacities

The RTOS provided a profile of the California heavy-duty vehicle fleet's opacity. The TRS produced the post-repair opacity statistics upon which the cutpoints were based. (See Figure 1.)

From 1992 through 1996, the ARB staff participated on the SAE J1667 committee. This broad-based committee was charged with developing a heavy-duty diesel engine smoke test procedure. This committee was comprised of trucking and bus industry representatives, smokemeter manufacturers, federal and state air quality regulators, heavy-duty diesel engine manufacturers and representatives from various universities and colleges. As stated above, this procedure was adopted unanimously by this committee in 1996. This process resolved most of the issues of controversy associated with the HDVIP and PSIP.

SUMMARY OF REGULATORY AMENDMENTS

Statutory Requirements Under AB 584 and AB 1460

As discussed earlier, AB 584 requires that the smoke test procedure used in the HDVIP must yield consistent and repeatable test results and result in no "false failures". Should false failures occur, they must be remedied without penalty to the vehicle owner. These requirements are codified in Health and Safety Code section 44011.6.

The regulatory amendments were designed to comply fully with these mandates by adopting the SAE J1667 test procedure, adding additional safeguards to minimize occurrences of false

failures and by retaining procedures that provide remedies for false failures, should they occur, without penalty to vehicle owners. Additionally, a definition for "excessive smoke" was included to meet the requirements of AB 1460.

Regulatory Amendments

The following amendments were adopted by the Board in December 1997 to fulfill the requirements of AB 584 and AB 1460, and to improve the regulations:

(1) Designate the SAE J1667 "Snap Acceleration Smoke Test Procedure for Heavy-Duty Diesel Powered Vehicles," issued February 1996, as the test procedure for determining smoke opacity under the HDVIP and PSIP

(2) Maintain the existing snap-acceleration opacity standards of 55 percent for pre-1991 model year and 40 percent for 1991 and newer model year heavy-duty diesel-powered engines, without reference to the engines' federal peak smoke certification level. These standards reflect data on maximum emissions from vehicles in good operating condition and set to manufacturers' specifications, gathered from the ARB's Truck Repair Study. These standards also include a significant safety margin to account for variability in smoke measurement. (On average, an SAE J1667-type smokemeter reads about 5 to 10 opacity points less for mechanical and electronic engines, respectively, as compared to a SAE J1243-type smokemeter.)

(3) Establish a mechanism under which owners of pre-1991 model year heavy-duty diesel-powered engines that have roadside snap-acceleration opacity levels between 55 percent and 70 percent are initially issued a Notice of Violation in lieu of a citation. If within 45 days, the owner demonstrates that the repairs have been made to bring the vehicle into compliance with the 55 percent opacity standard, there will be no penalty. If a demonstration of correction is not submitted within the 45 day period, a citation would be issued. The NOV mechanism would not apply where a previous NOV or citation had been issued for the vehicle in the preceding 12 months. Based on the initial experience with the NOV approach, the staff plans to report to the Board by the end of 1999 with its recommendation on whether the approach should be sunsetted.

A summary of the opacity standards discussed in (2) and (3) above is provided in Table 1.

(4) Retain exemptions to allow for technologically less stringent standards for specific engine families based on data submitted by the engine manufacturers, and "grandfather-in" exemptions of engine families issued under the preexisting HDVIP regulations.

(5) Require explicitly that a demonstration of correction for a vehicle failing a roadside smoke test or visual inspection must include evidence that the vehicle has passed a post-repair test or inspection of the pertinent components.

Table 1.
Smoke Opacity Standards and ARB Actions

Vehicles with Pre-1991 Model Year Engines Opacity Standards 55%		
Test Opacity	**ARB Action**	**Post-Repair Standard**
Higher than 70%	***Issue Citation***	**<55%**
Between 55 and 70%*	***Issue Notice of Violation***	**<55%**
***Applicable only to first violation in a 12-month period**		
Vehicles with 1991 and Newer Model Year Engines Opacity Standards 40%		
Test Opacity	**ARB Action**	**Post-Repair Standard**
Higher than 40%	***Issue Citation***	**<40%**

(6) Institute a new 15 month phase-in schedule for the PSIP, starting July 1, 1998.

(7) Allow the SAE J1243-type smokemeter to be used in PSIP testing at facilities and fleets that are not equipped with an SAE J1667 type smokemeter, until July 1,1999.

(8) Exempt the newest four model years of heavy-duty engines from the PSIP requirements under a four year "rolling exemption" process. Vehicles equipped with these engines would remain subject to the roadside inspections under the HDVIP.

(9) Define "excessive smoke" in the regulations, as required by AB 1460, as smoke opacity in excess of the opacity standards set forth in (2) and (3) above and summarized in Table 1 above.

(10) Retain the administrative hearing process to challenge citations. The staff plans to propose various amendments to the Administrative Hearing Program's regulations to be considered by the Board in the Spring of 1998.

(11) Make various other changes to generally improve the regulations and to make them more clear and readable.

(12) During the December 1997 hearing, the Board added language to the PSIP regulation that exempted from annual inspection requirements those heavy-duty diesel-powered vehicles that are not part of a fleet or are exclusively for personal use. (These vehicles would still be subject to the roadside HDVIP.)

OUTREACH AND PUBLIC RELATIONS

In preparation for the reinstatement of the smoke inspection programs, the ARB conducted an extensive outreach program. This took the form of numerous presentations at truck and bus association meetings and fleet facilities, and pre-enforcement smoke testing offered to fleets at no charge (and with no penalty.) During the period of October 1993 until the end of May 1998, the ARB visited over 1,000 fleets.

As an additional outreach program, the ARB participates in a partnership with community colleges and the heavy-duty vehicle industry to offer low-cost training. This partnership, called the California Council on Diesel Education and Technology (CCDET), provides an in-depth understanding of the smoke inspection regulations and training on the correct administration of the SAE J1667 smoke test procedure.

ENVIRONMENTAL AND ECONOMIC IMPACT ANALYSES

The evaluation of the air quality impacts of the amendments is based on a comparison of the HDVIP and PSIP with the amended regulations to the initial HDVIP and PSIP regulations. In conducting an emissions impact analysis, it was necessary to identify the "baseline" emissions, i.e., a starting point with whtch the initial and amended programs are compared. The baseline in this analysis consists of the emissions expected from heavy-duty trucks and buses in 1998 prior to resumption of either the original or amended programs. These estimated baseline emissions reflect the residual impact of the 1991-1993 HDVIP enforcement activities on the in-use emissions of heavy-duty trucks and buses in California

The incremental environmental impacts in 1999 for the initial programs compared to the amended programs are: -1.34 tpd, -2.46 tpd, and -1.06 tpd for the emissions of ROG, NOx, PM10, respectively. For the year 2010, the amended programs indicate that fewer benefits will be realized when compared incrementally to the original programs. For 2010, the differences are: -1.92 tpd, -5.10 tpd, and -1.18 tpd for the emissions of ROG, NOx, PM10, respectively.

With respect to smoking vehicles, the amended programs, when compared to the initial program will be less effective because some heavy-duty vehicles that marginally exceed the opacity standards under the preexisting procedures will not fail under the new test procedures. In 1999, the initial programs would have reduced the numbers of smoking vehicles by an estimated 35.4 percent while the amended programs will realize estimated reductions of 29.0 percent. This is a difference of 6.4 percent of the overall fleet and equates to 6,324 more smoking vehicles. In 2010, under the initial programs, smoking vehicles would have been reduced by an estimated 48.9 percent, compared to an estimated 36 percent under the amended programs. This represents a difference of 12.9 percent, or 13,889 vehtcles.

Although the amended programs result in fewer environmental benefits, when compared on an incremental basis to the initial programs, this is not to say that substantial reductions to the baseline will not occur due to their adoption. The reasons for the reduced benefits are due, in part, to the incorporation of the AB 584 requirements and the proposed four-year rolling exemption under the PSIP. Overall, adoption of the amended programs will result in estimated reductions (in tons per day) to the baseline statewide as follows:

	ROG	NOx	PM-10
1999	6.37	12.24	5.24
2010	5.30	14.03	3.19

The HDVIP and PSIP will produce benefits by reducing the emissions of criteria and toxic pollutants resulting fiom the repairs performed to reduce excessive smoke emissions. Based on the estimated program costs and criteria pollutant emission reductions, the cost effectiveness of the benefits of the HDVIP and PSIP is estimated to be $1.12 per pound in 1999 and $1.05 per pound in 2010. These estimates compare favorably to alternative emission control programs which primarily target criteria pollutants and typically cost between $2.50 and $5.00 per pound of emissions reduced. Additionally, diesel fuel consumption will be reduced by 0.69 and 0.66 percent in 1999 and 2010 respectively. This is a result of the repairs to the engines found to be out of compliance under the programs. This reduced fuel consumption equates to approximately 16.7 and 19.2 million gallons annually in 1999 and 2010, respectively. Over this 12 year period, approximately 250 million gallons of diesel fuel will be saved or over $212 million based on current diesel fuel prices.

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