CALIFORNIA 1994 STATE IMPLEMENTATION PROGRAM FOR OZONE IMPLEMENTATION ISSUES AND STRATEGIES FOR REDUCING EMISSIONS FROM HEAVY DUTY DIESEL VEHICLES

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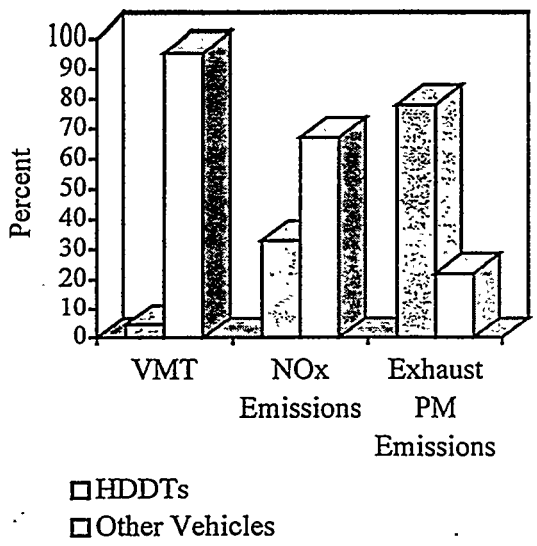
BACKGROUND

Heavy-duty vehicles carry over 60 percent of the transported goods, by weight, in California. The majority of these vehicles are powered by diesel engines. Because of their efficiency, reliability, and durability, diesel engines are expected to continue to be the engine of choice for the freight transport industry. The preference for diesel engines gives rise to an air quality challenge since emissions from diesel engines have not been controlled to the same extent as gasoline vehicles, particularly light- and medium-duty vehicles. Whereas emissions from light-duty vehicles have been reduced to greater than 95 percent compared to uncontrolled levels, existing control requirements for heavy duty diesel vehicles have only resulted in approximately 70 percent reductions of oxides of nitrogen (NOx) compared to uncontrolled levels. Furthermore, heavy duty diesel vehicles involved in goods movement applications typically accrue higher annual mileage than other vehicles. Consequently, the emissions, particularly of NOx and particulate matter (PM), from heavy duty diesel vehicles are disproportionately high compared to their population or vehicle miles traveled (VMT). In the SCAB, even though heavy duty diesel trucks accounted for about five percent of the VMT for all on-road vehicles in 1995, they emitted about 30 percent of the NOx emissions and almost 80 percent of the exhaust PM emissions from all on-road vehicles. Figure 1 shows the VMT and emission contributions of heavy duty diesel trucks compared to the total vehicle population. In addition, heavy duty vehicle VMT are projected to increase nearly 50 percent from 1995 to 2010. Thus, it is clear that emissions from heavy duty diesel vehicles have to be reduced further if air quality goals are to be achieved.

Figure 1

Percent of Vehicle Miles Traveled and Emissions from Heavy Duty Diesel Trucks in SCAB--1995

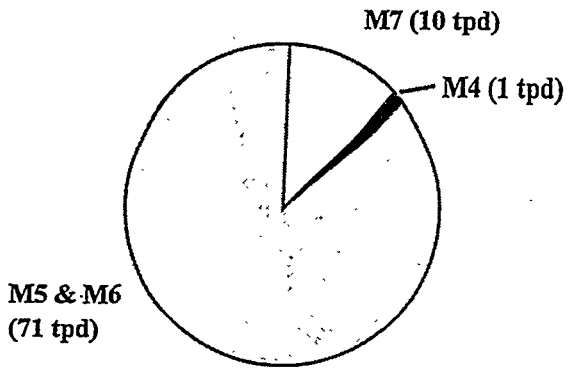


The ARB adopted the SIP in November 1994, in compliance with the requirements of the 1990 Clean Air Act Amendments. The SIP is a comprehensive effort aimed at reducing emissions from all sources, both mobile and stationary. It contains plans and strategies for non-attainment areas to achieve the Federal ambient air quality standards for ozone by the specified dates. A key focus is strategies to reduce emissions from on-road heavy duty diesel vehicles. The emphasis on heavy duty diesel vehicles comes directly from the magnitude of emissions from this source and the potential to further reduce these emissions.

The 1994 California SIP contains four measures specifically designed to reduce emissions from on-road heavy duty vehicles. Measure M4 is an incentive-based program to encourage the early introduction of reduced-emission heavy duty engines into fleets. Measure M5 calls for the adoption by ARB of a 2.0 grams per brake horsepower hour (g/bhp-hr) NOx emission standard for new heavy duty engines sold in California, or alternative measures, beginning in 2002. Measure M6 calls for Federal adoption of nationwide emission standards for heavy duty engines, equivalent to that proposed for M5, beginning in 2004. Measure M7 is an accelerated retirement program for heavy duty vehicles. Altogether, these SIP measures were designed to reduce over 80 tpd (40 percent) of Nox emissions from on-road heavy duty vehicles in 2010 in the South Coast Air Basin (SCAB). Figure 2 shows the heavy duty NOx emission reductions in the SCAB for these measures.

Figure 2

Anticipated NOx Emission Reductions Measures M4, M5, M6, M7, SCAB--2010



STATUS OF SIP MEASURES FOR HEAVY DUTY VEHICLES

Since the 1994 California SIP was adopted, ARB staff has participated in a number of efforts to further develop and implement these SIP measures for on-road heavy duty vehicles. While SIP measure M7, early retirement of heavy duty vehicles, does not appear to be able to achieve the desired emission reductions, notable successes were achieved for SIP measures M5 and M6 with the signing of the Statement of Principles (SOP), discussed below, with heavy duty engine manufacturers. Efforts to implement SIP measure M4 are ongoing. ARB staff is currently exploring options to increase implementation of SIP measure M4. The status of each of these four SIP measures is presented below.

MEASURES M5 AND M6

SIP measures M5 and M6 are the cornerstones of California's strategy to further reduce emissions from on-road heavy duty engines. Measures M5 and M6 call for the adoption, at the state and Federal levels, respectively, of an emission standard equivalent to 2.0 g/bhp-hr of NOx.

In 1995, heavy duty engine manufacturers, U.S. EPA, and ARB signed the SOP with the goal of reducing emissions from on-road heavy duty vehicles. Included in the SOP is a provision specifying national emission standards for on-road heavy duty engines. Heavy duty engine manufacturer signatories to the SOP are committed to developing on-road heavy duty engines capable of meeting a NOx emission level of approximately 2.0 g/bhp-hr beginning in 2004. The SOP provides manufacturers with the flexibility to choose between two different options: a) a combined non-methane hydrocarbon (NMHC) plus NOx standard of 2.4 g/bhp-hr; or b) a combined NMHC plus NOx standard of 2.5 g/bhp-hr with an NMHC cap of 0.5 g/bhp-hr. It is expected that these emission levels will be equivalent to the 2.0 g/bhp-hr NOx-only standard as proposed in the 1994 California SIP. With the implementation of the SOP through Federal and California rulemaking, NOx emissions from on-road heavy duty engines will be reduced by half while PM emission levels are maintained. A final Federal rule incorporating the SOP agreements is expected in August 1997.

The U.S. EPA is required to make a determi-

nation of feasibility in 1999 to assess the progress of engine manufacturers in meeting the 2004 emission standards for on-road heavy duty engines. Depending on the status of heavy duty engine technology at that time and on projections of future technology development, revisions to the standards could be considered. Assuming no revisions are necessary, on-road heavy duty diesel engines would be required to comply with the reduced emission standards by 2004. Thus, all but 6 tpd of the SIP emission reductions assigned for M5 and M6 would be fully realized. The unrealized 6 tpd are those emission reductions that would be achieved from a California-only standard for NOx emissions, effective in the 2002 and 2003 model years. For a number of reasons, ARB would prefer that the emissions from California-only standards in 2002 and 2003 could be obtained from alternative strategies. Due to the interstate nature of the trucking industry, a California-only emission standard could create a situation where California-based truck operators could be put at a competitive disadvantage if they have to buy more expensive engines compared to out-of-state truck operators. In addition, the time frame of a California-only standard, 2002 and 2003, in light of the upcoming national emission standard in 2004, could cause some truck operators to delay purchasing newer engines until 2004.

However, ARB has obligations to meet for reducing emissions, and we are committed to obtaining the emission reductions identified in the SIP. The major beneficiaries of the 2002 and 2003 emission reduction benefits from measure M5 are those districts that have 2005 attainment dates, although those emission reduc-tions are also important in the SCAB for attainment in 2010. Ensuring that reduced-emission engines are on the road before 2004 is an important heavy duty vehicle strategy. One provision of the upcoming Federal and California heavy duty vehicle emission requirements for 2004 is the averaging, banking, and trading (ABT) program. As discussed later in this paper, the ABT program may provide some benefits for certain areas in California, but may also result in some disbenefits for other areas, depending upon an area's attainment date. Another means of reducing emissions in the pre-2004 time frame is the use of incentives to place reduced-emission heavy duty vehicles in the fleet. This strategy is presented in the following section describing SIP measure M4.

MEASURE M4

SIP measure M4 relies on the early introduction of reduced emission heavy duty engines/-vehicles to achieve near-term emission reductions necessary in some non-attainment areas. This is to be accomplished through the use of incentives to encourage fleet operators to purchase reduced-emission heavy duty engines/vehicles. Incentives are necessary to partially or wholly offset the higher costs of heavy duty engines capable of meeting NOx emission levels much lower than required. At the present time, these are only alternative fuel engines. Although there may be reduced-emission diesel engines available before 2004, the emission reduction benefits from these engines will likely be retained by the engine manufacturers as ABT credits. In any case, it is unlikely that there will be diesel engines that can match the performance of alternative fuel engines over the next four years. Alternative fuel heavy duty engines have the potential to meet significantly lower NOx levels in the near term. In fact, some alternative fuel heavy duty engines are already meeting these much-lower emission levels. But limited availability and higher costs of these engines compared to diesel engines have so far limited their market appeal and have constrained their commercial penetration to only a few specialized applications, such as urban buses.

Ongoing efforts aimed at creating incentives that would be attractive to engine manufacturers, fleet operators, and fuel providers have not had the desired results. Cost has been the most basic of several obstacles that have, thus far, discouraged fleet operators from purchasing alternative fuel heavy duty engines. The approaches that have been considered to implement measure M4, therefore, share a common goal of reducing the higher cost to the operators of alternative fuel heavy duty engines so as to make them more economically

competitive with conventional diesel engines. The following discussion summarizes efforts to promote the more widespread use of reduced-emission heavy duty engines/vehicles, both alternative fuel and diesel, through incentives.

U.S. EPA's Averaging, Banking, & Trading Program

The ABT program provides that engines produced before 2004 and that are below the NOx standard that applies through 2003 (4.0 g/bhp-hr) earn credits that can be used after 2004. That is, if a manufacturer produces a cleaner engine than required before 2004, that manufacturer can produce a "dirtier" engine than is required after 2004. If a substantial number of manufacturers take advantage of the ABT provision, significant emission reduction benefits will accrue to those districts that have 2005 attainment dates because the pre-2004 heavy duty fleet will be cleaner that it would have been otherwise. However, because a greater number of "dirtier" engines could be produced than would otherwise be required after 2004, the emissions in 2010 would be more than if there were no ABT program.

Incentive Programs

In the effort to develop a strategy to implement measure M4, ARB has maintained a technology-neutral position regarding the choice of powerplants for on-road heavy duty vehicles. Our emphasis is to obtain the emission reductions for this measure as early as possible by encouraging the deployment of engines with emission characteristics as close to the SOP 2004 NOx emission levels as practicable. Only alternative fuel heavy duty engines have the potential to meet these low emission levels in the near term. Consequently, efforts to implement measure M4 have focused on providing incentives to make it more attractive for fleets to purchase alternative fuel heavy duty engines.

Various groups have focused on creating incentives via legislation that would provide financial assistance to offset the higher cost of reduced-emission heavy duty engines. The general approach with these legislative efforts has been to attempt to provide some tax relief for purchasers of reduced-emission heavy duty engines so that the cost of these engines is more competitive with conventional diesel engines. These efforts are still being pursued in the current legislative session.

A different approach to increase the number of reduced-emission on-road heavy duty vehicles involves the corridor concept. This approach attempts to reduce the cost of on-road alternative fuel heavy duty vehicles and make them more attractive to fleets by increasing purchasing power, sharing refueling infrastructure, and financial assistance. Two different, but potentially complementary, corridor projects are underway: the Interstate Clean Transportation Corridor (ICTC) project and the District Corridor Program.

Interstate Clean Transportation Corridor

The ICTC project is a public/private effort to develop an economically sustainable alternative fuel infrastructure along the western states interstate highways. This infrastructure would support on-road alternative fuel heavy duty vehicles in the transportation of goods throughout the region. ARB is one of several co-funders for the ICTC project and ARB staff also participates as a Steering Committee member of the ICTC. The goals of the ICTC project are to deploy 250 on-road alternative fuel heavy duty vehicles and to establish ten alternative fuel refueling and service stations along a triangulated interstate corridor connecting California, Nevada, and Utah. Phase I of the ICTC project began in January 1996 and ended on March 31, 1997. Phase II, which will focus on achieving the numerical vehicle and fueling station targets, is scheduled to begin in mid-1997.

District Corridor Program

The District Corridor Program is an effort by public agencies to develop an incentive-based program having uniform criteria that would apply to all participating air pollution control

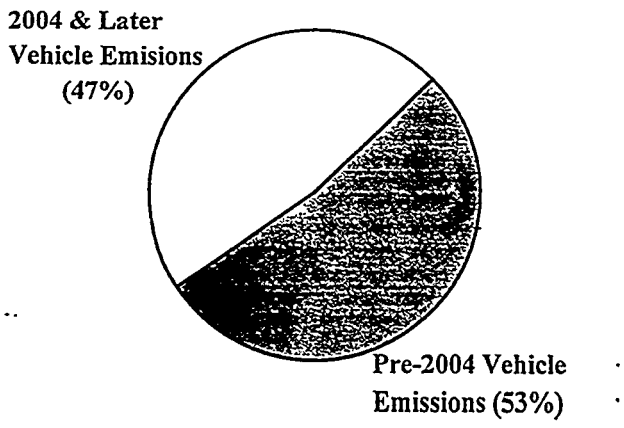
and air quality management districts that would assist in the deployment of reduced-emission heavy duty vehicles in California. ARB staff is working with air district staff, in the framework of the District Corridor Group, to formulate strategies and options for this inter-district program. The District Corridor Group is made up of representatives from ARB and air districts located along the Interstate 5 and Highway 99 corridors from Sacramento to Los Angeles. These two corridors are the principal north-south throughways for the commercial transport of goods in California. Since inter-district heavy duty vehicles typically would cross air district boundaries along these corridors, any emission benefits from reduced-emission heavy duty vehicles would be distributed among different districts as a direct result of those vehicles being driven within the district boundaries. The corridor project would establish funding criteria for reduced-emission projects and would provide for a way to distribute the cost of the projects among participating districts, based on the estimated share of emission reductions a particular district would receive from those projects. The money to fund this program would come from vehicle registration surcharge fees and other sources. In addition to cost sharing, another goal of the corridor project is to create a streamlined and uniform application process for truck operators, regardless of where their business is located or where they apply for project funding. The District Corridor Group is currently evaluating various options to implement this corridor program.

MEASURE M7

A particular attribute of heavy duty diesel engines is that they can be rebuilt many times during their lifetimes. This characteristic is one of the factors that results in diesel engines being the engine of choice when many hours of operation and high mileage are expected. However, this desirable characteristic of heavy duty diesel engines, from a fleet operation point of view, turns into a potential liability from an air quality perspective. Because of their long operating life, which could be extended considerably through rebuilds, older diesel engines with less effective emission control technology can continue operating well past the years they were originally manufactured. These older engines can continue to emit more pollutants per hour of operation than newer, cleaner engines. ARB staff estimates that, upon implementation of the 2004 emission standards, in the SCAB in 2010 trucks older than seven years will contribute over 50 percent of all on-road diesel truck NOx emissions for that region. This is shown graphically in Figure 3.

Figure 3

Contribution of Pre-2004 Vehicles to NOx Emissions from Heavy Duty Diesel Trucks -- SCAB in 2010



To reduce emissions from these older vehicles, SIP measure M7 called for the annual retirement (scrapping or removal) of about 1,600 of the oldest, high-emitting trucks in the SCAB, beginning in 1999 until 2010. As proposed in the SIP, incentives would be provided to operators of older trucks to purchase newer, lower-emitting vehicles in return for the retirement of the older models. This measure was estimated to result in a reduction of NOx emissions by 10 tpd in 2010 in the SCAB. Although ARB staff worked closely with the trucking industry to investigate possible ways to implement this measure, it is not likely that

this measure would be able to get the emission reductions anticipated in the SIP. To obtain the anticipated emission reductions, the scope of the program would have to be greatly expanded to include newer vehicles, as well as a much greater number of vehicles than anticipated in the SIP. The greatly expanded scope of an M7-type program would negatively impact its implementation feasibility since it is unlikely that sufficient money would be available to fully implement an expanded M7 program. Given the uncertainty in implementing measure M7, the emission reductions expected for M7 will have to be achieved through other means.

ISSUES AND STRATEGIES

From the foregoing discussion, a number of observations can be made. First, efforts to implement the SIP measures for heavy duty vehicles have had mixed results. Substantial strides were made in the implementation process of SIP measures M5 and M6 by the signing of the SOP and the soon-to-be-promulgated U.S. EPA rulemaking for on-road heavy duty engines. Successful implemen-tation of the 2004 standards will address a large portion, about 80 percent, of the emission reduction obligations assigned to on-road heavy duty vehicles. As discussed previously, the emission reductions from the other heavy duty vehicle measures may need to be achieved through alternative means. Continuing efforts to develop incentive-based programs to encourage the early introduction of reduced-emission heavy duty vehicles, if successful, would assist in that effort.

A second observation is the increased importance of incentive-based programs for heavy duty vehicles, especially for the near-term attainment strategies of some non-attainment areas. While much cleaner heavy duty diesel engines will be available in 2004, they will provide little assistance for areas that have to demonstrate attainment with the Federal ambient air quality standards for ozone by 2005. The only remaining viable option is to push for the rapid deployment of alternative fuel heavy duty vehicles so that they would be bought, instead of diesel vehicles, when fleets are replacing their older diesel vehicles. The emission reduction benefits of this strategy are obvious but the higher cost of these cleaner alternative fuel heavy duty engines remains the stumbling block that has prevented the penetration of these engines into the commercial freight transport market.

Diesel heavy duty engines will likely retain their prominent position in the industry, at least through the dates by which California must attain the air quality standards. Emissions from older diesel vehicles in both 2005 and 2010 will still be substantial despite efforts to reduce emissions from this source. As pointed out previously, emissions from trucks older than seven years will account for over 50 percent of the on-road heavy duty truck emissions in 2010 in the SCAB. If the emissions from those trucks in the total emission inventory could be reduced further, that would benefit California's SIP attainment efforts.

Reducing emissions from heavy duty vehicles to meet the SIP goals remains a challenge. ARB is balancing several strategies to achieve these goals. ARB plans to adopt U.S. EPA's 2004 emission standards for on-road heavy duty vehicles once the Federal regulation is promulgated. ARB also plans to participate with U.S. EPA in the research and development of even lower emission heavy duty diesel engines that would be capable of meeting a NOx emission level of approximately 50 percent of the 2004 standards. To address emissions from pre-2004 trucks, there is a need to phase in reduced emission engines expeditiously. To achieve this objective, incentives for heavy duty engine manufacturers need to be sufficiently attractive for them to produce en-gines capable of emitting sub-4.0 g/bhp-hr of NOx prior to 2004. The ABT component of the U.S. EPA's proposed regulation for on-road heavy duty vehicles may provide some of that incentive. ARB also plans to accelerate the efforts to encourage the deployment of alter-native fuel heavy duty vehicles through the ICTC and the District Corridor programs. However, the funding available for these programs is not

expected to be sufficient to meet the SIP goals unless efforts to seek legislation to support these types of programs are successful. If those efforts are successful, they could greatly accelerate the implement-ation of the incentive-based SIP programs.

CONCLUSIONS

Reducing emissions from heavy duty vehicles must remain a focus of the overall SIP strategy. Due to the nature of the trucking industry, the emission targets, and varied attainment dates, a successful strategy must necessarily be flexible. It would be impractical to favor a diesel-only approach since that would not yield sufficient emission reductions for areas that have near-term attainment dates. It would be as impractical to embrace an alternative-fuel only approach since the technology is not mature enough to meet the needs of the trucking industry. Accordingly, ARB plans to pursue strategies to realize near-term emission benefits offered by alternative fuel heavy duty engines while continuing to push for cleaner heavy duty diesel engines to ensure that longer-term attainment targets are met.

REFERENCES

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