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COLORADO AUTOMOBILE INSPECTION AND READJUSTMENT (AIR) PROGRAM

COLORADO DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT PERFORMANCE AUDIT

November 2006

Prepared for:

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November 22, 2006

Members of the Legislative Audit Committee:

This report contains the results of a performance audit of the Colorado Automobile Inspection and Readjustment (AIR) Program. The audit was conducted pursuant to Section 42-4-316, C.R.S., which requires the Legislative Audit Committee to "cause to be conducted performance audits of the [AIR] Program, including the clean screen program." The Office of the State Auditor contracted with de la Torre Klausmeier Consulting, Inc. to conduct this performance audit. The report presents the findings, conclusions, and recommendations, and the responses of the Colorado Department of Public Health and Environment.

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Department of Public Health and Environment
Performance Audit
November 2006

Authority, Purpose, and Scope

In accordance with the statute (Section 42-4-316, C.R.S.), the Legislative Audit Committee is required to cause to be conducted a performance audit of the Automobile Inspection and Readjustment (AIR) Program, including the clean screen program, every three years beginning January 1, 2000. The Office of the State Auditor contracted with de la Torre Klausmeier Consulting, Inc. to conduct this performance audit. The audit work was conducted from June to October 2006. The purpose of the audit was to determine the ongoing public need for the AIR Program and the audit considered the following factors:

- The demonstrable effect of the AIR Program on ambient air quality ("ambient" is the term used to describe the air we breathe).
- The cost to the public of the AIR Program.
- The cost-effectiveness of the AIR Program relative to other air pollution control programs.
- The need, if any, for further reduction of air pollution caused by mobile sources to attain or maintain compliance with National Ambient Air Quality Standards (National Standards).
- The application of the AIR Program to assure compliance with legally required warranties covering air pollution control equipment.
- The effectiveness of the Rapid Screen Program.
- Alternatives for improving the existing AIR Program.

We acknowledge the assistance and cooperation of the Colorado Department of Public Health and Environment, the Air Quality Control Commission, and the Regional Air Quality Council in completing the audit.

For further information on this report, contact the Office of the State Auditor at 303.869.2800.

Background

The Colorado General Assembly established the AIR Program in 1980 to reduce vehicle emissions and to meet federal air quality standards. The AIR Program, which is managed by the Colorado Department of Public Health and Environment (Department), measures emissions from motor vehicles. Vehicles with excessive emissions are required to be repaired. Until the end of Calendar Year 2006, two variations of the AIR Program are being operated in the Front Range – the enhanced program and the basic program. The enhanced program is operated in the seven-county Denver Metropolitan Area and vehicle emissions are measured at centralized testing facilities using a treadmill-like device to simulate actual driving (IM240 test). The basic program is operated in Colorado Springs, Fort Collins, and Greeley and vehicle emissions are measured while the vehicle is idling. The basic program will be discontinued effective January 1, 2007 because the areas within the program now meet the National Standards for carbon monoxide and the basic program was specifically adopted to meet these carbon monoxide standards. In October 2004 the Department also implemented the Rapid Screen Program, which uses remote sensing devices to measure emissions as vehicles drive past roadside monitors. The monitors measure vehicle emissions and record license plate numbers. If the monitors record two clean Rapid Screen readings within a ten-month window in the year prior to a vehicle's registration renewal, the vehicle owner will be notified on his or her registration renewal card that the Rapid Screen results satisfy the emissions inspection requirements and the owner does not have to go in for a traditional emissions test.

Under the AIR Program, a vehicle must pass either the traditional emissions test or the Rapid Screen test to be registered in the Front Range Area. All new vehicles are exempt from regular tests and inspections during their first four model-years. Model-year 1981 and older vehicles are required to be inspected every year, while 1982 and newer vehicles are subject to a biennial inspection. In Calendar Year 2006 there were about two million vehicles registered in the Front Range Area. The AIR Program, through the traditional emissions test and Rapid Screen test, inspected approximately 890,000 of these vehicles. Of these, about 838,000 (94 percent) vehicles passed their inspections the first time. Of the 52,000 (6 percent) vehicles that failed the test when they took it the first time, about 44,000 (85 percent) returned and subsequently passed the test or received a waiver from the test. Remote sensing data show that 4,000 of the remaining 8,000 vehicles are no longer operating in the Front Range Area; they either left the program area or were removed from service. The remaining vehicles are either operating without a registration or have been registered outside of the program area.

AIR Program Emissions Reductions and Costs

The AIR Program focuses on reducing ozone and carbon monoxide, which are the primary air quality concerns in the Front Range Area. Carbon monoxide is emitted directly from man-made sources, such as motor vehicles, while ozone is formed secondarily when carbon monoxide, hydrocarbons, and oxides of nitrogen (oxides of nitrogen are not a concern in the Front Range Area) mix together in the presence of sunlight. Mobile sources are the largest man-made source for these pollutants and mobile sources produce almost all of the carbon monoxide emitted in the Front Range Area and about 26 percent of the hydrocarbons.

We reviewed AIR Program data and found that the traditional emissions test program has reduced both hydrocarbon and carbon monoxide emissions from motor vehicles. On the basis of data collected between 2002 and 2005, we estimate that the traditional emissions test reduced hydrocarbon emissions from mobile sources during this period by 15 tons per day (from 127 tons per day to 112 tons per day), or by 12 percent. Carbon monoxide emissions from mobile sources were reduced during this period by 242 tons per day (from 1,210 tons per day to 968 tons per day), or by 20 percent. These reductions have contributed to improving the air quality in the Front Range Area. The AIR Program provides these reductions of hydrocarbon and carbon monoxide at a cost of $9,800 per ton. Overall, we estimate that the AIR Program cost Colorado taxpayers and vehicle owners about $42.5 million during 2005. Of the $42.5 million about $23.7 million (about 56 percent) was spent on inspections. Other costs were related to program administration and payments for repairs, as well as the costs associated with travel to the testing stations and motorist waiting time.

Summary of Audit Findings

We reviewed the State's attainment of National Ambient Air Quality Standards and evaluated the effectiveness of and need for the current AIR Program in the future, the effectiveness of the Rapid Screen Program in identifying both "clean" and "high-emitting" vehicles, and potential enhancements and improvements to the AIR Program. We found:

- **Need for the AIR Program.** Overall, we found that the AIR Program will probably not be needed in the long-term for the Front Range Area to comply with the National Standards for ozone. This is because hydrocarbon emissions (a primary contributor for ozone formation) will continue to drop significantly due to air pollution controls applied to stationary sources, limits on fuel volatility, and vehicle turnover, where older high-emitting vehicles are replaced by new vehicles that have close to zero emissions. However, the AIR Program may still be needed in the short-term to help the Front Range Area comply with the National Standards for ozone. We reviewed air quality data and found that although pollutants are decreasing in the Front Range Area, in 2005 and 2006 the Front Range Area was close to exceeding the National Standards for ozone and there is a possibility the Area could exceed the ozone standards in 2007. The future need of the AIR Program hinges on the State's ability to maintain compliance with the ozone standards during the summer of 2007. If the Front Range Area is in compliance with the ozone standards through April 15, 2008, the State may have the option of eliminating the AIR Program if it can show that the Program is no longer needed to maintain compliance with the National Standards. However, if the Front Range Area violates the ozone standards during the summer of 2007, the State will be required to submit a plan to the federal Environmental Protection Agency (EPA) in 2009 showing how the Front Range Area will attain compliance with the National Standards. If this occurs, it is likely the

AIR Program will be needed in some form within the Front Range Area to comply with the National Standards.

- **Effectiveness of Rapid Screen.** We reviewed Rapid Screen data collected by the Department from 2003 to 2005 and found that Rapid Screen technology has limitations in identifying vehicles that should pass the emissions test and vehicles that should fail. Specifically, we identified a sample of 607 vehicles that failed the traditional emissions test and received two Rapid Screen tests. Of these 607 vehicles, 130 vehicles (about 21 percent) passed the Rapid Screen test when they should have failed ("false passes"). Similarly, there were 1,263 vehicles in our data set that failed the Rapid Screen test. Of these 1,263 vehicles, 1,038 (82 percent) were false fails; in other words, these vehicles should have passed the Rapid Screen test, but did not. Additionally, we found that Rapid Screen is not effective at screening a sufficient proportion of the vehicle fleet. Of the 890,000 Front Range Area vehicles that were required to have an emissions test during 2005, only 27,000 vehicles (3 percent) received two passing Rapid Screen tests within 10 months of their registration renewals (the minimum requirement for receiving vehicle registrations under Rapid Screen). We identified enhancements to Rapid Screen that increase its effectiveness, but even with these enhancements, Rapid Screen cannot provide the same reductions in emissions currently achieved through the traditional emissions test.

- **Model-Year Exemptions.** The AIR Program exempts the newest four model-year vehicles from the traditional emissions test. We evaluated data on hydrocarbon emissions in the Front Range Area to determine the extent to which vehicles in each model year are contributing to emissions and whether the AIR Program could exempt more than four model-years without significantly impacting emissions reductions. We found that older vehicles contribute more hydrocarbon emissions in the Front Range Area than newer vehicles. We also found that, once exemptions extend beyond four model-years, emissions reductions are affected. Specifically, we found that by exempting six model-years, the AIR Program would eliminate 9 percent of the reductions in hydrocarbon emissions obtained currently (from 15 tons per day to 13.6 tons per day). Exempting eight model-years would eliminate 18 percent of the reductions in hydrocarbon emissions obtained currently (from 15 tons per day to 12.3 tons per day). Since the Front Range Area will be close to exceeding the ozone standard during the next year, the AIR Program should not reduce Program benefits by increasing the number of model-years exempted from the Program.

- **Program Alternatives.** If the air quality in the Front Range Area exceeds National Standards and the AIR Program is needed in the future to assist with further reducing emissions, we identified alternatives that could help further reduce emissions and, in some cases, reduce Program costs. Alternatives include:

- **On-Board Diagnostic System Testing.** Most 1996 and newer vehicles are equipped with emissions on-board diagnostic systems. These systems monitor virtually all components that make up the emissions control system and can identify malfunctions or deterioration of these components. When an emissions-related problem occurs, the malfunction indicator lamp comes on notifying the driver that repairs may be needed. We found that using on-board diagnostic system testing could potentially increase AIR Program benefits and reduce inspection costs. Our analysis of remote sensing data shows that using on-board diagnostic system testing could reduce hydrocarbon emissions by at least 16 tons per day at a cost of $9,500 per ton. This compares with 15 tons per day at a cost of $9,800 per ton under the current AIR Program.

- **Idle Test.** We reviewed the effectiveness of using the idle test instead of the IM240 test to inspect all vehicles. We found that idle tests would achieve the same benefits as the IM240 test (a reduction of hydrocarbon emissions by 15 tons per day and carbon monoxide emissions by 242 tons per day) at a lower cost. According to remote sensing data, vehicles that fail the idle test, are repaired, and then pass the idle test show a 40 percent reduction in hydrocarbon emissions. This compares with a 35 percent reduction in hydrocarbon emissions for vehicles that fail the IM240 test, are repaired, and then subsequently pass the test. We estimate that using the idle test would cost about $7,800 per ton, compared with $9,800 per ton under the current AIR Program.

- **Other Alternatives.** Other alternatives that could be implemented if the AIR Program is needed in the future include (1) inspecting vehicles for liquid fuel leaks; (2) increasing the stringency of AIR Program standards; (3) inspecting some 1995 and older model year vehicles annually; and (4) making changes to the Repair Your Air Campaign.

- **AIR Program and Emission Data.** The EPA requires the Department to use its mobile source emissions model, MOBILE6.2, to estimate future emissions levels in the Front Range Area. We found that MOBILE6.2 underestimates the amount that vehicle emissions will deteriorate in the Front Range Area because it does not appropriately account for changes in deterioration that occur in high-altitude areas. If the Department relies on MOBILE6.2 projections, it may underestimate the need for additional controls on vehicles to ensure the Front Range Area air quality is consistent with the National Standards. Additionally, we found the Department does not always conduct its own periodic evaluations of the individual components of the AIR Program before implementing changes to the Program.

Our recommendations and the responses of the Colorado Department of Public Health and Environment can be found in the Recommendation Locator and in the body of the report.

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RECOMMENDATION LOCATOR

AGENCY ADDRESSED: COLORADO DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT

Rec. No.	Page No.	Recommendation Summary	Agency Response	Implementation Date
1	34	Maintain the current AIR Program until April 15, 2008, the ozone demonstration date under the *Early Action Compact* and analyze data to determine the extent to which the AIR Program will be needed beyond 2007. If the Department determines the AIR Program is no longer needed, work with the Air Quality Control Commission to evaluate eliminating the AIR Program, and depending on the Commission's actions, with the federal Environmental Protection Agency to eliminate the Program from the State Implementation Plan.	Agree	December 2008
2	45	Conduct an evaluation of the effectiveness of using Rapid Screen to identify high-emitting vehicles. Work with the General Assembly to determine the appropriate policy direction to take with respect to the Program, and if necessary, seek statutory change to eliminate the requirement that Rapid Screen be used to identify high-emitting vehicles if it is found to not be effective for this purpose.	Agree	Ongoing
3	46	Consider retaining the Rapid Screen clean screen component of the AIR Program if the Front Range Area does not meet National Standards for ozone or if emissions reductions are needed in the future. If Rapid Screen is retained, require only one valid observation in conjunction with using a high-emitter index.	Agree	December 2008
4	51	Work with the Air Quality Control Commission to fully evaluate the impact of increasing the model-year exemptions and maintain the current four model-year exemption until the Commission considers and acts upon the results of the Department's evaluation.	Agree	December 2006
5	57	Evaluate options for integrating on-board diagnostic system testing into the AIR Program if the decision is made to continue the Program.	Agree	December 2008

RECOMMENDATION LOCATOR

AGENCY ADDRESSED: COLORADO DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT

Rec. No.	Page No.	Recommendation Summary	Agency Response	Implementation Date
6	58	Consider using the idle test for 1995 and older vehicles in conjunction with on-board diagnostic system testing for 1996 and newer vehicles.	Agree	December 2008
7	61	Consider alternatives to strengthen the AIR Program if it is needed in the future. Alternatives include inspecting vehicles for liquid fuel leaks, increasing the stringency of AIR Program standards, and annually inspecting 1995 and older vehicles that fail an inspection.	Agree	December 2008
8	61	Recommend to the Regional Air Quality Council that the Council evaluate whether to include vehicles in which the malfunction indicator lamp has been turned on due to emissions-related problems in the Repair Your Air Campaign.	Agree	March 2007
9	63	Work with the federal Environmental Protection Agency to ensure its new mobile source emissions model accurately reflects vehicle deterioration in high-altitude areas and use all available data to evaluate the AIR Program and to support recommendations for Program enhancements and modifications.	Agree	Ongoing

Overview of Air Pollution and the AIR Program

Title 42, Article 4 of the Colorado Revised Statutes provides authority for the Colorado Department of Public Health and Environment to administer the Automobile Inspection and Readjustment (AIR) Program. The Colorado General Assembly established the AIR Program in 1980 to reduce vehicle emissions and to meet federal air quality standards. The federal Environmental Protection Agency (EPA) requires that a vehicle inspection/maintenance program, such as AIR, be established in populated areas that fail to meet National Ambient Air Quality Standards for ozone or carbon monoxide.

The statutes (Section 42-4-316, C.R.S.) require the Legislative Audit Committee to "cause to be conducted performance audits of the [AIR] Program, including the clean screen program" every three years beginning January 1, 2000. The audit is to determine the ongoing public need for the Program and to consider the following factors:

- The demonstrable effect of the AIR Program on ambient air quality ("ambient" is the term used to describe the air we breathe).
- The cost to the public of the AIR Program.
- The cost-effectiveness of the AIR Program relative to other air pollution control programs.
- The need, if any, for further reduction of air pollution caused by mobile sources to attain or maintain compliance with the National Ambient Air Quality Standards.
- The application of the AIR Program to ensure compliance with legally required warranties covering air pollution control equipment.

The Office of the State Auditor contracted with de la Torre Klausmeier Consulting, Inc., to conduct this performance audit. In addition to evaluating the requirements set forth in the statutes (listed above), the audit also analyzed data to determine:

- The effectiveness of the Rapid Screen Program.
- Alternatives for improving the existing AIR Program.

The primary purpose for the AIR Program is to reduce air pollution from motor vehicles. In the first half of this Overview chapter, we provide a general discussion of air pollution in the Front Range Area (i.e., seven-county Denver

Metropolitan Area and Larimer and Weld counties), including federal standards for maintaining air quality. In the second half of this chapter, we provide a detailed description of the AIR Program, including a history of the Program and changes made to the Program since the last audit in 2003. We also present our analysis of the emissions reductions obtained by the AIR Program, the cost of the AIR Program, and the overall cost-effectiveness of the AIR Program, as required by the statutes. Our findings and recommendations related to the overall continued need for the AIR Program, the effectiveness of Rapid Screen, the appropriateness of additional model-year exemptions, and possible alternatives for improving the AIR Program are contained in Chapter 1.

Air Pollution

As stated previously, the primary purpose for the AIR Program is to reduce air pollution from motor vehicles. Air pollution has many causes, man-made as well as natural. Man-made pollution comes from both stationary and mobile sources. Mobile sources include both on-road and off-road motor vehicles. On-road vehicles are gasoline- or diesel-powered and includes passenger cars, light trucks (which include most sport utility vehicles and vans), and heavy-duty vehicles (heavy-duty trucks and buses). Off-road vehicles are diesel-powered and include construction equipment, locomotives, and marine vessels. The AIR Program aims to reduce emissions from on-road motor vehicles that emit more hydrocarbons and carbon monoxide than off-road vehicles and, thus, contribute more to ozone air pollution levels.

If the emissions from motor vehicles are not controlled, the emissions endanger human health, damage crops and forests, damage building materials, and impair visibility. Health effects from vehicle emissions can occur at a range of levels. Studies have shown that uncontrolled vehicle emissions can have adverse effects on the respiratory and immune systems of individuals in direct contact, and can cause cancer in human beings. While many inhaled pollutants have direct respiratory consequences, others affect the heart or nervous system. Prolonged exposure to vehicle emissions can result in a significant increase in mortality and morbidity. Additionally, some studies suggest that roadside air pollution can cause DNA damage through the addition of polluting chemicals to the DNA structure.

Ozone

Motor vehicle emissions can contribute to ozone, a type of air pollutant of particular concern in recent years. Although ozone occurs naturally in the stratosphere to provide a protective layer high above the earth, at ground level, ozone is a public health nuisance. When inhaled, even at very low levels, ozone can cause health problems, including acute respiratory problems, aggravated asthma, a temporary decrease in lung capacity (up to 20 percent for some healthy adults), inflamed lung tissue, and impaired immune system defenses. These health problems make people more susceptible to respiratory illness, including bronchitis and pneumonia, and can result in significant increases in emergency room visits and hospital admissions. Children are most at-risk from exposure to ozone, particularly those with symptoms of asthma.

Ground-level ozone also harms the environment in addition to causing health problems in humans. Ground-level ozone interferes with the ability of plants to produce and store food, which makes them more susceptible to disease, insects, other pollutants, and harsh weather. Ozone damages the leaves of trees and other plants, affecting the appearance of cities, national parks, and recreation areas. Ozone reduces crop and forest yields and increases plant vulnerability to disease, pests, and harsh weather.

Ozone is not emitted directly from man-made sources. It is formed secondarily when the following three pollutants mix together in the presence of sunlight:

- Carbon monoxide
- Oxides of nitrogen
- Volatile organic compounds (For ease of presentation, we will use the term “hydrocarbons” in place of “volatile organic compounds” throughout this report.)

Sources of these three pollutants include automobile exhaust, solvent fumes, and many other man-made emissions sources. However, these pollutants are also caused by natural emissions from trees and wildfires. Mobile sources are the largest man-made source category for these pollutants, contributing about 26 percent of the man-made ozone precursors (the elements that form ozone in the presence of sunlight) emitted in the Front Range Area. As discussed throughout this report, hydrocarbons are currently the primary concern of the AIR Program because the presence of hydrocarbons leads to the formation of ozone.

Air Quality Standards

Under the federal Clean Air Act, the Environmental Protection Agency is directed to establish standards for air quality that reduce pollutants to levels that do not impair health. To that end, the EPA has adopted National Ambient Air Quality Standards (National Standards) to protect the public health, allowing for an adequate margin of safety. The EPA has established National Standards for six pollutants: ozone, carbon monoxide, nitrogen dioxide, particulate matter, sulfur dioxide, and lead. Pollutants for which the EPA has established National Standards are referred to as "criteria pollutants." Two criteria pollutants, ozone and carbon monoxide, have been a concern in the Front Range Area for a number of years and, therefore, are the focus of this report.

National Standards for carbon monoxide and ozone are measured in parts per million (carbon monoxide) and parts per billion (ozone). Currently the National Standard for carbon monoxide is 9.5 parts per million. This means that a community is in compliance with the carbon monoxide standard if it does not exceed this threshold. Carbon monoxide levels are measured based on an eight-hour average. The current standard for ozone is 85 parts per billion, averaged over an eight-hour period. The test for compliance with the eight-hour ozone standard is the three-year average of the fourth highest reading, which must be less than 85 parts per billion. The ozone standard was revised effective January 1, 2004. Prior to 2004, there was a "one-hour" ozone standard. Ozone was measured on an hourly basis and was required to be below 120 parts per billion. The EPA enacted the new stricter "eight-hour" ozone standard after extensively studying the impact of exposure to elevated ozone levels on health. The eight-hour standard is more stringent than the one-hour standard because it requires that acceptable levels of ozone be maintained over a longer period of time. The new standard is designed to minimize the health effects described previously.

The Clean Air Act requires the EPA to periodically review air quality standards and revise them if necessary. The eight-hour ozone standard is currently undergoing such a review and may be made more stringent if the EPA believes it does not adequately protect public health.

Early Action Compact

The Environmental Protection Agency has been working with communities to achieve clean air as soon as possible by asking them to enter into *Early Action Compacts* (EAC) to reduce ground-level ozone pollution. Communities with *Early Action Compacts* started reducing air pollution earlier than required by the Clean Air Act.

During the three-year period spanning 2001 through 2003, the Front Range Area was not in compliance with the eight-hour National Standard for ozone. As a result, in December 2002 Colorado, along with a number of other states, submitted an *Early Action Compact* pledging to meet the eight-hour ozone standard earlier than required. These states have to meet a number of criteria and must agree to meet certain milestones. *Early Action Compacts* require communities to:

- Develop and implement air pollution control strategies,
- Account for emissions growth, and
- Achieve and maintain the national eight-hour ozone standard.

As noted above, in 2002 the state of Colorado, in cooperation with other entities such as the Regional Air Quality Council, entered into an *Early Action Compact* with the EPA. This date coincided with the period that the EPA began to enforce the eight-hour ozone standard. The *Early Action Compact* affects the Front Range Area. As long as Colorado demonstrates attainment of the milestones contained in the *Early Action Compact* through 2007, the Front Range Area will be designated as in attainment of the eight-hour ozone standard. In other words, if Colorado complies with the *Early Action Compact*, the Front Range Area will be designated in attainment for 2001 through 2007, even though it was technically not in compliance with the ozone standard for the period spanning 2001 through 2003. If the Front Range Area is in compliance with the ozone standard through 2007, it has until 2011 to submit a plan to the EPA showing how it will maintain compliance with the National Standards in the future. The State will have the option of eliminating the AIR Program if, through its technical analyses, it can show that the Program is no longer needed to maintain compliance with the National Standards. However, if the State violates the ozone standard, the State will be required to submit a plan for EPA approval in 2009 showing how the Front Range Area will attain compliance with the National Standards.

The AIR Program is the primary mobile sources air quality control mechanism for the Front Range Area in the *Early Action Compact* negotiated with the EPA. Therefore, to eliminate the AIR Program or reduce its benefits would require the State to enter into significant new negotiations with the EPA to assure the federal government that the benefits attributed to the AIR Program would be either met or exceeded by alternative strategies that replaced the AIR Program. For example, if changes to the AIR Program significantly decreased its benefits, the State would need to demonstrate that additional reductions would be obtained through other control measures.

Non-Criteria Pollutants

Motor vehicles emit other pollutants besides the six pollutants for which the EPA has set standards (criteria pollutants). These other pollutants are called "non-criteria" pollutants, and there are no National Standards for these pollutants. Non-criteria pollutants include air toxic pollutants that are suspected of carcinogenic or other health effects. Motor vehicles are a key source of many of these toxic pollutants. Air toxic emissions from mobile sources consist primarily of hydrocarbons and particulate matter and occur because the compounds are either present in gasoline or formed during the combustion of gasoline. The hydrocarbon compounds of greatest concern from mobile sources are listed below:

Benzene – A known carcinogen present in gasoline and emitted due to evaporation or incomplete combustion. Additional benzene is formed during the combustion by chemical reactions with other hydrocarbon compounds.

1,3butadiene – A known carcinogen that is formed during the combustion by chemical reactions with other hydrocarbon compounds.

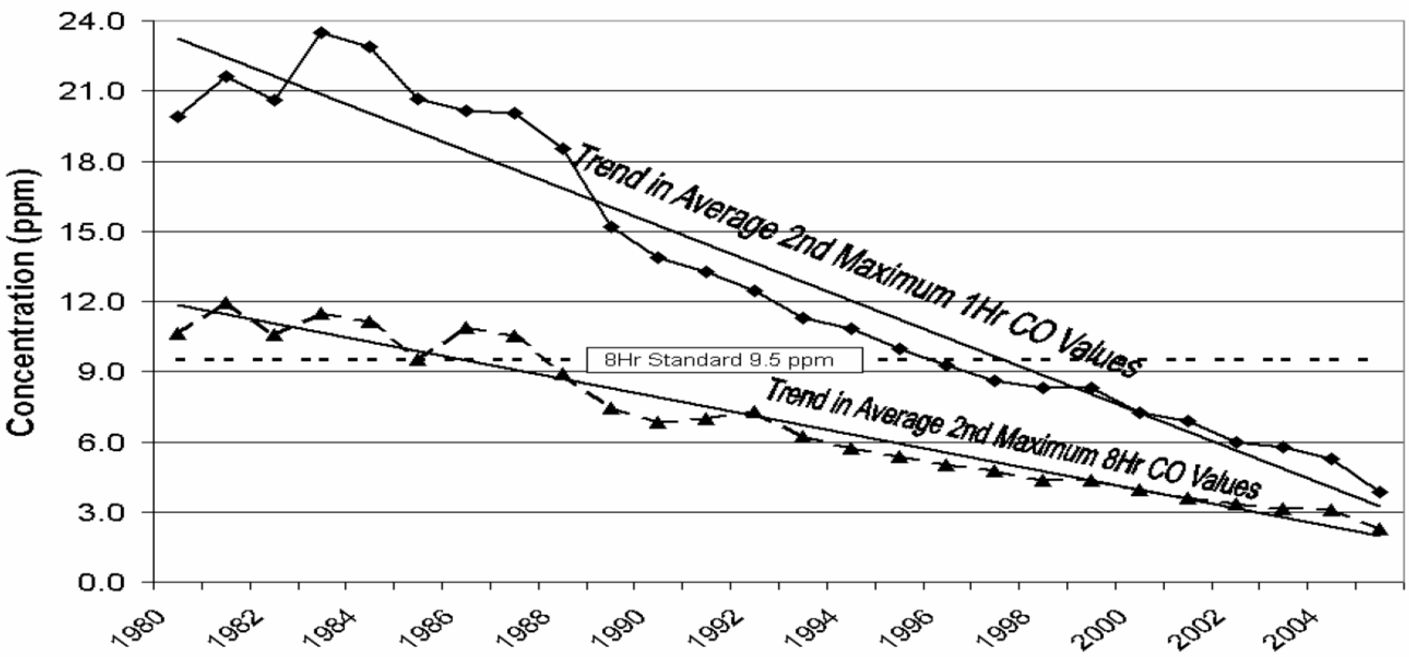
Formaldehyde and Acetaldehyde – Known carcinogens that are formed during the combustion by chemical reactions during gasoline combustion, especially ethanol containing gasoline.

Mobile sources account for half or more of the above toxic compounds found in the air. Programs such as the AIR Program directly reduce these toxic emissions. Other than federal regulations limiting the amount of benzene in gasoline, there are no standards specifically related to non-criteria pollutants; however, hydrocarbons are regulated as an exhaust component and through evaporative loss.

Emissions Standards for Motor Vehicles

Motor vehicle emissions standards have contributed to much of the progress made towards attainment of the National Standards for ozone and carbon monoxide. Since the first motor vehicle emissions standards were established by the EPA, they have become progressively more stringent. In the Front Range Area, motor vehicle emissions standards have had the greatest impact on carbon monoxide levels since most carbon monoxide comes from motor vehicles. As the following figure shows, carbon monoxide levels in the Front Range Area have decreased dramatically since 1980.

Statewide Ambient Trends: Carbon Monoxide (CO) in the Front Range Area



Source: *2005 Colorado Air Quality Data Report.*
Notes:
2nd maximum one-hour carbon monoxide is the 2nd highest one-hour average.
2nd maximum eight-hour carbon monoxide is the 2nd highest eight-hour average.

Motor vehicle emissions standards have also become more stringent for hydrocarbons and oxides of nitrogen, the two major pollutants leading to the formation of ozone. Newer vehicles (i.e. those 1996 and newer) emissions give off 95 percent less hydrocarbons and oxides of nitrogen than older vehicles without emission controls.

AIR Program

The AIR Program was established by the General Assembly in 1980 to reduce vehicle emissions and to meet the National Standards. The AIR Program measures emissions from automobiles and gasoline trucks. Vehicles with excessive emissions are required to be repaired. Until the end of Calendar Year 2006, two variations of the AIR Program are being operated in the Front Range Area:

- **Enhanced program** - Vehicle emissions are measured at centralized test facilities using a treadmill-like device to simulate actual driving. The enhanced program is operated in the seven-county Denver Metropolitan Area.

- **Basic program** - Vehicle emissions are measured while the vehicle is idling. The basic program is operated in three other Front Range cities, including Colorado Springs, Fort Collins, and Greeley. Under Colorado statutes, the Air Quality Control Commission has regulatory authority to eliminate the basic program when these areas comply with National Standards. The basic program will be discontinued effective January 1, 2007, because these areas now meet the National Standards for carbon monoxide and the basic program was specifically adopted to meet these carbon monoxide standards.

Under the AIR Program, a vehicle must pass an emissions test and inspection to be registered in the Front Range Area. The frequency of inspection depends on the age of the vehicle. All new vehicles are exempt from regular inspection, including a change of ownership inspection, during their first four model-years. Model-year 1981 and older cars and trucks are required to be tested every year, while 1982 and newer cars and trucks are subject to a biennial inspection. In addition to the regular annual or biennial inspection, every vehicle that is four years old or older must also be inspected prior to its sale, or upon initial registration in the Front Range Area.

In Calendar Year 2006 there were about two million vehicles registered in the Front Range Area. The AIR Program inspected approximately 890,000 of these vehicles. Of these, about 838,000 (94 percent) vehicles passed their inspections the first time. Of the 52,000 (6 percent) vehicles that failed the test when they took it the first time, about 44,000 (85 percent) returned and subsequently passed the test or received a waiver[1]. The remaining 8,000 (15 percent) vehicles never passed. Remote sensing data show that 4,000 of these 8,000 vehicles are no longer operating in the Front Range Area; they either left the program area or were removed from service. The remaining vehicles are either operating without a registration or have been registered outside of the program area.

Appendix A describes the current AIR Program, including implemented and planned changes.

[1] Motorists can receive a waiver (i.e., are not required to pass the emissions test) if they spend $650 or more on emissions-related repairs. Fewer than 400 vehicles received waivers in Calendar Year 2005.

History of the AIR Program

The AIR Program has changed significantly since it first began in 1980. When the Program was first initiated, the Front Range Area often exceeded the National Standards for carbon monoxide and, at times, the one-hour ozone standard. Vehicles are responsible for most of the carbon monoxide emissions in the Front Range Area. At the time, a major cause of excessive carbon monoxide emissions was carburetors that had idle air/fuel mixtures adjusted to provide more fuel than needed for proper combustion. The original AIR Program focused on identifying vehicles that emitted high concentrations of carbon monoxide and, thus, needed to have their idle mixtures adjusted for Colorado's high altitude. An emissions analyzer was used to identify vehicles with high carbon monoxide emissions while they were idling.

Over time, emissions control systems in vehicles have improved dramatically. Vehicles equipped with complex computer-controlled fuel injection systems have gradually replaced those with traditional manually adjusted carburetors. Along with improvements to vehicles, the EPA required states to make changes to their emissions test procedures. The EPA believed that the idle test could not identify many of the vehicles with emissions-related problems, leading it to require polluted areas to implement more stringent emissions tests.

Beginning in 1990, the EPA instituted a series of new requirements for states to implement enhanced inspection and maintenance programs in areas that did not meet the National Standards for ozone and carbon monoxide. In 1995 the AIR Program underwent many changes in response to these requirements. Colorado initiated centralized emissions inspections, using inspection stations set up and staffed by a private company, Environmental Systems Products (ESP). The Colorado Department of Public Health and Environment contracts with ESP to conduct emissions tests on all 1982 and newer vehicles registered in the Front Range Area. Private garages or ESP may inspect vehicles that are 1981 and older. ESP conducts emissions tests through centralized stations in 14 locations: Arvada, Broomfield, Boulder, Castle Rock, Central Denver, County Line Road, Golden, Ken Caryl, Longmont, Northglenn, Parker, Sheridan, Southeast Denver, and Stapleton.

Inspection Procedures

Under the AIR Program an emissions inspection typically includes three components:

- **IM240 test**. Vehicles with model-years that are 1982 or newer are subjected to a dynamometer test where they are placed on a treadmill-like device that simulates a driving cycle typical of urban driving. The driving cycle is called IM240 and corresponds to 240 seconds of the Federal Test Procedure (FTP), the test that is used on all new cars to determine if the vehicles meet new car certification standards. The IM240 test evaluates hydrocarbon, carbon monoxide, and oxides of nitrogen emissions. Colorado's emissions standards (or cutpoints, as they are commonly called) are set to primarily identify vehicles with high hydrocarbon and carbon monoxide levels, since these are the primary concerns in the formation of ozone. Similar to other states, Colorado's emissions standards for hydrocarbon and carbon monoxide emissions are set much higher (i.e., tolerate higher levels of hydrocarbons and carbon monoxide emissions) than the federal certification standards for new vehicles. This helps ensure that the emissions test fails only those vehicles that clearly emit hydrocarbon and carbon monoxide at substantially higher concentrations than the federal standards for new vehicles. It also helps to minimize the likelihood that the emissions test would mistakenly fail a vehicle. Vehicles that are 1981 or older, or heavy-duty vehicles that weigh more than 8,500 pounds, receive a two-speed idle test. The two-speed idle test measures emissions at idle and at raised idle (i.e., the gas pedal is depressed to increase the engine revolutions to 2,500 revolutions per minute). The two-speed idle test evaluates only hydrocarbon and carbon monoxide emissions and does not evaluate oxides of nitrogen emissions.

- **Gas cap test.** When a gas cap is missing or cannot hold pressure, a significant amount of hydrocarbon can evaporate into the air, contributing to the formation of ozone. Gas gap pressure checks are completed as part of the inspection to lower evaporative hydrocarbon emissions.

- **Anti-tampering inspection.** This is a visual inspection to make sure that the vehicle has all key emissions devices, that the devices appear to be working, and that no tampering has occurred. A catalytic converter is an example of a key emissions device.

The IM240 test, gas cap test, and anti-tampering inspection make up the typical vehicle emissions test currently conducted at Colorado's 14 centralized stations. For purposes of this report, we will refer to this as "the traditional emissions test program" or the "traditional emissions test."

Program Administration

The administration of the AIR Program is divided between two departments. In accordance with the statutes (Section 42-4-307, C.R.S.), the Colorado Department of Public Health and Environment (the Department) is responsible for the technical aspects of the AIR Program. This includes administering the licensing tests for emissions inspectors and mechanics, maintaining and analyzing emissions inspection data, and reporting emissions data to the Air Quality Control Commission. The Commission is responsible for evaluating the AIR Program to ensure compliance with the State Implementation Plan (the State's plan for complying with the National Standards, submitted to and approved by the EPA) and federal law. In Fiscal Year 2006 AIR Program expenditures at the Department of Public Health and Environment were $1.8 million and the Program had 16.6 FTE.

The statutes (Section 42-4-305, C.R.S.) also assign certain AIR Program responsibilities to the Department of Revenue. More specifically, the Executive Director of the Department of Revenue is responsible for (1) issuing all inspection station, facility, mechanic, and inspector licenses; (2) providing program oversight of all licensed stations, facilities, mechanics, and inspectors; and (3) performing announced and unannounced audits of inspection stations and facilities to ensure compliance with statutes, rules, and regulations.

Changes Made to the AIR Program Since the 2003 Audit

Following is a review of the major changes that have been made to the AIR Program since the previous audit conducted in 2003.

Elimination of the AIR Program outside of the Denver Metropolitan Area: In 2005 the Air Quality Control Commission took regulatory action to discontinue the AIR Program in the Fort Collins, Greeley, and Colorado Springs areas effective January 1, 2007. As discussed previously, these areas meet all National Air Quality Standards.

Changes to traditional emissions test procedures**:**

- **On-board diagnostics.** As explained in Chapter 1, most 1996 and newer model-year vehicles sold in the United States are equipped with engine/emissions on-board diagnostic systems, or Malfunction Indicator Lamps[2]. Prior to 2003, vehicles with the malfunction indicator lamp turned on failed the emissions inspection. AIR Program regulations were revised in 2003, and vehicles with the malfunction indicator lamp turned on no longer fail the emissions test, although the Department continues to

[2] Malfunction Indicator Lamp (MIL) is a term used for the light on the instrument panel that notifies the vehicle operator of an emissions-related problem. The MIL is required to display the phrase "check engine" or "service engine soon." The MIL is required to illuminate when a problem has been identified that could cause emissions to exceed a specific multiple of the standards the vehicle was certified to meet.

collect data related to the on-board diagnostic evaluation of all 1996 and newer vehicles during the emissions test. The Department eliminated the malfunction indicator lamp check because although the vehicles that failed the check had problems with their emissions systems, some of the vehicles did not have carbon monoxide or hydrocarbon emissions that were high enough to fail the emissions test under Colorado standards. As we discuss later in this report, there are options for using on-board diagnostic testing that result in reduced hydrocarbon and carbon monoxide emissions without increasing costs.

- **Increased emphasis on hydrocarbon emissions.** In response to concerns about increased ozone levels, beginning in 2003 changes were made to the AIR Program to tighten standards for hydrocarbon emissions. As discussed previously, hydrocarbons are precursors to ozone, and decreases in hydrocarbon emissions will help reduce the formation of ozone.

Rapid Screen Program: The General Assembly authorized the Department to develop a clean screen program (i.e., a program that uses remote sensing technology to identify vehicles that should pass their emissions test) through legislation enacted in 2001 and 2002. Data collection began in 2003 and the Department implemented the Rapid Screen Program in October 2004. The Rapid Screen Program is intended to reduce the number of vehicles that must undergo the traditional emissions test and, thus, decrease motorist inconvenience. The Rapid Screen Program uses remote sensing devices to measure emissions as vehicles drive past roadside monitors. The monitors measure vehicle emissions and record license plate numbers. If the monitors record two clean Rapid Screen readings (i.e., the vehicle "passes" the Rapid Screen emissions test two times) within a 10-month window in the year prior to a vehicle's registration renewal, the vehicle owner will be notified on the registration renewal card that he or she can substitute the Rapid Screen results for the traditional emissions test. If the owner chooses to substitute the Rapid Screen's emissions test, he or she can pay the emissions fee along with the registration renewal fee and will not have to take the vehicle to a testing facility for an emissions inspection. According to the Department, the number of vehicles inspected through Rapid Screen has been increasing as the program develops and the number of remote sensing vans increases. For example, ESP increased the number of vans screening vehicles from six to nine beginning in January 2006. In March 2006, Rapid Screen obtained two valid readings on almost 4,800 vehicles, or about 8 percent of the almost 59,100 vehicles due for registration that month. Of these 4,800 vehicles, about 3,700 passed the Rapid Screen test, representing about 6.3 percent of all vehicles tested through either the traditional emissions test or the Rapid Screen Program during March 2006. In contrast, in 2005 only 5 percent of the fleet was evaluated by Rapid Screen and only 3 percent passed the Rapid Screen test.

Assisting the Repair Your Air Campaign: This program, which the Regional Air Quality Council began in 2004 in partnership with the Department, uses remote sensing readings collected in the Rapid Screen Program to measure emissions and determine if a vehicle is a likely high-emitter. If the vehicle is identified as a high-emitter, the owner is notified and asked to come into a state technical center for repairs and the program will cover the cost of the repairs up to $1,000. Funding for these repairs is provided through a grant from the Federal Highway Administration. The amount of the grant totaled about $419,000 for Fiscal Year 2006. As of July 2006, about 300 vehicles have been repaired through this program since inception and about $115,500 has been spent on these repairs.

Contractual changes in the number and distribution of centralized emission test facilities: Effective December 5, 2003, ESP, the private contractor that operates the AIR Program, closed the centralized emissions station located in Commerce City due to eminent domain proceedings. ESP added additional lanes to some of its remaining 14 facilities. Closing the Commerce City facility increased motorist inconvenience slightly, since for some people, travel times to AIR stations are longer.

House Bill 2006-1302: House Bill 1302, enacted during the 2006 legislative session, seeks to increase the State's reliance on the Rapid Screen Program. Under the plan envisioned by House Bill 1302, Rapid Screen would not only be used to identify "clean" vehicles (i.e., vehicles that pass the standard emissions test), it would also be used to identify those vehicles that are "high emitters" of pollution and that therefore require repair. The goal of House Bill 1302 is to eliminate the traditional emissions test for most vehicles and only require high-emitting vehicles to be inspected, thereby reducing inspection costs and motorist inconvenience. As discussed later in this report, there are significant technical obstacles in using Rapid Screen to meet this goal without substantially increasing hydrocarbon and carbon monoxide emissions from motor vehicles.

AIR Program Emissions Reductions and Costs

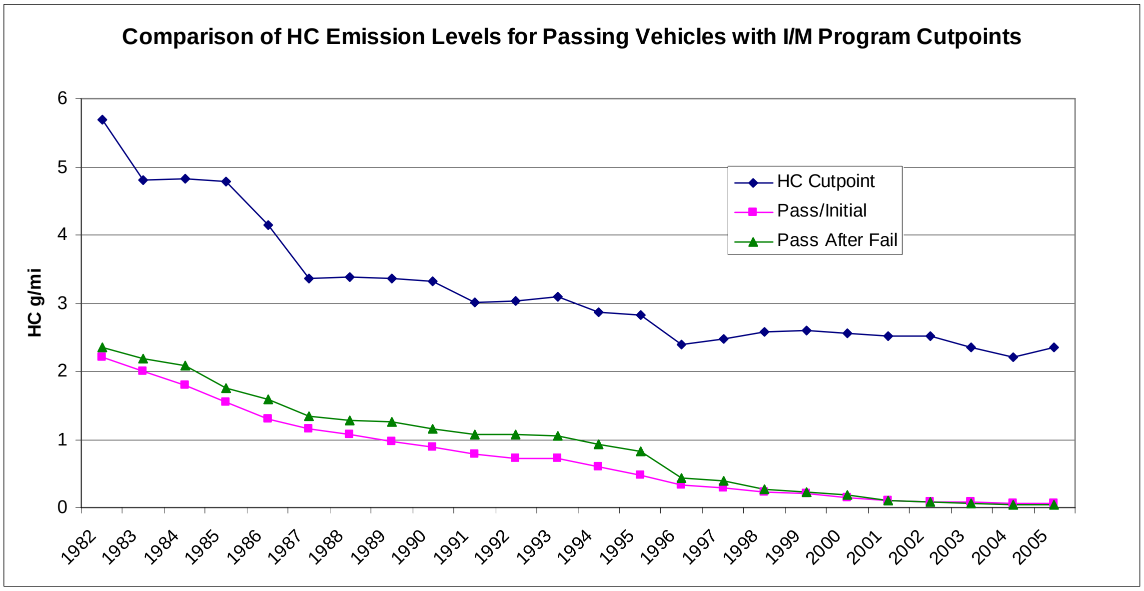
The statutes (Section 42-4-316, C.R.S.) require this performance audit to review the demonstrable effect of the AIR Program on ambient air quality. Additionally, the audit is to review the AIR Program's cost to the public and the cost-effectiveness of the AIR Program relative to other air pollution control programs. We address these issues, as they relate to the AIR Program's traditional emissions test component, in the next few sections.

We reviewed AIR Program data obtained from the Department to evaluate the impact of Colorado's traditional emissions test program on emissions reductions. We found that the traditional emissions test has reduced both hydrocarbon and carbon monoxide emissions from motor vehicles. On the basis of data collected from 2002 to 2005, we estimate that the traditional emissions test reduced hydrocarbon emissions between 2002 and 2005 by 15 tons per day (from 127 tons per day to 112 tons per day), or by 12 percent. Similarly, the traditional emissions test reduced carbon monoxide emissions during this period by 242 tons per day (from 1,210 tons per day to 968 tons per day), or by 20 percent. This has contributed to improving the air quality in the Front Range Area. In the future these benefits will be lower as older vehicles are replaced with newer, cleaner vehicles.

One of the reasons the traditional emissions test has achieved these emissions reductions is that the test does a relatively good job of identifying vehicles with high emissions (i.e., emissions that exceed Colorado's emissions standards, or "cutpoints"). When the traditional emissions test identifies these high-emitting vehicles and the owners repair them, the vehicles, when retested, have emissions levels that are almost identical to the emissions levels of vehicles that pass the emissions test the first time. During 2005 the AIR Program tested 890,000 vehicles through the traditional emissions test. Using either the IM240 or the two-speed idle test (depending on the vehicle), the AIR Program identified about 31,500 vehicles (3.5 percent of all vehicles tested) with high hydrocarbon and carbon monoxide emissions. (The 31,500 does not include the approximately 20,500 vehicles that failed the AIR Program traditional emissions test due to problems with their gas caps or tampering with emission control systems.) About 27,000 of the vehicles with high emissions were subsequently repaired (about 86 percent of the vehicles that failed the traditional test) and, when retested, passed the emissions test. The remaining 4,500 vehicles that failed the emissions test and were never retested are assumed to have been either removed from service, relocated outside of the Front Range Area, or operated with expired plates.

The following graph compares the hydrocarbon emissions of vehicles, that for the period 1982 through 2005 (1) initially failed either the IM240 or two-speed idle test, (2) were repaired and retested, and (3) subsequently passed the emissions test. After repair, emission levels were very close to emission levels for vehicles that passed their initial test. On average, vehicles that pass their initial tests (or pass after failing their initial tests and then are repaired) have emission levels much lower than Colorado's emissions standards or "cutpoints." We estimate that for Calendar Year 2005, repairs to vehicles failing the emissions test reduced hydrocarbon emissions by about 11.5 tons per day and carbon monoxide emissions by 242 tons per day. As explained in the next section, gas cap pressure tests reduce hydrocarbon emissions by an additional 3.5 tons per day, bringing total hydrocarbon emissions reductions to 15 tons per day for Calendar Year 2005.

Colorado Department of Public Health and Environment
Colorado Automobile Inspection and Readjustment (AIR) Program
Comparison of Hydrocarbon (HC) Emission Levels for Vehicles That Pass the Colorado Emissions Standards (or Cutpoints)



Source: *AIR Program data.*
Note: *See Appendix D for an explanation on how emissions benefits in grams per mile are estimated for the AIR Program.*

A second reason the traditional emissions test is effective in achieving emissions reductions is that the test includes a check for faulty gas caps. During Calendar Year 2005 the AIR Program identified 19,000 vehicles (or about 2 percent of the 890,000 vehicles tested) that had faulty gas caps. We estimate that replacement of these faulty gas caps reduced hydrocarbon emissions by 3.5 tons per day.

It is important to note that the actual emissions reductions achieved during 2005, calculated using AIR Program data, were greater then the emissions reductions estimated by the EPA's emissions model, MOBILE6. MOBILE6 is a vehicle emissions model developed by EPA for use in air quality modeling and control strategy development. States must use MOBILE6 to estimate benefits from inspection/maintenance programs. The emissions reductions assumed in the *Early Action Compact* are based on MOBILE6. In 2002, EPA adopted MOBILE6.2, an air-quality-modeling tool that estimates the emissions reductions that will be gained from a traditional emissions test program. MOBILE6.2 predicted that the AIR Program's traditional emissions test would reduce hydrocarbon (exhaust and evaporative emissions) and carbon monoxide emissions by 10 and 145 tons per day, respectively. As we have shown, our analysis, based on actual data from the AIR Program, shows that the traditional emissions test reduced hydrocarbon emissions by 15 tons per day and carbon monoxide emissions by 242 tons per day, significantly more than estimated by the EPA's modeling tool.

Fuel Economy Benefits

In addition to achieving significant reductions in hydrocarbon and carbon monoxide emissions, the AIR Program's traditional emissions test achieves other benefits. One benefit of the traditional emissions test is improved fuel economy for repaired vehicles. We identified a sample of about 9,000 vehicles that failed the traditional emissions test, were repaired, and retested. These 9,000 vehicles received a full-length, 240-second emissions test during both their initial test and their retest after repair, allowing us to make a meaningful comparison of fuel economy. We found that fuel economy for these 9,000 vehicles improved from an average of 20 miles per gallon to 22 miles per gallon after repair, for an overall increase in fuel economy of 10 percent. We projected these fuel economy improvements, by model-year category, before and after repairs, to the 27,000 vehicles that failed the traditional emissions test, were repaired, and then passed when they were retested. When projected, fuel economy for the 27,000 vehicles increased from about 20 miles per gallon to 22 miles per gallon as shown in the following table.

Colorado Department of Public Health and Environment
Impact of Repairs to Failed Vehicles on Fuel Economy (MPG)

Year of Vehicle	Test Sequence	Miles per Gallon (MPG)
82-90	Before Repair	19.94
	After Repair	22.28
91-95	Before Repair	19.69
	After Repair	21.90
96+	Before Repair	20.26
	After Repair	21.39
Average of MPG Before Repair		19.90
Average of MPG After Repair		22.04

Source: *AIR Program data: 2004 to 2005.*
Note: *Changes in the miles per gallon before and after repair were projected to these 27,000 vehicles based on the results of our sample of 9,000.*

Cost-Effectiveness of the AIR Program

Finally, we found that the AIR Program provides substantial reductions in hydrocarbon and carbon monoxide emissions at a cost of $9,800 per ton of ozone precursors reduced. (The cost-effectiveness calculation is the tons of hydrocarbons reduced added to the tons of carbon monoxide reduced and then divided by 60 and is used throughout the report whenever cost-effectiveness is discussed. The calculation of the cost per ton of ozone reduction is calculated by taking total costs and dividing those costs by the tons of hydrocarbons reduced plus the tons of carbon monoxide reduced divided by 60.) This cost is similar to costs incurred by other states' inspection/maintenance programs. During 2005 we estimate that Colorado taxpayers and vehicle owners spent a total of about $30 million on the AIR Program. This includes program administration and payments for testing and repairs. In addition, estimated costs for travel to testing stations and motorist waiting time are about $12 million, or approximately $6 per registered vehicle. Costs are partially offset by savings from improved fuel economy achieved through repairs to vehicles. Therefore, estimated total costs for the AIR Program are about $42.5 million, or about $21 per registered vehicle, as shown in the following exhibit.

Colorado Department of Public Health and Environment Colorado Automobile Inspection and Readjustment (AIR) Program Calendar Year 2005 Estimated Costs	
Item	**Cost**
Inspection Revenue -- ESP, Private Garages, State	$23,741,000
Repair Costs	$9,159,000
Fuel Savings Credit	-$2,987,000
Motorist Inconvenience – Travel[1]	$8,423,000
Motorist Inconvenience -- Wait Time	$3,764,000
Rapid Screen (RSD) Revenue[2]	$403,000
Total	**$42,503,000**
Cost per Vehicle Registered in the DMA	**$21.25**

Source: *Sierra Research analysis of AIR Program costs; see Appendix C.*
[1] Motorist inconvenience for travel is calculated using two different methodologies, resulting in a high and a low value. The low value was selected for this estimate. The assumptions used in this calculation are as follows: distance to stations = 5 miles one way; average speed is 20 mph; average cost to operate a vehicle is $0.30/mile; average consumer wage rate is $19.36/hour; overall tax rate is 37 percent; average station queue wait time is 10 minutes; average testing time is 10 minutes.
[2] Cost to Public to Operate Remote Sensing Devices (Rapid Screen) – According to the Department's contractor ESP, ESP does not charge to operate the remote sensing device vans used for Rapid Screen. ESP collects revenue for vehicles that are clean screened only. According to Sierra Research's estimates, the contractor operates the Rapid Screen Program at a loss.

As discussed previously, the AIR Program reduced hydrocarbon and carbon monoxide emissions by about 15 and 242 tons per day, respectively, between 2002 and 2005. AIR Program costs for these reductions were about $9,800 per ton.

Other Pollution Controls

There are other sources of hydrocarbon emissions, other than motor vehicles, that can be reduced at a lower cost per ton. It is important to note that a number of factors contribute to ozone formation, and reducing hydrocarbon emissions from one type of source may not necessarily affect ozone formation to the same extent as reducing hydrocarbon emissions from another type of source.

In addition to controlling emissions from motor vehicles, the State has established air pollution controls for numerous other sources of hydrocarbon emissions. In 2004 the Air Quality Control Commission adopted additional ozone reducing controls as part of the *Early Action Compact*. Other sources of hydrocarbon emissions include flash emissions (i.e., evaporative emissions resulting from pressure changes that occur when processing petroleum products), oil and gas production, and large reciprocating internal combustion engines (e.g., an engine used to run a pipeline gas compressor). The Department committed to implementing these additional controls in its *Early Action Compact* as well as to continue other strategies contained in the existing ozone maintenance plan. On the basis of the Department's supporting documentation, the State reduces hydrocarbon emissions in the Front Range Area by about 60 tons per day by controlling hydrocarbon emissions from these three types of sources at substantially lower costs per ton than the AIR Program ($9,800 per ton). As of 2007, controls on flash emissions are projected to reduce hydrocarbon emissions by 55 tons per day at a cost of about $250 per ton. Controls on oil and gas operations are projected to reduce hydrocarbon emissions by 1 ton per day at a cost of between $400 and $2,700 per ton. Industrial engine controls are projected to reduce hydrocarbon emissions by 4 tons per day at a cost of about $1,400 per ton. Since air pollution controls for these sources are so cost-effective, the Department is proposing to apply these air pollution controls outside of the Front Range Area beginning May 2008. The Department believes that air pollution controls for these sources will help with attainment of the ozone standard, since much of the ozone in the Front Range Area moves in from outside the area as a result of weather patterns. In addition to the hydrocarbon controls discussed above, the Department has adopted controls for oxides of nitrogen emissions. According to the Department, these two control strategies coupled together help provide a more comprehensive overall strategy for reducing ozone formation in the State.

There are other sources of hydrocarbon emissions for which the Department could establish controls relatively cost-effectively. These include sources such as automotive aftermarket products (e.g., automotive refinishing or painting), architectural coatings, household and personal products, adhesives and sealants, pesticide application, and lawn and garden products, among others. Currently the State relies upon federal control technique guidelines to control emissions from these sources. Emissions from these sources could be further reduced if the State adopted more stringent emissions standards, such as those adopted by California. Under these more stringent standards, hydrocarbon emissions from automotive aftermarket products could be reduced by 11 tons per day at a cost of $1,500 per ton. Hydrocarbon emissions from architectural coatings could be reduced by 6 tons per day at a cost of $6,000 per ton. The northern region of Kentucky was able to eliminate its AIR Program and offset hydrocarbon emissions reductions by implementing controls over automotive aftermarket products. It is important to note, however, that the State may not be able to substitute some of these controls and get the same reductions as those currently obtained through the AIR Program. For example, a 10 ton per day reduction obtained through more stringent controls for automotive aftermarket products may not reduce ozone levels as much as a 10 ton per day reduction from mobile sources (i.e., vehicles). This is because the creation of ozone is affected by the distribution of emissions as well as the reactivity of the specific hydrocarbons emitted by different sources. We estimate the emissions reductions and cost per ton for applying air pollution controls to these sources in Appendix C.

The statutes also require the audit to consider whether the application of the AIR Program ensures compliance with legally required warranties covering air pollution control equipment. Emission system failures when detected by the on-board diagnostic system while the vehicle is still under warranty would be required to be repaired as part of the warranty agreement with the vehicle's manufacturer. A failed emissions test while the vehicle is still under warranty, if not detected by the on-board diagnostic system, is not required to be repaired by the vehicle manufacturer. However, most dealers will make repairs to an emissions system while a vehicle is under warranty, regardless of whether the problem was detected through on-board diagnostics or through the traditional emissions test.

Our audit evaluated the continued need for the AIR Program and the effectiveness of the Rapid Screen Program. We also analyzed a number of alternatives the Department could consider for improving the AIR Program while reducing its costs. The following chapter summarizes our findings and recommendations related to these issues. Details of our data analysis and methodology are presented in the Appendices.

Findings and Recommendations
Chapter 1

As discussed in the Overview chapter, air quality in the Front Range Area has generally improved over the last two decades. Improvements are due, in large part, to new vehicle emissions certification standards, more rigorous emissions testing procedures, and enhancements to stationary source emissions controls. These changes and improvements have contributed to reducing air pollution and improving air quality in Colorado.

Air quality in the Front Range Area is expected to continue to improve as older vehicles are removed from the vehicle fleet and replaced with newer vehicles. This raises questions about whether the AIR Program will be needed in the future to ensure the State is in compliance with National Ambient Air Quality Standards (National Standards).

In this chapter, we review the State's attainment of the National Standards. We also evaluate the effectiveness of and need for the current AIR Program in reducing air pollution and complying with the National Standards in the short- and long-term. Additionally, we evaluate the effectiveness of the Rapid Screen Program in identifying both "clean vehicles" (vehicles that should pass their emissions tests) and "high-emitting vehicles" (vehicles that should fail their emissions tests). Finally, we evaluate the appropriateness of exempting additional model-years from the AIR Program and potential enhancements and improvements to the Program that could contribute to its cost-effectiveness.

Need for the AIR Program

The statutes (Section 42-4-316, C.R.S.) require this performance audit to consider the "need for further reduction of air pollution caused by mobile sources to attain or maintain compliance with National Ambient Air Quality Standards." As described in the Overview chapter, the federal Environmental Protection Agency (EPA) has established National Standards for criteria pollutants. Standards exist for six criteria pollutants; two criteria pollutants—carbon monoxide and ozone—have historically been a problem for the Front Range Area. Our review focused on the need for the AIR Program to ensure compliance with National Standards for ozone and, in particular, reducing emissions for two ozone precursors:

hydrocarbon and carbon monoxide, because these two pollutants are the major contributors to the formation of ozone in the Front Range Area.[3]

We reviewed air quality data provided by the Department for Calendar Years 2003 through 2005 to evaluate historical trends for criteria pollutants from both stationary and mobile sources in the Front Range Area. Overall, we found that criteria pollutants are decreasing in the Front Range Area. Also, the Front Range Area has met all of the National Standards for criteria pollutants for Calendar Years 2004 and 2005.

Although we found the Front Range Area has met the National Standards for all criteria pollutants for the past few years, the Area's attainment of the ozone standard has been borderline. As a result of high ozone readings that occurred during the summers of 2005 and 2006, there is a possibility that the Front Range Area could exceed the ozone standard during 2007. According to EPA's complex formula for eight-hour ozone compliance, which is measured using a rolling three-year average, the Front Range Area could exceed the ozone standard if, in 2007, the fourth highest reading from the monitor located at Chatfield exceeds 84 parts per billion. The Chatfield monitor is the monitor that in the last two years has had the highest eight-hour ozone readings in the Front Range Area.

While there is a possibility that the Front Range Area may exceed the ozone standard in 2007, it is unlikely that the ozone standard will continue to be a concern for the Front Range Area in the longer term. This is because hydrocarbon emissions (a primary contributor to ozone formation) will continue to drop significantly in the future. Hydrocarbon emissions will decline due to air pollution controls applied to stationary sources, limits on fuel volatility, and vehicle turnover, where older high-emitting vehicles are replaced by new vehicles that have close to zero emissions. These hydrocarbon emissions will decline even if Colorado did not have an AIR Program.

As we discussed in the Overview chapter, the AIR Program is effective at reducing hydrocarbon and carbon monoxide emissions from motor vehicles, and these emissions contribute to the formation of ozone. However, motor vehicles are relatively small contributors to the overall ozone problem. A study conducted on six western cities[4] characterized the various sources contributing to the creation of ozone. The study analyzed ozone air quality data from the Front Range Area from Calendar Year 2001 through 2005. On days when the Front

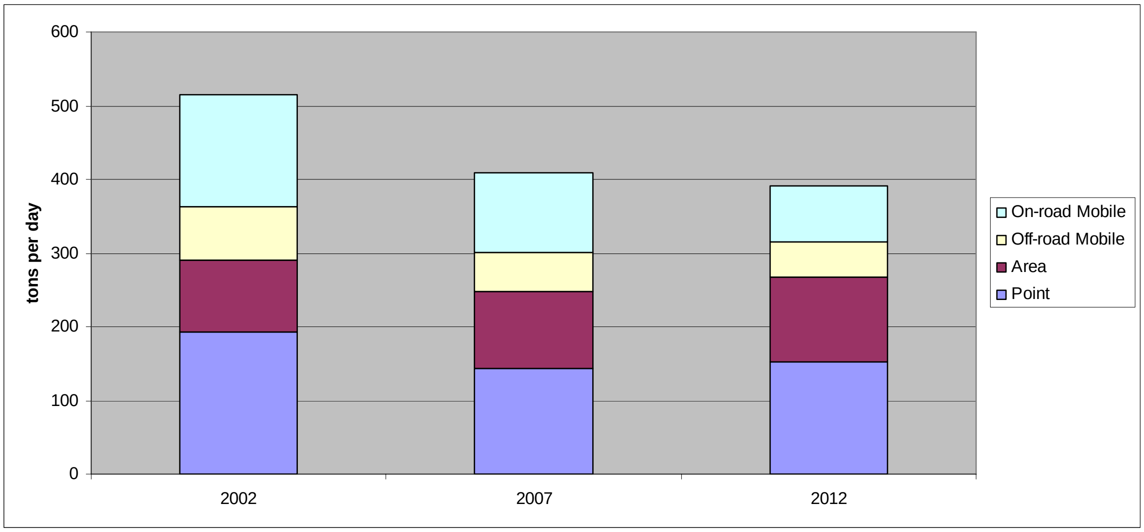
[3] Although ozone is formed by photochemical reactions between hydrocarbons, carbon monoxide and oxides of nitrogen, air quality studies in the Front Rang indicate that controls on hydrocarbons and to a lesser extent carbon monoxide have the biggest impact on ozone levels.

[4] This study was conducted by Sonoma Tech under contract to the Western States Resources Council. The study covered Seattle, Phoenix, Salt Lake City, Denver, Las Vegas, and Farmington (New Mexico).

Range Area exceeded the National Standard of 85 parts per billion, 35 parts per billion was natural background ozone (i.e., ozone that is present from natural sources), 35 parts per billion was transported anthropogenic ozone (i.e., ozone from man-made sources transported into the area due to weather patterns), and 23 parts per billion was locally generated anthropogenic ozone (i.e., ozone from man-made sources generated locally, including ozone from stationary sources and ozone generated by motor vehicles). Assuming that mobile sources contribute about 26 percent of the man-made hydrocarbon emissions in the Front Range Area, about 6 parts per billion of the locally generated ozone from man-made sources was due to motor vehicle emissions. In other words, motor vehicles are the source of about 7 percent of the ozone on days when the Front Range Area exceeds the standard (85 parts per billion). The 12 percent reduction in mobile source hydrocarbon emissions from the AIR Program translates into a 1 percent, or 1 part per billion, reduction in ozone.

With respect to hydrocarbons, motor vehicle emissions now make up a relatively small percentage of the hydrocarbons present in the Front Range Area's air. This trend will continue in the future as older vehicles are continually replaced with newer vehicles with effective emissions equipment. Department data project that during Calendar Year 2007, hydrocarbon emissions from all man-made sources in the Front Range Area will average 409 tons per day. Motor vehicles will contribute 108 tons per day (or about 26 percent) of local man-made hydrocarbon emissions. We display this information in the following exhibit which compares hydrocarbon emissions in the Front Range Area from all sources, including motor vehicles, during 2002 with projections for 2007 and 2012. As the exhibit shows, the mobile source portion of man-made hydrocarbon emissions is projected to drop from 30 percent of total hydrocarbon emissions in 2002 to 18 percent in 2012.

Colorado Department of Public Health and Environment
Colorado Automobile Inspection and Readjustment (AIR) Program
Hydrocarbon Emissions in the Front Range Area
Man-made Sources – 2002, 2007, and 2012



Source: *Early Action Compact (March 12, 2004).*
Notes:
On-Road Mobile: Cars, trucks, and buses
Off-Road Mobile: Construction equipment, locomotives, marine
Area: Architectural coatings, lawn and garden, consumer products, automotive aftermarket
Point: Factories, refineries, other stationary sources.

As discussed in the Overview chapter, the AIR Program reduced hydrocarbon emissions by 15 tons per day during Calendar Year 2005. Since hydrocarbon emissions from all sources (including naturally occurring emissions, emissions transported in from other areas, and locally generated emissions) are expected to total 877 tons per day in 2007, a 15 ton per day reduction in hydrocarbon emissions from motor vehicles represents an overall reduction in hydrocarbon emissions of only 1.7 percent. Although the AIR Program reductions likely contributed to the Front Range Area achieving the National Standards for ozone during the past few years, these data indicate that the Program does not have a significant impact on the Front Range Area's hydrocarbon emissions levels and, thus, the formation of ozone. However, since the Front Range Area is very close to exceeding the ozone standard for at least the next year or two, and small increases in emissions could cause the Front Range Area to exceed the ozone standards, the AIR Program provides some additional assurance to help the Front Range Area meet the ozone standards.

The future need for the AIR Program hinges on the State's ability to maintain compliance with the ozone standard during the summer of 2007. The ozone demonstration date for the Front Range Area under the *Early Action Compact* is April 15, 2008. If the Front Range Area is in compliance with the ozone standard through 2007, the State has until 2011 to submit a plan to the EPA showing how it will maintain compliance with the National Standards in the future. The State will have the option of eliminating the AIR Program if, in its modeling, it can show that the Program is no longer needed to maintain compliance with the National Standards. Reductions in emissions from vehicle turnover alone will likely be sufficient to assure the EPA that mobile source emissions will continue to decrease in the future, even if the AIR program were discontinued. This is because older vehicles will be replaced with newer vehicles that are built to comply with federal new car emissions standards. However, if the State violates the ozone standard during the summer of 2007, the State will be required to submit a plan in 2009 to the EPA for approval showing how the Front Range Area will attain compliance with the National Standards. Federal regulations prohibit the EPA from approving a plan that eliminates a current air pollution control mechanism, such as the AIR Program, unless the State can demonstrate that compensating reductions are provided from other types of air pollution control mechanisms.

The *Early Action Compact* requires the State to maintain the AIR Program until at least the ozone demonstration date of April 15, 2008. The State has an established infrastructure in place for controlling motor vehicle emissions through the current AIR Program. The AIR Program reduced hydrocarbon and carbon monoxide emissions at a reasonable cost, contributing to ensuring compliance with the National Standards for criteria pollutants. Therefore, the Department should maintain the current AIR Program, as required by the *Compact*, until the ozone demonstration date. In the mean time, the Department should collect and analyze data on air pollution from all sources, including motor vehicles, and determine the extent to which the reductions from the AIR Program will be needed to maintain compliance with the National Standards, or to ensure the health of residents, beyond 2007. If the Department determines that AIR Program reductions are no longer needed, the Department should work with the Air Quality Control Commission to evaluate whether the AIR Program should be eliminated. If the Department determines that the AIR Program is still needed, or if the Front Range Area violates the ozone standards in 2007, alternatives exist to further reduce motor vehicle emissions while, in some cases, reducing costs and motorist inconvenience. These alternatives are discussed later in this chapter.

Recommendation No. 1:

The Colorado Department of Public Health and Environment should:

a. Maintain the current AIR Program until April 15, 2008, the ozone demonstration date under the *Early Action Compact*, to help ensure attainment of the ozone standard.

b. Analyze data evaluating the extent to which AIR Program emissions reductions will be needed beyond 2007 to ensure compliance with National Ambient Air Quality Standards and to preserve the health of Front Range Area residents. If the Department determines the AIR Program is no longer needed, the Department should work with the Air Quality Control Commission to evaluate eliminating the Program and, depending on the Commission's actions, with the federal Environmental Protection Agency to eliminate the AIR Program from Colorado's State Implementation Plan.

Colorado Department of Public Health and Environment Response:

a. Agree. Implementation date: December 2008.

The current AIR Program should continue in support of achieving attainment status for ozone, at a minimum, through the Summer of 2007. The current AIR Program is part of the Ozone Early Action Compact with the U.S. Environmental Protection Agency. The EAC will survive intact until affirmatively amended or replaced by a different plan to be proposed by the Air Pollution Control Division and presented to the Air Quality Control Commission. The plan to be developed will be dependent on the Denver area's 2007 compliance with the National Ambient Air Quality Standard (NAAQS) for Ozone. If the Denver area complies with the NAAQS for ozone, the Division plans to present an Ozone Maintenance Plan (i.e., a revision to the State Implementation Plan) to the Commission by the end of 2008.

b. Agree. Implementation date: December 2008.

The Department agrees to analyze data to evaluate the need for AIR Program emissions reductions beyond 2007. After the summer of 2007, the Department will know the attainment status of the Denver area with regard to the National Ambient Air Quality Standard (NAAQS) for Ozone. The Department has been planning to re-evaluate emissions control strategies at that time in order to develop a plan to ensure long-term compliance with the standard. NAAQS are established by the U.S. Environmental Protection Agency to protect public health.

If the Front Range Area is in attainment for ozone after 2007, the Department will work with the Air Quality Control Commission and the EPA, among others, to evaluate the necessity and benefit of continuing the AIR Program, and will propose to eliminate this Program and remove the Program from the State Implementation Plan (SIP) if it is deemed not to be a necessary element to maintain compliance with the ozone standard. The Department will undertake any such evaluation consistent with the provisions of HB06-1302 and other state statutes that relate to the Program. The Air Pollution Control Division will conduct this analysis during the 2008 calendar year and, assuming compliance with the National Ozone Standard, will present the evaluation of the need to retain the Program by December 2008 to the Air Quality Control Commission for its consideration in an Ozone Maintenance Plan.

Rapid Screen

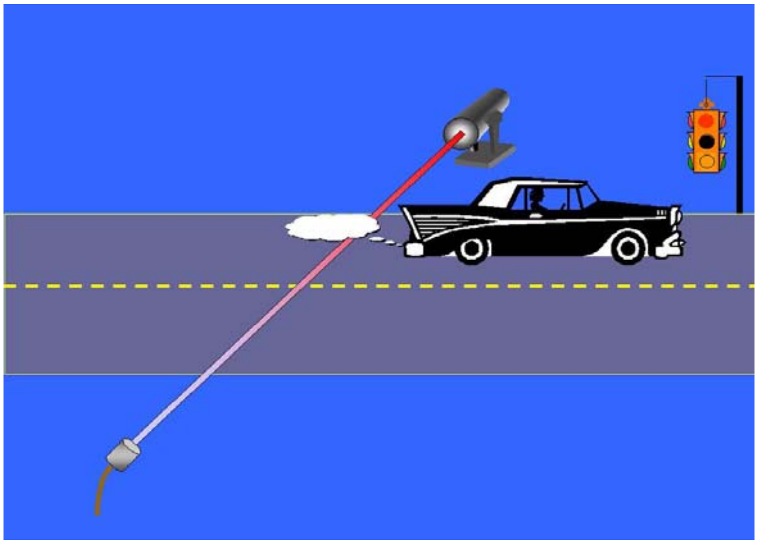
The Rapid Screen Program uses remote sensing devices to measure emissions as vehicles drive past roadside monitors. Currently Rapid Screen is used to identify vehicles that should pass the traditional emissions test, and thus, can be certified without going to an AIR test station. If a vehicle receives two “clean” screens (i.e., “passes” the Rapid Screen test) within the 10-month window before the owner’s registration is due, the vehicle owner is notified by mail. The owner can return the notification, along with the $25 fee to pay for the Rapid Screen test, and forego the traditional emissions test.

House Bill 2006-1302, enacted in 2006, seeks to increase the State’s reliance on the Rapid Screen Program. Under the plan envisioned by House Bill 1302, the State would expand the use of Rapid Screen in the Front Range Area to both identify vehicles that “pass” the emissions test and identify vehicles that are “high emitters” of pollution and that therefore require repair. House Bill 1302 would eventually replace the current requirement for the traditional emissions test at emissions stations with a program that identifies “high emitters” and requires only these vehicles to receive a traditional emissions test, substantially improving motorist convenience and reducing costs to motorists.

In the 2003 audit, it was recommended that the Department evaluate the costs and benefits of using remote sensing to identify "clean" and "high-emitting" vehicles. As part of the current audit, we reviewed Rapid Screen data collected by the Department from 2003 to 2005. We found that Rapid Screen technology has limitations in identifying either vehicles that should pass the emissions test or vehicles that should fail. We identified enhancements to Rapid Screen that increase its effectiveness, but even with these enhancements, Rapid Screen cannot provide the same reductions in emissions currently achieved through the traditional emissions test.

What Is Rapid Screen?

The Rapid Screen test is conducted by using sensing devices that measure vehicle emissions remotely by passing an infrared or ultraviolet light beam across a highway to a source detector on the other side. When a vehicle passes through the light beam, the changes in the intensity of the transmitted light indicate the concentrations of the exhaust gases being monitored. The vehicle should be moderately accelerating when the Rapid Screen test is performed. Rapid Screen has a camera module that takes a picture of the license plate of each vehicle. The vehicle data file contains emission results, pictures of the back of the vehicle, along with speed and emissions data. Rapid Screen offers the opportunity to obtain a large number of vehicle emissions measurements quickly with minimum inconvenience to motorists.



We reviewed Rapid Screen data collected from 2003 through 2005 for 29,000 vehicles that were tested by both (1) Rapid Screen and (2) the traditional emissions test (i.e., the IM240 test conducted at centralized testing facilities for 1982 and newer vehicles and the two-speed idle test conducted at centralized testing facilities for 1981 and older vehicles). We found that a substantial percentage of vehicles pass the Rapid Screen test when they actually fail the traditional emissions test (we call these instances “false passes”) and that a substantial percentage of vehicles fail the Rapid Screen test when they actually pass the traditional emissions test (we call these instances “false fails”). The reason for “false passes” and “false fails” is because, as discussed later in this section, Rapid Screen is not as accurate as the traditional emissions test. Rapid Screen takes only an instant “snapshot” under one type of driving condition, moderate acceleration, while the traditional emissions test covers 240 seconds replicating a range of driving conditions.

Additionally, we found that Rapid Screen technology is not effective at identifying high-emitting vehicles (i.e., vehicles that should fail their emissions tests). Effectively identifying high-emitting vehicles is a key component of any emissions reductions program, since all of the emissions reductions are obtained by identifying high-emitting vehicles. Vehicle owners then repair these vehicles or remove them from the vehicle fleet. Finally, we found that Rapid Screen is currently unable to effectively screen a significant percentage of the vehicle fleet. We discuss these issues in the next section.

Using Rapid Screen to Identify “Clean” Vehicles

As discussed previously, Rapid Screen is currently used to identify vehicles in the Front Range Area that should pass their emissions test and, therefore, are “clean.” We evaluated Department data to determine how accurately Rapid Screen identifies “clean” vehicles. We matched traditional emissions test data and Rapid Screen data for 2003 through 2005 for vehicles that received the IM240 test in the one-year period after they were observed through remote sensing. We identified 607 vehicles in the Rapid Screen data set that failed the IM240 or two-speed idle component of their traditional emissions test. Of these 607 vehicles, 130 vehicles (about 21 percent) passed Rapid Screen yet they failed the IM240 or two-speed idle test (these are false passes). We provide information on these false passes, broken out for both 1995 and older vehicles and 1996 and newer vehicles, in the table below.

Number and Percentage of Vehicles That Pass[1] the Rapid Screen Test but Fail the Traditional Emissions Test –Two Rapid Screen Observations Within One Year						
VEHICLE MODEL YEAR	**1995 and older**		**1996 and newer**		**TOTAL**	
	Number	**Percent**	**Number**	**Percent**	**Number**	**Percent**
Vehicles Failing the Traditional Emissions Test[1]	480	100%	127	100%	607	100%
Vehicles Passing[2] **Rapid Screen but Failing the Traditional Emissions Test**	77	16%	53	42%	130	21%

Source: Department inspection station and Rapid Screen data for 2005.

[1]*These numbers include vehicles that failed the IM240 or two-speed idle test at emissions stations but do not include vehicles that failed the gas cap pressure test.*

[2]*Vehicles passed Rapid Screen if carbon monoxide emissions were 0.5 percent or less and hydrocarbon emissions were 200 parts per million or less.*

These data indicate that Rapid Screen would pass about one-fifth of the vehicles that should fail their emissions tests. As discussed previously, only 8 percent of the fleet is currently being evaluated by Rapid Screen. As a result, only a small percentage of vehicles that should fail their emissions test are being falsely passed. However, during 2005 about 31,500 vehicles failed their IM240 or two-speed idle tests at emissions stations. If Rapid Screen had obtained valid screens for these 31,500 vehicles and had the same false pass rate as the rate for the vehicles in our sample, Rapid Screen would have passed more than 6,700 vehicles that should have failed their emissions tests. Furthermore, Rapid Screen technology cannot screen vehicles for gas cap pressure through remote sensing technology. The AIR Program obtains a reduction of 3.5 tons per day in evaporative hydrocarbon emissions from the gas cap pressure test performed during the traditional emissions test. The fact that Rapid Screen cannot test for gas cap pressure and that it passes one-fifth of the vehicles that should fail their emissions tests is significant. As explained previously, the AIR Program achieves all of its carbon monoxide emissions reductions (242 tons per day) and hydrocarbon emissions reductions (15 tons per day) by identifying vehicles that fail their emissions tests. Vehicle owners either repair these vehicles or remove them from service.

Using Rapid Screen to Identify "High-Emitting" Vehicles

We also evaluated Rapid Screen's effectiveness in identifying high-emitting vehicles, or vehicles that should fail the traditional emissions test. House Bill 2006-1302 requires the State to develop a plan to use Rapid Screen to identify high-emitting vehicles in addition to identifying vehicles that pass the emissions test. Currently Rapid Screen does not have emissions standards for identifying high-emitting vehicles because the Rapid Screen component focuses on identifying "clean" vehicles, i.e., vehicles that pass the emissions test. Since Rapid Screen standards for identifying high-emitting vehicles do not currently exist, we developed three sets of standards for our review: most stringent, moderately stringent, and least stringent. We found that even when using the most stringent standard, Rapid Screen identified only 225 (37 percent) of the 607 vehicles in our sample that failed the traditional emissions test. Using the least stringent standard, Rapid Screen identified only 38 (6 percent) of the 607 vehicles that failed the traditional emissions test. We display these data in the table below.

Effectiveness of Rapid Screen in Identifying High-Emitting Vehicles
Two Rapid Screen Observations Within One Year

EVALUATION CRITERIA	Most Stringent[1]		Moderately Stringent[2]		Least Stringent[3]	
	Number	Percent	Number	Percent	Number	Percent
Vehicles Failing the Traditional Emissions Test[4]	607	n/a	607	n/a	607	n/a
Vehicles Failing Both Rapid Screen and the Traditional Emissions Test	225	37%	98	16%	38	6%

Source: *Department inspection station and Rapid Screen data for 2005.*

Notes: *Vehicles exceeded the standards during both observations.*

[1] *Carbon monoxide emissions cannot exceed 1 percent; hydrocarbon emissions cannot exceed 300 parts per million; oxides of nitrogen cannot exceed 2,000 parts per million.*

[2] *Carbon monoxide emissions cannot exceed 3 percent; hydrocarbon emissions cannot exceed 500 parts per million; oxides of nitrogen cannot exceed 3,000 parts per million.*

[3] *Carbon monoxide emissions cannot exceed 5 percent; hydrocarbon emissions cannot exceed 1,000 parts per million; oxides of nitrogen cannot exceed 5,000 parts per million.*

[4] *For the purpose of this analysis, traditional emissions test failures include only those vehicles that failed the IM240 or two-speed idle test and do not include vehicles that failed their gas cap pressure tests.*

The table shows that under the most stringent standards, Rapid Screen identified only 37 percent of the vehicles that failed their traditional emissions tests. Conversely, Rapid Screen did not identify 63 percent of the vehicles that failed their traditional emissions tests. This means that if Rapid Screen were able to obtain a valid screen for all 31,500 vehicles that failed their IM240 or two-speed idle test during 2005, Rapid Screen would not identify close to 22,000 of the vehicles that should have failed their emissions tests. Again, this is significant because the Air Program obtains all of its emissions reductions by identifying high-emitting vehicles. Owners then either repair the vehicles or remove them from the fleet.

Using the same standards for identifying high-emitter vehicles, we also evaluated Rapid Screen's effectiveness in ensuring that the Rapid Screen test does not fail vehicles that should pass their emissions test (false fails). Using the most stringent standards, we identified 1,263 vehicles in our data set that failed the Rapid Screen emissions test. Of these 1,263 vehicles, 1,038 (82 percent) were false fails, i.e. these 1,038 vehicles passed their traditional emissions tests. Using the least stringent standards, we identified 83 vehicles in our data set that failed the Rapid Screen emissions test. Of these 83 vehicles, 45 (54 percent) were false fails, i.e. these 45 vehicles passed their traditional emissions tests. This indicates that Rapid Screen cannot identify vehicles that should fail their emissions tests without also identifying a significant percentage of false fails. We display these data in the table below.

Effectiveness of Rapid Screen in Minimizing False Fails
Two Rapid Screen Observations Within One Year

EVALUATION CRITERIA	Most Stringent[1]		Moderately Stringent[2]		Least Stringent[3]	
	Number	Percent	Number	Percent	Number	Percent
Vehicles Failing Rapid Screen	1,263	n/a	376	n/a	83	n/a
Vehicles Failing Rapid Screen That Passed the Traditional Emissions Test[4] (False Fails)	1,038	82%	278	74%	45	54%

Source: *Department inspection station and Rapid Screen data for 2005.*

Notes: *Vehicles exceeded the standards during both observations.*

[1] *Carbon monoxide emissions cannot exceed 1 percent; hydrocarbon emissions cannot exceed 300 parts per million; oxides of nitrogen cannot exceed 2,000 parts per million.*

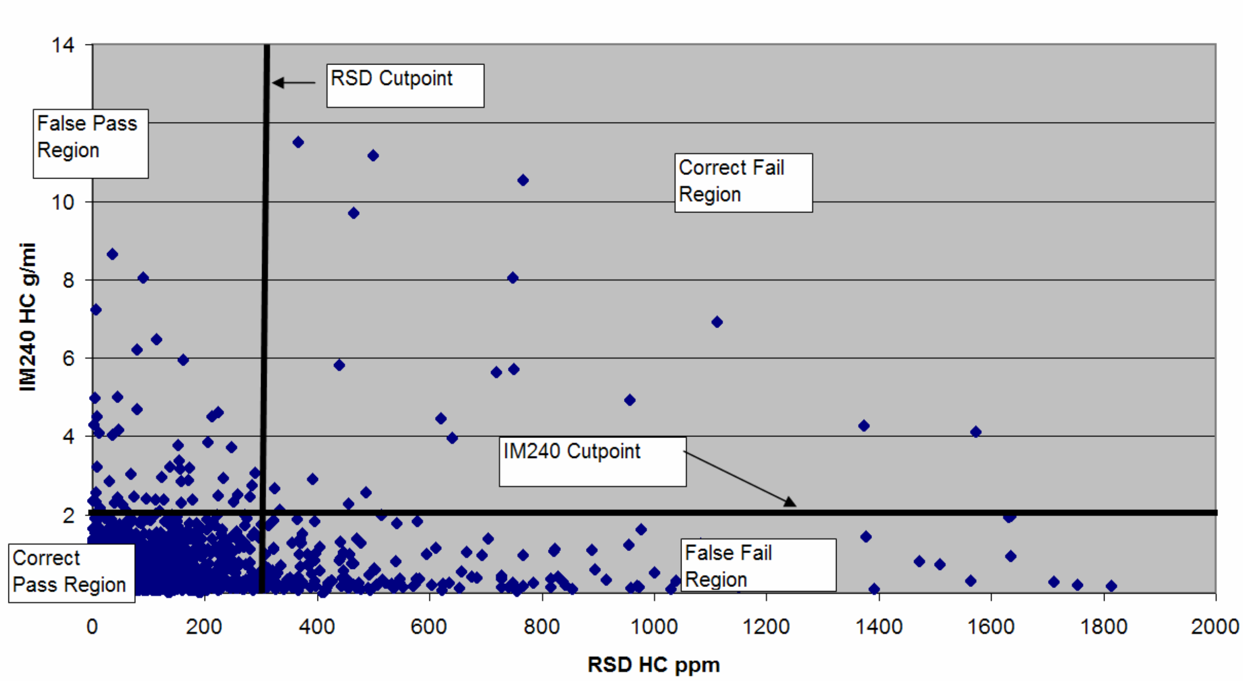
[2] *Carbon monoxide emissions cannot exceed 3 percent; hydrocarbon emissions cannot exceed 500 parts per million; oxides of nitrogen cannot exceed 3,000 parts per million.*

[3] *Carbon monoxide emissions cannot exceed 5 percent; hydrocarbon emissions cannot exceed 1,000 parts per million; oxides of nitrogen cannot exceed 5,000 parts per million.*

[4] *For the purpose of this analysis, traditional emissions test failures include only those vehicles that failed the IM240 or two-speed idle test and do not include vehicles that failed their gas cap pressure tests.*

We also extracted Rapid Screen and IM240 emissions test results from our data set for all 1995 model-year vehicles. We selected this model-year for our analysis because it was a year with substantial emissions reductions from the AIR Program and the data set had a high number of Rapid Screen observations. We matched the results of the most recent Rapid Screen test taken before the same vehicle's IM240 test. The following chart shows the distribution of false passes and false fails for the 5,800 vehicles in our sample.

Colorado Department of Public Health and Environment
Colorado Automobile Inspection and Readjustment (AIR) Program
Correlation Between IM240 Test Results and Rapid Screen Results
for 1995 Model-Year Passenger Vehicles



Source: *Colorado Department of Public Health and Environment Rapid Screen and IM240 data.*
Correct Pass: Below the established cutpoint for both the Rapid Screen and IM240 tests.
False Pass: Below the established cutpoint for Rapid Screen but above IM240 cutpoint.
False Fail: Below the established cutpoint for the IM240 test but above the Rapid Screen cutpoint.
Correct Fail: Above the established cutpoint for both the Rapid Screen and IM240 tests.

These data indicate that Rapid Screen cannot effectively identify a significant percentage of the vehicles that should fail their emissions tests without also failing a high percentage of vehicles that should pass. This means that Rapid Screen is not only ineffective at identifying high-emitting vehicles, Rapid Screen may not reduce inconvenience for motorists. This is because the majority of motorists who fail their Rapid Screen tests would have to travel to an emissions station for a traditional emissions test, only to find out that their vehicles actually passed.

One reason that Rapid Screen has problems correctly identifying either passing ("clean") vehicles or high-emitting vehicles is that the Rapid Screen technology, by design, has limitations. Rapid Screen is designed to test emissions over a very short period of time (instantaneous) under one type of driving condition (moderate acceleration). However, vehicles operate under a wide variety of driving conditions (i.e., cold start, bumper-to-bumper traffic, high-speed cruising) and, depending upon the driving conditions, emit different levels of exhaust pollutants. In contrast, the IM240 test measures emissions over a 240-second test cycle under a much wider range of loads (acceleration) than can be observed in an instant Rapid Screen test. IM240 emission tests will therefore provide a better measure of emission levels than Rapid Screen. The IM240 emission test also does a better job of replicating the results of the Federal Test Procedure, the test required to certify the emissions for new vehicles.

Rapid Screen Coverage

Currently the Department's *Early Action Compact* with the EPA allows up to 50 percent of the vehicles in the Denver area to pass an emissions test through Rapid Screen. To determine the effectiveness of Rapid Screen in obtaining sufficient coverage of the vehicle fleet to achieve the 50 percent target, we evaluated the number and percentage of vehicles that received two passing tests by Rapid Screen within 10 months of registration renewal during 2005. We found that Rapid Screen is not effective at screening a sufficient proportion of the vehicle fleet. Of the 890,000 Front Range Area vehicles that were required to have an emissions test during 2005, only about 27,000 vehicles (3 percent) passed two Rapid Screen tests within 10 months of their registration renewals. All of these 27,000 vehicle owners were notified that their vehicle had passed the Rapid Screen test. Only 16,000 vehicles (just under 2 percent of the 890,000 vehicles) had owners that took advantage of passing the Rapid Screen emissions tests by mailing in their notification along with the $25 fee. The remaining 11,000 vehicles had owners that took their vehicle in for a traditional emissions test.

One of the reasons that Rapid Screen is only able to obtain screens on such a small percentage of vehicles is that Rapid Screen currently requires two valid observations for each vehicle in order to have a complete test. During 2005, Rapid Screen made 1.5 million separate observations. From these 1.5 million observations, only about 151,000 vehicles received two or more observations. Once all Rapid Screen criteria were applied (the vehicle was moderately accelerating, the vehicle was registered in the Denver Metropolitan Area, the two observations occurred on two separate days, the two observations were within 10 months of the registration renewal), only 39,000 vehicles were eligible for the Rapid Screen evaluation. Using the current Rapid Screen criteria, the number of observations would need to increase by 800 percent, to 20 million observations, to screen 50 percent of the vehicle fleet (about 445,000 vehicles per year) as allowed by the *Early Action Compact.* During 2005 the AIR Program contractor, ESP, operated six Rapid Screen vans. Each van screened an average of about 250,000 vehicles during the year. In 2006, ESP expanded the number of Rapid Screen vans to nine. To reach 445,000 vehicles, ESP would need at least 63 more vans. Considering Rapid Screen's ineffectiveness in identifying high-emitting vehicles, this would be a substantial expansion of the Rapid Screen Program in exchange for minimal reductions in emissions and no decrease in inconvenience or costs to a significant number of motorists.

Rapid Screen Emissions Reductions

Finally, we estimated the emissions reductions that Rapid Screen would achieve if the State relied on Rapid Screen alone to identify high-emitting vehicles as envisioned by House Bill 1302. We found that due to the problems with false failures and the poor fleet coverage discussed above, Rapid Screen would provide less than half of the AIR Program's current reductions in hydrocarbon and carbon monoxide emissions obtained from the IM240 or two-speed idle test and would not reduce motorist inconvenience for vehicles that had false fails. Additionally, since Rapid Screen cannot test gas cap pressure through remote sensing technology, Rapid Screen loses the emissions benefits achieved from gas cap pressure tests (these tests are currently performed as part of the AIR Program's traditional emissions test). As discussed previously, the AIR Program currently obtains 3.5 tons per day in hydrocarbon emissions reductions from the gas cap pressure test. The emissions impact of Rapid Screen is discussed in greater detail in Appendix D.

If Rapid Screen were used in conjunction with the traditional emissions test to only identify "clean" vehicles rather than high-emitting vehicles, and if Rapid Screen could obtain enough coverage to screen and pass 50 percent of the vehicle fleet, AIR Program benefits from reductions in hydrocarbon emissions would decrease by 20 percent. In other words, instead of obtaining 15 tons per day in hydrocarbon emissions reductions, the AIR Program would obtain 12 tons per day. Program costs would increase from $9,800 per ton with the Rapid Screen component to $10,900 per ton, on the basis of 2005 data. This assumes that the current test fee of $25 is sufficient to provide the number of Rapid Screen tests needed to clean screen 50 percent of the fleet.

Improving the Effectiveness of Rapid Screen

We examined ways to change the Rapid Screen test to determine if it could become more effective at identifying either vehicles that should pass their emissions tests (clean vehicles) or vehicles that should fail (high-emitters). We did not identify any methods for improving Rapid Screen that would identify high-emitters effectively without also false-failing a high percentage of vehicles. However, with the improvements discussed below, Rapid Screen could become somewhat more effective at identifying "clean" vehicles.

To improve Rapid Screen so that the test identifies the highest number of "clean" vehicles with the lowest number of false passes, the Department could consider implementing one Rapid Screen observation in conjunction with a High-Emitter Index, as described below:

- **One observation.** As discussed previously, Rapid Screen currently requires two valid observations to identify a vehicle that passes its emissions test. Using only one observation instead of two observations would expand Rapid Screen coverage of the fleet by almost 150 percent (from about 151,000 vehicles to about 374,000 vehicles).

- **High-emitter index.** A high-emitter index is a measure of the historical probability that a vehicle will fail an AIR inspection based on the year, make, and model of the vehicle. If Rapid Screen applied a high-emitter index of 50 percent, Rapid Screen would automatically exclude the top 50 percent of the historically highest-polluting vehicles from passing the Rapid Screen test and thus reduce the percentage of vehicles that receive false passes. Vehicles excluded on the basis of the high-emitter index would then be required to undergo a traditional emissions test.

By implementing (1) one observation in conjunction with (2) a 50 percent high-emitter index as part of Rapid Screen, we estimate that on the basis of 2005 data, Rapid Screen could pass 91,000 of the approximately 890,000 vehicles (10 percent) that must be screened each year. Of this number, about 370 vehicles screened (.4 percent) would be false passes. These estimates assume that Rapid Screen would obtain at least 1.5 million observations during the year, which Rapid Screen achieved during 2005 using six vans. These estimates also assume that the remaining 90 percent of vehicles (approximately 799,000 vehicles) would be tested through the traditional emissions test. Implementing Rapid Screen in this manner would result in about 14.5 tons per day reduction in hydrocarbon emissions at a cost of about $9,900 per ton, compared with 15 tons per day at a cost of $9,800 per ton under the current Program.

Currently no other state operates a program such as Rapid Screen as the only program for identifying vehicles that are high-emitters and, thus, should fail their emissions tests. Only two states, Texas and Virginia[5], have remote sensor programs to identify high-emitters, and both operate them in conjunction with their traditional emissions test programs. One state, Missouri, operated a remote sensor program to clean screen vehicles. Missouri will begin eliminating its

[5] Virginia's remote sensing program started in 2004 but to date has not been used to identify high-emitters. Texas uses remote sensing to identify high-emitters for off-cycle emissions tests. The high-emitters identified represent a small fraction of Texas' vehicle fleet (<1 percent).

remote sensor program in 2007 and replacing it with an on-board diagnostics-only program. We discuss on-board diagnostic alternatives later in this chapter.

As discussed previously, the Front Range Area is borderline for meeting ozone standards for 2007. Until the ozone demonstration date of April 15, 2008, the Department should maximize hydrocarbon and carbon monoxide emissions reductions by maintaining the traditional emissions test as the key component of the AIR Program. After April 15, 2008, if the Front Range Area meets the ozone standard and the Department's analysis, as discussed in Recommendation No. 1, shows that the AIR Program is no longer needed, the Department could take steps to eliminate the AIR Program, including both the traditional emissions test and Rapid Screen. If the Front Range Area does not meet the ozone standard, or if the Department's analysis indicates that the AIR Program is still needed, the Department could improve the Rapid Screen Program as discussed above and use Rapid Screen, along with the traditional emissions test, to identify "clean" vehicles. This would allow the Department to achieve meaningful emissions reductions while somewhat improving motorist convenience. Alternatively, the Department could consider one of the options for further reducing emissions and costs as discussed later in this chapter. Regardless of whether or not the AIR Program continues, the Department should conduct its own evaluation of the effectiveness of Rapid Screen to identify high-emitting vehicles. This evaluation should expand on the analysis conducted for this report and include 2006 data and take into account the three extra vans that have been added to the Program. If based on this evaluation the Department determines that Rapid Screen does not effectively identify high-emitting vehicles, the Department should work with the General Assembly to determine the appropriate policy direction to take with respect to the AIR Program specifically with respect to Rapid Screen.

Recommendation No. 2:

The Colorado Department of Public Health and Environment should conduct its own evaluation of the effectiveness of using Rapid Screen to identify high-emitting vehicles, incorporating current Rapid Screen data. If based on this evaluation the Department determines that Rapid Screen does not effectively identify high-emitting vehicles, the Department should work with the General Assembly to determine the appropriate policy direction to take with respect to the Program, and if necessary, seek statutory change to eliminate the requirement that Rapid Screen be used for this purpose.

Colorado Department of Public Health and Environment Response:

Agree. Implementation date: Ongoing.

The Department agrees that it should conduct its own evaluation of the feasibility and effectiveness of using Rapid Screen for high emitter identification. The Department acknowledges that available and published studies, data, and literature in this area conflict on the effectiveness of remote sensing high emitter identification. The General Assembly has, however, directed the Department, in HB06-1302, to develop a plan to significantly increase the use of the remote sensing program, specifically focusing on the development of a high emitter identification program. The Department is in the process of doing so. HB06-1302 contemplated the challenges inherent to implementing a high emitter identification program, and directed the Department to undertake efforts to address these challenges. HB06-1302 provides flexibility to the Department and the Air Quality Control Commission in addressing challenges that may exist with developing and implementing remote sensing high emitter programs. If upon completion of the Department's evaluation it is shown conclusively that these challenges cannot effectively, and cost-effectively, be overcome, then the Department will work with the Air Quality Control Commission and, as necessary, the General Assembly to propose the elimination of the requirement to implement a high emitter program within the bounds of HB06-1302 or by seeking to revise those statutory provisions.

The Department is in the process of developing the high emitter identification program and does not believe a specific month and year to evaluate an, as yet, undeveloped program can be identified or committed to with any certainty. The Department does commit to expedite an evaluation of the program once it has been implemented and there are data to evaluate.

Recommendation No. 3:

The Colorado Department of Public Health and Environment should consider retaining the Rapid Screen clean screen component of the AIR Program if the Front Range Area does not meet the National Ambient Air Quality Standard for ozone in 2007, or if the Department's analysis indicates that emissions reductions are still needed in the future. If the Department determines that it is necessary to retain the Rapid Screen clean screen component of the AIR Program, the Department should consider proposing improvements to Rapid Screen and reducing the false pass rate by requiring only one valid observation in conjunction with the use of a high-emitter index.

Colorado Department of Public Health and Environment Response:

Agree. Implementation date: December 2008.

The Department agrees that it should consider retaining the clean screen component as an adjunct to the traditional emissions test even in an ozone non-attainment situation. This is consistent with the directives of HB06-1302 and is part of the 1302 implementation plan to be presented to the Air Quality Control Commission in December 2006.

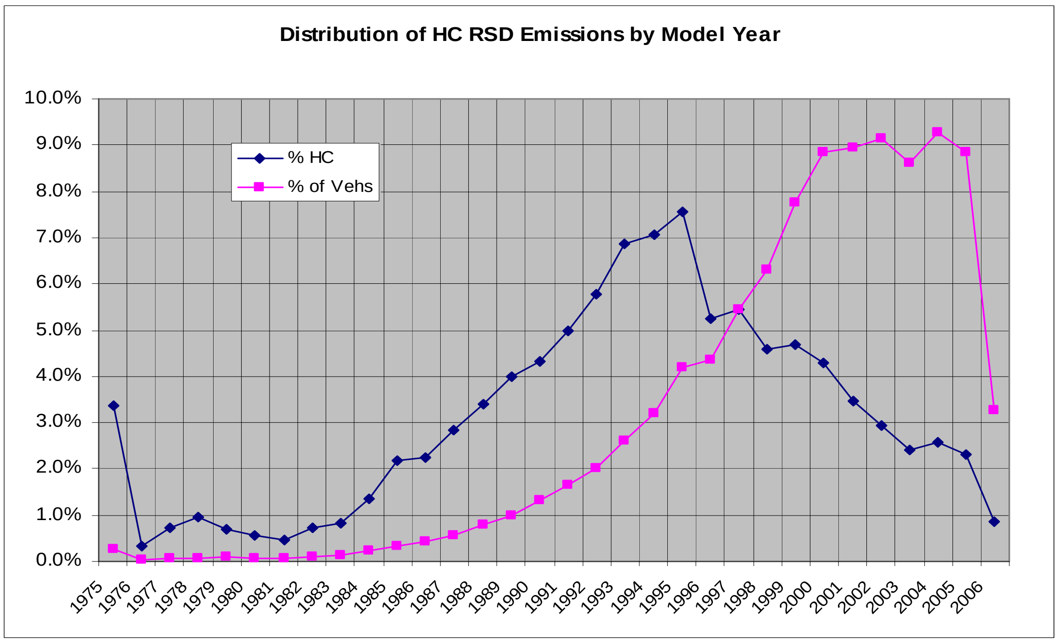
Further, the Air Pollution Control Division is in the process of evaluating the use of an emissions index in conjunction with a single valid remote sensing reading as a program improvement, and this will be reflected in the HB06-1302 implementation plan to be presented to the Air Quality Control Commission in December 2006. It should be noted, however, that Colorado may be constrained from utilizing a single observation and/or a high emitter index under the terms of the existing Ozone Early Action Compact, a formal, enforceable State Implementation Plan (SIP) document with the EPA, which currently requires two valid observations. The Department will conduct an evaluation of using an emissions index and single valid remote sensing reading by the end of 2008.

Model-Year Exemptions

Currently the AIR Program exempts the newest four model-years from traditional emissions tests. The AIR Program requires the remainder of the gasoline-powered fleet to be inspected. As part of this audit, we evaluated data on emissions by model-year to determine whether the current four-year exemption is appropriate and whether the number of exemption years could be expanded to decrease motorist inconvenience without significantly affecting emissions reductions.

We evaluated data on hydrocarbon emissions from Rapid Screen tests in the Front Range Area to determine the extent to which vehicles in each model year are contributing to emissions. We found that although most of the vehicles in the Front Range Area are 2000 model-years or newer, these are not the vehicles that contribute most of the emissions. Rather, older vehicles contribute more hydrocarbon emissions in the Front Range Area than newer vehicles. The relationship between vehicle age and emissions is displayed in the following graph.

Colorado Department of Public Health and Environment
Colorado Automobile Inspection and Readjustment (AIR) Program
Hydrocarbon Emissions by Model-Year

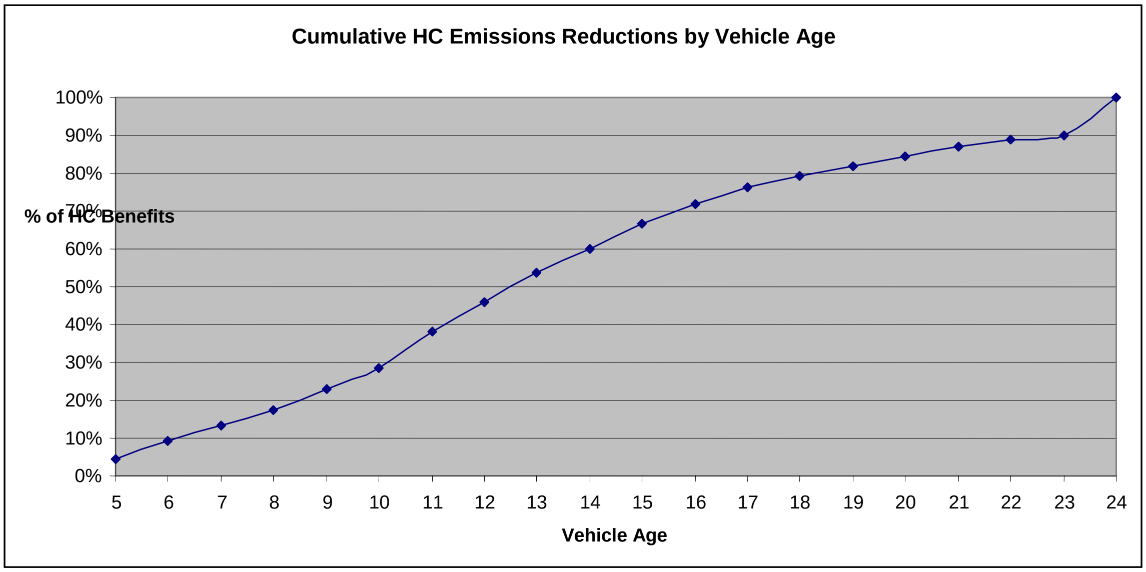


Source: *Department of Public Health and Environment Rapid Screen data.*

The graph shows that the four most recent model-years (2003 through 2006) account for a little more than 7 percent of the vehicle emissions and about 30 percent of the vehicles being driven. Exempting these four model-years has little impact on emissions reductions, since by screening 2002 model-year vehicles and older, the AIR Program currently identifies 93 percent of the emissions in the Front Range Area.

We also evaluated data on vehicle emissions by model-year to determine whether the AIR Program could expand the model-year exemptions beyond four years without significantly impacting emissions reductions. We found that once exemptions extend beyond four model-years, emissions reductions are affected. We display the cumulative hydrocarbon emissions reductions achieved by the AIR Program for vehicles five years and older in the following graph.

Colorado Department of Public Health and Environment
Colorado Automobile Inspection and Readjustment (AIR) Program
Cumulative Hydrocarbon Emissions by Vehicle Age



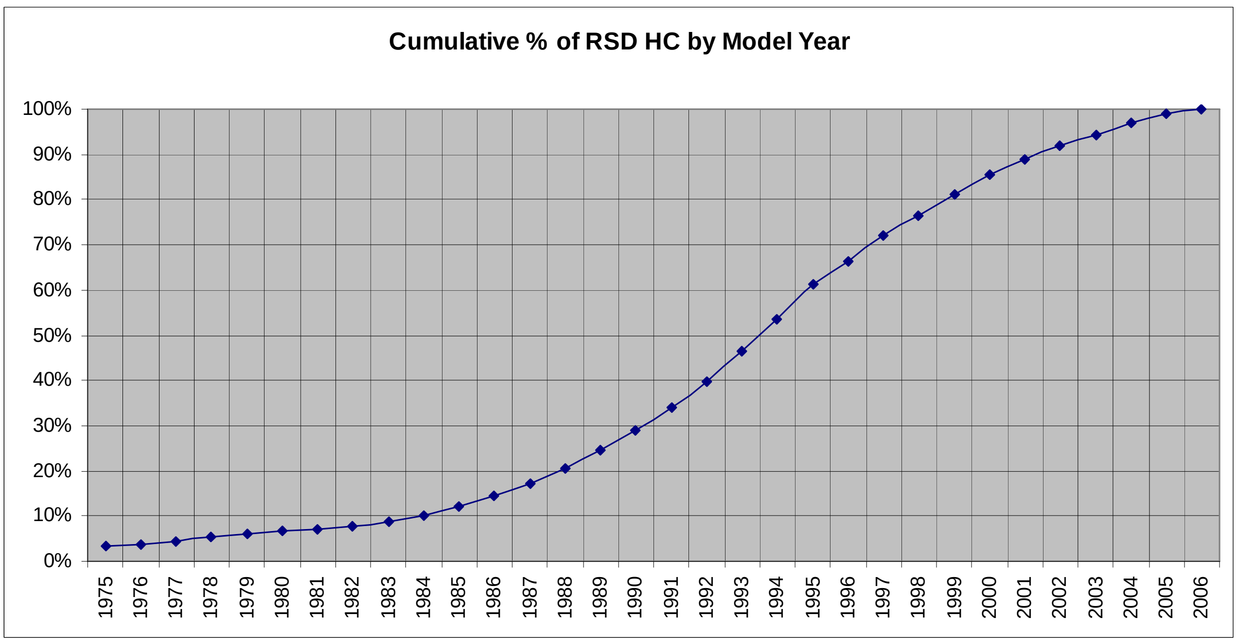
Source: *de la Torre Klausmeier Consulting analysis of Colorado Department of Public Health and Environment data on AIR Program tests.*

The graph shows that by exempting vehicles that are five and six years old, the AIR Program eliminates 9 percent of the reductions in hydrocarbon emissions. In other words, instead of obtaining 15 tons per day in hydrocarbon emissions, the AIR Program would obtain 13.6 tons per day (9 percent less). By exempting vehicles that are up to eight years old, the AIR Program eliminates 18 percent of the reductions in hydrocarbon emissions. This means that the AIR Program would obtain 12.3 tons per day in hydrocarbon emissions instead of 15 tons per day. One advantage to increasing model-year exemptions is that it does reduce the cost per ton for emissions reductions. This is because fewer vehicles are inspected, reducing inspection costs, repair costs, and motorist inconvenience costs. Exempting six model-years reduces costs per ton from the current $9,800 to $9,200; exempting eight model-years reduces costs per ton to $8,300. We provide detailed information on these costs in the Appendix D.

As an alternative to expanding model-year exemptions, the Department could consider using Rapid Screen, with the recommended improvements discussed previously, to reduce customer inconvenience. Expanding the model-year exemption from four years to six years would reduce the number of inspections conducted by the AIR Program each year by 140,000 vehicles. If the Department could implement improvements and expand Rapid Screen's coverage to a level where Rapid Screen could screen and pass 140,000 vehicles, Rapid Screen would only eliminate 5 percent, or .7 tons per day, of the hydrocarbon emissions reductions currently obtained from the AIR Program. In other words, this alternative would obtain 14.3 tons per day in hydrocarbon emissions reductions, which is better than the 13.6 tons per day that would be obtained by exempting six model-years from the AIR Program.

Finally, we evaluated whether the AIR Program should continue to inspect older model-year vehicles. Some states (Illinois and Missouri) have revised their inspection and maintenance programs to inspect only vehicles that are 1996 and newer. This can reduce overall inspection costs. We reviewed vehicle emissions by model year and found that vehicles that are 1995 and older account for 61 percent of hydrocarbon emissions from vehicles in the Front Range Area. We display this information in the graph below. These data indicate that the AIR Program should continue to inspect older vehicles to identify the vehicles responsible for the greatest proportion of hydrocarbon emissions.

Colorado Department of Public Health and Environment
Colorado Automobile Inspection and Readjustment (AIR) Program
Cumulative Hydrocarbon Emissions by Model-Year



Source: *Colorado Department of Public Health and Environment Rapid Screen data.*
Note: *See Appendix D for comparison of average Rapid Screen readings by model-year with average IM240 readings by model-year.*

The four model-year exemption is currently included in the *Early Action Compact*. Since the Front Range Area is very close to exceeding the eight-hour ozone standard, the AIR Program should maintain the four model-year exemption and not expand the exemption to six or eight years. If the Front Range Area is in compliance with the standard, the AIR Program may no longer be needed as discussed previously. However, if the Front Range Area violates the eight-hour ozone standard, the Department will need to consider a range of controls for meeting standards and can re-evaluate the model-year exemption at that time.

Recommendation No. 4:

The Colorado Department of Public Health and Environment should work with the Air Quality Control Commission to fully evaluate the impact of increasing model-year exemptions for the AIR Program greater than the current four model-years, including evaluating the economic benefits of increasing the model-year exemptions as well as the possible impact on remote sensing. The current four model-year exemption should be maintained until the Commission considers and acts upon the results of the Department's evaluation.

Colorado Department of Public Health and Environment Response:

Agree. Implementation date: December 2006.

This is a matter for the Air Quality Control Commission, which has noticed a public hearing on this specific issue to be considered on December 14 and 15, 2006. The Commission will consider the impacts of increasing the model year exemption by one, two, three, or four model years (or stay with the present exemptions). The Commission will make this policy determination for the Program after a public hearing and thorough consideration of the information presented. The Department will present an evaluation of relevant information to the Commission for its consideration at the hearing. The Air Pollution Control Division's analysis of air quality impacts using MOBILE6.2 demonstrates that exempting an additional four model years would increase hydrocarbon emissions by one ton per day in 2007, which is modest. The small increases in emissions due to increases in model year exemptions would have a significant positive impact on the cost effectiveness of the Program and would significantly reduce motorist inconvenience. This, combined with the decreasing need for the Program due to fleet turnover and overall reduced vehicle emissions, make the option of increasing model year exemptions a cost effective approach to continued Program operation. The Commission will hold its public hearing in December 2006, consider the information that will be presented by the interested stakeholders and the Department, and make the decision to increase model year exemptions or not. If the Commission adopts any increases beyond the current model-year exemptions, those would not take effect until approved by the EPA, which would be sometime after the Early Action Compact ozone demonstration date (April 15, 2008). The Air Quality Control Commission's consideration of a potential increase in model-year exemptions will occur on December 14, 2006.

Auditor Addendum

The Department's projected increases in hydrocarbon emissions, noted in its response, were calculated for Calendar Year 2007 using MOBILE6.2, the modeling tool required by the EPA. In contrast, our estimated increases in hydrocarbon emissions were calculated for Calendar Year 2005 using actual Program data. When we project increases in hydrocarbon emissions for Calendar Year 2007 using MOBILE6.2, we estimate hydrocarbon emissions would increase by 1.2 tons per day.

Program Alternatives

If the air quality in the Front Range Area exceeds National Standards and the AIR Program is needed in the future to assist with further reducing emissions, we have identified alternatives to the current Program that the Department should consider. These alternatives, as discussed below, would help to further reduce emissions and, in some cases, reduce Program costs.

On-Board Diagnostic System Testing

Most 1996 and newer model-year vehicles sold in the United States are equipped with engine/emissions on-board diagnostic systems. Model-year 1995 and older vehicles are not equipped with these systems. On-board diagnostic systems monitor virtually all components that make up the engine management and emissions control systems. These systems can detect malfunctions or deterioration of these components, often well before the motorist becomes aware of any problem. Vehicle on-board computers have diagnostic trouble codes that technicians can use to determine what problems exist with the emissions system and where they are located. When an emissions-related problem occurs, the malfunction indicator lamp (e.g., "check engine" or "service engine soon" light) on the vehicle instrument panel comes on. All on-board diagnostic systems have consistent standards for what will cause the light to come on.

Prior to 2003 the AIR Program used on-board diagnostic systems during emissions inspections to fail vehicles if the malfunction indicator lamp was on. In 2003 the Air Quality Control Commission made the decision to discontinue this practice because the on-board diagnostic standards for emissions-related problems that cause the light to come on were more stringent than AIR Program standards. According to federal on-board diagnostic system standards, the light comes on when vehicle emissions exceed certification standards by a factor of 1.5. However, AIR Program standards implemented through the IM240 test allow vehicle emissions to be more than five times certification standards before the vehicle fails the emissions test. The Commission was also concerned about the lack of overlap at that time between vehicles that failed the IM240 test and vehicles that failed the on-board diagnostic system inspection; in other words, many vehicles that failed the IM240 test did not fail the on-board diagnostic system inspection. However, the Department has found through its study of more recent AIR Program data that, for vehicles receiving both the IM240 test and an on-board diagnostic system inspection, the on-board diagnostic system inspection identified problems in a majority of the vehicles failing the IM240 test. We discuss these issues in more detail in Appendix D.

We reviewed the effectiveness of on-board diagnostic system inspections to determine if the Department should reconsider its decision to discontinue using these inspections in the AIR Program. Overall, we found that using on-board diagnostic system inspections could potentially increase AIR Program benefits and reduce inspection costs.

We reviewed two different ways that on-board diagnostic system inspections could be integrated into the current AIR Program and assessed the costs and benefits of each approach. First, we looked at following the EPA's recommended on-board diagnostic system test. According to the EPA guidance, vehicles will fail an on-board diagnostic system test if (1) the malfunction indicator lamp is turned on, (2) the malfunction indicator lamp does not come on at all because the lamp has been tampered with or is not functioning properly, or (3) three or more of the vehicle's thirteen system monitors have not been checked by the on-board diagnostic system and cleared as working properly.

Second, we looked at a hybrid approach that would incorporate both an on-board diagnostic system inspection and the IM240 tailpipe test currently used by the AIR Program. Under this approach, an on-board diagnostic system test would be completed on every vehicle and vehicles showing no indication of a malfunction would pass. Vehicles in which the malfunction indicator lamp is on and the diagnostic trouble codes indicate significant hydrocarbon or carbon monoxide emissions impact would fail. For those vehicles that have some indication there is a problem with the on-board diagnostic system (e.g., malfunction indicator lamp is on), but the diagnostic trouble codes do not indicate hydrocarbon or carbon monoxide emissions impact, an IM240 test could be conducted. Vehicles passing the IM240 test would pass the inspection.

Remote sensing data indicate that on-board diagnostic system tests can potentially result in more hydrocarbon emission reductions than can be achieved by the current IM240 tests. Our analysis shows that emission reductions would be 16.9 tons per day in hydrocarbons under the EPA-recommended approach and 16 tons per day under the hybrid approach. This compares with 15 tons per day for the current AIR Program. Additionally, the inspection costs associated with on-board diagnostic system tests should be lower than the costs associated with the IM240 test because the on-board diagnostic system test can be completed more quickly. On the basis of what other emission inspection contractors charge, we estimate the on-board diagnostic system test should cost about $15 compared with $25 for the IM240 test. However, our analysis shows that repair costs would be higher under both on-board diagnostic system options than they are under the current AIR Program. This is because the on-board diagnostic system test identifies more vehicles with emissions problems than the IM240 test, and therefore, more vehicles would need to be repaired. The Department would have to consider the total costs and benefits of reincorporating on-board diagnostic system tests into the AIR Program. As the following table shows, the hybrid approach would result in emissions reductions of one ton per day more than the current AIR Program at a lower cost per ton. The table compares the costs, emissions benefits, and cost-effectiveness of the two on-board diagnostic system inspection options compared with the current AIR Program.

Colorado Department of Public Health and Environment
Colorado Automobile Inspection and Readjustment (AIR) Program
Comparison of On-Board Diagnostic System Testing With AIR Program

	On-Board Diagnostics		Current AIR Program
	EPA Approach	Hybrid Approach	
Inspection Fees	$18,486,000	$19,280,000	$23,741,000
Repair Costs	$22,694,000	$15,517,000	$9,159,000
Overall Cost	$50,784,000	$44,401,000	$42,503,000
Hydrocarbon Emissions Reductions (Tons Per Day)	16.9	16.0	15.0
Cost per ton	$10,300	$9,500	$9,800

Source: *de la Torre Klausmeier Consulting, Inc. analysis of AIR Program data.*

Note: *On-board diagnostic system tests can only be used on 1996 and newer mode-year vehicles because vehicles made before 1996 do not have on-board diagnostic systems.*

On-board diagnostic system testing under either the EPA-recommended or hybrid approaches can be conducted at the current centralized inspection facilities.

There are also options for using on-board diagnostic system testing to "clean screen" vehicles through a decentralized program structure. These options use on-board diagnostic system testing as a screening tool for 1996 and newer vehicles. Using on-board diagnostic system testing in this manner would be consistent with the intent of House Bill 1302 and its goal of reducing inspection costs and motorist inconvenience. Options include:

- **Tests at gas stations, service stations, oil change facilities, and automotive repair facilities.** The equipment needed to conduct these tests at decentralized facilities is relatively inexpensive and costs about $1,700 per unit.

- **Self-service kiosks.** Self-service kiosks can be located at a gas station or in any location that provides drive-up service, and motorists can perform their own on-board diagnostic system test at any time. Oregon is currently implementing self-service kiosks.

- **Wireless systems.** Motorists can purchase a wireless device for about $50 that permits a vehicle to be monitored remotely by the State's emissions contractor. The vehicle owner would be notified that he or she has passed or failed the on-board diagnostic system test. Motorists with wireless systems on their vehicles are able to comply with state emissions requirements without ever having to go in for an inspection. Oregon is currently pilot-testing these wireless systems.

Vehicles failing the on-board diagnostic system screen conducted through one of the mechanisms described above would be required to undergo a traditional emissions test at one of the centralized IM240 testing facilities. According to current AIR Program data, about 85 percent of all 1996 and newer vehicles would pass the on-board diagnostic system "clean screen" test and would not be required to undergo any additional testing. Assuming a $15 test fee and an 85 percent pass rate, we estimate an on-board diagnostic system clean screen program would save about $5 million in inspection costs and about $6 million in inconvenience costs to vehicle owners. Additionally, we estimate that using on-board diagnostic systems as a screening tool would result in reductions of 14.8 tons per day of hydrocarbon emissions at a cost of $7,100 per ton. This compares with a reduction of 15 tons per day of hydrocarbon emissions at a cost of $9,800 per ton under the current AIR Program.

One of the advantages of using on-board diagnostic system testing is that it educates drivers of the need to repair vehicles. In other words, drivers learn that when their malfunction indicator lamp is illuminated, their vehicle needs repair, regardless of whether the vehicle is due for an emissions test in the near future. When these repairs occur, they provide immediate reductions in emissions rather than waiting for an emissions test to notify the vehicle owner that repairs are needed.

Colorado is in the minority with respect to its use of on-board diagnostics during the emissions inspection process. Most states use on-board diagnostic systems to identify emissions malfunctions in 1996 and newer vehicles. Five states use on-board diagnostic system inspections exclusively. Colorado is the only state out of the 31 states with major inspection and maintenance programs that does not require vehicles to pass an on-board diagnostic system inspection. If some version of the AIR Program is needed to ensure the Front Range Area air quality remains within National Standards, the Department should evaluate options for integrating on-board diagnostic system testing back into the Program. Using on-board diagnostic system testing could help increase the hydrocarbon reduction benefits currently obtained through the AIR Program and decrease inspection costs.

Recommendation No. 5:

The Colorado Department of Public Health and Environment should evaluate options for integrating on-board diagnostic system testing into the AIR Program if the decision is made to continue the Program to further reduce emissions. Options might include adopting the Environmental Protection Agency's recommended approach, implementing a hybrid approach that incorporates both an on-board diagnostic system inspection and the IM240 test currently used by the AIR Program, or using on-board diagnostic system testing as a screening tool.

Colorado Department of Public Health and Environment Response:

Agree. Implementation date: December 2008.

If the Department determines that the traditional AIR Program is necessary to obtain further emission reductions, then all emission control options in the Program should be explored. Such evaluation would work to balance the elements of HB06-1302 with the suggestions made in these recommendations (as well as other strategies). Any of these strategies, or a combination of these strategies, may be appropriate to obtain further emissions reductions for the Colorado vehicle fleet. When the State's ozone status becomes clearer towards the end of 2007, the needs of a maintenance plan or non-attainment State Implementation Plan (SIP) will dictate the duration of future programs. Assuming compliance with the National Ozone Standard, the Air Pollution Control Division expects to present an ozone maintenance plan to the Air Quality Control Commission by the end of 2008 for its consideration. This plan would consider alternatives of this nature.

Idle Tests

As discussed previously, an idle test measures vehicle emissions at idle and elevated idle (i.e., the gas pedal is depressed to increase the engine revolutions) conditions. The two-speed idle test evaluates hydrocarbon and carbon monoxide emissions. The AIR Program currently uses the idle test for 1981 and older modl-year vehicles, and those vehicles weighing over 8,500 pounds.

We reviewed the effectiveness of using the idle test, instead of the IM240 test, to inspect all vehicles. We found that idle tests would achieve the same benefits as the IM240 test (a reduction of hydrocarbon emissions by 15 tons per day and carbon monoxide emissions by 242 tons per day) at a lower cost. Specifically, we compared the percentage of hydrocarbon reductions that can be obtained from using the idle test to identify vehicles with emissions problems with reductions obtained from using the IM240 test. According to remote sensing data, vehicles that fail the idle test, are repaired, and then pass the idle test show a 40 percent reduction in hydrocarbon emissions. This compares with a 35 percent reduction in hydrocarbon emissions for vehicles that fail the IM240 test, are repaired, and then subsequently pass the test. EPA's MOBILE6.2 model predicts that both tests get the same hydrocarbon and carbon monoxide emissions reductions.

Additionally, we evaluated the impact of using the idle test on Program costs. As discussed previously, the idle test for 1981 and older vehicles costs $15 per inspection. The IM240 test for 1982 and newer vehicles costs $25 per inspection. If all vehicles receive the idle test, we estimate inspection costs would decrease about $8.2 million (from $23.7 million to $15.5 million). Repair costs would also decrease. According to AIR Program data, when vehicles fail the idle test, repairs typically cost about $230 compared with $344 for vehicles failing the IM240 test. This is because the idle test typically identifies problems that are easier to repair; more complex problems often do not show up during the idle test. Finally, we reviewed the cost effectiveness of using the idle test rather than the IM240 test. We estimate that using the idle test would cost about $7,800 per ton, compared with $9,800 per ton under the current AIR Program.

If the need for the AIR Program continues, the Department should consider using the idle test for 1995 and older vehicles in conjunction with on-board diagnostic system testing for 1996 and newer vehicles, as discussed in the previous recommendation. This approach would produce similar emission reduction benefits obtained through the current AIR Program and decrease Program costs. Under this approach, the IM240 test would no longer be needed.

Recommendation No. 6:

If the Colorado Department of Public Health and Environment determines that the AIR Program is needed in the future to further reduce vehicle emissions, the Department should consider using the idle test for 1995 and older model-year vehicles, and using the idle test in conjunction with on-board diagnostic system testing for 1996 and newer vehicles, as discussed in Recommendation No. 5.

Colorado Department of Public Health and Environment Response:

Agree. Implementation date: December 2008.

If the Department determines that the traditional AIR Program is necessary to obtain further emissions reductions, then all emissions control options in the Program should be explored. Such evaluation would work to balance the elements of HB06-1302 with the suggestions made in these recommendations (as well as other strategies). Any of these strategies, or a combination of these strategies, may be appropriate to obtain further emissions reductions for the Colorado vehicle fleet. When the State's ozone status becomes clearer towards the end of 2007, the needs of a maintenance plan or non-attainment State Implementation Plan (SIP) will dictate the duration of future programs. Assuming compliance with the National Ozone Standard, the Air Pollution Control Division expects to present an ozone maintenance plan to the Air Quality Control Commission by the end of 2008 for its consideration. This plan would consider alternatives of this nature.

Other Alternatives

There are other alternative approaches the Department could implement to improve the AIR Program if the Program is needed in the future to further reduce emissions in the Front Range Area. Alternatives include:

- **Inspecting vehicles for liquid fuel leaks.** Studies conducted by the EPA and the state of California have shown that vehicles with liquid fuel leaks release significant amounts of evaporative hydrocarbon emissions. A California Bureau of Automotive Repair study, completed in 2002, found that about 1.7 percent of vehicles have fuel leaks. If half of the vehicles with fuel leaks are identified through tests and repaired, evaporative hydrocarbon emissions could be reduced by an additional 2 tons per day. The study also found that, on average, liquid fuel leak repairs would cost about $111 per vehicle. Fuel leak inspections would cost about $3,000 per ton of reduced hydrocarbon emissions.

- **Increasing AIR Program standards.** Colorado's AIR Program's standards for failing vehicles under the IM240 test are less stringent than the standards recommended by the EPA. For example, for 1996 and newer passenger cars, the EPA recommends hydrocarbon standards be set at 0.6 grams per mile, and the AIR Program's standards are set at 1.2

grams per mile. MOBILE6.2, the EPA's modeling program, estimates that if the AIR Program adopted the EPA's recommended standards, hydrocarbon emissions would be reduced by an additional 2.7 tons per day. However, repair costs would increase by about 50 percent, since 50 percent more vehicles would fail their emissions tests under the more stringent EPA standards. If the AIR Program adopted these standards, reductions would cost about $9,300 per ton compared with current Program costs of $9,800 per ton of reduced hydrocarbon emissions. The reduced per ton cost is achieved because higher repair costs are offset by the increased reductions in emissions.

- **Inspecting some 1995 and older model year vehicles annually.** AIR Program data indicate that 1995 and older vehicles that fail their initial inspection and then pass a second inspection are more likely to fail an inspection the next year. These data suggest there would be additional benefits from annually testing 1995 and older vehicles that fail an inspection. The Department would need to conduct further analyses to determine the emissions benefits of this approach. We estimate that requiring 1995 and older vehicles to be inspected every year would increase inspection costs by about $800,000 per year.

- **Changes to the Repair Your Air Campaign.** In addition to the alternatives described above, the Department could work with the Regional Air Quality Council to determine if changes can be made to the Repair Your Air Campaign to increase program participation. As discussed previously, this program identifies high-emitting vehicles using remote sensing data and offers to repair the vehicle for free up to $1,000 in repairs. Since the Program began, the Council has notified 5,000 vehicle owners that their vehicles are high-emitters and has offered to cover the costs of the repairs. As of July 2006, only 300 vehicle owners have responded to this offer and had their vehicles repaired. The Department may want to work with the Council to determine if the program can be expanded to include vehicles in which the malfunction indicator lamp has been turned on due to an emissions-related problem to increase program participation and benefits. Data indicate that vehicles that have high remote sensing emissions levels and have their malfunction indicator lamp turned on have much higher IM240 emission levels than those in which the lamp has not been turned on. The Department could work with the Council to identify these vehicles through the on-board diagnostic system review currently conducted during AIR Program inspections.

Recommendation No. 7:

The Colorado Department of Public Health and Environment should consider alternatives to strengthen the AIR Program if it is determined that further emissions reductions are needed in the Front Range Area to comply with the National Standards. Alternatives include inspecting vehicles for liquid fuel leaks, increasing the stringency of AIR Program standards, and annually inspecting 1995 and older vehicles that fail an inspection.

Colorado Department of Public Health and Environment Response:

Agree. Implementation date: December 2008.

If the Department determines that the traditional AIR Program is necessary to obtain further emissions reductions, then all emissions control options in the Program should be explored. Such evaluation would work to balance the elements of HB06-1302 with the suggestions made in these recommendations (as well as other strategies). Any of these strategies, or a combination of these strategies, may be appropriate to obtain further emissions reductions for the Colorado vehicle fleet. When the State's ozone status becomes clearer towards the end of 2007, the needs of a maintenance plan or non-attainment State Implementation Plan (SIP) will dictate the duration of future programs. Assuming compliance with the National Ozone Standard, the Air Pollution Control Division expects to present an ozone maintenance plan to the Air Quality Control Commission by the end of 2008 for its consideration. This plan would consider alternatives of this nature.

Recommendation No. 8:

The Colorado Department of Public Health and Environment should recommend to the Regional Air Quality Council that the Council evaluate whether to include vehicles in which the malfunction indicator lamp has been turned on due to emissions-related problems in the Repair Your Air Campaign to help increase program participation and benefits.

Colorado Department of Public Health and Environment Response:

Agree. Implementation date: March 2007.

We will provide this recommendation to the Regional Air Quality Council, which is the implementing agency for the Repair Your Air Campaign. This program is not a part of the AIR Program and is operated by the Regional Air Quality Council. It is our understanding that the Congestion Mitigation Air Quality (CMAQ) grant received by the Regional Air Quality Council was provided based upon specific remote sensing criteria, which do not include on-board diagnostics (OBD)/malfunction indicator lamp (MIL)-related repairs. Moreover, the Colorado Air Quality Control Commission specifically omitted MILs as a failure indicator for the AIR Program. The Department will provide this recommendation to the Regional Air Quality Council in the first quarter of 2007.

AIR Program and Emissions Data

Developing reasonable and effective control strategies requires accurate estimates of current and future emissions. We reviewed the Department's evaluation of the Front Range Area emissions and data collected by the AIR Program and found that improvements are needed, as described below.

The EPA requires the Department to use its mobile source emissions model, MOBILE6.2, to estimate future emissions levels in the Front Range Area. We reviewed the accuracy of future emissions estimates obtained using MOBILE6.2 and found this model may not accurately predict emissions levels for the Front Range Area. Using data for vehicles tested through the AIR Program in 2003, we used MOBILE6.2 to project the deterioration in vehicle emissions (i.e., how quickly and to what extent the amount of pollutants emitted from a vehicle increase, or worsen) that would occur for these vehicles between 2003 and 2005. We compared the MOBILE6.2 projections with AIR Program data that showed the actual deterioration in emissions between 2003 and 2005 for these vehicles. We found that MOBILE6.2 underestimated the amount that vehicle emissions would deteriorate during this period. The inconsistencies in MOBILE6.2 projections could be due to the fact that it does not appropriately account for changes in deterioration that occur in high-altitude areas such as Denver. If the Department relies on MOBILE6.2 projections, it may underestimate the need for additional controls on vehicles to ensure the Front Range Area air quality is consistent with National Standards. The EPA is in the process of developing a new mobile source emissions model termed MOVES. The Department should work with the EPA to ensure that MOVES accurately reflects vehicle deterioration in high-altitude areas such as Denver.

We also found that the Department does not always conduct its own periodic evaluations of the individual components of the AIR Program before implementing changes to the Program. For example, the Department did not compare Rapid Screen results with IM240 results and provide this information to the General Assembly when House Bill 2006-1302 was being considered. As we discuss in the report, we identified significant concerns with the effectiveness of Rapid Screen. Had the Department conducted this analysis and provided its results to the General Assembly, the outcome of House Bill 2006-1302 may have been different. The Department should evaluate all components of the AIR Program using all available data and resources to ensure that it has sufficient information to make appropriate recommendations regarding changes to the Program.

Recommendation No. 9:

The Colorado Department of Public Health and Environment should ensure that it has sufficient, accurate information related to the AIR Program and emissions in the Front Range Area to support decision-making by:

a. Working with the Environmental Protection Agency to ensure that MOVES, the EPA's new mobile source emissions model, accurately reflects vehicle deterioration in the high-altitude areas.

b. Using all available data and resources to evaluate the various components of the AIR Program and to support recommendations for Program enhancements and modifications.

Colorado Department of Public Health and Environment Response:

Agree. Implementation date: Ongoing.

The Department agrees that accurate information is essential in support of evaluating the current AIR Program, developing future programs, and supporting the EPA in development of the upcoming MOVES model. Within the last month the Department has been in communication with the EPA regarding the development of MOVES. As a result, the Department has supplied Colorado inspection data to the EPA to help in the development of MOVES.

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Appendices

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APPENDIX A

BACKGROUND ON AIR PROGRAM

1) **Types of tests administered**

a. Light Duty Gasoline Vehicles (LDGV*) and Light Duty Gasoline Trucks (LDGT)
   i. 1982 and newer LDGV and LDGT receive an I/M240 inspection
   ii. 1981 LDGV and LDGT receive a Two Speed Idle (TSI) inspection with pass/fail at 2500 RPM
   iii. 1980 and older vehicles receive a TSI with pass/fail at idle only
   iv. I/M240 untestable vehicles receive TSI inspection with pass/fail at 2500 rpm
   v. All 1975 and newer vehicles receive a pass/fail anti-tampering inspection for:
      1. Catalytic Converter(s)
      2. Oxygen (O2) sensor(s)
      3. Fuel filler neck restrictor(s)
      4. Air Injection System(s)
      5. Gas cap presence
   vi. All 1975 and newer vehicles (if applicable) receive an advisory only inspection of the "check engine" light illumination
   vii. 1975 and newer LDGV/LDGT receive pass/fail gas cap pressure test
   viii. 1996 and newer LDGV and LDGT receive an advisory only OBDII interrogation
   ix. All vehicles receive a pass/fail visible smoke inspection

b. Heavy Duty Gasoline Vehicles (HDGV*)
   i. 1981 and newer receive TSI inspection with pass/fail at 2500 rpm
   ii. 1980 and older receive TSI with pass/fail at idle only
   iii. 1975 and newer receive a pass/fail anti-tampering inspection for:
      1. Catalytic Converter(s)
      2. Oxygen (O2) sensor(s)
      3. Fuel filler neck restrictor(s)
      4. Air Injection System(s)
      5. Gas cap presence
   iv. All 1975 and newer vehicles (if applicable) receive an advisory only inspection of the "check engine" light illumination
   v. All vehicles receive a pass/fail visible smoke inspection

* The 1982 and newer fleet can only be inspected by Environmental Systems Products (ESP) as part of the centralized inspection network. Either ESP or an independent inspection only station can inspect vehicles 1981 and older.

NOTE: All vehicles receive a free retest if the vehicle fails and is reinspected within the first 10 days following the failure. If an independent station inspects the vehicle, the vehicle must also be returned to that station that performed the initial inspection.

2) **Network**

a. 1981 and older: Environmental Systems Products 14 centralized stations; or private facilities

3) Program coverage areas

a. Denver Metro Area which includes the following counties
   i. Adams (Partial county)
   ii. Arapahoe (Partial county)
   iii. Boulder
   iv. Broomfield
   v. Denver
   vi. Douglas
   vii. Jefferson

4) Test Frequencies

a. AIR Program
   i. All 1982 and newer vehicles inspected on a biennial basis.
   ii. All 1981 and older vehicles inspected on a annual basis.
   iii. Vehicle model-years 1960 and newer and at a minimum 25 years old AND registered as Collector Series vehicles are required to be inspected at the time of their original application for Collector Series designation, the inspection is valid until the vehicle is sold or transferred.
   iv. Vehicle model-years older than 1960 AND registered as Collectors Series vehicles are not required to be inspected.

5) Model Years

a. AIR Program
   i. All vehicles are required to be inspected with the following exceptions:
      1. Vehicles four model-years old and newer are exempted (required to be inspected at age five).
      2. Out-of-State vehicles being registered in Colorado must undergo an inspection even if four model-years old or newer.

6) Test On Resale

a. AIR Program
   i. Vehicles that are NOT in their first three years of their four-year exemption period are required to be inspected at the time of sale or transfer.

7) Program Waiver Requirements

a. AIR Program
   i. All vehicles must pass the anti-tampering and visible smoke requirement to be eligible for a waiver.
   ii. A one time economic hardship (as determined by the Department of Revenue) waiver is available for vehicles where the owner can not afford repairs up to the required minimum waiver repair limit.
   iii. As determined by DOR, all repairs must be applicable to the emissions failure.

8) Waiver Repair Cost Limit

a. AIR Program
   i. Model-years 1968 and newer must spend a minimum of $715 to qualify for a waiver.
   ii. Model-years 1967 and older must spend a minimum of $75 to qualify for a waiver.

9) Vehicle Non-compliance Information

a. AIR Program
   i. Vehicles operating within the program area for a minimum of 90 days within a 12 month period must comply with the program area requirements.
   ii. Based on a 1995-96 analyses of 300 vehicles that failed their initial inspection and did not pass a retest, only 4 percent of these vehicles were registered in the Denver Metro Area.

10) Program Enforcement

a. The AIR Program is a registration denial program.

11) Internal Program Enforcement

a. AIR Program
   i. The AIR and Remote Sensing Device Programs' (RSD) oversight are divided between the Colorado Department of Public Health and Environment (CDPHE) and the Department of Revenue (DOR). CDPHE's duties include the majority of the technical elements of the Program with DOR's duties being contractor audit and enforcement.
   ii. DOR performs overt audits on each I/M240 lane quarterly and covert audits biannually for each lane. Overt audits consist of both equipment and inspector performance.
   iii. DOR performs drive-by RSD audits once every two weeks utilizing gas dispensing audit trucks.

Rules and Regulations

1) Colorado Revised Statutes can be accessed at:
   a. http://198.187.128.12/colorado/lpext.dll?f=templates&fn=fs-main.htm&2.0
2) Regulation 11, (AIR Program Regulation), can be accessed at:
   a. http://www.cdphe.state.co.us/op/regs/airregs.asp

COLORADO AIR PROGRAM FEES

1) Inspection Fee for all enhanced area non-fleet vehicles 1982 and newer - $25 ($24.75 to the contractor, $0.25 to state).

2) Inspection Fee for all enhanced area vehicles1981 and older - $15(max) ($14.75 to inspection shop, $0.25 to state).

3) Fee collected by the County Clerk for registration based program enforcement - $ 0.70 (Annual on all vehicles in program area).

4) Fee collected by the County Clerk to implement pay-upon-registration - $ 0.83 -- (CLEAN-SCREENED VEHICLES ONLY).

5) Registration fee collected by the County Clerk for State oversight funding for CDPHE & DOR – $ 1.50, (annual on all vehicles in program area).

SIGNIFICANT CHANGES TO THE AIR PROGRAM WITHIN THE LAST SIX YEARS

1) Removal of the pass/fail criteria for check engine light
2) Increase of waiver limit from $450 to $715
3) Eliminated change of ownership inspection requirement for vehicles in their first three years of their four year exemption period
4) Implemented a Clean Screen element to the current AIR Program
5) As a result of eminent domain, lost Commerce City ESP station as of December 5, 2003, additional lanes added to the Stapleton and Northglenn stations
6) Elimination of the basic program in Ft. Collins, Greeley, and Colorado Springs as of January 1, 2007

LIST OF PROBLEMS AND SUGGESTED IMPROVEMENTS

The following list of problems and suggested improvements were taken from previous audits of the AIR Program.

The problem of accurate repair data remains an issue today. The majority of after-repair inspections contain zero for repair costs. The Program no longer collects information on what system/components were repaired.

The suggested improvements were:

1) Additional model year exemptions
2) Clean screen program
3) High emitter program/profile

AIR PROGRAM DATA AND REPORTS ANALYZED

1) Vehicle Inspection Database
   a. Vehicle Test Records (VTR) for Calendar Years 2003 to 2005
      i. Total repair costs*
      ii. Costs of parts*
      iii. Costs of labor*
      iv. Miscellaneous related repair costs*
      v. Diagnostic costs
      vi. Repairs warranty/recall related (yes/no)

vii. Repaired by owner (yes/no)
viii. Repair technician number
ix. Dealer/repair facility number

b. Vehicle Onboard (VOB) records for Calendar Years 2003 to 2005

2) Remote Sensing Data for Calendar Years 2004 to 2006

* These repair costs are reported as individual repair attempts i.e. individual costs at the time of each reinspection, and an accumulated cost (sum of cost for all repair attempts).

RAPID SCREEN BACKGROUND

Structure of the RapidScreen Program

The clean screen program in Colorado is called the Rapid Screen Program. This Program utilizes Remote Sensing Devices (RSD) to collect emissions measurements on vehicles that drive by the testing units. These measurements are used to screen vehicles with low emissions and exempt them from their traditional emissions test. Currently only light duty gas vehicles, 1982 and newer, are entitled to participate in Colorado's Rapid Screen Program. These vehicles are eligible to participate if their two most recent consecutive emissions readings observed during the 12-month time period prior to their registration renewal date and the most recent passing emissions reading occurred on a different day or at a different site from the prior observation. The measurements from these systems are kept in a database that is queried each month for emissions due vehicles. This query is conducted approximately two months before the vehicle's registration month to allow for data processing and notification time. Therefore, the data available for a Rapid Screen Program qualification are based on a rolling ten months.

Rapid Screen is a voluntary program in that owners of qualified vehicles can chose to have a traditional IM test done. County Clerks notify vehicle owners that have qualified for Rapid Screen by printing a "Passed Roadside Emissions" statement on their registration renewal cards. The vehicle owner can send in the testing fee with their registration renewal to utilize the RSD test or they can go to an emissions station and have a traditional inspection.

RAPID SCREEN CRITERIA

The following steps are used on a monthly basis to determine vehicle clean screen eligibility.

1. ESP specifies month and year corresponding to registration expiration date (esp_month_year).

2. Vehicle registration must expire in month and year specified by ESP. The date that the next emissions test is due must be less then or equal to ESP specified month and year plus 1 year.
   (next_insp_dt) <= ((esp_month_year) +1)).

3. Fuel type must be 'g' (gas).

4. Vehicle model year must be 1982 and newer and the vehicle must be registered in counties, 1, 7, 10, 11, 12, 47, or 64.

5. Last three digits of 'License Type' cannot = 'CNY', 'CTY', or 'SOC'.

6. Emission_flag (emission required) must be Yes.

7. Number of years between vehicle registration expiration year and vehicle model year must be greater than or equal to 4 years.

((Registration_expiration_year) – (vehicle_model_year)) >= 4 years

8. If one or more vehicle test records from centralized testing exist, the most recent test result must be a ‘pass.’

9. Use the two most recent remote sensing roadside test records, ignoring duplicates for the same site on the same date. If multiple tests on the same date at the same site exist, only the first test of that day will used. The second test would have to occur at a different site or on a different date.

10. For each of the two most recent remote sensing roadside test records, the test dates must be greater than or equal to the registration_expiration_date - one year, i.e. the test records cannot be greater than one year old based on the registration expiration date.

11. For each of the two most recent remote sensing roadside test records, both HC and CO must be equal to or less then 200 ppm and 0.5 percent respectively.

12. For the two most recent remote sensing roadside test records, the Envirotest image QA reviewer must confirm the following by visual review:
    - The two images match each other
    - Each image matches the registration data

13. Using Polk PCVIS (or equivalent) VIN decoding software
    If model year < 1979, then GVW <= 6000 lb.
    If model year => 1979 then GVW <= 10,000 lb
    If GVW cannot be determined then set criteria to eligible

14. Ambient temperature must be between 20^o and 120^o F.

15. Acceleration must >= 0mph/second.

16. Alignment alarm flag must not be set.

Chronology of significant changes to RapidScreen

Program Area

1) Northern Front Range Program:
   i. In March 2001, remote sensing data collection began with two RSD 3000 units.
      1. The contractor notified passing motorists by mail and collected the test fee directly.
   ii. In August 2003, the testing in the Northern Front Range was reduced to one RSD 4000, 40 hours a month.
2) Denver Metropolitan Area Program:
   i. In August 2003, remote sensing data collection began in the Denver Metropolitan Area.

ii. In August 2004, the Rapid Screen clean screen pay-upon-registration notifications began with the mailing of October 2004 vehicle registration renewal cards by the Department of Revenue.

RSD Units

1) During 2005 and early 2006 there were six RSD 4000 units and vans operating (with one spare remote sensing device).
2) Three additional RSD 4000 units and vans are scheduled to be delivered around August 2006.

RSD Technology:

1) In July 2003, the RSD 3000 units were upgraded to the RSD 4000 technology.
2) In mid 2004, there was a software modification to correct for temperature and barometric pressure variations.
3) In mid 2004, the transfer mirror module was upgraded to a corner cube mirror.
4) The RSD 4000 was upgraded to an enclosed unit with temperature control for the spectrometer and an internal calibration cell.

Sites:

1) In 2005, there were about 60 permitted and licensed sites in the Denver Metropolitan Area.
2) Currently, there are about 100 permitted and licensed sites in the Denver Metropolitan Area.
   a. Additional sites are being approved and licensed every month.

SIP Percentages, Fleet Coverage 50 percent maximum allowed in Ozone Early Action Compact:

1) In 2005, fleet coverage was approximately 4.28 percent.
2) For January through May 2006, fleet coverage was approximately 7.78 percent.

A list of problems and suggested improvements previously considered for RapidScreen:

1) Additional sites needed to ensure adequate fleet coverage.
2) Sufficient amount of units and vans to ensure adequate fleet coverage.

Improvements/recommendations:

1) The use of unmanned RSD units.
2) Additional unit requirements are being evaluated.
3) The use of Vehicle Specific Power calculation is being considered to replace the current positive acceleration requirement.
4) Two units are operating double shifts to evaluate longer testing hours.

New Legislation

HOUSE BILL 06-1302

The Governor signed House Bill 06-1302 in law on May 25, 2006. This legislation requires the Colorado Department of Public Health and Environment (CDPHE) to develop a plan subject to the approval of the Air Quality Commission to expand the current Rapid Screen Program and to implement a High-Emitter Program.

REPAIR YOUR AIR:

The Repair Your Air Campaign (RYAC) was a campaign conducted by the Regional Air Quality Council (RAQC) in partnership with CDPHE. The RAQC received a grant to conduct this campaign under the Congestion Mitigation/Air Quality funding program. The RAQC's goal was to reduce ozone pollution through the identification and repair of vehicles that emit excessive amounts of hydrocarbons. RYAC was a voluntary program that provided notification mailings to potential high emitting vehicle owners. In addition, if the vehicle owner participated and failed the confirmatory test, the vehicle was repaired up to a $500 limit (the limit is now $1,000).

CDPHE's role in the RYAC was to screen the remote sensing data and send a list of potential high emitters to the RAQC. In addition, CDPHE Emissions Technical Centers (ETC) conducted vehicle confirmatory testing and diagnosis. Depending on the type of repair, the vehicles were either repaired at the ETC or sent to a participating repair shop.

The RAQC applied for and received an additional grant to conduct RYAC II as a follow up. RYAC II began in June 2005 and continues to operate. CDPHE's role in this program is the same as in RYAC. The campaign's goals were expanded to:

1) Repair up to 850 vehicles over a three-year period to reduce ozone-forming pollutants in the Denver region.
2) Study the effectiveness of RSD technology to identify high emitting vehicles.
3) Develop a training curriculum and a corresponding manual for the automotive repair industry so they can more effectively repair high hydrocarbon vehicles.

Data/information on Attainment Plans (i.e. state implementation plan, early action compact, etc.)

The following links contain the majority of the information on attainment plans:

http://www.cdphe.state.co.us/ap/attainmaintain.asp

http://apcd.state.co.us/documents/techdocs.html

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APPENDIX B
ANALYSIS OF AIR QUALITY IN THE FRONT RANGE AREA

INTRODUCTION

As part of the State of Colorado's audit for its Inspection/Maintenance (I/M) Program, Eastern Research Group (ERG) was tasked with evaluating previous work that assessed the air quality in the Front Range Area. This appendix summarizes twelve air quality reports related to the Front Range Area.

In the 1960's, the Clean Air Act (CAA) was passed by Congress. The Act established the U.S. Environmental Protection Agency (EPA) to regulate six common air pollutants based on health-effects criteria. Consequently, these six pollutants were referred to as criteria pollutants. The criteria pollutants are: carbon monoxide (CO); lead; oxides of nitrogen (NO_x); sulfur dioxide (SO_2); particulate matter up to 10 microns in aerodynamic diameter (PM_{10}, formerly total suspended particulates); and ozone. The CAA was amended in 1963, 1977, and 1990. National Ambient Air Quality Standards (NAAQS) were set for each criteria pollutant.[1]

For many years, the main air quality issues in Colorado involved carbon monoxide, lead, particulate matter, and ozone. For example, 13 of 17 state-operated carbon monoxide monitors exceeded the NAAQS 8-hour standard in 1980. Additionally, the lead NAAQS was also violated in that same year. In later years, particulate matter and ozone have violated their NAAQS.[2,3]

After Congress passed the 1990 CAA Amendments, the Front Range Area (includes seven-county Denver metropolitan area and Larimer and Weld counties) was classified as non-attainment for the 1-hour ozone NAAQS. By 2001, the Front Range Area was redesignated to attainment.[4] In 1997, EPA established a new, more stringent NAAQS for ozone and particulate matter (2.5 microns).[5,6] Under the new 8-hour ozone standard, the Front Range Area was slated to be designated non-attainment by EPA. However, in 2004, state and local agencies in the Front Range Area entered into an Ozone Early Action Compact (EAC) with the EPA to defer non-attainment designation.[4] The region has to meet the terms of the agreement and demonstrate attainment for the new ozone standard by December 31, 2007 using mandatory and voluntary measures.

REPORTS REVIEWED

As mentioned above, ERG reviewed 12 air quality or air quality-related reports, and those are presented in table below. Information gleaned from these reports is the basis for the observations reflected in this appendix. Eight of the 12 reports focused on ozone, while 3 focused on air quality for multiple pollutants. One report focused only on PM_{10}.

Table B-1. Front Range Area Air Quality Reports Reviewed by ERG

Title	Report Year	Authors	Pollutants Covered
Colorado, 2003 Air Quality Data Report	2004	Colorado Department of Public Health and Environment: Air Pollution Control Division	CO, PM_{10}, $PM_{2.5}$, NO_2, SO_2, Ozone, Lead
Colorado, 2004 Air Quality Data Report	2005	Colorado Department of Public Health and Environment: Air Pollution Control Division	CO, PM_{10}, $PM_{2.5}$, NO_2, SO_2, Ozone, Lead
2005 Report: "Let's Take Care of our Summer Air"	2006	Denver Regional Air Quality Council	Ozone
Regional and Local Contributions to Peak Local Ozone Concentration in Six Western Cities	2006	STI for Western States Air Resources Council	Ozone
Ozone Early Action Compact Front Range Metropolitan Area	2004	Regional Air Quality Council; Colorado Department of Public Health and Environment: Air Pollution Control Division	Ozone
Update on Ozone Modeling to Support Denver 8-Hour Ozone Early Action Compact: 2007 Control Strategy Evaluation	2003	Environ and Alpine Geophysics	Ozone
Colorado State Implementation Plan for PM_{10}: Revised Technical Support Document	2005	Colorado Department of Public Health and Environment: Air Pollution Control Division	PM_{10}
Performance Audit of the Colorado Automobile Inspection and Readjustment (AIR) Program: Final Report	2003	Environ and Air Sciences for the Colorado Office of the State of Auditor	CO, PM_{10}, $PM_{2.5}$, NO_2, SO_2, Ozone, Lead
Air Quality Modeling Analysis for the Denver Early Action Ozone Compact: 2007 Base Case, Control Strategy, and Sensitivity Analysis Modeling (Draft Final)	2004	Environ and Alpine Geophysics for Denver Regional Air Quality Council	Ozone
Air Quality Modeling Analysis for the Denver Early Action Ozone Compact: 2007 Emission	2004	Environ and Alpine Geophysics for Denver Regional Air Quality Council and Colorado Department of Public Health and	Ozone

Title	Report Year	Authors	Pollutants Covered
Reduction Sensitivity Modeling (Final Report)		Environment: Air Pollution Control Division	
Air Quality Modeling Analysis for the Denver Early Action Ozone Compact: 2007 Control Strategy Modeling for the Denver EAC (Final Report)	2004	Environ and Alpine Geophysics for Denver Regional Air Quality Council and Colorado Department of Public Health and Environment: Air Pollution Control Division	Ozone
Air Quality Modeling Analysis for the Denver Early Action Ozone Compact: Ozone Source Apportionment Modeling for the Denver EAC (Final Report)	2004	Environ and Alpine Geophysics for Denver Regional Air Quality Council and Colorado Department of Public Health and Environment: Air Pollution Control Division	Ozone

GEOGRAPHIC DEFINITIONS

Air quality evaluated in these technical reports was often grouped in to differing geographic regions. Some of these geographic regions include: 1) the entire State of Colorado; 2) Monitoring Area Communities; 3) the Denver Metropolitan Statistical Area; 4) select counties in and around the Denver area, referred to as the Denver Metropolitan Area (DMA); and 5) counties grouped in Early Action Compact (EAC) modeling studies.

For purposes of this appendix, the DMA for this study is comprised of seven counties: Adams, Arapahoe, Broomfield, Boulder, Denver, Douglas, and Jefferson. The Denver Metropolitan Statistical Area (DMSA) is comprised of the DMA counties plus an additional two counties: Elbert County and Park County. The DMSA is split into three different Monitoring Area Communities: Mountain Communities; the Northern Front Range Communities; and the Eastern Plains Communities. Under the EAC, modeling demonstrations were performed for an eight county region and an eleven county region. Table B-2 presents these different geographic designations.

Table B-2. Geographic Designations of Front Range Area Counties

County Name	Denver Metropolitan Area (DMA)	Denver MSA (DMSA)	Northern Front Range Community	Mountain Community	Eastern Plains Community	EAC 8-County	EAC 11-County
Adams	X	X	X			X	X
Arapahoe	X	X	X			X	X
Boulder	X	X				X	X
Broomfield	X	X	X			X	X
Clear Creek				X			
Denver	X	X	X			X	X
Douglas	X	X	X			X	X
Elbert		X			X		X
Gilpin		X		X			
Jefferson	X	X	X			X	X
Larimer							X
Morgan							X
Park		X		X			
Weld						X	X
Source: ERG review of Colorado Air Quality reports.							

HISTORICAL DATA TRENDS FOR THE DENVER METROPOLITAN AREA

The Colorado Air Quality Data Reports for 2003 and 2004 were reviewed to evaluate historical trends of the criteria pollutants for the DMA.[2,3] The following table summarizes the number of monitors showing an increasing, decreasing, or no apparent trend for each criteria pollutant based *on visual inspection* of 10-year annual graphs. Evaluation is determined by comparing the earliest annual average (~1995) to the most recent annual average (2004).

Table B-3. Criteria Pollutant Trends for Front Range Area Monitors

Pollutant	Number of Statewide Monitors	Number of DMA Monitors	Averaging Type	Number of DMA Monitors Increasing	Number of DMA Monitors Decreasing	Number of DMA Monitors with No Apparent Change
CO	14	6	1-hour	0	6	0
			8-hour	0	6	0
Ozone	15	10	1-hour	0	8	2
			8-hour	1	7	2
SO_2	3	3	24-hour	0	3	0
NO_2	2	2	Annual	0	2	0
PM_{10}	41	7	Daily	4	1	2
			Annual	2	2	3
$PM_{2.5}$	12	3	Daily	2	0	1
			Annual	0	1	2
Lead	6	4	Quarterly	2	2	0
Source: **ERG review of Colorado Air Quality reports.**						

Overall, the DMA monitors are showing more of a decreasing trend in annual concentrations than increasing. Additionally, no exceedances of CO, SO_2, NO_2, or lead have occurred in the last 10 years. Despite these encouraging trends, exceedances of the ozone standard have occurred in recent years. Seven of ten ozone monitors in the DMA registered exceedances, while four of five outside the DMA registered exceedances. Due to the ozone exceedances in 2002 and 2003, the entire Denver MSA was in danger of violating the 1-hour ozone NAAQS and being designated as non-attainment. Fortunately, no exceedances were registered for any Denver MSA monitors in 2004, and non-attainment designation for the 1-hour ozone standard was avoided.

Although the Denver MSA is designated as attainment for PM_{10}, it is required to develop a state implementation plan (SIP) to maintain this designation. [7] Part of this maintenance plan is to demonstrate continued attainment of the PM_{10} NAAQS through air quality modeling. In 2002 and 2003, seven different Colorado monitors registered PM_{10} exceedances; however, all of these monitors were outside the DMA. The SIP states that continued attainment is expected through 2025.

REGIONAL AND LOCAL CONTRIBUTIONS TO DENVER AREA OZONE

Ozone is not directly emitted from anthropogenic (i.e. man-made) sources, but is formed secondarily by the mixture of CO, volatile organic compounds (VOCs), and NO_x in the presence of sunlight. [8] Emission sources of NO_x and VOC include automobile exhaust, solvent fumes, and many other anthropogenic emissions sources, but can also include natural emissions from trees and wildfires.

A study on six western cities was conducted to characterize the contributions of each of these sources of ozone. [9] Denver was one of the six cities. On days when the Front Range Area exceeded 85 parts per billion, 35 parts per billion was natural background ozone (i.e., ozone that is present from natural sources, 35 parts per billion was transported anthropogenic ozone (i.e., ozone from manmade sources transported into the area due to weather patterns) and 23 parts per billion was locally generated anthropogenic ozone (i.e., ozone from man-made sources generated locally, including ozone from stationary sources and ozone generated by motor vehicles).

Considering the last 15 years, the Front Range Area has not violated the NAAQS for CO since 1995, ozone since 1990, and PM_{10} since 1993. It is the opinion of this audit and the 2003 AIR audit report that there is little chance of the Front Range Area violating CO NAAQS in future years.[10] Despite this encouraging trend, the new ozone NAAQS may continue to be problematic for the Denver area. Observations in ambient monitoring data have shown that Denver is historically in a VOC-limited area. Consequently, any future increases in VOC concentrations could cause violations of the new ozone standard. However, understanding of the kinetics of ozone formation may provide further insight to future VOC issues. For example, ozone accumulation occurs when NO_x preferentially reacts with VOC compounds, rather than ozone. Research has shown that delaying the kinetic mechanisms of ozone formation may be an effective strategy for reducing ozone concentrations.[11] The morning hours (6am-9am) are a peak time for VOC emissions due to increased mobile sources activity. If part of these (and other stationary source) VOC emissions can be delayed until later in the day, then the concurrent NO_x emissions can preferentially react with the transported ozone, thereby acting as a potential sink to this transported ozone during the morning. This titration of the transported ozone by NO_x may reduce ozone accumulation in the Denver area during peak ozone times, later in the day. Ironically, if NO_x emissions are increased during the time VOC emissions are delayed, the titration (lowering) of transported ozone is more pronounced and peak ozone levels later in the day are reduced even further.

EARLY ACTION COMPACT (EAC) FOR OZONE

In an effort to avoid non-attainment designation for the 8-hour ozone NAAQS, the Front Range Area has agreed to develop and follow an EAC for ozone.[4] A modeling demonstration showing attainment of the new ozone standard is due to EPA by December 2007.

The Contribution of Mobile Sources to Total VOC Emissions in the Front Range Area

The ozone action plan in the *Early Action Compact* (EAC) for the Front Range Area includes projections of past and future emissions inventories with and without controls. These inventories are presented on Tables 2 and 3. In 2002, on-road mobile sources contributed 28 percent to the total anthropogenic VOC inventory. In 2007, mobile sources with implementation of proposed EAC controls, contributed 26 percent of total anthropogenic VOC inventory. Mobile source emissions are projected to drop from 153 tons/day (TPD) in 2002 to 117 TPD in 2007 in the absence of additional mobile source controls. Additional controls of mobile sources reduce VOC emissions from mobile sources from 117 TPD to 108 TPD. These controls include revisions to the AIR Program and limits on Reid vapor pressure (RVP) of gasoline.

Table B-4. 2002 and 2007 Base Case Emission Inventories(tons per average episode day) Adams, Arapahoe, Boulder, Broomfield, Denver, Douglas, Jefferson, and Weld Counties

Source Category	2002 VOCs (tons/day)	2007 VOCs (tons/day)	2002 NOx (tons/day)	2007 NOx (tons/day)
Flash	133.9	146.1	0	0
Gas Stations	22.3	16.0	0.1	0.1
Oil and Gas Production	4.1	4.5	0.2	0.2
Reciprocating Internal Combustion Engines	7.8	8.7	93.5	94.7
Other Stationary Sources	24.6	28.8	11.4	12.2
Total Point	192.8	204.1	105.2	107.1
Automotive After Market Products	27.2	29.0	0	0
Architectural Coatings	19.5	20.8	0	0
Household and Personal Products	17.0	18.2	0	0
Adhesives and Sealants	14.7	15.7	0	0
Pesticide Application	8.9	10.0	0	0
Other Area Sources	9.6	10.4	25.6	27.6
Total Area	96.9	104.1	25.6	27.6
Lawn & Garden	47.3	31.2	9.31	9.3
Other Off-Road	25.8	22.5	78.7	73.2
Total Off-road	73.1	53.7	87.99	82.5
On-road Mobile	**152.8**	**117.5**	**157.8**	**119.3**
Total Anthropogenic	515.6	479.4	376.6	336.5
Total Biogenic	468.1	468.1	37.1	37.1
Total	983.7	947.5	413.7	373.6

Source: EAC Ozone Plan; March 2004.
Note: Inventories merely are a part of the technical basis for the attainment demonstration, and should not be construed to describe the scope of the plan. The geographic scope of the plan shall be determined by the final boundaries set by the U.S. EPA.

Table B-5.VOC Emission Inventories(tons per average episode day)
Adams, Arapahoe, Boulder, Broomfield, Denver, Douglas, Jefferson, and Weld Counties

Source Category	2002 Base (tons/day)	2007 Base (tons/day)	2007 Control (tons/day)	2012 Control (tons/day)
Flash	133.9	146.1	91.3	100.9
Gas Stations	22.3	16.0	14.8	10.2
Oil and Gas Production	4.1	4.5	3.7	4.1
Reciprocating Internal Combustion Engines	7.8	8.7	4.8	5.4
Other Stationary Sources	24.6	28.8	28.7	32.3
Total Point	192.8	204.1	143.3	152.9
Automotive After Market Products	27.2	29.0	29.0	31.5
Architectural Coatings	19.5	20.8	20.8	22.6
Household and Personal Products	17.0	18.2	1 8.2	19.8
Adhesives and Sealants	14.7	15.7	15.7	17.1
Pesticide Application	8.9	10.0	10.0	11.5
Other Area Sources	9.6	10.4	10.4	11.6
Total Area	96.9	104.1	104.1	114.0
Lawn & Garden	47.3	31.2	31.0	26.7
Other Off-road	25.8	22.5	22.6	21.0
Total Off-road	73.1	53.7	53.5	47.7
Total On-road Mobile	**152.8**	**117.5**	**108.4**	**76.0**
Total Anthropogenic	515.6	479.4	409.3	390.6
Total Biogenic	468.1	468.1	468.1	468.1
Total	983.7	947.5	877.4	858.7

Source: EAC Ozone Plan; March 2004.
Note: Inventories merely are a part of the technical basis for the attainment demonstration, and should not be construed to describe the scope of the plan. The geographic scope of the plan shall be determined by the final boundaries set by the U.S. EPA.

Modeling Approach

Base case modeling scenarios for 2002 and 2007 were developed for the 8-county EAC area using monitoring data, emission inventories, demographics, and vehicle miles traveled (VMT) estimates.[12,13,14,15,16]

Control measures in place in 2002 were assumed to be in place for the 2007 inventory year. These measures include, but are not limited to: 1) federal tailpipe standards and regulations, including small engine and non-road mobile sources; 2) the AIR Program (Colorado's I/M Program); 3) Air Quality Commission Regulations No. 3, 6, 7, and Common Provisions covering gasoline station and industrial source control programs; and 4) a 9.0 PSI (10.0 PSI for ethanol blends) RVP gasoline requirement.

Due to the presence of wildfires, the average daily wildfire emission contributions for VOC, CO, and NO_x were assumed to be 15 tons per day, 323 tons per day, and 7 tons per day, respectively, for modeling purposes. [4] Finally, as discussed previously, EAC modeling simulations were performed for an 8-county region and an 11-county region in the Front Range Area.

Model Emission Results

Two modeling simulations were performed to project 2007 VOC and NO_x emissions. The first modeling simulation used typical growth factors from 2002 to 2007 with no additional controls in place beyond those in 2002 (or those already "on-the books"). This scenario is often referred to as "Growth Packet, No Control Packets." The second modeling simulation, often referred to as "Growth and Control Packets" used the same growth packet as in the first simulation, but added additional control strategies not "on-the-books."

1. Growth Packet, No Control Packet

Base case point source VOC emissions for the 8-county area increased from 192.8 tons per day to 204.1 tons per day from 2002 to 2007, while area sources increased from 96.9 tons per day to 104.1 tons per day. Conversely, off-road emissions decreased from 73.1 tons per day to 53.7 tons per day, while on-road emissions decreased from 152.8 tons per day to 117.5 tons per day. Total anthropogenic VOC emissions decreased from 515.6 tons per day to 479.4 tons per day from 2002 to 2007. [4] Similar trends are expected for the 11 county EAC area.

Base case point source NO_x emissions for the 8-county area increased slightly from 105.2 tons per day to 107.1 tons per day from 2002 to 2007, while area sources increased slightly from 25.6 tons per day to 27.6 tons per day. Off-road emissions decreased from 87.99 tons per day to 82.5 tons per day, while on-road emissions decreased from 157.8 tons per day to 119.3 tons per day.[4] Total anthropogenic NO_x emissions decreased from 376.6 tons per day to 336.5 tons per day from 2002 to 2007. Similar trends are expected for the 11 county EAC area.

3. Growth and Control Packets

Four additional control measures were used to demonstrate attainment of the 8-hour ozone standard in the Front Range Area by 2007. [4] They include: 1) an RVP limit of 8.1 PSI; 2) amending Regulation No 7 to reduce flash emissions of VOC from condensate collection, storage, processing, and handling operations; 3) amending Regulation No 7 to require additional controls on reciprocating internal combustion engines (RICE); and 4) amending Regulation 7 to require VOC emission reductions from dehydration towers and oil and gas operations. The growth packet did not change.

Base case point source VOC emissions for the 8-county area decreased from 192.8 tons per day to 143.3 tons per day from 2007 to 2012, while area source emissions increased from 96.9 tons per day to 104.1 tons per day. On-road emissions decreased from 152.8 tons per day to 108.4 tons per day, while non-road emissions decreased from 73.1 tons per day to 53.5 tons per day. Total anthropogenic VOC emissions decreased from 515.6 tons per day to 409.3 tons per day from 2002 to 2007.[4] Similar trends are expected for the 11 county EAC area.

Base case point source NO_x emissions for the 8-county area decreased from 105.2 tons per day to 88.3 tons per day from 2002 to 2007, while area sources increased slightly from 25.6 to 27.6 tons per day. Off-road emissions decreased from 87.99 tons per day to 82.5 tons per day, while on-road emissions decreased from 157.8 tons per day to 119.3 tons per day. Total anthropogenic NO_x emissions decreased from 376.6 tons per day to 317.5 tons per day from 2002 to 2007.[4] Similar trends are expected for the 11 county EAC area.

4. Model Ozone Concentration Results: 2007 Control Case

The 2007 control case is based on the calculation of the 2002 Base Case Design Value multiplied by a relative reduction factor (RRF).[15] Attainment of the 8-hour ozone NAAQS is demonstrated when the 2007 control case design value at each Denver monitor is less than 85 ppb.

When the plan for the EAC was developed in 2004, the Rocky Flats monitor recorded the highest 8-hour ozone levels. In 2005 and 2006, the Chatfield monitor recorded the highest ozone levels. Accordingly, this monitor is most likely to lead to a violation of the three year ozone standard in 2007. The following discussion refers to the Rocky Flats monitor. The conclusions based on modeling the Rock Flat monitor likely apply to the Chatfield monitor also.

Predicted (controlled) design values are less than 85 ppb at all area monitoring sites except the Rocky Flats North monitor. However, if a site is modeled to be less than 90 ppb, additional "Weight of Evidence" can be used to demonstrate attainment. The Rocky Flats modeled ozone concentrations are below 90 ppb, but above 85 ppb.[4] As determined by the contractor, the modeling results are very "stiff", implying that the design values are not very sensitive to the emission controls applied. This stiffness can be attributed in part to high temperature and low mixing height anomalies experienced during the 2003 ozone season, and can result in overestimation of future design values.[4] If the 2007 Base Case and Control Package design values are projected from the 2000-2002 period (rather than the 2001-2003 period), the design values would demonstrate attainment for the 8-hour ozone standard.[15]

Additionally, the model itself has a tendency to under-predict by 20 percent, where less ozone was likely attributable to local emission than occurred in actuality.[4] Model runs predict that 74 percent of the predicted ozone concentration at the Rocky Flats North monitor is due to transport.[15]

The Model runs also predict that VOC controls are more effective than NO_x controls for reducing the 8-hour ozone concentrations at all monitors in/near the area, with one exception; a 10 percent VOC control results in a 0.3 to 0.4 ppb reduction at Rocky Flats while a 10 percent NO_x control increases the ozone by 0.4 ppb at Rocky Flats. A combined 10 percent VOC/NO_x control reduces the Rocky Flats ozone level by 0.2 to 0.3 ppb.[14] These sensitivity model runs indicate that VOC reductions are more important than NO_x reductions in reducing ozone.

Summary and Conclusions

Twelve technical reports describing Front Range Area's air quality were reviewed and summarized to understand the local-, natural-, and transported-influences of ozone and its precursors. Generally, ozone air quality is dominated by natural sources (48 percent), followed by transport (34 percent), and local sources (18 percent). The Colorado Department of Public

Health and Environment has initiated several mandatory and voluntary emission reduction programs to reduce local contributions.

Four Policy-Relevant Questions were used to guide our analysis:

1. *What is the effect of the AIR Program on ambient air quality in the Front Range Area, specifically with respect to ozone and/or any of the national ambient air quality standards?* The AIR Program was deemed by the reports reviewed a success since it contributed significantly to the trend of carbon monoxide emissions and concentrations decreasing dramatically from 1995 to 2004. A side benefit to this program was the decrease in hydrocarbon (some of which were Volatile Organic Compound) emissions and concentrations. For a Volatile Organic Compound-limited region like the Denver area, reductions in carbon monoxide and volatile organic compound emissions can lead to further reductions in concentrations in ozone.

2. *Does the current AIR Program sufficiently address the region's needs with respect to meeting national ambient air quality standards?* For all NAAQS, with the exception of ozone, the Front Range Area is projected to be in attainment. Removal of the AIR Program will likely slow the trend of decreasing volatile organic compounds, thereby increasing the potential for ozone concentrations to increase.

3. *Is there a need for further reduction of air pollution caused by mobile sources to help the State attain or maintain compliance with national ambient air quality standards?* Throughout this analysis, the main air quality issues challenging the Front Range Area are attainment of the new ozone standard. The Front Range Area could exceed the ozone standard if, in 2007, the fourth highest reading from one monitor exceeds 84 parts per billion. On the basis of 2005 and 2006 data, the Chatfield monitoring site is most likely to record an exceedance of the new 8-hour ozone standard. Additionally, the Denver area is volatile organic compound-limited. Further reduction of volatile organic compounds from mobile sources may be necessary if the pollutants approach their NAAQS. Many of the voluntary programs can be expanded to include more participation/awareness.

4. *Should the Program be modified to better suit the needs of the region, given the future trends projected for the air quality standards? If so, how?* After review of the air quality reports, this question cannot be fully answered. However, we conclude that the AIR Program should continue to operate until the Colorado Department of Public Health and Environment determines that it's no longer needed for attainment, because the AIR Program focuses on reducing volatile organic compound emissions from the largest source of manmade volatile organic compounds – motor vehicles. The Front Range Area is a volatile organic compound-limited ozone region.

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APPENDIX C

COST OF THE AIR PROGRAM

dKC's subcontractor, Sierra Research, analyzed cost of the AIR Program. The following cost components were considered:

- Inspection Revenue:
    - Cost for inspections at centralized facilities;
    - Cost for inspections at decentralized facilities;
    - State oversight fee
- Rapid Screen
- Repair costs
- Fuel Savings
- Motorist inconvenience costs

Annual costs are summarized in the following table and chart. Total estimated costs were between $40.8 million and $48.4 million with a central estimate of $42.5 million for the current analysis, versus estimated costs in 2003 of $37 million (without costs for replacing vehicles that fail instead of being repaired[1]). The primary reason for the higher cost estimate is that Sierra estimated higher costs for motorist inconvenience: $8.4 million versus $5.5 million. These differences are due to the increased cost to operate a vehicle (Sierra used $0.30/mile vs $0.25 per mile used in the last audit) and in the increase in the average wage rate (Sierra Research used $19.36/hour versus $15.15/hour used in the 2003 audit).

[1] Sierra's estimates do not include the cost to replace vehicles that fail and are replaced instead of being repaired. Costs to replace these vehicles were included in the 2003 audit estimates. The cost-effectiveness calculations do not include benefits from vehicles being replaced.

Table C-1

Estimated Cost of AIR Program Calendar Year 2005			
ITEM	**Best Point Estimate Cost**	**Low Range Estimate of Cost**	**High Range Estimate of Cost**
Inspection Revenue -- ESP, Private Garages, State	$23,741,472	$23,741,472	$23,741,472
Repair Costs[1]	$9,159,062	$7,857,999	$9,458,121
Fuel Savings Credit[2]	-$2,986,901	-$3,371,021	-$2,597,295
Motorist Inconvenience – Travel[3]	$8,423,469	$8,423,469	$14,028,719
Motorist Inconvenience -- Wait Time	$3,764,207	$3,764,207	$3,764,207
Rapid Screen (RSD) Revenue[4]	$403,300	$403,300	$1,553,353
Total	**$42,504,609**	**$40,819,427**	**$48,395,224**

Source: Sierra Research analysis of Calendar Year 2005 costs.

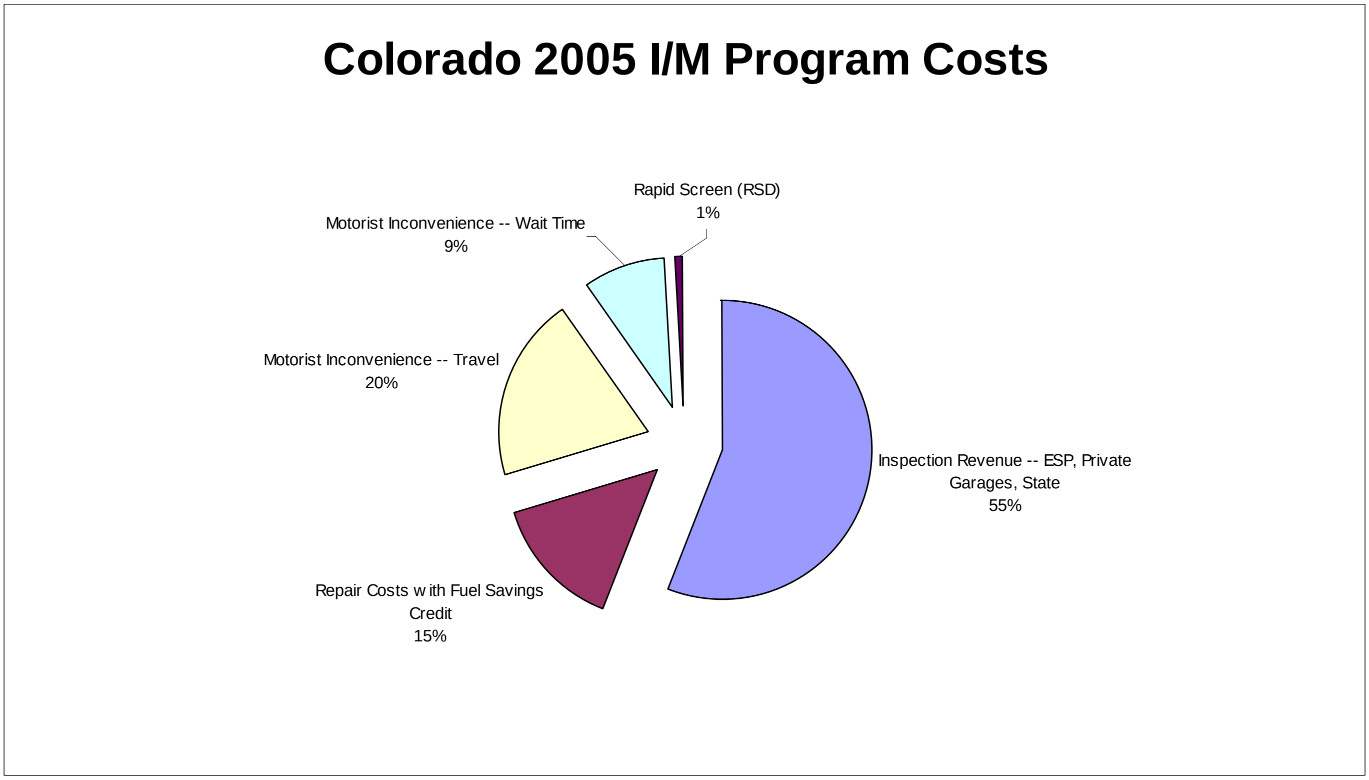
[1] Repair cost range based on 95 percent confidence limit for tailpipe repairs; averaged calculated for three different categories (IM240, Idle, and Heavy-Duty). Gas cap repair cost added separately as a single value (no range).

[2] Fuel Saving Credit is based on a central estimate with a 95 percent confidence range providing the low and high estimates. Due to the weighting of the different categories (IM240, Idle, and Heavy-Duty) the central estimate is not mathematically in the middle of the low and high.

[3] Motorist Inconvenience for travel is calculated using two different methodologies, resulting in only a high and a low value. The low value was selected for the central estimate due to its use in previous audits. The assumptions used in this calculation are as follows: distance to stations = 5 miles one way; average speed is 20 mph; average cost to operate a vehicle is $0.30/mile; average consumer wage rate is $19.36/hour; overall tax rate is 37 percent; average station queue wait time is 10 minutes; average testing time is 10 minutes.

[4] Cost to Public to Operate RSD – The way Colorado has established the RSD program the contractor does not charge to operate the RSD units. The contractor collects revenue for vehicles that are clean screened only. Sierra Research's estimates show that the contractor operates the RSD program at a loss. The High estimate represents the additional cost if all of the contractor's costs were passed on to the public.

Figure C-1



Source: Sierra Research analysis of Calendar Year 2005 costs.

Inspection Costs

Sierra Research's cost model[2] was used to estimate costs for centralized facilities. This model estimates costs for the contractor to operate the I/M facilities. Estimated costs were nearly identical (under 1percent difference) to the cost based on the fees ($24.25 for IM240 tests and $14.75 for idle tests) times the number of vehicles tested currently being charged by Environmental Systems Products (ESP), the State's contractor.

Repair Costs

Repair costs are based on repair data in the vehicle test record (VTR) database. Average repair costs for IM240 failures were around $344(±$18); average costs for idle test failures were around $229 (±$46). Sierra Research found that the repair cost data in the VTR had issues that raise questions about its use for any analysis[3].

As a result of this concern over the existing Colorado data, a literature search was performed to locate repair costs that represent estimates with more confidence in the

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[2] Sierra developed a spreadsheet model for the U.S. EPA to estimate the cost of operating a centralized I/M program (T.C. Austin and R.W. Joy, "Estimating the Cost of I/M Programs," Sierra Research Report No. SR02-03-02, prepared for the U.S. Environmental Protection Agency, March 20, 2002.). For this work Sierra modified this spreadsheet to develop costs for operating the contractor facilities in the Colorado program.

[3] Sierra found that the VTR repair data include $0 cost repairs for 90 percent of the data, additionally another 4 percent reported repair costs of under $50. The remaining data is an unknown selection of reported data, making these data very questionable for use in developing inferences to the entire population. Although the average repair cost used for this analysis are generated from the VTR, Sierra Research used outside literature to support these repair costs.

reported repair values. Repair costs for IM240 type of repairs were reported as $316 (±$100) for 1996 and newer vehicles with over 100,000 miles in one study (Gardetto 2005). Additionally, in the follow-up analysis with additional data, the average repair cost for IM240 type failures was found to be $458 ((±$165) (unpublished analysis Gardetto, 2006). A study done in Colorado reported IM240 costs in a controlled laboratory setting. Sierra Research used the data provided in this report to calculate an average repair cost of $504 ((±$97) (Barrett, 2005) All of these studies probably overestimate the average "real world" repair cost since in all cases there were no incentives to save or "skimp" on the repairs. Based on these separate studies, it appears that the Colorado data estimate for repairs is within an acceptable range for the vehicles repaired for IM240 failure. Note that the range of values is very wide for the literature costs of IM240 repairs ($216 to $601).

Sierra Research estimated gas cap only repair costs based on current retail cost of replacement gas caps. Sierra used $10 for the cost of light-duty vehicle gas caps and $15 for the cost of heavy-duty gas caps.

These estimates do not include the cost to replace vehicles that fail and are replaced instead of being repaired.

Fuel Saving Generated from Repairs

Generally an I/M program like Colorado's that primarily controls for hydrocarbons and carbon monoxide will reduce fuel consumption in repaired vehicles. The IM240 test data provides an estimate of each vehicle's fuel economy and the difference between the pre- and post-repair data indicate the fuel economy benefit associated with the repairs. For this analysis, Sierra Research was provided with the average fuel economy benefit from the emission benefit analysis. Because 1981 and older vehicles use an idle test, which does not provide fuel economy results, Sierra Research assumed that these older vehicles will have the same fuel economy benefit as the 1982 and newer portion. Sierra Research believes this assumption is valid since both the IM240 (as utilized by Colorado) and the idle test target hydrocarbon and carbon monoxide and not oxides of nitrogen. If the Colorado program also targeted oxides of nitrogen emissions with the IM240 this assumption would not be valid. As with the older light-duty fleet, the heavy-duty (HD) fleet does not have fuel economy values reported from the Colorado program, Sierra Research assumed that the percentage increase in fuel economy for the HD fleet was the same as for the light-duty fleet. Due to the small number of HD vehicles this assumption does not have much impact on the overall results, so while it can be debated, the actual percentage increase is not very important for the final costs of the I/M program.

Fuel savings are based on IM240 test results on vehicles for fuel economy change between failing test and passing test. dKC developed a dataset of pairs of vehicles that failed in 2004 and passed in 2004 or 2005. dKC then identified pairs where full length IM240 tests were done on the failing initial tests and passing retests. A total of 9,005 pairs were identified. Results are shown in the following table. Note that fixing gas cap failures did not improve fuel economy (miles per gallon - MPG) as determined by the IM240 test. This makes sense, since IM240 MPG estimates are based on exhaust emissions, which are not affected by replacing faulty gas caps. The IM240 test does not measure fuel savings from capturing vapors that would have escaped due to faulty gas caps.

Table C-2

Improvements in Fuel Economy (MPG)

for Vehicles that Failed an Emissions Test, Were Repaired, and Then Passed

Calendar Years 2004 and 2005

		MPG Before/After Repair by Failure Reason		
Year Category	**MPG**	**Failed IM240**	**Failed Gas Cap Test Only**	**All Fails**
82-90	**Before**	19.93	19.95	19.94
	After	22.47	20.08	22.28
91-95	**Before**	19.76	19.10	19.69
	After	22.23	19.07	21.90
96+	**Before**	21.77	18.77	20.26
	After	23.98	18.85	21.39
Average of MPG_Before Repair		20.02	19.19	19.90
Average of MPG_After repair		22.51	19.26	22.04

	Confidence Levels for Emission Fails		
Parameter	**95 Percent Confidence Level**	**Low Benefit**	**High Benefit**
95% Conf Before	0.13	20.15	19.89
95% Conf After	0.17	22.34	22.68
	Percent Increase in MPG	10.85%	14.00%

Source: de la Torre Klausmeier consulting, Inc analysis of AIR Program data.

Public Cost of Time and Travel

Travel Time -- Part of the overall cost of Colorado's I/M program is the cost in consumer's time to travel to and from the inspection lanes. At least two different approaches exist to estimate in monetary terms the dollar amount the public's travel time. The first approach attributes the time spent in traveling to and from the centralized inspection station at one half the consumer wage rate. This was the methodology utilized in the 2003 audit of the Colorado AIR Program. This analysis is known as Method A and treats the time spent in the vehicle driving to and from the inspection station as if the consumer was being paid some hourly taxable rate. The alternative method, Method B, is based on work done by Brownstone and Small of the University of California Irvine and assumes that consumers are willing to pay to avoid travel. The Brownstone/Small study recognized the dramatic increase in this rate over previous methodologies and offered a conservative rate of $20 per hour which is approximately equal to the consumer wage rate used in method A, so for this analysis the consumer rate was utilized to approximate this new methodology. Other assumptions are shown in the following table. Travel time to and from private facilities was calculated in the same manner with the same assumptions.

Table C-3

Assumptions Used to Estimate Customer Inconvenience for Travel Time To AIR Stations	
Parameter	**Assumed Value**
Distance to station	5 miles
Average speed	20 mph
Average cost to operate vehicle	$0.30/mile
Consumer wage rate	$19.36/hour
Overall tax rate	37 percent
Source: Sierra review of AIR Program contract.	

The distance to the station of 5 miles is based upon the contract requirement that 80 percent of the population be within 5 miles of a contractor station. The average speed of 20 mph is based upon the average speed value used in the MOBILE model for urban modeling scenarios. The $0.30 per mile is a value selected based on AAA's estimate that it cost approximately $0.55/mile to operate a new vehicle [citation]. The consumer wage rate is from the BLS for 2005. The tax rate of 37 percent is the all inclusive tax rate for 2005 (BLS).

- **Method A --** Using one half the consumer wage rate and taxing it at 37 percent resulted in a total cost of about $6.4 million. This method was utilized by Environ in the 2003 audit. Environ adapted it from a study by McConnel and Harrington.
- **Method B --** Using the methodology developed by Brownstone/Small and not taxing the amount since this method assumes that the consumer is willing to pay for the ability to avoid the driving resulted in a travel time cost of just over $14 million.

While a case can be made for both methodologies neither is selected as the most representative, instead both are used to provide a range of possible costs.

Waiting Time costs – Similar to the consumer's travel cost, the consumer also places a value on their time spent waiting in queue to be inspected. An additional value estimated is the time spent waiting for the actual inspection to be completed. Information on queue wait times was not used from the Colorado database due to concerns that it was not accurate. Sierra Research utilized several wait time scenarios to estimate the amount of time spent in queue. The first is 10 minutes, based on the contractor's requirement that the wait time not exceed 10 minutes for any 120 minute basis. This estimate provides the worst-case scenario assuming the contractor is able to maintain this requirement. The second value is 5 minutes for the average wait time in the program. These values were used for the vehicles inspected at private facilities also, since no method of estimating average wait times is available, but a value of zero would be unrepresentative and unrealistic.

The time a consumer waits for their vehicle to finish testing after waiting in the queue is included in the total costs associated with the program as well. For this analysis it was assumed that the average time for a vehicle to complete the testing was 10 minutes. Sierra Research's experience shows that this value is highly variable for any one vehicle and that this variability makes distinguishing between the test types (idle or IM240), an unsupportable stratification of the data.

Cost-Effectiveness of the AIR Program

Cost-effectiveness of the AIR program is based total program costs for one year divided by estimates of program benefits for one year.

Tons per day reductions from inspecting vehicles in 2005 – dKC estimated the benefits of the AIR Program. The total benefit from identifying and repairing high emitting vehicles during one year of the AIR Program was calculated as follows:

- **Exhaust Emissions --** Observed grams per mile readings before and after repairing IM240 failures were multiplied times the number of tailpipe failures that ultimately passed and assumed annual mileage accumulation. Results were calculated by vehicle type and model-year and then were summed to determine total exhaust emission benefits.
- **Evaporative Emissions --** The number of gas cap failures were multiplied times the assumed benefit from replacing faulty gas caps and assumed annual mileage accumulation. In 2005, 20,000 vehicles failed the gas cap inspection.

Benefits also factor in repair longevity, (i.e., how long the repair reduces emissions). Repair longevity is based upon the number of vehicles that pass after failing in 2002/2003 that then go on to pass their initial tests in 2004/2005. Tons per day benefits estimated for repairing vehicles that fail during one year of the AIR program are shown below.

- Hydrocarbons: 10.5 tons per day,
- Carbon Monoxide: 86 tons per day.

Table C-4

Tons per Day Impact of One Year of the AIR Program				
Vehicle Type	**Exhaust HC**	**Evaporative HC**	**Total HC**	**CO**
Cars	3.11	2.13	5.24	41.35
Trucks	3.11	2.10	5.21	44.78
Total	6.22	4.23	10.46	86.13
Source: de la Torre Klausmeier consulting, Inc analysis of AIR Program data.				

Annual Cost – Annual costs for the AIR program are based on the best point estimate presented above. They are estimated to be $42.5 million per year.

Overall, the AIR program is estimated to reduce ozone precursors (defined as HC + CO/60) for a cost of $9,800.

Cost Effectiveness of Alternative Control Measures

The following table shows emission reductions and cost-effectiveness of controls listed in the Early Action Compact (EAC). The State committed to establishing air pollution controls for evaporative VOC emissions from condensate tanks, oil and gas production, large reciprocating internal combustion engines and on-road mobile sources in its Early Action Compact with the EPA. On the basis of the Department's supporting documentation submitted with the Early Action Compact, air pollution controls applied to VOC flash emissions, oil and gas production, and large reciprocating internal combustion engines reduce hydrocarbon emissions at a cost that is less than $3,000 per ton. The cost per ton for these air pollution controls is less than the cost per ton for the AIR Program ($9,800 per ton). Since air pollution controls for these sources (flash emissions, oil and gas production, and large reciprocating internal combustion engines) are so cost-effective, the Department is proposing to apply these air pollution controls outside of the Front Range Area. The Department believes that air pollution controls for these sources will help with Denver's attainment of the ozone standard since, as discussed previously, much of the ozone in the Front Range Area is transported in from outside the area.

Table C-5

Volatile Organic Compound Emission Controls			
Source Category	**2007 Base (tons/day)**	**2007 Control (tons/day)**	**Cost Effectiveness of Additional Controls (Dollars/ton VOC)**
Flash	146.1	91.3	Controls already applied in EAC: $250/ton
Gas Stations	16.0	14.8	Controls already applied via on-board refueling control systems. State can require CA rules for portable fuel containers: unknown reduction; $800/ton
Oil and Gas Production	4.5	3.7	Controls already applied in EAC: $400/ton to $2,700/ton
Reciprocating Internal Combustion Engines	8.7	4.8	Controls already applied in EAC: $1,400/ton
On-road Mobile	**117.5**	**108.4**	**AIR: $9,800/ton** RVP reductions: $8,600/ton to $13,000/ton
Source: Early Action Compact, March 2004.			

The next table shows emission reductions and cost effectiveness of controls for sources listed in the EAC that are currently uncontrolled. Colorado has not committed to further air pollution controls for the remaining nine sources for hydrocarbon emissions (other stationary sources, automotive after market products, architectural coatings, household and personal products, adhesives and sealants, pesticide application, other area sources, lawn and garden, and other off-road sources) in its EAC. Where possible, we estimated the amount of reduction the State could achieve, and the estimated cost per ton for achieving that reduction.

Table C-6

Additional Volatile Organic Compound Emission Controls That Could Implemented				
Source Category	**2007 Base (tons/day)**	**2007 Emissions Reductions (tons/day)**	**Cost Effectiveness (Dollars/ton VOC)**	**Control Strategy**
Other Stationary Sources	28.8	Unknown	Unknown	Cannot define without details on sources
Area: Automotive After Market Products	29.0	11	$1,500	Require CA rules
Area: Architectural Coatings	20.8	6.4	$6,400	Require CA rules
Area: Household and Personal Products	18.2	2.5	$800	Require CA rules
Area: Adhesives and Sealants	15.7	Unknown	$500-$5,000	Require CA rules
Area: Pesticide Application	10.0	0	Unknown	Unknown controls
Other Area Sources	10.4	Unknown	Unknown	Cannot define without details on sources
Lawn & Garden	31.2	Unknown	$2,000 to $1,000,000	Range of controls possible
Other Off-road	22.5	Unknown	$12,000 to $1,000,000	Range of controls possible
Source: Emissions Estimates: Early Action Compact: March 2004; Control Strategy Costs and Effectiveness: E. H. Pechan, 2001.				

By adopting regulations requiring that area sources such as automotive after market products, architectural coatings, and household and personal products meet California specifications, it may be possible to achieve the same reductions as the AIR Program for lower costs. Note, however, that the State cannot just substitute controls that get the same reductions as the AIR Program and stay in compliance with the EAC. The attainment demonstration in the EAC was based on ozone modeling studies in the DMA. Ozone is sensitive to the spatial and temporal distribution of emissions, as well as the reactivity of the specific VOCs emitted by different sources. For example, a 10 ton per day reduction through revised specifications on area sources may not reduce ozone as much as a 10 ton per day from mobile sources.

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APPENDIX D

ANALYSIS OF DATA ON VEHICLE TEST RESULTS AND REMOTE SENSING DEVICE READINGS IN THE AIR PROGRAM

The key results of this audit are based primarily on an analysis of data collected in the AIR Program. These data can be grouped into three categories:

- **Vehicle Test Results (VTR) – I/M test results from AIR stations;**
- **Rapid Screen or Remote Sensing Device (RSD) results, and**
- **Results of on-board diagnostic (OBD) tests during AIR inspections.**

Table D-1 lists the datasets that were analyzed for this audit. Following is a summary of all the analysis results.

Table D-1 – Datasets Analyzed for Audit

Date	Provider Org	Description
6/15/06	CDPHE	Jan - June 2002 I/M data, see "example Co IM data.xls" for fields and format
6/15/06	CDPHE	July - Nov 2002 I/M data, see "example Co IM data.xls" for fields and format
6/15/06	CDPHE	Dec 2002 I/M data, see "example Co IM data.xls" for fields and format
6/15/2006 6/27/06	CDPHE	Jan - May 2003 I/M data, Note: CD was bad, no data could be retrieved. New CD Rcvd 6/27/06.
6/15/06	CDPHE	June - Oct 2003 I/M data, see "example Co IM data.xls" for fields and format
6/15/06	CDPHE	Nov - Dec 2003 I/M data, see "example Co IM data.xls" for fields and format
6/15/06	CDPHE	Jan - May 2004 I/M data, see "example Co IM data.xls" for fields and format
6/15/06	CDPHE	June - Sept 2004 I/M data, see "example Co IM data.xls" for fields and format
6/15/06	CDPHE	Oct - Dec 2004 I/M data, see "example Co IM data.xls" for fields and format

Date	Provider Org	Description
6/15/06	CDPHE	Jan - May 2005 I/M data, see "example Co IM data.xls" for fields and format
6/15/06	CDPHE	Jun3 - Sept 2005 I/M data, see "example Co IM data.xls" for fields and format
6/15/06	CDPHE	Oct - Dec 2005 I/M data, see "example Co IM data.xls" for fields and format
6/20/06	CDPHE	Jan - May 2006 I/M data, see "example Co IM data.xls" for fields and format
6/20/06	CDPHE	2002 OBD I/M data -
6/20/06	CDPHE	2003 OBD I/M data -
6/20/06	CDPHE	2004 OBD I/M data -
6/20/06	CDPHE	2005 OBD I/M data -
6/20/06	CDPHE	Jan - May 2006 OBD I/M data -
6/20/06	CDPHE	April 1, 2002 - May 19, 2006 Rapid Screen inspection data
7/17/06	CSTARS	Registration data, counties listed in individual text files, all counties in one text file, and Access database with all counties
8/11/06	CDPHE	Jan - May 2005 I/M data, see "example Co IM data.xls" for fields and format
8/11/06	CDPHE	Jun3 - Sept 2005 I/M data, see "example Co IM data.xls" for fields and format
8/11/06	CDPHE	Oct - Dec 2005 I/M data, see "example Co IM data.xls" for fields and format

DERIVING AIR PROGRAM BENEFITS FROM VEHICLE TEST RESULTS (VTR)

The following procedure was used to derive estimates of the impact of the AIR Program on emissions.

- Eastern Research Group (ERG) developed spreadsheets showing grams per mile emissions by model-year and vehicle type (cars vs. trucks) broken down by AIR Program results for initial tests and re-tests.
- Using VTR data for 2004 and 2005, dKC calculated the failure rate by model-year and vehicle type.
- Using data on VTR results for 2004 and 2005, dKC calculated the percent of vehicles that failed in 2004 that ultimately passed.
    - Data from remote sensing devices (RSD) were used to determine the fraction of the vehicles that never pass that continue to operate in the program area. This analysis indicated that about half of the vehicles that failed and never passed are no longer being driven in the program area.
- dKC calculated the emission reductions from repairing failed vehicles to obtain a passing result.
    - dKC calculated the change in vehicle emissions by model-year and vehicle type considering the emission reductions for failed vehicles, the percent of vehicles failing, and the percent of failed vehicles that ultimately pass.
    - dKC weighted as received (initial test results) and after repair composite levels by the number of vehicles tested by model-year and vehicle type and their assumed mileage accumulation rate.
    - Based upon the weighted emission levels for as-received and after-I/M cases, dKC calculated the percent reduction in vehicle emissions from identifying and repairing high emitting vehicles. This percent reduction is defined as the ***single cycle emission reduction.***
    - Tons per day reductions were determined by multiplying the reduction for failed vehicle in grams per mile by the number of failed vehicles and assumed annual vehicle miles traveled by model-year and vehicle type. Based upon input from CDPHE, dKC used MOBILE6 default values for annual VMT by model-year and vehicle type.
    - dKC adjusted the tons per day reductions for expected repair life based upon the percent of vehicles that fail and then pass in one cycle that pass again at the next cycle. Based upon data on vehicles tested over two inspection cycles, 77 percent of the vehicles that are repaired pass their next inspection two years later.
    - dKC calculated the benefits from the gas cap pressure test by first calculating the number of vehicles that failed the gas cap pressure test.

dKC multiplied the number of gas cap failures times the assumed benefit from replacing faulty gas caps. These benefits were based upon studies by the California Bureau of Automotive Repair. Again, the benefits by model-year were adjusted by the number of failures by model-year, assumed accumulated mileage by model-year, and expected repair life.

- Emissions reductions over **two biennial test cycles** were calculated as follows:
    - Using data on vehicles that were tested in both 2002/2003 and 2004/2005, dKC calculated test counts and average IM240 emissions by test disposition in 2003. (Pass Initial, Fail/Pass, Fail/?, Fail/Waiver)
    - Assuming that failed vehicles were not repaired in the 2002/2003 tests, dKC calculated IM240 emission rates in the 2004/2005 period for a no AIR program scenario.
    - Using data on 2004/2005 tests, dKC calculated IM240 emission rates after complying with AIR Program requirements.
    - IM240 emission rates in 2004/2005 for the no AIR Program scenario were compared to emission rates after AIR in 2004/2005

Spreadsheets are available that show the calculation of program benefits using the above procedures.

Table D-2 shows the mileage accumulation assumptions that were used in calculating total benefits.

Table D-2 -- Assumed Mileage Accumulation Rates
LDGV -- Light-Duty Gasoline Vehicles (Passenger Cars)
LDGT -- Light-Duty Gasoline Powered Trucks

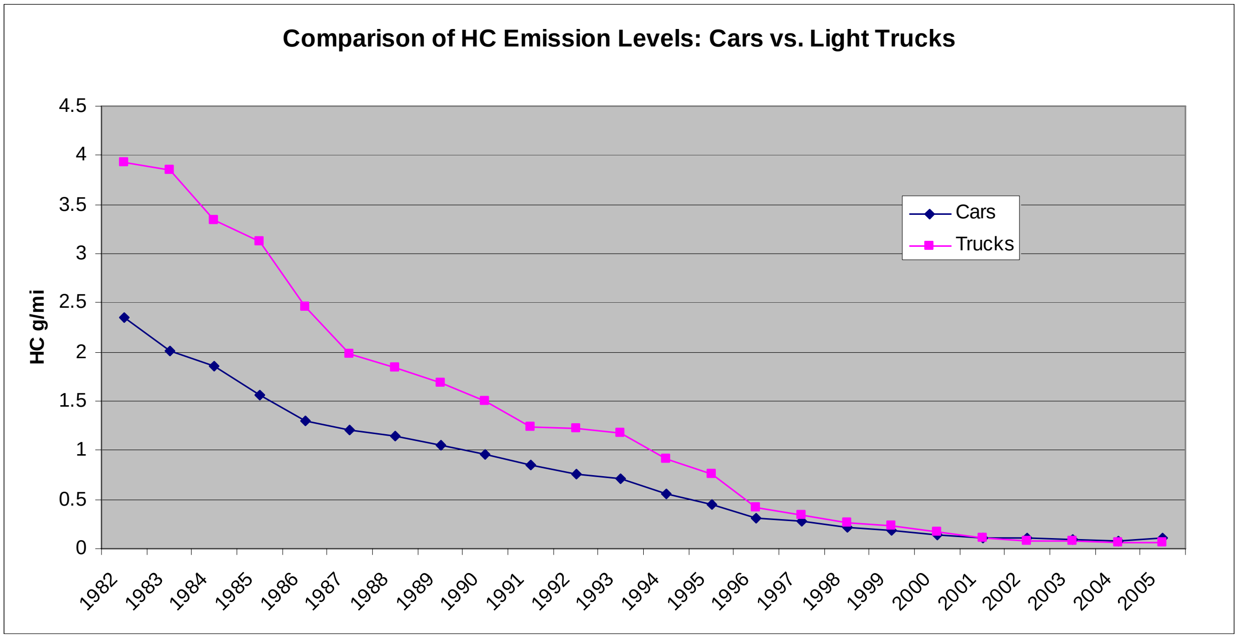
Yr	LDGV	LDGT
2004	14910	20251
2003	14174	19258
2002	13475	18054
2001	12810	16912
2000	12178	15577
1999	11577	14576
1998	11006	13562
1997	10463	12616
1996	9947	11694
1995	9456	10868
1994	8989	10010
1993	8546	9253
1992	8124	8496
1991	7723	7815
1990	7342	7154
1989	6980	6565
1988	6636	6001
1987	6308	5435
1986	5997	4931
1985	5701	4468
1984	5420	4055
1983	5152	3685
1982	4898	3312
Source: MOBILE6.2 User's Guide.		

Estimating Vehicle Emissions in Grams per Mile

Estimates of emissions and emission reductions in grams per mile were derived directly from IM240 test results provided in the VTR. dKC assumed that IM240 values in grams per mile can be used to project emissions and emission changes for vehicles receiving two-speed idle (TSI) tests. This assumption has virtually no impact on the benefits calculated for passenger cars, since 95 percent of them received IM240 tests. This assumption would impact the benefits calculated for trucks if there were significant real differences in the benefits for TSI versus IM240 failures, since 17 percent of the trucks tested received TSI tests. The reason why trucks have a lower percentage of IM240 tests is that heavy-duty gasoline powered trucks (those between 8,500 and 14,000 lbs. GVW) were only tested by the two-speed idle (TSI) test. Based upon analysis of data from remote sensing devices (RSD), dKC determined that vehicles that failed TSI tests and were repaired saw similar reductions in RSD emission levels as IM240 failures. Initially, dKC had planned to use equations to convert TSI results in to grams per mile results to generate grams per mile estimates for vehicles that received TSI tests instead of IM240 tests. However, the TSI to gram per mile conversions yielded inconsistent results, so they were not used.

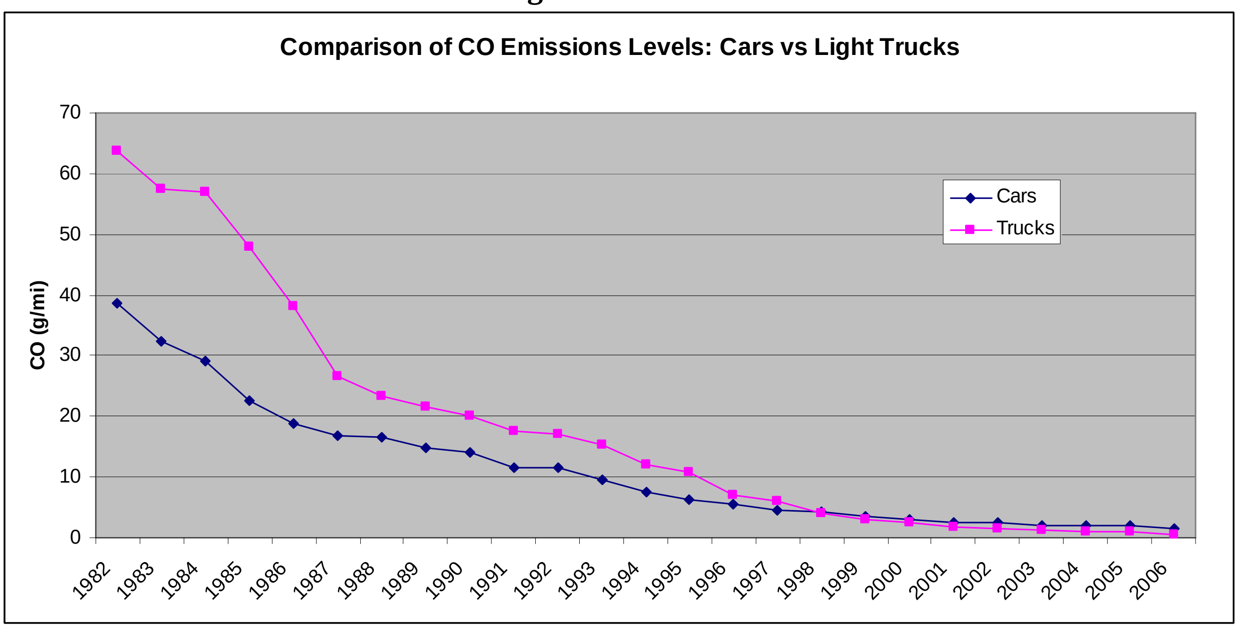
Emission Rates Observed in the AIR Program -- Figure D-1 shows a comparison of HC emission rates as measured by IM240 tests in the AIR Program in 2005. Figure D-2 shows a comparison of CO emission rates as measured by IM240 tests in the AIR Program in 2005. As shown, up to the 1996 model-year, light-duty trucks emit significantly more HC and CO than cars. Beginning with the 1996 model-year, cars and light trucks had similar emission standards, so the agreement for 1996 and newer vehicles makes sense.

Figure D-1



Source: de la Torre Klausmeier Consulting, Inc analysis of AIR Program data.

Figure D-2



Source: de la Torre Klausmeier Consulting, Inc analysis of AIR Program data.

Impact of Repairs on Vehicle Emissions

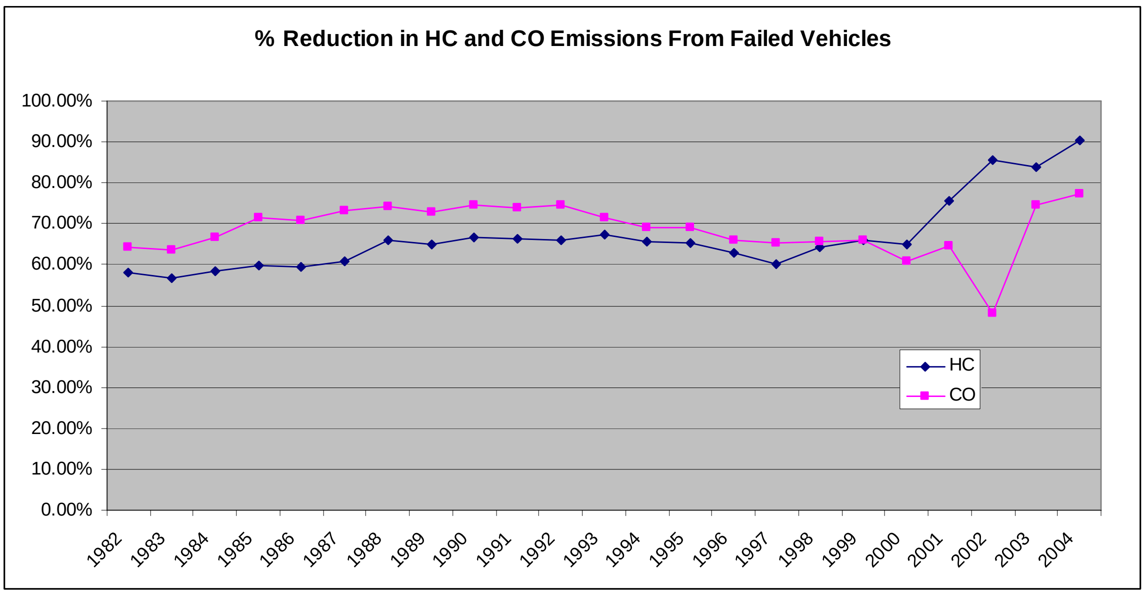
Repairs to vehicles failing the AIR inspection reduced HC and CO emissions as measured by the IM240 test by over 60 percent. NOx emissions, on the other hand, saw either a slight increase or no change. Figure D-3 shows the percent reduction in HC and

CO emissions from failed vehicles. Most failed vehicles, regardless of their model-year, showed large HC and CO emission reductions.

After repair emission levels were very close to emission levels for vehicles that passed their initial test, which is considered the ideal target (Figures D-4 and D-5). On average, vehicles that pass their initial tests or pass after failing their initial tests have emission levels much lower than AIR Program cutpoints, as shown on Figures D-6 and D-7.

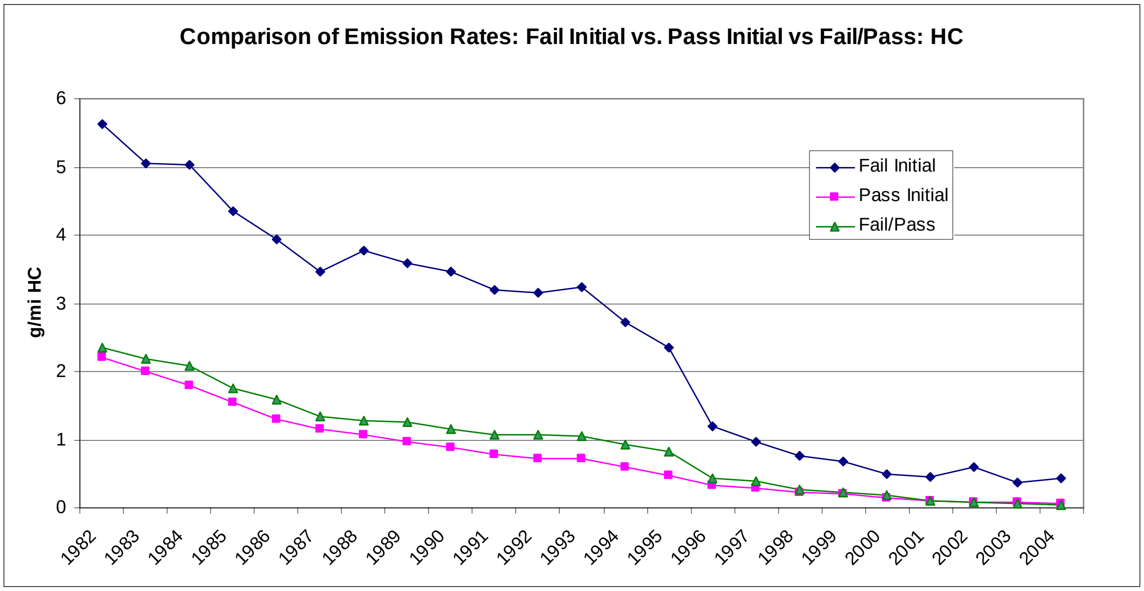
Overall, 85 percent of the vehicles that fail AIR inspections ultimately comply with AIR Program standards. Although, ideally, the percentage should be 100 percent, this percentage is higher than observed in many other I/M programs. Also, data from remote sensing devices indicate that at least half of the vehicles that fail and never pass are not operated in the program area. Results are fairly consistent by model-year (Figure D-8).

Figure D-3



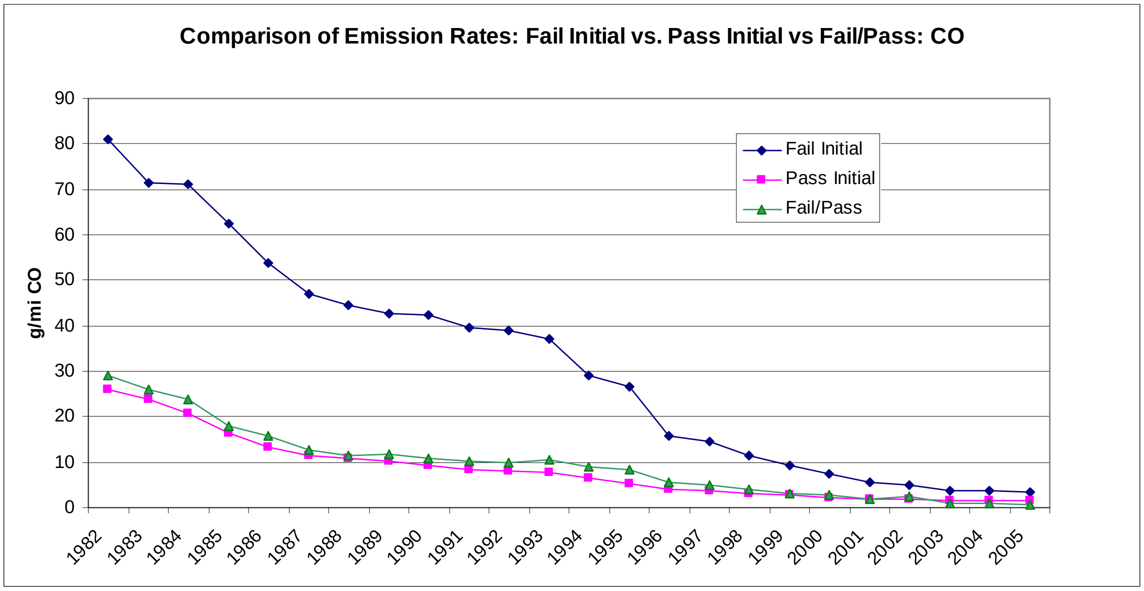
Source: de la Torre Klausmeier Consulting, Inc analysis of AIR Program data.
Note: Most vehicles that fail and are repaired show large HC and CO emissions reductions.

Figure D-4



Source: de la Torre Klausmeier Consulting, Inc analysis of AIR Program data
Note: HC emission levels after repair (Fail/Pass) are very close to levels for vehicles that pass their initial test, which is considered to be the target.

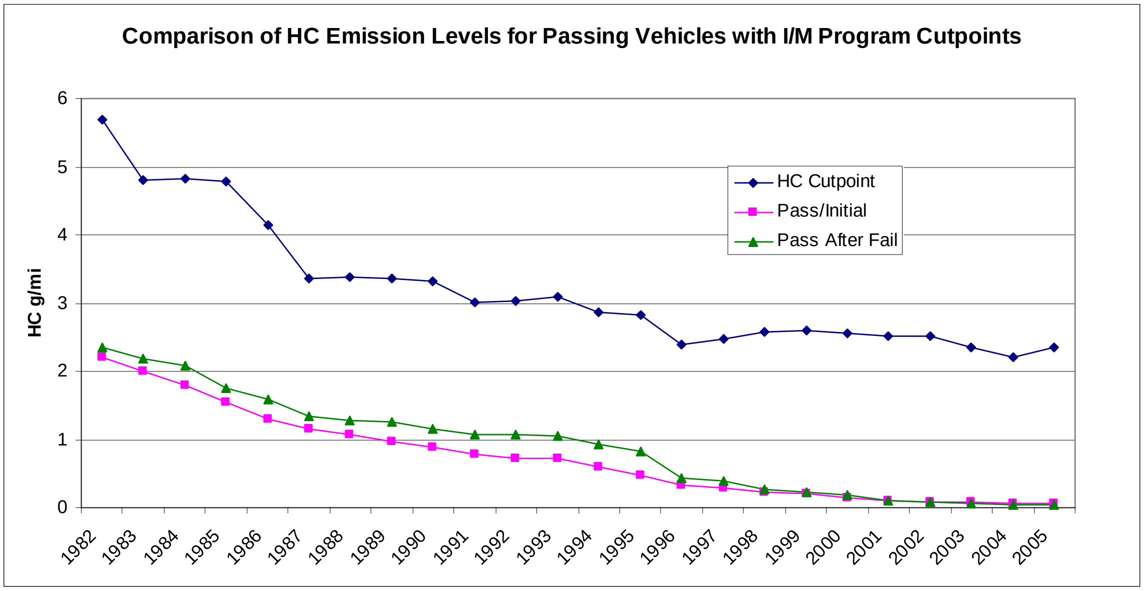
Figure D-5



Source: de la Torre Klausmeier Consulting, Inc analysis of AIR Program data.

Note: CO emission levels after repair are very close to levels for vehicles that pass their initial test, which is considered to be the target.

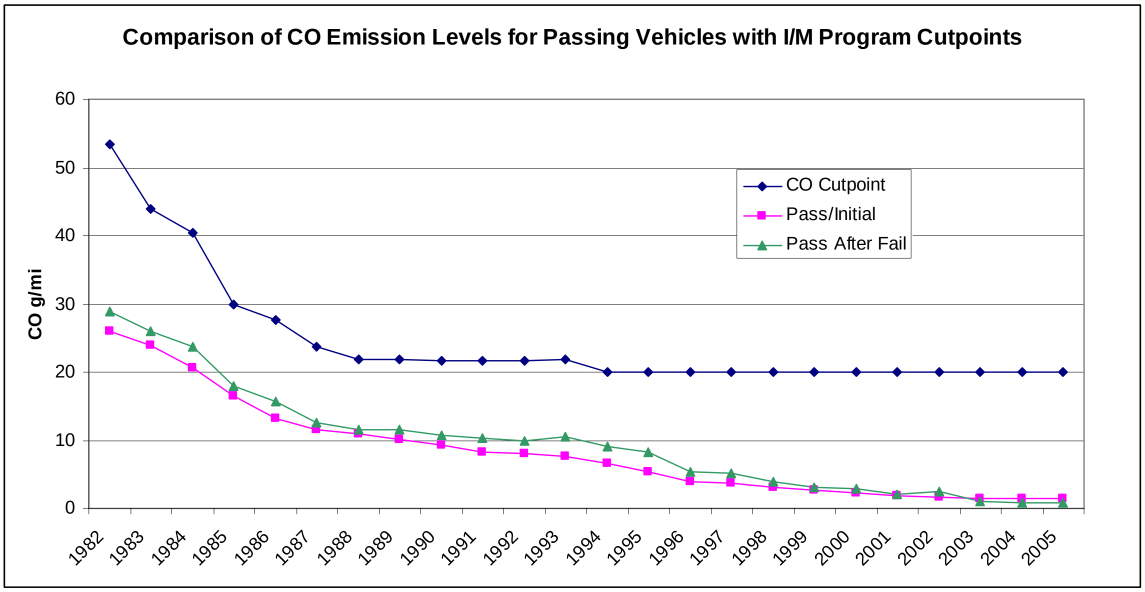
Figure D-6



Source: de la Torre Klausmeier Consulting, Inc analysis of AIR Program data.

Note: This chart compares average HC cutpoints with after repair emission levels. Technicians are not just repairing vehicles to meet the cutpoint.

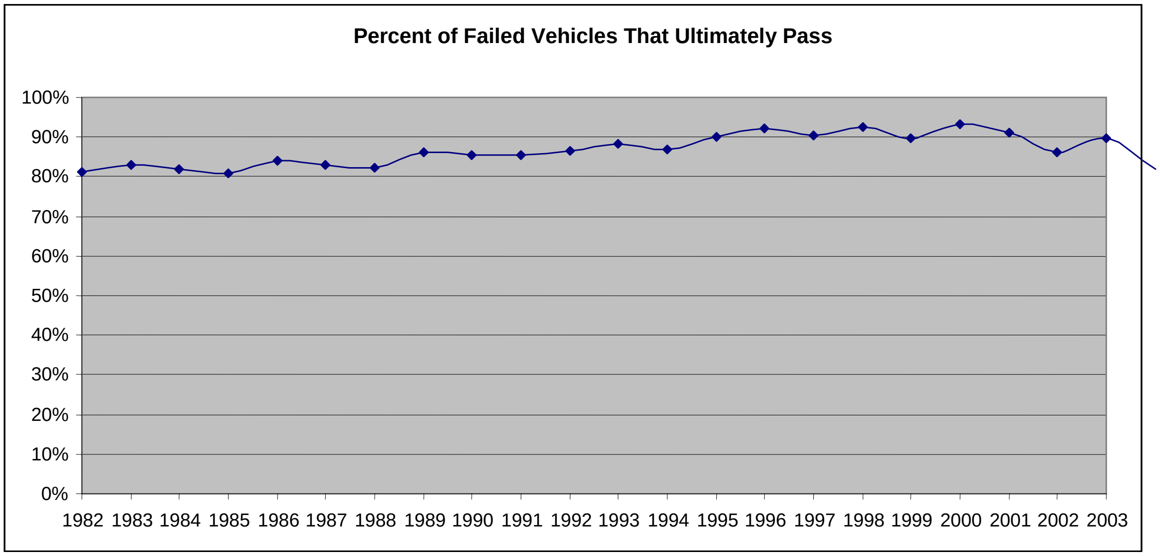
Figure D-7



Source: de la Torre Klausmeier Consulting, Inc analysis of AIR Program data.

Note: This chart compares average CO cutpoints with after repair emission levels. Technicians are not just repairing vehicles to meet the cutpoint.

Figure D-8



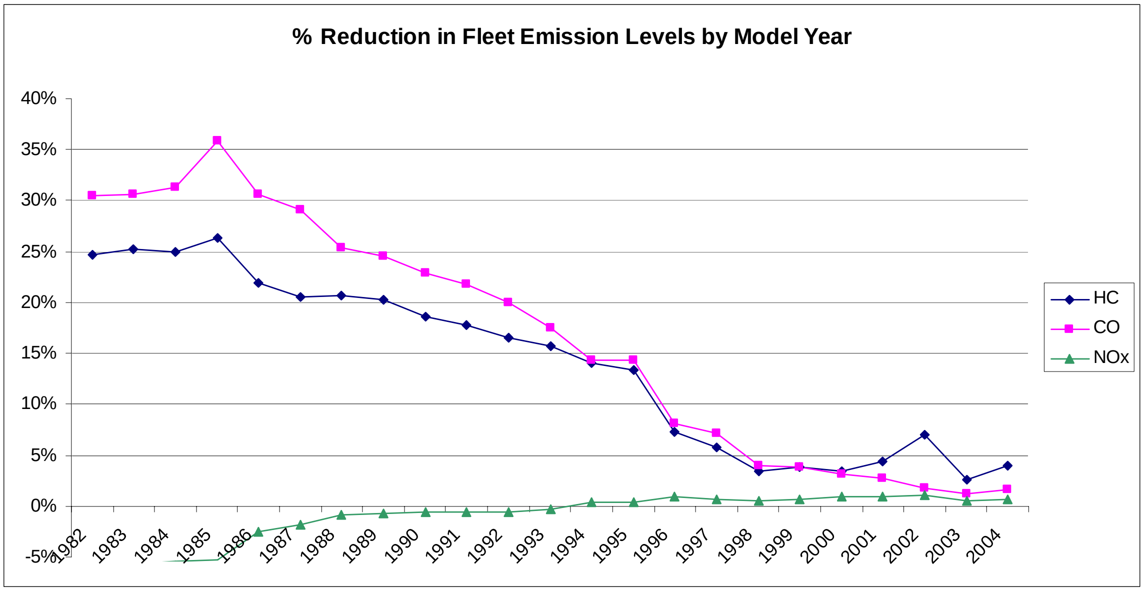
Source: de la Torre Klausmeier Consulting, Inc analysis of AIR Program data.

Note: 80 to 90 percent of the failed vehicles ultimately comply with AIR standards. The overall average is 85 percent.

Overall Exhaust Emission Reduction from One Test-and-Repair Cycle

One test-and-repair cycle in the AIR Program is estimated to reduce HC exhaust emissions from the tested vehicle population by 14 percent and CO emissions by 16 percent. NOx emissions increase slightly, about 0.1 percent. Results by model-year are shown on Figure D-9. The greatest emission reductions come from testing and repairing the oldest vehicles. As shown on Figure D-10, on a percent reduction basis trucks get slightly lower emission reductions than cars. These estimates do not account for any repairs made before a vehicle obtained its initial AIR test.

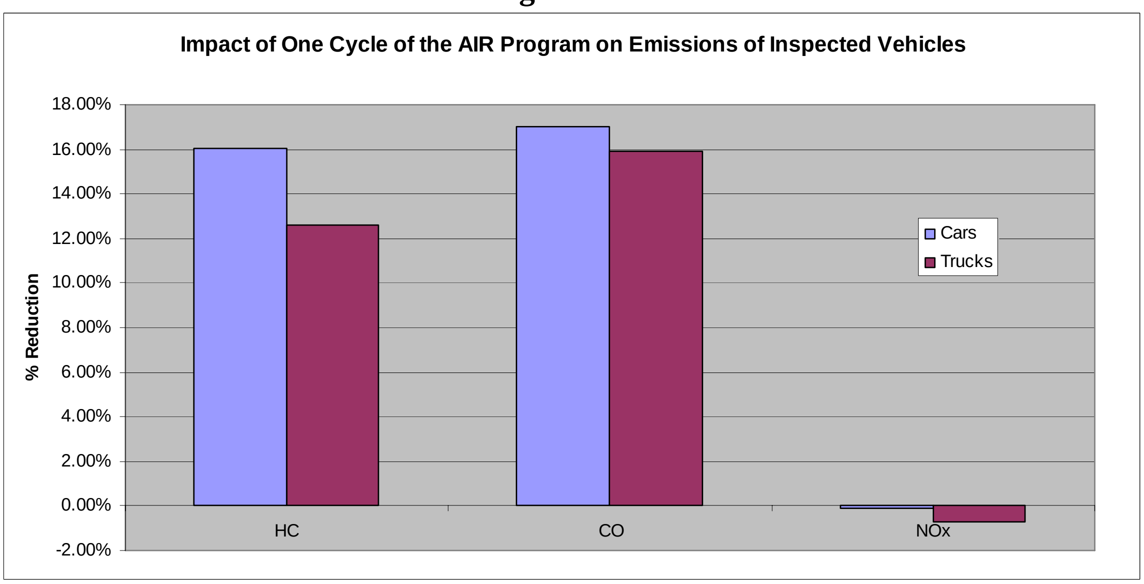
Figure D-9



Source: de la Torre Klausmeier Consulting, Inc analysis of AIR Program data.

Note: On a percentage basis, older models show the greatest HC and CO benefits from the AIR Program. For older model-years, average NOx emissions were increased by repairs.

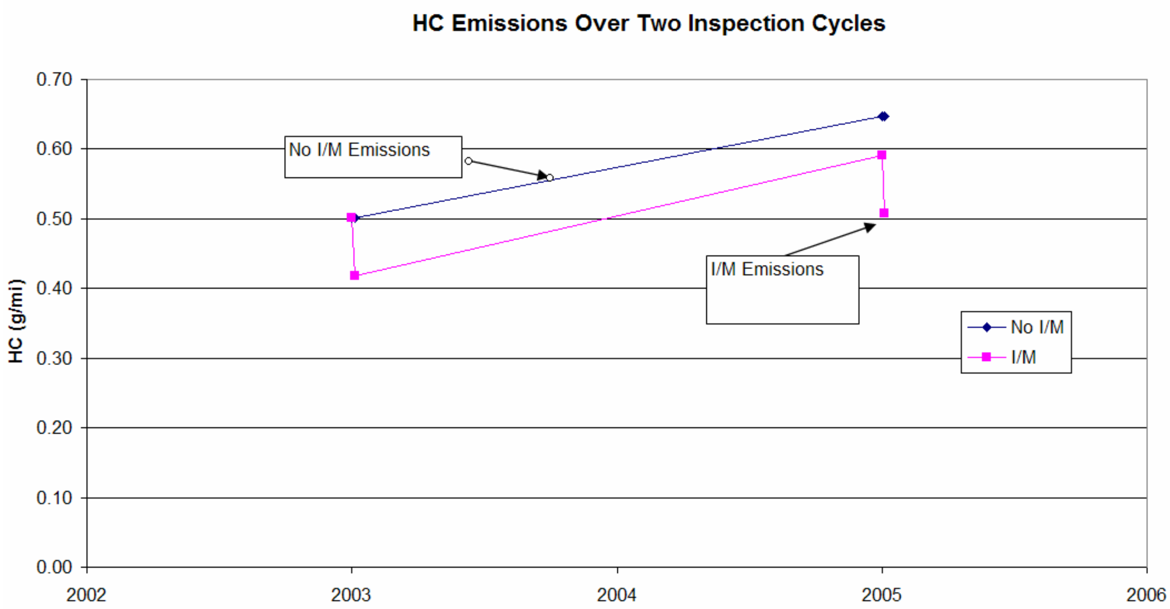
Figure D-10



Source: de la Torre Klausmeier Consulting, Inc analysis of AIR Program data.

Emission Reduction Over Two Test-and-Repair Cycles -- Using data on vehicles that were tested in both 2002/2003 and 2004/2005, dKC estimated the emission reductions from repairs and projected overall emission reductions over two inspection cycles. Total reductions in on-road exhaust emissions were estimated to be 19 percent for HC and 20 percent for CO. This estimate accounts for the 1st 4 model-years being exempted. Results for HC are shown on Figure D-11.

Figure D-11



Source: de la Torre Klausmeier Consulting, Inc analysis of AIR Program data.

HC Reduction by Reason for Failure – Currently, the AIR Program has exhaust emission standards for HC and CO. Since the focus is now more on HC emission reductions, we investigated if the AIR Program should continue to fail for excessive CO emissions. We compared HC emissions for vehicles passing for CO with HC emissions for vehicle passing for HC. As shown below, the AIR Program gets greater HC benefits from CO failures than HC failures.

Table D-2a – HC Emission Reductions (IM240) by Reason for Failure

Condition	HC g/mi	Percent Reduction in HC[1]
As Received	0.615	--
Pass CO	0.470	23.63%
Pass HC	0.493	19.86%

Source: de la Torre Klausmeier Consulting, Inc analysis of AIR Program data.

[1] Assumes vehicles that fail are repaired so that there emission levels equal those that pass the inspection.

Evaporative Emissions Reductions

The traditional emissions test includes a check for faulty gas caps. During *Calendar Year* 2005, the AIR Program identified 19,000 vehicles (or about 2 percent of the 890,000 vehicles tested) that had faulty gas caps. The assumed gram per mile benefit from replacing faulty gas caps was based on studies by the California Bureau of Automotive Repair (BAR) and MOBILE6. BAR studies indicate that faulty gas caps increase HC emissions by at least two grams per mile. MOBILE6 assumes lower benefits from gas cap inspections. MOBILE6 appears to assume an impact of around 1.3 gram per mile, based upon based on its estimates of the impact of gas cap tests on HC emissions. dKC assumed a benefit of two gram per mile.

Comparison with MOBILE6

MOBILE6 is a vehicle emission factor model developed by EPA for use in air quality modeling and control strategy development. States must use MOBILE6 to estimate benefits from I/M programs. Accordingly, the emission reductions assumed in the Early Action Compact (EAC) are based upon MOBILE6. dKC compared emission reductions based upon AIR data with those based upon MOBILE6. MOBILE6 predicts that the AIR Program reduces exhaust HC emissions by 14 percent and CO emissions by 13 percent. Based on data from two-cycles of the AIR Program, dKC calculates that the AIR Program reduces exhaust emissions by 19 percent for HC and 20 percent for CO. It's difficult to directly compare the two methods. MOBILE6 estimates the impact of the AIR Program on composite vehicle emissions which is a range of operating conditions starting with cold start through hot transient operation. Emission reductions based upon the AIR Program are limited to hot transient operation, since vehicles are tested in the warmed-up condition with the engine running. However, the differences in emission reduction benefits raise concerns that MOBILE6 may underestimate the importance of the AIR Program as an emission reduction strategy.

MOBILE6.2 estimates emissions by making assumptions on the base emission levels for different types of motor vehicles. The base emission levels include two key components:

1. How much motor vehicles emit when they are brand new, termed zero mile levels or ZML, and
2. How much motor vehicle emissions increase as vehicles age, otherwise known as deterioration.

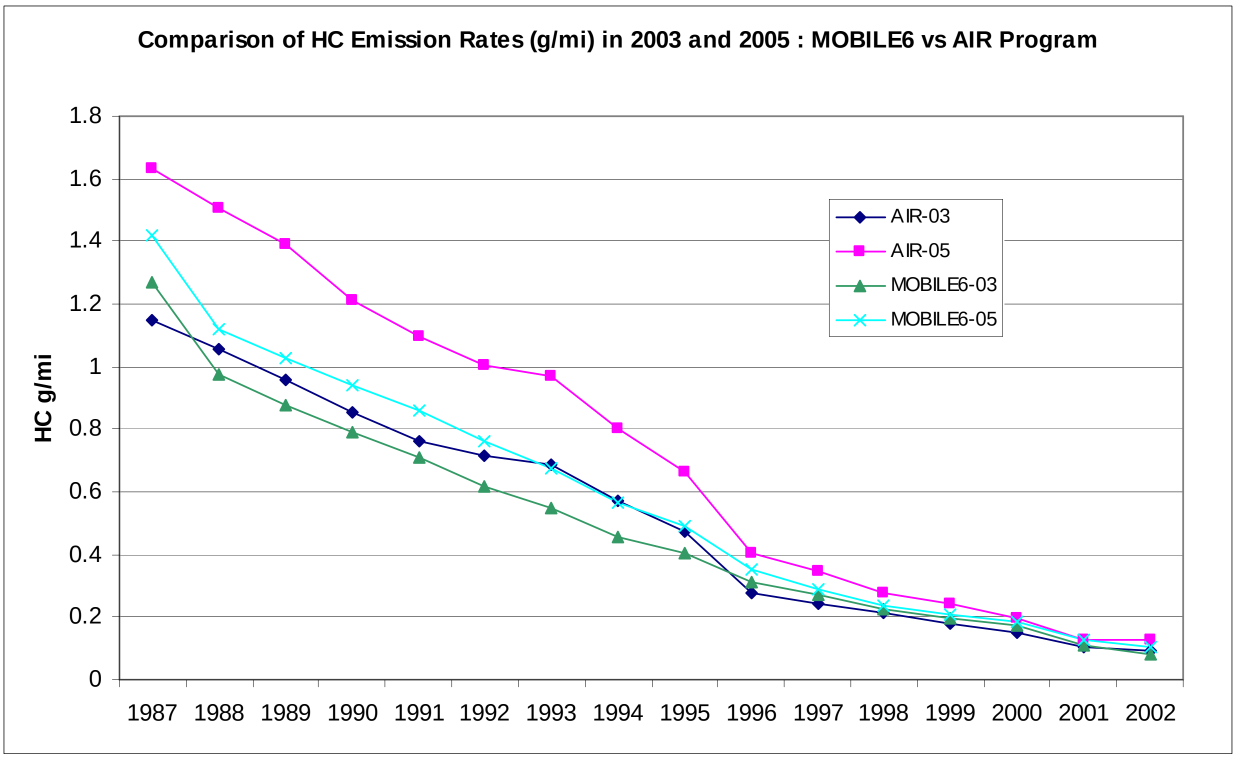
There's little uncertainty in the 1st component. ZMLs are close to zero for most vehicles. Assumptions on vehicle deterioration have the greatest impact projected emission rates from motor vehicles.

To help verify the accuracy of MOBILE6 assumptions on vehicle deterioration, dKC compared deterioration rates assumed by MOBILE6 with deterioration rates observed in vehicles that receive AIR Program tests in the Denver metropolitan area. Fortunately, the AIR Program measures vehicle emissions in grams per mile (gpm) which is the same units used by MOBILE6. dKC analyzed data on vehicles that were tested in both 2003 and 2005 in the AIR Program. dKC then compared the deterioration observed in the emission rates for these vehicles with the deterioration projected by MOBILE6 from 2003 to 2005. Figure D-12 shows projections of vehicle emissions based on four scenarios:

- AIR Program tests in 2003;
- AIR Program tests in 2005;
- MOBILE6 emission rates in 2003; and
- MOBILE6 emission rates in 2005.

As shown, emission rates in 2003 compare fairly well with MOBILE6 estimates for 2003. However, based upon AIR Program tests, vehicles emissions deteriorate much more during the two-year period than projected by MOBILE6, as shown by the comparison between 2005 estimates.

Figure D-12



Source: de la Torre Klausmeier Consulting, Inc analysis of AIR Program data.

Note that the AIR Program test is based upon the IM240 test, which essentially is the warmed-up portion of the Federal Test Procedure (FTP) while MOBILE6 is based upon the complete Federal Test Procedure adjusted for vehicle operating conditions in the Denver metropolitan area. It is fortuitous that the 2003 levels based on the AIR Program are similar to MOBILE6, since this allows a comparison of the relative emission rates in 2005 projected by both methods.

The impact of these findings is that MOBILE6 may under estimate future emissions from motor vehicles and, accordingly, the importance of controls on motor vehicles. If MOBILE6 had used greater deterioration rates, it would predict greater benefits from the AIR Program.

Overall Tons Reduction from the AIR Program

The overall benefits in tons per day for the AIR Program were calculated two ways:

1. **Using MOBILE6 estimates of program benefits –** The estimated benefit based on MOBILE6 in grams per mile was multiplied by daily vehicle miles traveled (VMT) in the DMA (as reported in EAC document).
2. **Using benefits derived from IM240 tests conducted in the AIR Program –** The percent reductions observed for two cycles of the AIR Program were multiplied times the "no I/M" exhaust emission factor generated by MOBILE6 and daily VMT. The benefits for the gas cap test was based on the percent of vehicles that fail gas cap tests (2.1 percent in 2005) times the assumed benefit in grams per mile and daily VMT.

The 2nd method calculates greater benefits. The range in cumulative AIR Program benefits are shown below:

- HC : 10 to 15 tons per day,
- CO: 147 to 245 tons per day.

Cost-Effectiveness of Expanding Model-year Exemptions

Data from AIR Program tests were analyzed to determine the impact of expanding model-year exemptions beyond 4 model-years. Expanding model-year exemptions beyond four years significantly affects the benefits of the Program. For example, if the 1st six model-years are exempted, the Program would achieve 91 percent (100 percent-9 percent) of the benefits of the current Program.

Table D-2b presents the cost effectiveness of expanding model-year exemptions. Although expanding model-year exemptions reduces AIR Program benefits, costs are reduced by a greater percentage than emissions benefits. Therefore, the cost effectiveness of the AIR Program improves (drops) with additional model-year exemptions. For example, the cost-effectiveness of the AIR Program with six model-year exemptions is $9,200 vs $9,800 per ton for the current Program.

Table D-2b -- Cost Effectiveness of Additional AIR Program Exemptions

Parameter	Years Exempted				
	Current (4 years)	**5**	**6**	**7**	**8**
Costs	$42,504,609	$40,263,265	$36,235,261	$33,521,028	$30,043,851
Emission Reductions (Tons/Day)	15	14.4	13.6	13.0	12.4
Dollars/ton	$9,791	$9,697	$9,186	$8,919	$8,363

Source: de la Torre Klausmeier Consulting, Inc analysis of AIR Program data.

The emission reductions on Table D-2b are based on dKC's analysis of AIR Program data. dKC also evaluated the impact of model-year exemptions using MOBILE6.2. The number of years exempted is in an input into MOBILE6.2. MOBILE6.2 agrees well with AIR Program data in terms of the relative impact, but because MOBILE6.2 estimates smaller absolute benefits from the AIR Program, it predicts less mass impact from expanding model-year exemptions. Inputting 8 years instead of 4 years decreases AIR Program benefits for HC by 17 percent, or 1.6 tons per day. This compares with 17 percent, or 2.6 tons per day based on AIR Program data.

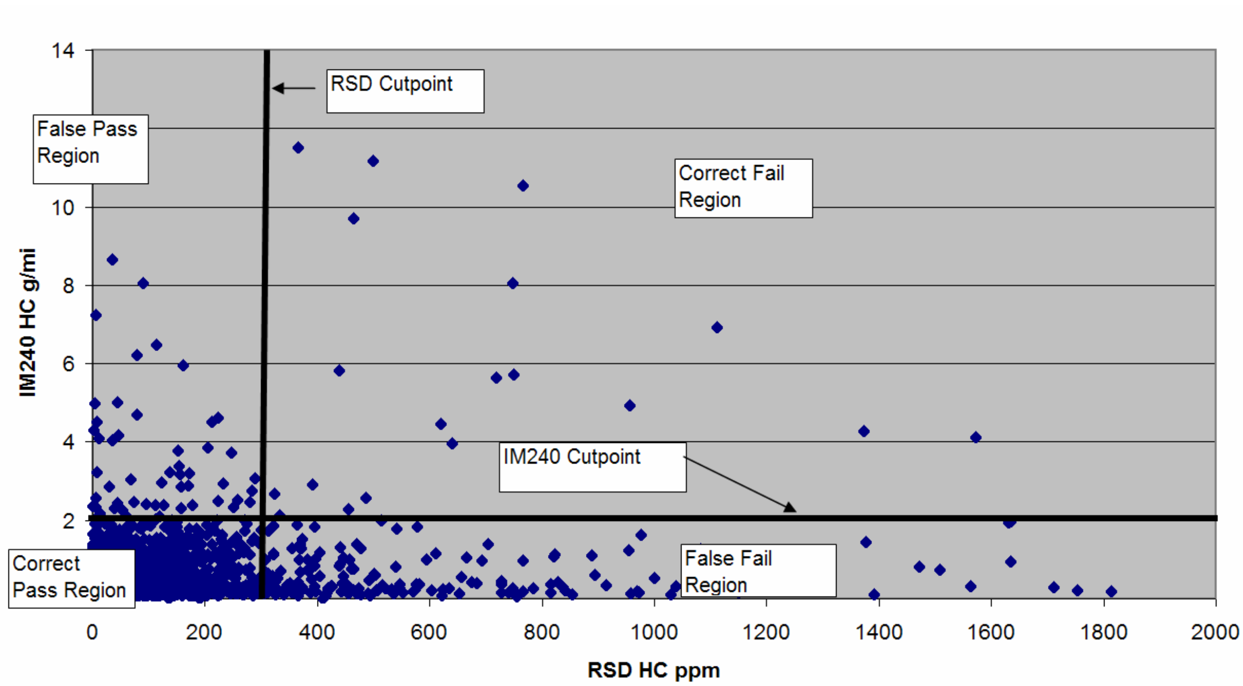
ANALYSIS OF DATA FROM RAPID SCREEN TEST IN THE DMA

Since 2004, ESP has been conducting on-road emissions tests using RSD. These tests are termed Rapid Screen. Rapid Screen measurements provide an instantaneous snapshot of vehicle emissions under moderate acceleration.

Correlation Between RSD and IM240 Emission Rates

Figure D-13a shows a scatter plot of IM240 HC readings matched with RSD readings. A hypothetical cutpoint of 300 ppm HC is used to identify vehicles that are high-emitters according to Rapid Screen. As shown, there's poor correlation among the high emitting vehicles.

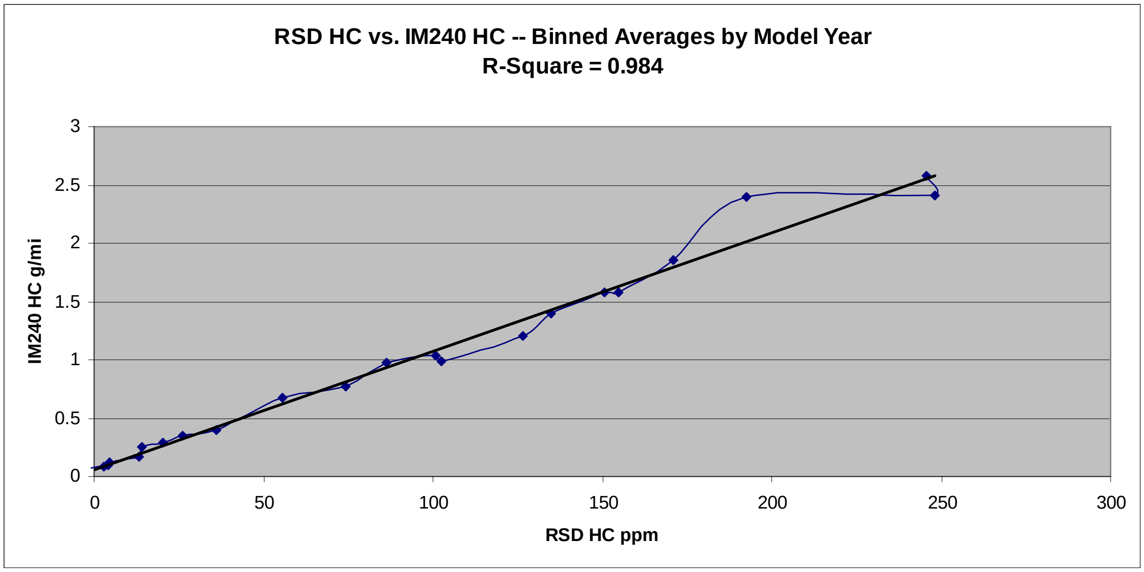
Figure D-13a - IM240 HC vs. Rapid Screen HC for 1995 Model-year Passenger Vehicles



Source: de la Torre Klausmeier Consulting, Inc analysis of AIR and Rapid Screen Program data.

Although individual Rapid Screen results do not correlate well with individual IM240 results, Rapid Screen results do provide an accurate measure of vehicle emissions trends. This is shown on Figure D-13b, which correlates average Rapid Screen results by model-year with average IM240 results. Looking at averages is termed binning. Binned Rapid Screen results for HC correlate well with binned IM240 results. R-square equals 0.984; a perfect correlation has an R-square of 1.0. From this analysis, we conclude that average RSD levels provide an accurate measure of fleet emissions trends.

Figure D-13b



Source: de la Torre Klausmeier Consulting, Inc analysis of AIR and Rapid Screen Program data.

RSD Emission Rates Before and After AIR Tests

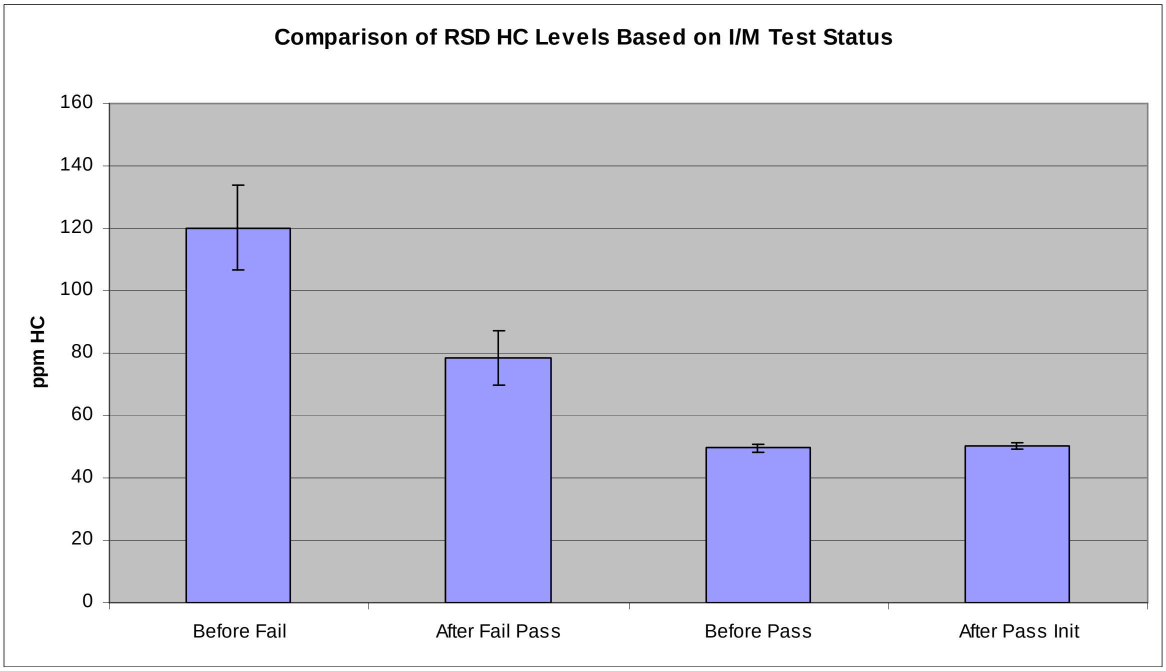
Data from remote sensing devices (RSD) confirm that the AIR Program significantly reduces vehicle emissions. Because RSD is only a snapshot of vehicle emissions while the IM240 test measures vehicle emissions over a complete driving cycle, a direct comparison in results from RSD and IM240 tests is difficult. What we are looking for in this case is the impact of repairs to vehicles that fail the test. dKC matched RSD results with AIR results and then calculated average RSD emissions before and after AIR inspection. Figure D-14 shows a comparison of average RSD HC emissions for the following scenarios:

- Before failing initial AIR tests;
- After failing and then passing AIR test;
- Before passing initial test;
- After passing initial test.

RSD observations were limited to one year before or 185 days after the AIR test. Results were broken down by model-year and then weighted based on the number of vehicles tested in the AIR Program by model-year.

Emission levels after repair are compared with emission levels for vehicles that pass their initial test, which is considered to be the ideal emission rate for a vehicle that fails and is repaired in an I/M program[2]. RSD HC emission levels for vehicles after passing a retest (i.e., they failed their initial test) were closer to the emission levels for vehicles that pass their initial inspection than the emission levels for vehicles before they fail their initial inspection. This indicates that most repairs effectively address reasons why the vehicle had high HC emissions and were not temporary fixes to get the vehicle to pass the AIR test. Results were similar for CO (Figure D-15).

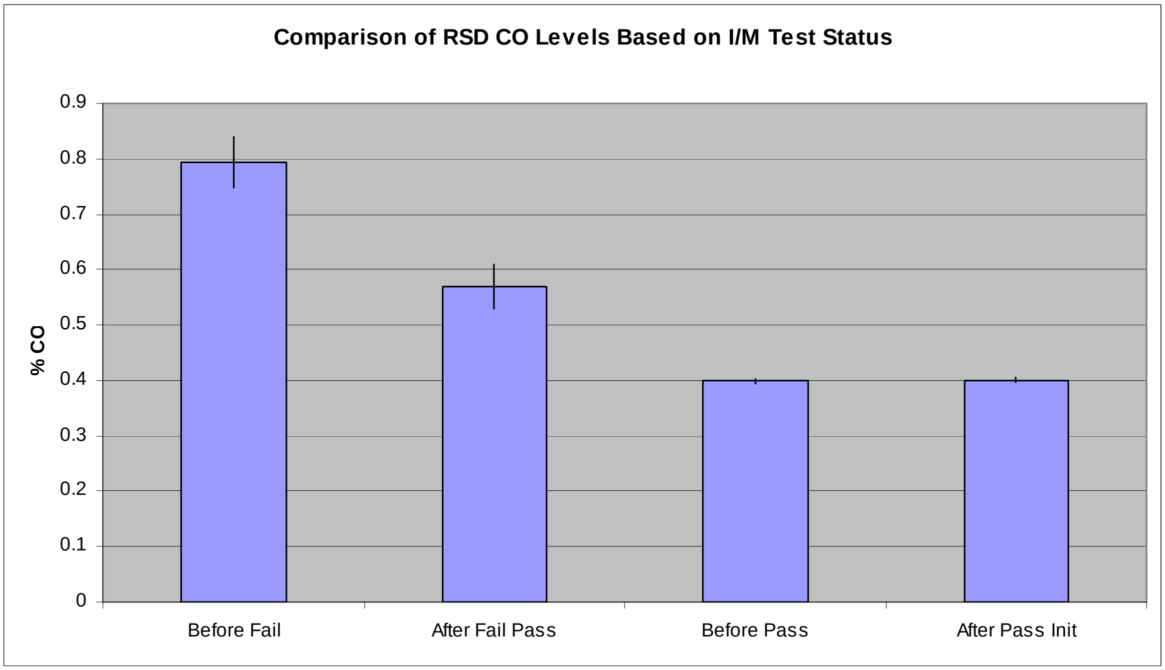
Figure D-14



Source: de la Torre Klausmeier Consulting, Inc analysis of AIR and Rapid Screen Program data.

[2] The time window is 365 days before AIR inspection and 185 days after AIR inspection.

Figure D-15

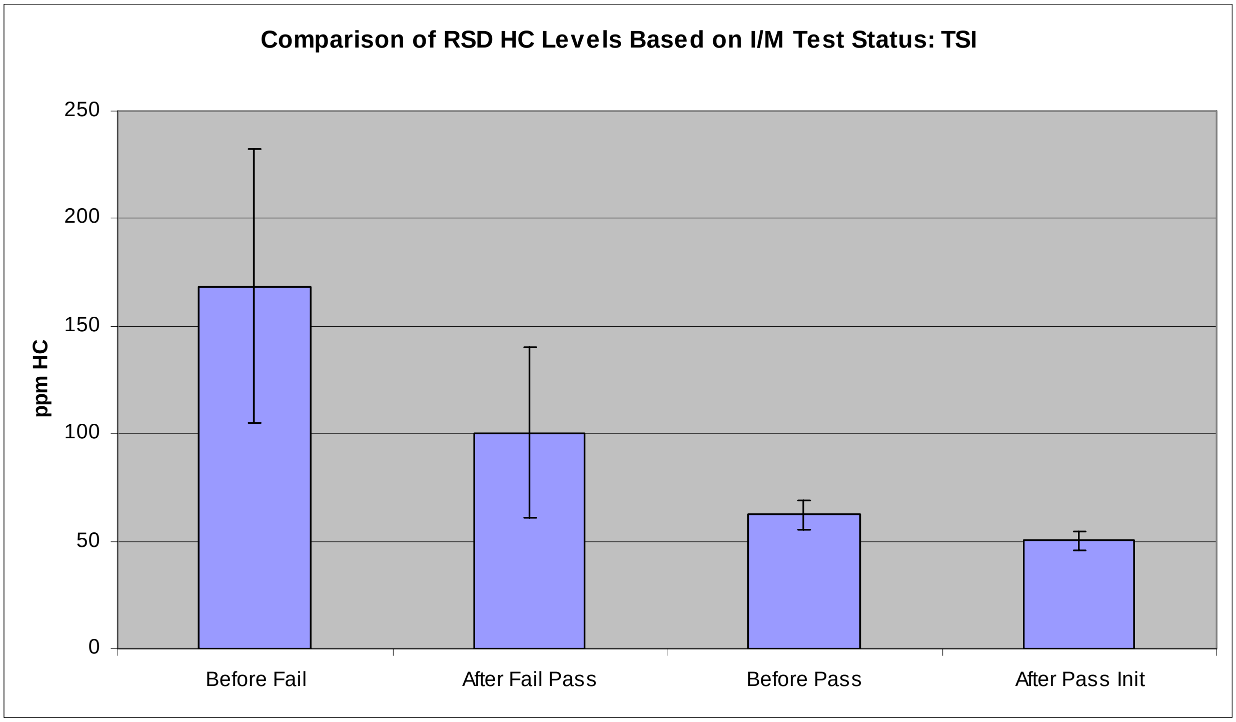


Source: de la Torre Klausmeier Consulting, Inc analysis of AIR and Rapid Screen Program data.

Note: Data from remote sensing devices indicate that repairs to vehicles failing AIR inspections significantly lower their CO and HC emission rates.

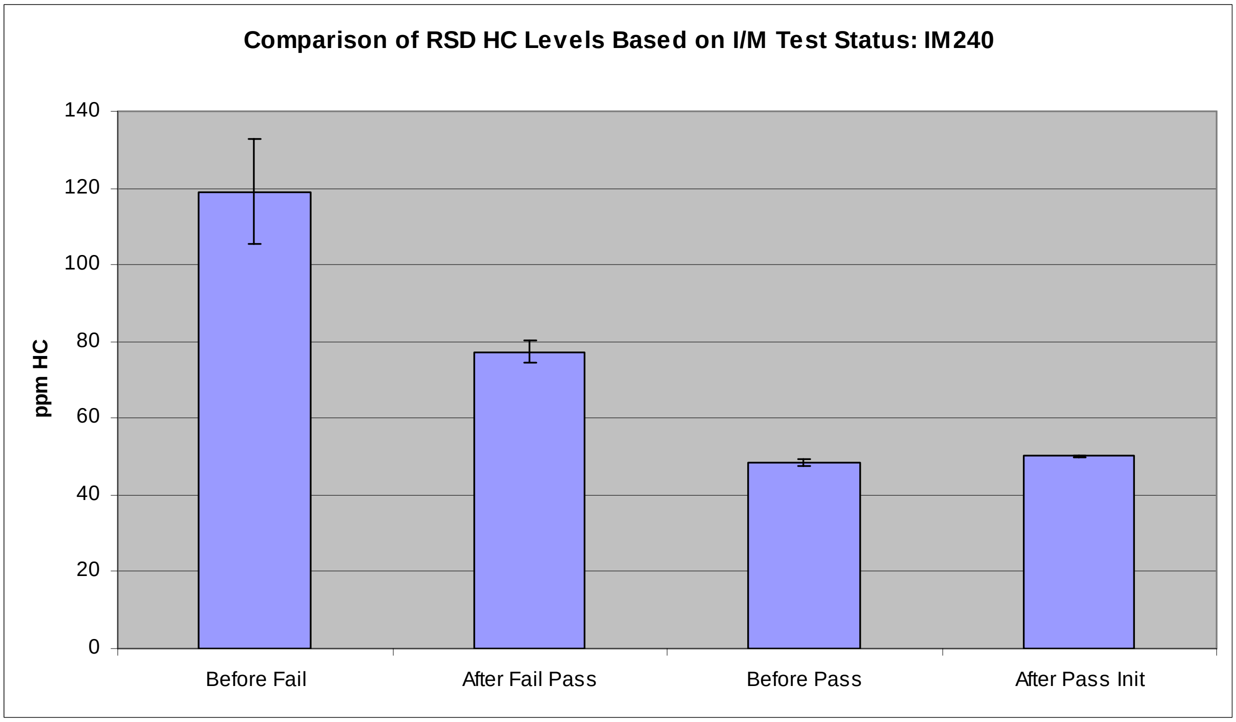
IM240 vs Two-Speed Idle (TSI) Tests – Emission reductions based on RSD for vehicles failing IM240 tests were similar to the emission reductions based on vehicles failing TSI tests. Vehicles failing IM240 tests showed a 35 percent reduction after repairs, while vehicles failing idle tests showed a 40 percent reduction after repairs. The results for TSI tests are more uncertain than the results for IM240 tests because the sample size in the RSD dataset is for tests before and after TSI tests are much smaller than before and after IM240 tests (Figures D-16 and D-17).

Figure D-16



Source: de la Torre Klausmeier Consulting, Inc analysis of AIR and Rapid Screen Program data.

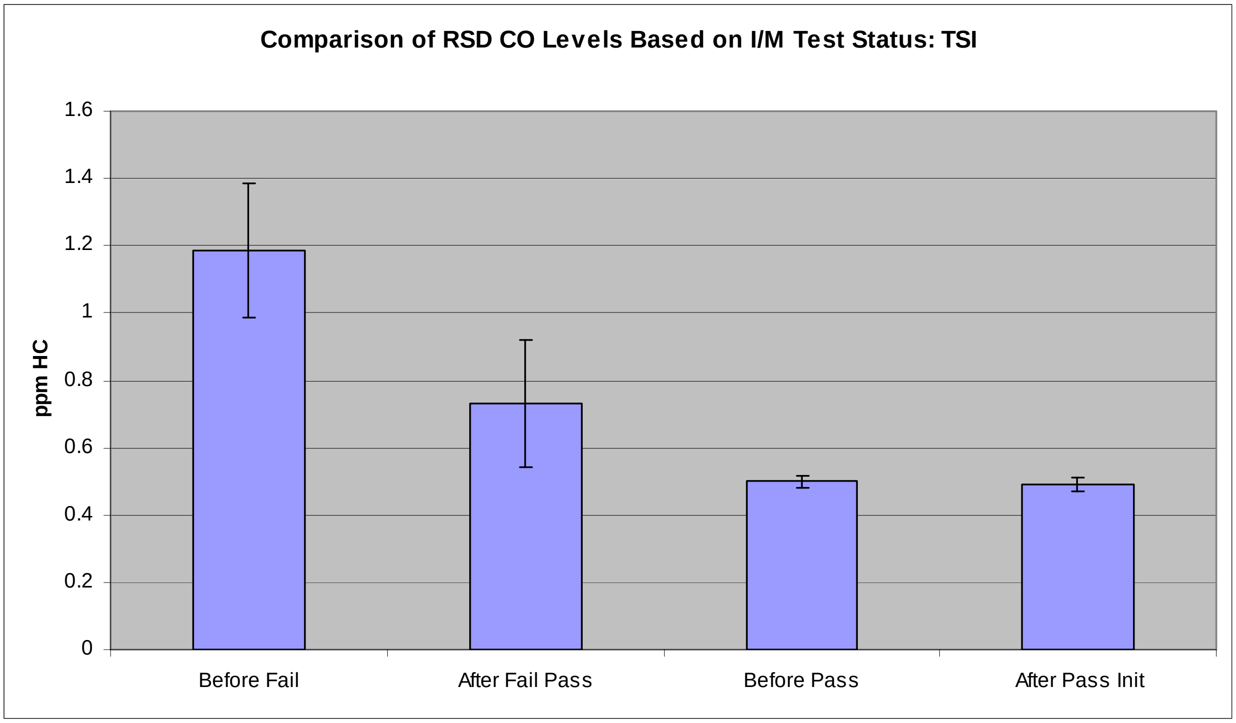
Figure D-17



Source: de la Torre Klausmeier Consulting, Inc analysis of AIR and Rapid Screen Program data.

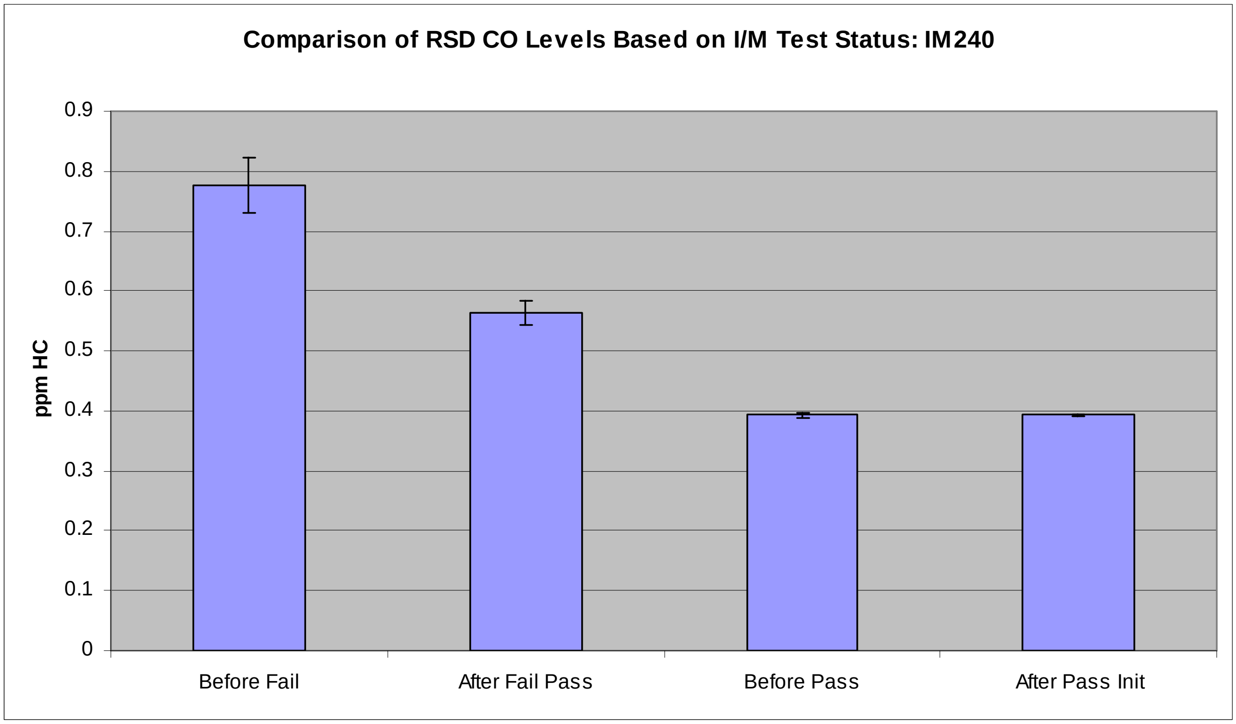
Results were similar for CO. CO emissions based on RSD were 38 percent lower after failing a TSI test versus 28 percent lower after failing an IM240 test. These results are shown graphically on Figures D-18 and D-19. Again, there's much more uncertainty in the TSI than IM240 results.

Figure D-18



Source: de la Torre Klausmeier Consulting, Inc analysis of AIR and Rapid Screen Program data.

Figure D-19



Source: de la Torre Klausmeier Consulting, Inc analysis of AIR and Rapid Screen Program data.

Analysis Of The Effectiveness Of The Rapid Screen Program

The process of using Rapid Screen to identify vehicles that are likely to pass the traditional emissions test is termed "Clean Screen". The process of using Rapid Screen to identify vehicles that are likely to fail the traditional emissions test is termed "Dirty Screen".

dKC analyzed Rapid Screen and AIR Program data (Vehicle Test Results, VTR) to evaluate the effectiveness of Rapid Screen as a means to identify clean screen and dirty screen candidates. dKC developed datasets matching RSD results with vehicle test records (VTR) results. We developed the following models for using Rapid Screen:

- Impact of One-Hit Clean Screen on AIR Program Effectiveness.
- Impact of Two-Hit Clean Screen on AIR Program Effectiveness.
- Impact of One-Hit Dirty Screen on AIR Program Effectiveness.
- Impact of Two-Hit Dirty Screen on AIR Program Effectiveness.
- Impact of Two-Hit Clean Screen on percent of OBD Failures Identified.
- Impact of Two-Hit Dirty Screen on percent of OBD Failures Identified.

Detailed outputs of the model are presented at the end of this Appendix.

Here is a breakdown of how we generated the dataset of two Rapid Screen results matched with the nearest AIR results:

1. The initial query identified vehicles that 2 RSD hits before they received an AIR test. If they had more than two hits before an AIR test, the two hits that were closest in time before the AIR test were selected. All aborted tests were removed from the AIR test dataset before results were matched. This dataset had 98342 matches of which 3543 failed emissions (EM_RES=F) and 5032 failed AIR (RESULT=F).

2. A time restriction was placed on the above dataset to limit it to matches where no more than 1 year elapsed between the oldest RSD observation and the AIR test. This dataset had 45077 matches of which 1166 failed emissions (EM_RES=F) and 1992 failed AIR (RESULT=F).

3. The above dataset was restricted to matches where we were able to establish a high-emitter index based on the vehicle's year, make, model and type (car or truck). This dataset had 28390 matches of which 729 failed emissions (EM_RES=F) and 1301 failed AIR (RESULT=F).

4. Records where both RSD hits were on the same day were removed. This dataset had 24541 matches of which 607 failed emissions (EM_RES=F) and 1108 failed AIR (RESULT=F).

Emissions Impact of Rapid Screen as a Clean Screen Tool

In order to assess the impact of Rapid Screen notices on AIR Program effectiveness, dKC concentrated on the dataset that matched two RSD results with VTR results. We applied Rapid Screen criteria to vehicles in this dataset and then calculated the number and percent of AIR failures that would qualify for Rapid Screen.

We compared Rapid Screen results with IM240 results for 29,000 vehicles that were also subject to Rapid Screen observations during the 2003 to 2005. We found that:

- 42 percent of the 1996 and newer vehicles that failed their IM240 test would have passed the Rapid Screen test
- 16 percent of the 1995 and older vehicles that failed the IM240 test would have passed the Rapid Screen test.

The composite total for all vehicles of all model-years is 21 percent. See Table D-3.

Table D-3 –Percent of AIR Failures That Qualify for Rapid Screen – Two RSD Observations Within One Year

Both Observations Less Than 0.5 percent CO and 200 ppm HC

Parameter	1995-	1996+	ALL
Percent of Fleet That Passes Rapid Screen Test[3]	46%	82%	71%
Percent of Emissions Fails That Pass Rapid Screen	16%	42%	21.4%
Number in sample	8,585	19,805	28,390

Source: de la Torre Klausmeier Consulting, Inc analysis of AIR and Rapid Screen Program data.

Just over 8 percent of the vehicles due for registration in March 2006 were inspected through Rapid Screen. Because of this small number, there is relatively low risk of having too many vehicles pass Rapid Screen when they would have failed the IM240 test. The Early Action Compact (EAC) allows the state to use Rapid Screen pass up to 50 percent of the fleet. If Rapid Screen were operating at its 50 percent potential, a significant number of vehicles would "falsely pass" the test.

The results on Table D-3 apply only to exhaust emissions. The loss in evaporative emission benefits must also be taken into account. Rapid Screen does not effectively find vehicles with high evaporative emissions. Evaporative emissions currently account for 23 percent of the HC benefits of the AIR Program. If 50 percent of the fleet complied via Rapid Screen, half of the evaporative emission benefits would be lost.

We examined ways to change the Rapid Screen test to make it more effective as a tool for passing clean vehicles. In other words, is there a way that Rapid Screen can pass clean vehicles without falsely passing vehicles that should fail? We first looked at changing pollutant outpoints. Tightening (lowering) these cutpoints will indeed reduce the number of false passes. Table D-4 shows that cutting Rapid Screen clean screen cutpoints in half, cuts the false pass rate from 21 percent to 12 percent.

Table D-4 -- Impact of More Stringent Clean Screen Cutpoints on Rapid Screen Accuracy -- Readings Must Be Less than Value, Sample Size: 29,000

Parameters	0.5 Percent CO, 200 ppm HC	0.25 Percent CO, 100 ppm HC
Percent of Vehicles That Pass Rapid Screen Test	71%	49.1%
Percent of Emissions Fails That Pass Rapid Screen	21%	12%

Source: de la Torre Klausmeier Consulting, Inc analysis of AIR and Rapid Screen Program data.

[3] Percent of vehicles meeting all Rapid Screen eligibility requirements.

We also looked at using a “high-emitter index” (HEI) as a possible component to the Rapid Screen program. We found that this too will greatly reduce the likelihood that a vehicle will falsely pass a Rapid Screen test. HEI is a measure of the historical probability that a vehicle will fail an AIR inspection. Utilizing a 50 percent HEI, for example, means that 50 percent of the historically highest polluting vehicles will be automatically excluded from the Rapid Screen test. When one of these historically high emitting vehicles passes by a remote unit, the test results will not be counted.

As shown in Table D-5 below, imposing a 50 percent HEI reduces the percentage of IM240 failures that would pass Rapid Screen from 21 percent to 9.6 percent, while the portion of the fleet passing the Rapid Screen test is only reduced from 71 percent to 60 percent. Imposing an HEI limit of 25 percent reduces the percentages of IM240 failures that would pass Rapid Screen down to 2 percent while reducing portion of the fleet passing the Rapid Screen test to 34 percent.

Table D-5 -- Impact of Including an High-Emitter Index (HEI) in the Determination of Rapid Screen Candidates – Two RSD Observations Within One Year – HEI readings Must Be Less than Value, Clean Screen Cutpoint: 0.5 Percent CO, 200ppm HC

Parameters	No HEI	HEI=50%	HEI=25%
Percent of Vehicles that Pass Rapid Screen Test	71%	60%	34%
Percent of Emissions Fails That Pass Rapid Screen	21.4%	9.6%	1.5%

Source: de la Torre Klausmeier Consulting, Inc analysis of AIR and Rapid Screen Program data.

So far we have assumed a continuation of the Rapid Screen requirement of two observations. It is also possible to run the Rapid Screen Program requiring only one observation. A single Rapid Screen observation (in conjunction with an HEI) could provide the about same accuracy as two observations (with an HEI) while greatly increasing program coverage. With a 50 percent HEI, for example, the percentage of IM240 failures that would pass Rapid Screen increases slightly from 9.6 percent for the 2-observation scenario to 12 percent for the 1-observation scenario (Table D-6). This approach would greatly expand the potential number of vehicles passing the Rapid Screen test. Potential coverage is discussed later.

Table D-6 -- Impact of Including a High-Emitter Index (HEI) in the Determination of Rapid Screen Candidates – One RSD Observation Within One Year, Clean Screen Cutpoint: 0.5 Percent CO, 200ppm HC, Sample Size: 127,000

Parameters	No HEI	HEI=50%	HEI=25%
Percent of Vehicles That Pass Rapid Screen Test	82%	63%	34%
Percent of Emissions Fails That Pass Rapid Screen	40%	12%	2.0%

Source: de la Torre Klausmeier Consulting, Inc analysis of AIR and Rapid Screen Program data.

How effective is Rapid Screen in identifying high-emitters?

In light of HB1302 we also looked at how effective Rapid Screen is in identifying high-emitters. This process is termed "Dirty Screen". We 1st looked at three different sets of pollution "cutpoints" at which a vehicle would fail a Rapid Screen exam. See Table D-7. For each of these sets we estimated:

- Percent of vehicles identified as high-emitters by Rapid Screen (percent Fail Rapid Screen). This percentage only applies to the vehicles that receive Rapid Screen tests.
- The percent of vehicles failing the IM240 test that would fail the Rapid Screen test (percent of IM240 failures identified). This percentage only applies to the vehicles that receive Rapid Screen tests. The overall percentage of IM240 fails identified equals the percent of vehicles that receive Rapid Screen tests times this percentage. For example, if 10 percent of the fleet receives Rapid Screen tests and the test identifies 40 percent of the IM240 failures, then 4 percent of the IM240 failures are identified.
- The percent of those vehicles failing the Rapid Screen test that would pass a subsequent IM240 test (percent false failures).

We found that the cutpoints (1/300/200) at which Rapid Screen would find the most high-emitters (37 percent of the vehicles receiving two Rapid Screen tests) would also be the same cutpoints having the most false failures (82 percent). At the cutpoints (5/1000/5000) where Rapid Screen would cause the fewest false failures (54 percent) would also be where Rapid Screen would detect a very low percent of high-emitters (6 percent). There is not a set of cutpoints at which Rapid Screen can find a majority of high-emitters without at the same time falsely failing a majority of the vehicles.

Table D-7 -- Effectiveness of RSD Tests in Identifying High-emitters: Two RSD Observations, Both Observations Must Exceed Cutpoints

	RSD Cutpoints (Percent CO/ppmHC/ppmNOx)		
Evaluation Criteria	**1/300/2000**	**3/500/3000**	**5/1000/5000**
Percent Fail Rapid Screen	4.4%	1.32%	0.3%
Percent of IM240 Fails Identified	37.1%	16.14%	6.3%
Percent of False Failures	82.2%	73.9%	54.2%

Source: de la Torre Klausmeier Consulting, Inc analysis of AIR and Rapid Screen Program data.

Second, we looked at using a high-emitter index (HEI). As previously noted, an HEI was helpful in the case of identifying clean vehicles. Unfortunately it does not greatly help us find high-emitters. Table D-8 shows that the percentages of false failures do not decrease significantly as different levels of HEI are utilized.

Table D-8 -- Effectiveness of RSD Tests in Identifying High-emitters: Two RSD Observations, Both Observations Must Exceed Cutpoints;

Sample Size: 29,442

	RSD Cutpoints (Percent CO/ppmHC/ppmNOx)		
Evaluation Criteria	**1/300/2000**	**3/500/3000**	**5/1000/5000**
No HEI Cutpoint			
Percent Fail Rapid Screen	4.4%	1.32%	0.3%
Percent of IM240 Fails Identified	37.1%	16.14%	6.3%
Percent False failures	82.2%	73.9%	54.2%
HEI Cutpoint=50%			
Percent Fail Rapid Screen	3.21%	1.05%	0.24%
Percent of IM240 Fails Identified	31.80%	14.66%	5.27%
Percent False Failures	78.8%	70.2%	53.6%
HEI Cutpoint=75%			
Percent Fail Rapid Screen	1.6%	0.6%	0.13%
Percent of IM240 Fails Identified	19.4%	9.9%	3.29%
Percent False Failures	73.4%	65.5%	47.4%

Source: de la Torre Klausmeier Consulting, Inc analysis of AIR and Rapid Screen Program data.

Finally, we looked at the scenario of using one Rapid Screen observation instead of two. This scenario will cover a much larger fraction of the vehicle fleet and identify considerably more high-emitters. But, as Table D-9 indicates, the percentages of false failures increase under this scenario.

Table D-9 -- Effectiveness of RSD Tests in Identifying High-emitters: One RSD Observation, Sample Size: 127,000

	RSD Cutpoints (Percent CO/ppmHC/ppmNOx)		
Evaluation Criteria	**1/300/2000**	**3/500/3000**	**5/1000/5000**
No HEI Cutpoint			
Percent Fail RSD Criteria	14.35%	5.73%	1.60%
Percent of AIR Exhaust Fails Identified	56.14%	30.99%	13.42%
Percent False Failures	89.73%	85.80%	77.99%
HEI Cutpoint=50%			
Percent Fail RSD Criteria	8.88%	3.87%	1.17%
Percent of AIR Exhaust Fails Identified	49.37%	27.89%	12.30%
Percent False Failures	85.41%	81.06%	72.38%
HEI Cutpoint=75%			
Percent Fail RSD Criteria	4.11%	2.00%	0.68%
Percent of AIR Exhaust Fails Identified	31.95%	19.04%	8.42%
Percent False Failures	79.58%	74.95%	67.33%

Source: de la Torre Klausmeier Consulting, Inc analysis of AIR and Rapid Screen Program data.

The results on Tables 8 and 9 apply only to exhaust emissions. If Rapid Screen was the only method used to identify high-emitters, most of the evaporative emissions benefits of the AIR Program would be loss, since Rapid Screen does not preferentially find vehicles with high evaporative emissions. Evaporative emissions currently account for 23 percent of the HC benefits of the AIR Program.

Number of Vehicles Receiving At Least Two Rapid Screen Tests

In 2005, ESP conducted a total of 1.5 million Rapid Screen emissions observations. A total of 150,650 vehicles subject to the AIR Program received 2 or more observations in 2005. However, when all the Rapid Screen criteria are applied we found that only 39,000 vehicles were eligible for Rapid Screen testing. This equates to less than 5 percent of the number of vehicles that receive traditional emissions tests in the AIR Program. Currently, to be eligible for a Rapid Screen evaluation, vehicles must receive two valid Rapid Screen observations within 10 months of being sent their registration notices.

Following is an analysis of how 1.5 million observations led to only 39,000 valid tests:

- Overall, 1,481,759 valid observations[4] were made. Out of these observations, 1,206,025 observations (81 percent) were matched with the registration database. These tests were on 646,734 unique vehicles.
- Of the unique vehicles tested, 436,239 vehicles were more than four years old and thus subject to the AIR Program (if they were registered in the DMA).

[4] A valid observation is one that meets appropriate quality control criteria for the emissions measurements and includes valid speed and acceleration readings along with a readable plate.

- Out of the 436,239 vehicles more than 4 years old, 374,244 vehicles were registered in DMA counties (numbers 1, 7, 10, 11, 12, 47, 64). This equates to about 21 percent of the vehicles that were subject to AIR Program tests.
- Two or more valid observations were made on 150,650 vehicles that were registered in DMA counties. This equates to about 8 percent of the vehicle population subject to the AIR Program.
- Both observations were on separate days: 135,000.
- Both observations were taken when the vehicle was accelerating: 131,000.
- Assuming that 42 percent are within 10 months of AIR test date, 55,000 vehicles qualify to be evaluated.
- Other screening criteria reduce this value to 39,000 eligible vehicles.

Of the 39,000 vehicles eligible for Rapid Screen evaluation, 70 percent or approximately 27,000 vehicles passed the Rapid Screen clean screen test and were sent notices that they did not need get a traditional emissions test. About 16,000 vehicle owners (59 percent of the 27,000) took advantage of accepting the Rapid Screen results without going in for a traditional emissions test.

Six RSD vans were used in 2005. A rough estimate of the cost for remote sensing is $260,000 per van-year. This cost includes tag editing and matching with the vehicle registration database. At this cost, Rapid Screen cost ESP $1,550,000 in 2005. Based on the above costs and number of RSD notices redeemed in 2005, it costs $99 per Rapid Screened vehicle.

In 2006, ESP expanded the number of testing vans from 6 to 9 thereby increasing coverage. ESP reports that in March 2006, 8 percent of the vehicles were eligible for evaluation in the first 5 months of 2006; 6 percent qualified for clean screen and were sent notices.

If dirty screen criteria were applied to the 39,000 vehicles that received two observations in 2005, we estimate that at most 2 percent of the IM240 failures would be identified. Loosening the restrictions on the eligibility requirements for Rapid Screen tests could double the percentage of IM240 failures identified to about 4 percent. Increases in coverage will proportionally increase the number of high-emitters identified. Based on Rapid Screen tests conducted in 2006, up to 6 percent of the vehicles that would fail an IM240 test will be identified under a 2-hit scenario.

The RSD units are capturing expected numbers of vehicles. Following is a breakdown of number of valid observations by RSD unit.

Table D-10 – Number of RSD Observations by Test Unit

V_RSD_UNIT	Valid Observations
01034010	153,878
02024010	20,888
03034011	168,723
03034013	278,911
06034015	223,150
06034016	86,247
06034017	2,360
08024008	401,113

Source: de la Torre Klausmeier Consulting, Inc analysis of AIR and Rapid Screen Program data.

RSD units are focusing on the counties of interest. In 2005, about 90 percent of the observations were on vehicles registered in the counties of interest.

Number of Vehicles Receiving At Least One Rapid Screen Tests

Relying on one RSD observation (hit) instead of two observations will greatly expand the number of vehicles eligible for Rapid Screen tests. In 2005, there were 2.5 times as many vehicles that had one or more Rapid Screen observations than had two or more (374,244 vs. 150,650).

As noted above, using a High-emitter Index (HEI) in conjunction with a single Rapid Screen observation provides better clean screen accuracy than the current criteria provides with two Rapid Screen observations. This approach would greatly expand the potential number of vehicles passing the Rapid Screen test. Based on data collected in 2005, this approach is estimated to reduce inconvenience costs by $1,100,000. Using coverage estimates based on 2006 data, inconvenience costs are reduced by over $1,500,000.

Concerning dirty screen, if the State can live with the high false fail rates (based on confirmatory IM240 tests) that are associated with single hit scenarios, a single hit scenario will identify a lot more high-emitters. If dirty screen criteria were applied to the 374,000 vehicles that received one observation in 2005, we estimate that up to 18 percent of the IM240 failures would have been identified. Based on Rapid Screen tests conducted in 2006, up to 27 percent of the vehicles that would fail an IM240 test could be identified under a 1-hit scenario. However, under this scenario, approximately 90 percent of the vehicles identified as high-emitters would pass an IM240 test. Also, as mentioned before, the evaporative emissions benefits would be reduced in proportion to percent of the fleet that's identified by Rapid Screen as being high-emitters. The minimum negative impact would a 94 percent reduction in evaporative emissions benefits. Overall, the maximum Rapid Screen effectiveness scenario (based on 2006 data) would reduce AIR program HC benefits by 79 percent.

Cost Effectiveness of Using RSD to Identify High-emitters

dKC evaluated the cost-effectiveness of using Rapid Screen to identify high-emitters (Table D-11). Again, using data from 2005, dKC projected the total number of high-emitters that would be identified under two different scenarios as described below.

1. Using one RSD observation in conjunction with stringent RSD cutpoints (1 percent CO/300ppm HC/2000ppm NOx; No HEI cutoff)
2. Using one RSD observation in conjunction with stringent RSD cutpoints (1 percent CO/300ppm HC/2000ppm NOx; HEI=50 percent or higher)
3. Using one RSD observation in conjunction with moderately stringent program cutpoints (3 percent CO/500ppm HC/3000ppm NOx; HEI=50 percent or higher).
4. Using two RSD observations in conjunction with stringent RSD cutpoints (1 percent CO/300ppm HC/2000ppm NOx; HEI=50 percent or higher).
5. Using two RSD observations in conjunction with moderately stringent program cutpoints (3 percent CO/500ppm HC/3000ppm NOx; HEI=50 percent or higher).
6. Using two RSD observations in conjunction with least stringent program cutpoints (5 percent CO/1000ppm HC/5000ppm NOx; No HEI cutoff)

Emission reductions and cost-effectiveness are calculated for two cases: 1) a biennial inspection program where vehicles can only be inspected once every two years, and 2) an annual inspection program where vehicles can only be inspected every year. The biennial scenario assumes that vehicles can only be tested once every two years, so coverage is effectively cut in half.

Table D-11 -- Cost Effectiveness of Using RSD to Identify High-emitters

Parameter	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
Number of Observations	**1**	**1**	**1**	**2**	**2**	**2**
Dirty Screen Cutpoint	1/300/2000	1/300/2000	3/500/3000	1/300/2000	3/500/3000	1/300/2000
HEI Cutpoint	none	50%	50%	50%	50%	none
Cost of Dirty Screen	$1,550,000	$1,550,000	$1,550,000	$1,550,000	$1,550,000	$1,550,000
Number of Vehicles Seen by RSD	374,244	374,244	374,244	150,650	150,650	150,650
Percent Fail Dirty Screen	14.4%	8.9%	3.9%	3.2%	1.1%	4.4%
Number of Fail Dirty Screen	53,891	33,308	14,483	4,821	1,657	6,629
Percent Fail AIR	10%	15%	19%	21%	30%	18%
Number of AIR Fails Identified	5,551	4,860	2,743	1,022	497	1,193
Dollars/AIR Fail Identified by RapidScreen	$279.24	$318.96	$565.05	$1,516.62	$3,117.80	$1,299.08
Percent of AIR Fails Identified -- Annual	17.66%	15.46%	8.73%	3.25%	1.58%	3.80%
Percent of AIR Fails Identified -- Biennial	8.83%	7.73%	4.36%	1.63%	0.79%	1.90%
Number Confirmatory Tests	53,891	33,308	14,483	4,821	1,657	6,629
Confirmatory Test Cost	$1,347,278	$832,693	$362,081	$120,520	$41,429	$165,715
Repair Cost	$1,909,471	$1,671,701	$943,635	$351,571	$171,018	$410,443
Inconvenience costs	$737,986	$456,116	$198,334	$66,016	$22,693	$90,772
Fuel Savings	($527,393)	($461,721)	($260,631)	($97,103)	($47,235)	($113,364)
Total Costs: Annual	$5,017,342	$4,048,789	$2,793,420	$1,991,004	$1,737,905	$2,103,566
Total Costs: Biennial	$3,283,671	$2,799,394	$2,171,710	$1,770,502	$1,643,952	$1,826,783
Emission Reductions Exhaust TPY Annual	494	432	244	91	44	106
Emission Reductions Evap Annual	93.56	57.82	25.14	8.37	2.88	11.51
Total Ozone Reductions TPY Annual	587.17	489.97	269.08	99.25	47.09	117.61
Total Ozone Reductions TPY Biennial	293.58	244.98	134.54	49.63	23.54	58.80
Total Ozone Reductions TPD Annual	1.61	1.34	0.74	0.27	0.13	0.32
Total Ozone Reductions TPD Biennial	0.80	0.67	0.37	0.14	0.06	0.16
Dollars/ton ozone Annual	$8,545.01	$8,263.37	$10,381.41	$20,059.99	$36,909.09	$17,886.02
Dollars/ton ozone Biennial	$11,184.81	$11,426.84	$16,141.80	$35,676.73	$69,827.51	$31,065.22

Source: de la Torre Klausmeier Consulting, Inc analysis of AIR and Rapid Screen Program data.

The overall cost-effectiveness of using Rapid Screen to identify high-emitters according to the above scenarios is between $8,300 and $70,000 per ton of ozone precursors (defined as HC plus CO/60). This compares with the cost effectiveness of the current program of $9,800 per ton. The one hit scenarios are much more cost effective in terms of $/ton of ozone precursors, but they also has the highest false fail rate (see Table D-9), in terms of vehicles that pass AIR after being identified as high-emitters by RSD.

EFFECTIVENESS OF OBD INSPECTIONS

In 2003, Colorado stopped failing vehicles for faults identified by the on-board diagnostic (OBD) system. As part of this audit, we reviewed information on the effectiveness of OBD inspections to determine if Colorado should reconsider its decision to drop OBD inspections.

Most I/M programs in the U.S. look for emissions malfunctions in 1996 and newer vehicles by interrogating the OBDII system, rather than probing the tailpipe for excessive exhaust emissions. In fact, as shown on Table D-12, Colorado is the only major I/M program out of 31 programs that does not require vehicles to pass an OBD inspection.

Table D-12 – Status of OBD Tests in US I/M Programs for Gasoline Powered Vehicles

State	OBD included?	Tailpipe Test: TSI (Two Spd Idle), ASM, IM240, BAR31, Other
AK	yes	TSI
AZ	yes	IM240 (AZ147)
CA	yes	TSI/ASM
CO	**NO**	**TSI/IM240**
CT	yes	ASM
D.C.	yes	IM240
DE	yes	TSI
GA	yes	ASM
IL	yes	IM240
IN	yes	IM240
MA	yes	BAR31
MD	yes	IM240
ME	yes	None-OBD-Only
MO	yes	IM240
NC	yes	None-OBD-Only
NH	yes	None-OBD-Only
NJ	yes	ASM
NV	yes	TSI
NY -- Upstate	yes	None-OBD-Only
NY -- NYC area	yes	IM240
OH	yes	IM240/TSI
OR	yes	BAR31
PA	yes	ASM/TSI
RI	yes	BAR31
TN	yes	TSI

State	OBD included?	Tailpipe Test: TSI (Two Spd Idle), ASM, IM240, BAR31, Other
TX	yes	ASM
UT	yes	ASM,IM240, TSI
VA	yes	ASM
VT	yes	None-OBD-Only
WA	yes	ASM (No NOx)
WI	yes	IM240

Source: de la Torre Klausmeier Consulting, Inc.

Most I/M programs perform the EPA recommended OBD test. EPA guidance states that vehicles fail an OBDII inspection if they have the following conditions:

- MIL does not illuminate during the key on engine off (KOEO); or
- MIL is commanded on by the PCM (on board computer).
- The vehicle has more than two monitors not ready.

Do OBD Tests Identify Vehicles with High Emissions?

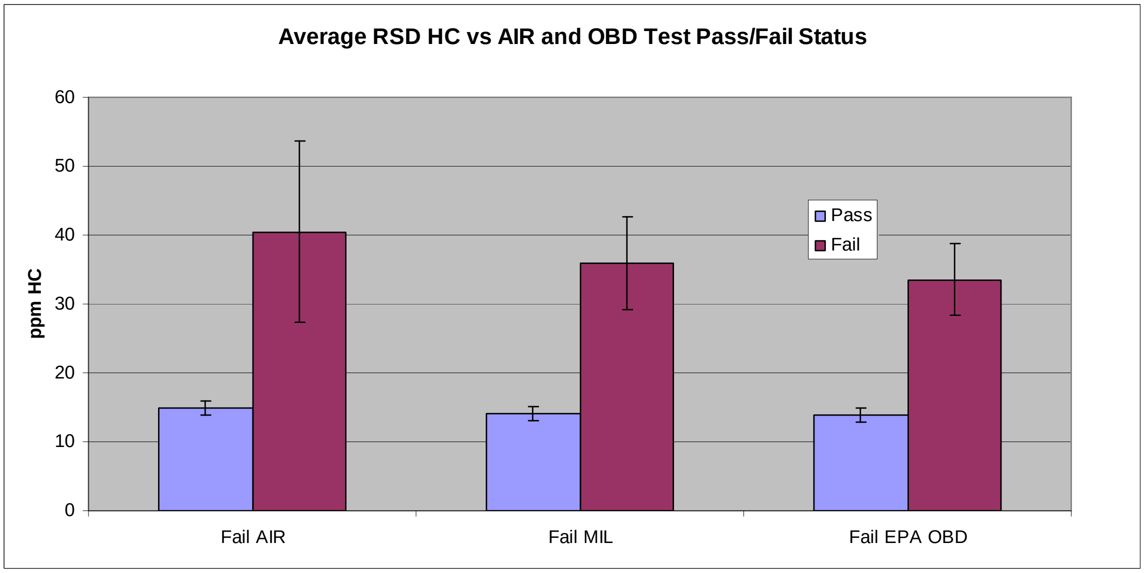
Data from Rapid Screen tests on vehicles that received IM240 and OBD tests were analyzed to determine the effectiveness of OBD tests in identifying vehicles with high emissions. Figure D-20 compares average HC emissions from Rapid Screen tests for the following pass/fail scenarios:

- Pass or Fail Current AIR test.
- MIL-on (fail) vs. MIL-off (pass): Fail if MIL is illuminated regardless of whether or not any monitors are not ready. This is the criterion that Colorado used when it failed cars that had an illuminated MIL.
- Pass or Fail EPA OBD test as described above. (Fail if MIL is on, <u>or</u> more than 2 monitors[5] are not ready.)

As shown, trends are similar for all three scenarios: vehicles failing the AIR test or OBD tests have on average significantly higher HC emissions than those that passing these tests.

[5] EPA recommends a 1 monitor limit for 2001 and later models. This analysis assumes a 2 monitor limit.

Figure D-20



Source: de la Torre Klausmeier Consulting, Inc analysis of AIR and Rapid Screen data.

dKC calculated the fraction of total HC emissions in the sample that were identified by the three test scenarios presented above. We also calculated how much emissions would be reduced if the failures were repaired so that they had average emission levels equal to vehicles passing the test. Results of this analysis are shown on Table D-13. Because the two OBD test scenarios fail a much greater fraction of the vehicle fleet, they identify more HC emissions and have greater projected emission reductions than the current AIR test. As discussed later, OBD tests also are projected to increase costs, due to their greater failure rate.

Table D-13 -- Theoretical Benefits of AIR Tests vs OBD Tests Based on RSD: Sample Size = 65,000

Test Scenario	Percent Fail	Percent of HC	Percent HC Reduction[6]
Fail AIR	1.98%	5.17%	3.26%
Fail MIL	6.41%	14.88%	9.05%
Fail EPA OBD	8.39%	18.21%	10.71%

Source: de la Torre Klausmeier Consulting, Inc analysis of AIR and Rapid Screen data.

Correlation Between IM240 Results and OBDII Results

Although Colorado stopped enforcing compliance with the OBD malfunction indicator light (MIL) check, its inspection contractor (ESP) continued to perform OBDII tests on 1996 and newer vehicles. Using data on IM240 tests matched with OBD results, we

[6] Assumes vehicles that fail are repaired so that there emission levels equal those that pass the inspection.

calculated the percent of IM240 failures and excess IM240 emissions[7] that are identified by the EPA OBD tests. We also calculated the percent of IM240 failures that had any indication that a problem had been identified by the OBD system. We defined a vehicle with an OBD identified problem as one with either a MIL illuminated or an unset readiness monitor. An unset readiness monitor could indicate that MIL had been extinguished by clearing the memory of the on-board computer[8].

The results of our evaluations are set forth in Table D-14. As shown, 58 percent of the IM240 fails will also fail the EPA OBDII test. Note that this 58 percent figure jumps to 80 percent when the "Any OBD Fault" criteria is used. In other words, 80 percent of the IM240 fails have some indicator that the OBD system identified a problem, as indicated by one or more monitors being not ready or the MIL being illuminated. Because the IM240 test is being used as a standard to evaluate the OBDII test, it by definition will always be 100 percent effective in identifying AIR Program failures and excess emissions. It is impossible as a practical matter for OBDII tests to identify 100 percent of the AIR Program failures and excess emissions. In fact, in back-to-back IM240 tests, the second test only identifies 88 percent of the failures according to the first test, as acknowledged by CDPHE in its OBD vs IM240 study:

> ***"False Failure Results from the ESP Inspection Lane***
>
> *The false failure rate, from the ESP inspection lanes, was examined based on Colorado and EPA IM240 cut points. The false failure rate was greater when EPA final cut points were applied. Based on the second chance to pass test at the ESP Inspection lane, seventy-seven of the 97 vehicles that were FTP tested exceeded Colorado IM240 cut points. The false failure rate for these 77 vehicles was 11.7 percent."*

Table D-14. Relationship Between OBDII Test Results and AIR Program Results Based on Matched AIR Test and OBDII Test Data: Sample Size = 256,146

Parameter	Fail EPA OBDII	Fault Identified by OBD[9]
Percent of Sample	8%	15%
Percent of AIR Emissions Fails Identified	58%	80%
Percent of Excess HC Identified	67%	82%
Percent of Excess CO Identified	74%	89%

Source: de la Torre Klausmeier Consulting, Inc analysis of AIR Program data.

[7] Excess emissions are emissions in excess of the IM240 cutpoint.
[8] Readiness status for all monitors is set to "not ready" when fault codes are cleared and the MIL is extinguished by a technician with a scan tool.
[9] MIL-on or any monitor not ready.

How easy is it to cheat an OBDII Test?

I/M program managers have been concerned about motorists finding ways to get a vehicle that should fail an OBDII test to pass. Ways of cheating OBDII tests are listed below:

- OBDII Cheater Devices**:** Officials in Colorado and California have expressed concerns about devices that can allow a vehicle with a catalyst fault to pass an OBDII inspection. Devices are available on the Internet that can help some vehicles pass inspections by simulating rear oxygen sensor voltages of vehicles with good catalysts thereby masking catalyst faults. Catalyst faults currently make up approximately six percent of all OBDII detected faults and can have substantial emission consequences if proper repair is avoided. The scope and impact of these devices is not precisely known. Most I/M experts believe that the current impact of these devices is negligible, but their use could expand as the OBDII fleet ages.

- Code Clearing**:** Code clearing refers to the process of extinguishing illuminated MILs by clearing codes. This process sets all readiness monitors to not ready. Code clearing can allow some vehicles with emission malfunctions to slip through OBDII programs without being fixed. Most I/M programs allow vehicles to pass if they have no more than two monitors not ready. A vehicle can pass after clearing codes if it sets all but two monitors to ready before the fault is redetected and MIL is illuminated. Programs can tighten this "loop-hole" by requiring vehicles that come back after repair for certain problems to have the monitors that identified the problem set. For example, vehicles that fail for catalyst problems, as indicated by a catalyst DTC stored, must have the catalyst monitor ready on retests.

- Clean scanning**:** A third potential method of cheating is to substitute a fault free vehicle for the vehicle being inspected. This problem has been effectively addressed by other states by collecting and monitoring OBDII System parameters, to assure that the vehicle that should be tested is in fact being tested.

Evaluation of OBDII Inspection – Costs and Benefits

In order to determine the costs and benefits of an OBDII program, we examined two different ways in which an OBD inspection could be integrated in the current AIR inspection. We investigated the following two OBDII inspection options, representing a range of the possibilities available to the State:

1. Perform EPA's current OBDII test procedure: Vehicles fail if their MIL is on or if more than 2 monitors are not ready. Although we assumed these inspections would be done at existing facilities, this scenario also could be done at decentralized facilities.

2. Hybrid OBDII/Tailpipe Test Option (Centralized Facilities Only)**:** The State has several possible methods available to increase HC emission reductions and improve motorists' convenience at the centralized test sites currently operated by ESP. The following testing scenario for 1996 and newer vehicles has the

potential to significantly increase the emission benefits from inspections at centralized test sites.

a. Conduct an OBDII test and immediately pass vehicles that have no indication of a possible OBDII related fault.

b. Immediately fail the vehicle if the MIL is on and the vehicle has DTCs associated with significant HC or CO emissions impact.

c. Conduct an IM240 test on vehicles that do not fail the above criteria but have some indication of an OBDII system fault as indicated by the MIL being on for other DTCs and/or onset readiness monitors.

Table D-15 presents the advantages and disadvantages of these scenarios.

Table D-15 – Advantages and Disadvantages of OBDII Implementation Options

Option	Advantages	Disadvantages
1. Perform EPA's current OBDII test procedure	Gets greater emission reductions than IM240 tests on 1996+ vehicles. Lower cost and more convenient inspections than IM240	Much greater repair costs than IM240 (although more likely to be covered by warranty).
2. Hybrid OBDII/Tailpipe Test Option	Gets greater emission reductions than IM240 tests on 1996+ vehicles. Lower cost inspections than IM240 Lower repair costs than Option 1.	Only works at current facilities. Complicated to explain to motorists.

Source: de la Torre Klausmeier Consulting, Inc.

Note: The OBDII alternative would require changes to Colorado statutes.

Emission Reductions for OBDII Implementation options

Data from RSD tests indicate that OBDII tests have the potential to result in more HC emission reductions than can be achieved by the current IM240 tests. A simple way to evaluate OBDII versus IM240 results is to calculate the emission reductions if all failing vehicles after repair emit at the rate of passing vehicles. Table D-16 shows a comparison of the current AIR Program with the two OBDII options based upon data from RSD. As shown, the two OBDII options increase the benefits of the AIR Program in reducing emissions of ozone precursors by 1.1 to 2 tons per day.

Table D-16 – Theoretical HC and CO Emission Reductions Based on RSD of OBDII vs. AIR Program Tests on 1996 and Newer Vehicles – Assumes Failing Vehicles are Repaired to Equal Passing Vehicle Emission Rate, Sample Size = 64,645

Option	Percent Fail	Percent HC Reduction: 1996+	Percent CO Reduction: 1996+	TPD Ozone (HC+CO/60): 1996+
Current AIR Program	2.19%	3.67%	2.06%	4.2
OBD Option 1: EPA OBD Test	8.15%	10.00%	5.99%	6.2
OBD Option 2: Hybrid: Fail for Specific DTCs + OBD Clean Screen for IM240 Test	4.18%	7.11%	3.77%	5.3

Source: de la Torre Klausmeier Consulting, Inc analysis of AIR and Rapid Screen data.

Costs of OBDII vs. AIR Program Tests

Table D-17 shows the cost and cost effectiveness of the three OBDII inspection options.

Table D-17 -- Costs Effectiveness of OBD Scenarios

Parameter	OBD Scenario 1	OBD Scenario 2	Current AIR Program -- No OBD
Inspection Fees AIR -- 1996+	$13,138,075	$13,138,075	$13,138,075
Inspection Fees with OBD – 1996+	$7,882,845	$8,676,385	NA
Number Fail OBD	42,830	21,967	11,080
OBD Repair Costs	$14,733,563	$7,556,600	NA
Current Repair Cost for 1996+	$1,198,664	$1,198,664	$1,198,664
Repair Cost Increase	$13,534,899	$6,357,936	NA
Inspection Fee Decrease	**$5,255,230**	**$4,461,690**	NA
Overall cost impact	$8,279,669	$1,896,246	NA
Cost for current AIR Program	$42,504,609	$42,504,609	$42,504,609
Cost for current program + OBD	$50,784,278	$44,400,855	NA
Emission Reductions with OBD (TPY Ozone)	4,931	4,661	4,341
Dollars/ton	$10,299	$9,525	$9,792
Source: de la Torre Klausmeier Consulting, Inc analysis of AIR and Rapid Screen data.			

Inspection costs**:** OBDII tests should cost much less than IM240 tests because the test can be done quickly. Table D-17 shows inspection costs projected for the two different OBDII scenarios. The two OBDII scenarios reduce inspection costs by $4 million to $5 million per year. This is based upon the number of tests performed in 2005. This number would increase rapidly as more OBDII vehicles are tested. These savings assume the State can negotiated a fee decrease of $10/test, if OBDII instead of IM240 tests are performed on most 1996 and newer vehicles. This assumption takes into account the fact that ESP currently charges $15 for the idle test instead of the $25 for the IM240 test. The costs associated with the OBDII are closer to those involved in the idle test.

Repair Costs**:** Table D-17 shows the projection of repair costs for the three scenarios. Since failure rates will increase from 2 percent to 8 percent by changing to an EPA OBDII test, repair costs increase significantly. Assuming $344 per OBDII failure (the same cost as IM240[10]), repair costs increase by about $13,000,000. Adopting the EPA OBDII scenario (option 1) increases costs of the AIR Program by 19 percent. The other OBDII scenario also increase repair costs relative to the current AIR Program, but the overall program costs increase by only 5 percent, because of the significant reduction in inspection costs.

Motorist Inconvenience**:** OBDII tests can be performed in centralized or decentralized facilities with equal effectiveness. Travel time to inspection stations could drop if an expanded decentralized inspection network were used. The scenarios evaluated assume that tests will continue to be done at existing centralized facilities, so there is little impact on motorist inconvenience costs. (Colorado may well wish to explore the feasibility of having these tests done at decentralized facilities in the foreseeable future.)

Cost-Effectiveness of OBDII Inspections: The cost-effectiveness of OBDII inspections are projected based upon estimates of total program costs and emission benefits for the different AIR Program scenarios with OBDII inspections. OBDII Scenario One increases costs by 19 percent, while emissions benefits increase by 15 percent. Therefore, this scenario increases the cost per ton to $10,300. OBDII Scenario Two increases costs by 4 percent, while they increase emissions benefits by 7 percent, so cost per ton drops to $9,500.

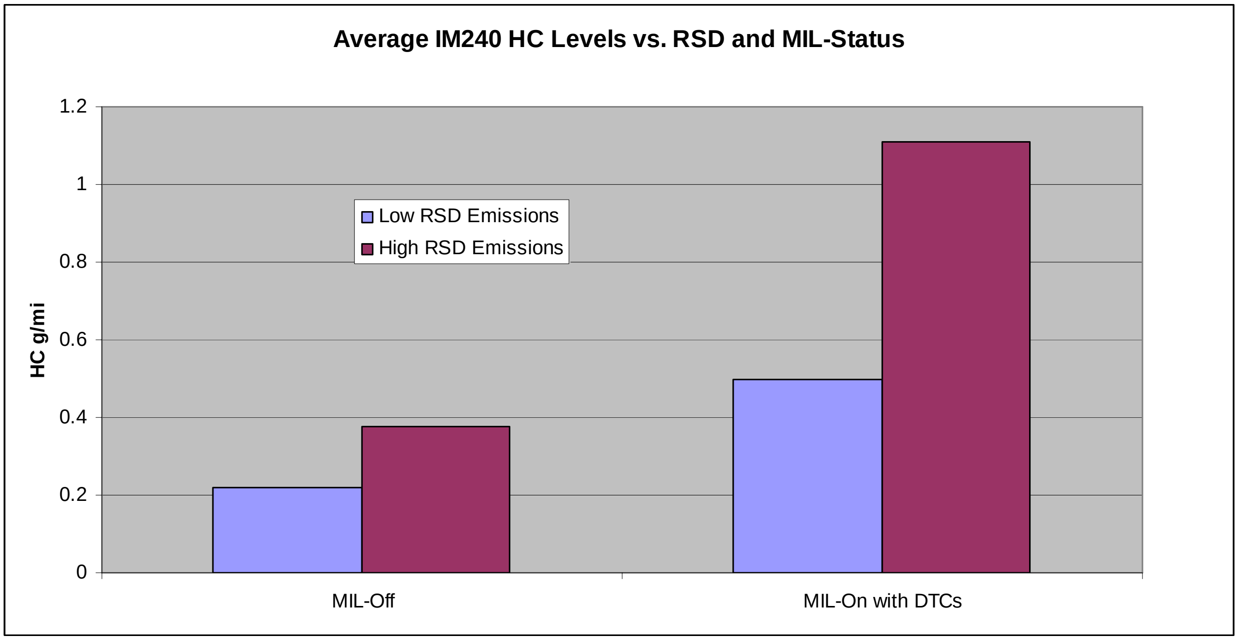
Rapid Screen and OBD

Tables are presented at the end of this Appendix showing Rapid Screen effectiveness with regard to clean screening vehicles with OBD faults. We found that 66 percent of the vehicles with MILs on would pass a Rapid Screen clean screen test. In addition, the most stringent remote sensing device (RSD) dirty screen criteria only identifies 5 percent of the vehicles with MILs on. Rapid Screen may be sending the wrong message to motorists by telling them that it's OK to ignore illuminated MILs.

In the Repair Your Air Campaign, owners of some vehicles with high emissions as measured by RSD are sent notices offering free repairs. Officials may want to expand the program to include vehicles that had illuminated MILs (as determined by last AIR inspection) and high RSD levels. As shown on Figure D-21, vehicles with high RSD emission levels and illuminated MILs have much higher IM240 emission levels than vehicles with high RSD emission levels without illuminated MILs. Motorists may be more likely to respond to notices for free repairs if their MIL were on, since they know their vehicle has a problem.

[10] The average repair cost in EPA and state cost studies for OBD repairs has been around $300. (reference EPA's high mileage study.)

Figure D-21



Source: de la Torre Klausmeier Consulting, Inc analysis of AIR and Rapid Screen data.

OUTPUTS OF RAPID SCREEN CLEAN SCREEN AND DIRTY SCREEN MODELS (Source: de la Torre Klausmeier analysis of AIR and Rapid Screen data)

For Clean Screen, Rapid Screen readings must be below cutpoints.

Rapid Screen Clean Screen Summary -- One Hit + High-Emitter Index

Cutpoints	CO	HC	NOx	HEI	Accel
	0.5	200	9,999	100%	0

Number of Rapid Screen Candidates	103,335
Percent Rapid Screen Candidates	82%
Number of Fail Emissions	3,324
Number of Fail Emissions/Pass Rapid Screen	1,315
Percent of Emissions Fails that Pass Rapid Screen	39.6%
Percent of Rapid Screen Candidates that Fail Emissions	1.3%

Cutpoints	CO	HC	NOx	HEI	Accel
	0.5	200	9,999	50%	0

Number of Rapid Screen Candidates	80,390
Percent Rapid Screen Candidates	63%
Number of Fail Emissions	3,324
Number of Fail Emissions/Pass Rapid Screen	402
Percent of Emissions Fails that Pass Rapid Screen	12.1%
Percent of Rapid Screen Candidates that Fail Emissions	0.5%

Cutpoints	CO	HC	NOx	HEI	Accel
	0.5	200	9,999	25%	0

Number of Rapid Screen Candidates	42,976
Percent Rapid Screen Candidates	34%
Number of Fail Emissions	3,324
Number of Fail Emissions/Pass Rapid Screen	69
Percent of Emissions Fails that Pass Rapid Screen	2.1%
Percent of Rapid Screen Candidates that Fail Emissions	0.2%

Rapid Screen Clean Screen Summary -- Two Hit + High-Emitter Index

Cutpoints	CO	HC	NOx	HEI	Accel
	0.5	200	9,999	100%	0

Number of Rapid Screen Candidates	17,032
Percent Rapid Screen Candidates	71.3%
Number of Fail Emissions	607
Number of Fail Emissions/Pass Rapid Screen	130
Percent of Emissions Fails that Pass Rapid Screen	21.4%
Percent of Rapid Screen Candidates that Fail Emissions	0.8%

Cutpoints	CO	HC	NOx	HEI	Accel
	0.5	200	9,999	50%	0

Number of Rapid Screen Candidates	14,264
Percent Rapid Screen Candidates	59.7%
Number of Fail Emissions	607
Number of Fail Emissions/Pass Rapid Screen	58
Percent of Emissions Fails that Pass Rapid Screen	9.6%
Percent of Rapid Screen Candidates that Fail Emissions	0.4%

Cutpoints	CO	HC	NOx	HEI	Accel
	0.5	200	9,999	25%	0

Number of Rapid Screen Candidates	8,218
Percent Rapid Screen Candidates	34.4%
Number of Fail Emissions	607
Number of Fail Emissions/Pass Rapid Screen	9
Percent of Emissions Fails that Pass Rapid Screen	1.5%
Percent of Rapid Screen Candidates that Fail Emissions	0.1%

Rapid Screen Dirty Screen Summary
One Hit + High-Emitter Index

For Dirty Screen, Rapid Screen readings must be above cutpoints.

Most Stringent Cutpoints	CO	HC	NOx	HEI	Accel
	1	300	2,000	0%	0

Number of Rapid Screen Fails	18,174
Percent Rapid Screen Fails	14%
Number of Fail Emissions	3324
Number of Fail Emissions/Fail Rapid Screen	1,866
Percent of Emissions Fails that Fail Rapid Screen	56%
Percent of Rapid Screen Candidates that Fail Emissions	10%

Cutpoints	CO	HC	NOx	HEI	Accel
	1	300	2,000	50%	0

Number of Rapid Screen Fails	11,245
Percent Rapid Screen Fails	9%
Number of Fail Emissions	3,324
Number of Fail Emissions/Fail Rapid Screen	1,641
Percent of Emissions Fails that Fail Rapid Screen	49%
Percent of Rapid Screen Candidates that Fail Emissions	15%

Cutpoints	CO	HC	NOx	HEI	Accel
	1	300	2,000	75%	0

Number of Rapid Screen Fails	5,202
Percent Rapid Screen Fails	4%
Number of Fail Emissions	3,324
Number of Fail Emissions/Fail Rapid Screen	1,062
Percent of Emissions Fails that Fail Rapid Screen	32%
Percent of Rapid Screen Candidates that Fail Emissions	20%

Rapid Screen Dirty Screen Summary
One Hit + High-emitter Index

Moderately Stringent Cutpoints

CO	HC	NOx	HEI	Accel
3	500	3,000	0%	0

Number of Rapid Screen Fails	7,254
Percent Rapid Screen Fails	6%
Number of Fail Emissions	3,324
Number of Fail Emissions/Fail Rapid Screen	1,030
Percent of Emissions Fails that Fail Rapid Screen	31%
Percent of Rapid Screen Candidates that Fail Emissions	14%

Cutpoints

CO	HC	NOx	HEI	Accel
3	500	3,000	50%	0

Number of Rapid Screen Fails	4,894
Percent Rapid Screen Fails	4%
Number of Fail Emissions	3,324
Fail Emissions/Fail Rapid Screen	927
Percent of Emissions Fails that Fail Rapid Screen	28%
Percent of Rapid Screen Candidates that Fail Emissions	19%

Cutpoints

CO	HC	NOx	HEI	Accel
3	500	3,000	75%	0

Number of Rapid Screen Fails	2,527
Percent Rapid Screen Fails	2%
Number of Fail Emissions	3,324
Number of Fail Emissions/Fail Rapid Screen	633
Percent of Emissions Fails that Fail Rapid Screen	19%
Percent of Rapid Screen Candidates that Fail Emissions	25%

Rapid Screen Dirty Screen Summary
One Hit + High-emitter Index

Least Stringent Cutpoints

CO	HC	NOx	HEI	Accel
5	1,000	5,000	0%	0

Number of Rapid Screen Fails	2,026
Percent Rapid Screen Fails	2%
Number of Fail Emissions	3,324
Number of Fail Emissions/Fail Rapid Screen	446
Percent of Emissions Fails that Fail Rapid Screen	13%
Percent of Rapid Screen Candidates that Fail Emissions	22%

Cutpoints

CO	HC	NOx	HEI	Accel
5	1,000	5,000	50%	0

Number of Rapid Screen Fails	1,481
Percent Rapid Screen Fails	1%
Number of Fail Emissions	3,324
Number of Fail Emissions/Fail Rapid Screen	409
Percent of Emissions Fails that Fail Rapid Screen	12%
Percent of Rapid Screen Candidates that Fail Emissions	28%

Cutpoints

CO	HC	NOx	HEI	Accel
5	1,000	5,000	75%	0

Number of Rapid Screen Fails	857
Percent Rapid Screen Fails	1%
Number of Fail Emissions	3,324
Number of Fail Emissions/Fail Rapid Screen	280
Percent of Emissions Fails that Fail Rapid Screen	8%
Percent of Rapid Screen Candidates that Fail Emissions	33%

Rapid Screen Dirty Screen Summary -- Two Hit + High-emitter Index

Most Stringent Cutpoints	CO	HC	NOx	HEI	Accel
	1	300	2,000	0%	0

Number of Rapid Screen Fails	1,263
Percent Rapid Screen Fails	4.4%
Number of Fail Emissions	607
Number of Fail Emissions/Fail Rapid Screen	225
Percent of Emissions Fails that Fail Rapid Screen	37.1%
Percent of Rapid Screen Candidates that Fail Emissions	17.8%

Cutpoints	CO	HC	NOx	HEI	Accel
	1	300	2,000	50%	0

Number of Rapid Screen Fails	910
Percent Rapid Screen Fails	3.2%
Number of Fail Emissions	607
Number of Fail Emissions/Fail Rapid Screen	193
Percent of Emissions Fails that Fail Rapid Screen	31.8%
Percent of Rapid Screen Candidates that Fail Emissions	21.2%

Cutpoints	CO	HC	NOx	HEI	Accel
	1	300	2,000	75%	0

Number of Rapid Screen Fails	443
Percent Rapid Screen Fails	1.6%
Number of Fail Emissions	607
Number of Fail Emissions/Fail Rapid Screen	118
Percent of Emissions Fails that Fail Rapid Screen	19.4%
Percent of Rapid Screen Candidates that Fail Emissions	26.6%

Rapid Screen Dirty Screen Summary -- Two Hit + High-emitter Index

Moderately Stringent Cutpoints	CO	HC	NOx	HEI	Accel
	3	500	3,000	0%	0

Number of Rapid Screen Fails	376
Percent Rapid Screen Fails	1.3%
Number of Fail Emissions	607
Number of Fail Emissions/Fail Rapid Screen	98
Percent of Emissions Fails that Fail Rapid Screen	16.1%
Percent of Rapid Screen Candidates that Fail Emissions	26.1%

Cutpoints	CO	HC	NOx	HEI	Accel
	3	500	3,000	50%	0

Number of Rapid Screen Fails	299
Percent Rapid Screen Fails	1.1%
Number of Fail Emissions	607
Number of Fail Emissions/Fail Rapid Screen	89
Percent of Emissions Fails that Fail Rapid Screen	14.7%
Percent of Rapid Screen Candidates that Fail Emissions	29.8%

Cutpoints	CO	HC	NOx	HEI	Accel
	3	500	3,000	75%	0

Number of Rapid Screen Fails	174
Percent Rapid Screen Fails	0.6%
Number of Fail Emissions	607
Number of Fail Emissions/Fail Rapid Screen	60
Percent of Emissions Fails that Fail Rapid Screen	9.9%
Percent of Rapid Screen Candidates that Fail Emissions	34.5%

Rapid Screen Dirty Screen Summary -- Two Hit + High-emitter Index

Least Stringent Cutpoints	CO	HC	NOx	HEI	Accel
	5	1,000	5,000	0%	0

Number of Rapid Screen Fails	83
Percent Rapid Screen Fails	0.3%
Number of Fail Emissions	607
Number of Fail Emissions/Fail Rapid Screen	38
Percent of Emissions Fails that Fail Rapid Screen	6.3%
Percent of Rapid Screen Candidates that Fail Emissions	45.8%

Cutpoints	CO	HC	NOx	HEI	Accel
	5	1,000	5,000	50%	0

Number of Rapid Screen Fails	69
Percent Rapid Screen Fails	0.2%
Number of Fail Emissions	607
Number of Fail Emissions/Fail Rapid Screen	32
Percent of Emissions Fails that Fail Rapid Screen	5.3%
Percent of Rapid Screen Candidates that Fail Emissions	46.4%

Cutpoints	CO	HC	NOx	HEI	Accel
	5	1,000	5,000	75%	0

Number of Rapid Screen Fails	38
Percent Rapid Screen Fails	0.1%
Number of Fail Emissions	607
Number of Fail Emissions/Fail Rapid Screen	20
Percent of Emissions Fails that Fail Rapid Screen	3.3%
Percent of Rapid Screen Candidates that Fail Emissions	52.6%

Two RSD Hits: Impact on IM240 and OBD

Rapid Screen Clean Screen Summary: OBD and IM240

Cutpoints	CO	HC	NOx	Accel
	0.5	200	9,999	0

Number of Rapid Screen Candidates	14,675
Percent Rapid Screen Candidates	79.53%
Number of Fail Emissions	122
Number of Fail Emissions/Pass Rapid Screen	47
Number of Fail MIL	1,249
Number of Fail MIL Pass Rapid Screen	827
Percent of Emissions Fails that Pass Rapid Screen	38.52%
Percent of Rapid Screen Candidates that Fail Emissions	0.32%
Percent of MIL Fails that Pass Rapid Screen	66.21%
Percent of Rapid Screen Candidates that Fail MIL	5.64%

Rapid Screen Dirty Screen Summary: OBD and IM240

Most Stringent Cutpoints	CO	HC	NOx	Accel
	1	300	2,000	0

Number of Rapid Screen Fails	315
Percent Rapid Screen Fails	1.71%
Number of Fail Emissions	122
Number of Fail Emissions/Fail Rapid Screen	30
Number of Fail MIL	1,249
Number of Fail MIL Fail Rapid Screen	60
Percent of Emissions Fails that Fail Rapid Screen	24.59%
Percent of Rapid Screen Candidates that Fail Emissions	9.52%
Percent of MIL Fails that Fail Rapid Screen	4.80%
Percent of Rapid Screen Fails that Fail MIL	19.05%

Rapid Screen Dirty Screen Summary: OBD and IM240

Moderately Stringent Cutpoints	CO	HC	NOx	Accel
	3	500	3,000	0

Number of Rapid Screen Fails	76
Percent Rapid Screen Fails	0.41%
Number of Fail Emissions	122
Number of Fail Emissions/Fail Rapid Screen	13
Number of Fail MIL	1,249
Number of Fail MIL Fail Rapid Screen	15
Percent of Emissions Fails that Fail Rapid Screen	10.66%
Percent of Rapid Screen Candidates that Fail Emissions	17.11%
Percent of MIL Fails that Fail Rapid Screen	1.20%
Percent of Rapid Screen Fails that Fail MIL	19.74%

References

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