

State of California  
California Environmental Protection Agency

AIR RESOURCES BOARD

Mobile Source Emission Reduction Credits

Guidelines for the Generation and Use of  
Mobile Source Emission Reduction Credits

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# Mobile Source Emission Reduction Credits

## SUMMARY

In California, mobile sources<sup>1</sup> account for about 60 percent of all ozone forming emissions<sup>2</sup> and for over 90 percent of all carbon monoxide (CO) emissions from all sources. To reduce these pollutants, California has developed the nation's most extensive and stringent mobile source emission controls and fuels programs. As a result of these programs, emissions will be significantly reduced. However, opportunities do exist to further reduce emissions from mobile sources. The public, industry, and regulatory agencies have expressed considerable interest in such reductions. The suggested uses of these reductions include offsetting the increases in emissions associated with economic growth, using reductions from mobile sources in lieu of obtaining emission reductions from industrial sources, and using reductions to improve California's air quality.

In July 1992, the Air Resources Board (ARB/Board) staff released a paper entitled "Mobile Source Emission Reduction Credits: A Concept Paper on the Generation of Emission Reduction Credits from Mobile Sources." This paper was subsequently presented to the Board as an informational item at the August 1992 Board meeting. At the Board's direction, the ARB staff held public consultation meetings and solicited written and oral comments which were then incorporated into the paper and formally approved by the Board in February 1993. Also at the Board's direction, the staff extended the mobile source credits concepts to the cases of credits generated through the retrofit of light-, medium- and heavy-duty vehicles. After incorporation of public comments, these retrofit credit guidelines were approved by the board in November 1993 and incorporated into the existing guidelines. Most recently, the Board approved a set of guidelines for generating mobile source credits through the purchase of new, reduced-emission heavy-duty vehicles. This document contains all of the ARB's guidance to air pollution control, and air quality management districts (districts) for development and implementation of mobile source emission reduction credit programs for all the programs considered thus far.

The ARB encourages the districts to use these guidelines whenever applicable. However, these guidelines are not formal regulations and do not preclude the development of other options for mobile source emission reduction credit programs. By adopting and implementing a mobile source emission reduction credit program the district creates an opportunity for businesses and industry to create and

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<sup>1</sup> Mobile sources include vehicles such as passenger cars, trucks, buses, trains, ships, motorcycles, and construction and farm equipment.

<sup>2</sup> Reactive organic gases (ROG) and oxides of nitrogen (NOx) react in the presence of sunlight to form ozone.

use mobile source emission reduction credits. Participation in such a program is voluntary on the part of businesses wishing to use mobile source emission reductions for emission reduction credits.

The guidelines cover the following three areas:

- 1) Overall program development and implementation
- 2) Uses for mobile source emission reduction credits
- 3) Specific guidelines for generation of credits using:
  - a. Accelerated retirement of older vehicles
  - b. Purchase of low-emission transit buses
  - c. Purchase of zero-emission vehicles
  - d. Retrofit of light- and medium-duty vehicles
  - e. Retrofit of heavy-duty vehicles
  - f. Purchase of new, reduced-emission heavy-duty vehicles.

### **Mobile Source Emission Reduction Credit Programs**

Mobile source emission reduction credits are created when reductions in emissions from cars, buses, or other mobile sources exceed the reductions required by federal, state, and local laws. In addition, mobile source emission reduction credits must exceed the requirements of district rules and regulations as well as the requirements of the district's air quality attainment plans. Mobile source emission reduction credit programs need to be carefully designed so that they do not exacerbate a district's air quality problem by allowing credit for emission reductions required by other programs, rules, or laws.

These programs provide flexibility to industry in meeting requirements for emission reductions. Such a program does not necessarily benefit air quality--unless the emission reduction credits are purchased specifically to benefit air quality. For example, districts along with environmental groups might choose to obtain mobile source emission reduction credits to meet air quality goals.

Examples of how such credits could be produced include the application of control technology earlier than required by existing regulations or by the use of emission control equipment not otherwise required. For example, mobile source emission reduction credits could be created by the purchase of low-emission transit buses or by the elimination of old, high-emitting cars through an accelerated retirement program. Some possible uses of mobile source emission reduction credits include delaying compliance with prohibitory rules, offsetting emissions from temporary sources, improving air quality in general, and using them as an alternative to controls otherwise required of industrial sources.

### **Criteria Mobile Source Emission Reduction Credits Must Satisfy**

For emission reductions to qualify as mobile source emission reduction credits, several specific fundamental criteria must be met. These criteria include:

1. The reductions must not be required by law or regulation, or otherwise assumed to occur as part of a regional air quality plan.

2. The reductions must be real, and quantified to an acceptable degree of certainty.
3. To be used as stationary source offsets or to replace other emission reduction requirements, the mechanism used to obtain mobile source emission reduction credits must be enforceable and legally binding.
4. The life of the reduction must be reasonably established, and commensurate with the proposed use of the credit.

### **Examples of Potential Mobile Source Emission Reduction Credit Programs**

Various opportunities for generating mobile source emission reduction credits exist. This document presents guidelines for the implementation of five of the most widely discussed programs. All programs are voluntary because they are meant to be used as an additional means of flexibility for industry to meet emissions requirements. Mobile source emission reduction credit programs do not require emission reductions from industry. The first program involves removing older, higher polluting cars from the fleet, thus accelerating the retirement rate. This results in reductions beyond existing regulations and the normal retirement of older vehicles. The second program examines the purchase of low-emission transit buses. Methanol (M100), compressed natural gas (CNG), and electric buses have demonstrated the capability to reduce exhaust emissions. Any bus that can be certified to one of the low-emission standards discussed in Chapter 6 would be equally eligible to be used in a mobile source emission reduction credit program. The third program discusses the generation of credits through the purchase of zero emission vehicles (ZEVs) in excess of regulatory requirements. The fourth and fifth programs consider the generation of credits by retrofitting light-, medium- and heavy-duty vehicles to low-emission configurations. The sixth program covers the purchase of new, reduced-emission heavy-duty vehicles other than urban transit buses.

All but one of these examples are straightforward programs that are clearly over and above existing regulations established by the ARB. However, the third program, the purchase of zero-emission vehicles (ZEVs), is more complicated because state regulations currently govern the production and sale of ZEVs. The requirements of California's Low-Emission Vehicle (LEV) regulations limit the opportunity to generate mobile source emission reduction credits by purchasing ZEVs because they require manufacturers to produce a minimum number of ZEVs beginning in 1998. The LEV regulations also allow manufacturers who exceed the ZEV requirements to use any ZEV they produce in excess of requirements to compensate for emissions from other vehicles that meet less stringent standards. Additionally, "excess" ZEVs can be used to meet minimum ZEV production requirements in future years. Consequently, for another party to obtain mobile source emission reduction credits by purchasing ZEVs, vehicle manufacturers must first be willing to sell or transfer their rights to use those ZEVs to meet the ARB's LEV regulations, something that they may be reluctant to do.

### **Credit Generating Potential and Costs**

Table 1 illustrates the potential benefits and some of the costs associated with the mobile source emission reduction credit programs mentioned above. For each program, information is provided

regarding the number of vehicles that would be needed to generate 25 tons per year of emission reduction credits in 1993<sup>3</sup>. The total cost represents the estimated cost of the entire program and is presented for the programs for which cost estimates are possible. The life of the mobile source emission reduction credit is limited by the number of years that the emission reduction is valid. (Note that no reduction or cost estimates are presented for the reduced-emission heavy-duty vehicle scenario due to the large and unknown variety of possible cases.)

Table 1: Number of Vehicles Needed to Generate 25 Tons per Year of Emission Reduction Credits in 1993				
Emission Reduction Credit Program	Approximate Number of Vehicles Needed		Approximate Cost	Expected Life of Credits
	ROG	NOx		
Accelerated Retirement of Old Cars <sup>B</sup>	440		\$350,000	3 Years
		1,700	\$1.3 Million	
Low-emission Transit Buses (Methanol M100)	NC <sup>C</sup>	50	\$1.9 Million to \$3.5 Million <sup>A,D</sup>	12 Years
Low-emission Transit Buses (CNG)	NC <sup>C</sup>	50	\$400,000 to \$2.2 Million <sup>A,D</sup>	12 Years
Electric Transit Buses	NC <sup>C</sup>	25	NC <sup>E</sup>	18 Years
Zero-emission Vehicles <sup>G</sup>	3,800	3,800	NC <sup>F</sup>	10 Years
Light- and Medium-Duty Retrofit <sup>H</sup>	4,200 <sup>H</sup>	4,200 <sup>H</sup>	NC <sup>I</sup>	10 Years <sup>H</sup>
Heavy-Duty Retrofit <sup>J</sup>	NC <sup>K</sup>	58	NC <sup>I</sup>	3 Years <sup>J</sup>

<sup>3</sup> The information in Table 1 is extracted from Chapters 5 through 9. See these chapters for the details on calculations.

- Note A: Approximate cost for methanol and CNG buses reflects the incremental costs above new, conventional diesel buses equipped with particulate traps.
- Note B: Based on purchase of pre-1972 vehicles, for \$700 plus a \$100 administrative fee.
- Note C: Not Calculated - Transit buses emit relatively low amounts of ROG; thus, this program would not provide significant ROG benefits.
- Note D: Based on large transit district scenario.
- Note E: Not Calculated - Due to the uncertainty of prices involved in electric bus infrastructure, cost was not calculated.
- Note F: Not Calculated - Cost figures are not provided for the zero-emission vehicles because reliable cost data are not available at this time.
- Note G: Figures calculated for ZEVs purchased in 1996. Note H: ROG + NOx value based on example of Table 27, Chapter 7. Other scenarios may be significantly different.
- Note I: Not calculated - Retrofit cost data not currently reliable.
- Note J: Based on example of Table 35, Chapter 9. Other scenarios may be significantly different
- Note K: Retrofit from diesel would have insignificant HC reductions.

The analysis in Table 1 illustrates the viability of the examined programs. Of the programs for which reliable cost calculations could be made, the accelerated retirement of old, high-emitting vehicles is the least costly option for ROG emission reductions, with a total cost of \$350,000 to produce 25 tons per year of credits in 1993. In addition to ROG, this program also creates some NOx credits. However, the life of these mobile source emission reduction credits is fairly short at only three years. In addition, the number of vehicles needed to generate a given amount of mobile source emission reduction credit will vary with time, as the natural turnover of the fleet removes older, higher emitting vehicles, replacing them with newer, lower emitting ones. This program would probably have an application when credits are needed for only a short period of time. This could include, for example, delaying compliance with a regulation or providing mitigation for a temporary source.

The low-emission or electric bus examples provide mobile source emission reduction credits for the longest time period of all the examined programs. Purchasing M100 or CNG fueled buses could provide credits valid for about 12 years. Mobile source emission reduction credits generated from the purchase of electric buses could last about 18 years. The total incremental cost for generating 25 tons per year of NOx, including the cost of the buses, fueling infrastructure, and the fuel is approximately \$1.9 million to \$3.5 million for methanol and approximately \$400,000 to \$2.2 million for CNG. Because much of this cost is for fixed capital equipment, the cost per ton of emission reductions decreases as more buses are added to the fleet. Because NOx emissions are the only reductions that are generated in significant amounts, no reduction is shown for ROG.

In the ZEV example, 3,500 cars would have to be purchased to generate 25 tons per year of ROG emission reductions and 25 tons per year of NOx. In a ZEV mobile source emission reduction credit program, more vehicles are required to participate than the accelerated retirement program if the same amount of reductions is to be obtained, because the emission reduction is calculated from the difference between a ZEV and a new vehicle instead of the old vehicle and an average vehicle. However, the life of these reductions is fairly long at ten years. Cost figures are not provided for the purchase of ZEVs because reliable cost data are not available at this time. The viability of ZEVs as a source of mobile source emission reduction credits will depend on the price competitiveness with conventionally-fueled low-emission vehicles.

Due to the wide variety of possible retrofit applications and scenarios, no cost data is presented for retrofit credit programs. However, some inferences can be made. The light- and medium-duty retrofit example shown requires a very large number of vehicles to achieve a 25 ton per year reduction in ROG and NOx combined. The number of vehicles required to achieve a 25 ton per year reduction in ROG or NOx alone would be even higher, which indicates that this could be an expensive program depending on the retrofit cost per vehicle, although the relatively long credit life is attractive. The number of retrofit heavy-duty vehicles needed to achieve a 25 ton per year NOx reduction is relatively low, about the same as required under a low-emission bus program. However, the credit life is relatively short which could make the overall costs quite high. The credit applicant is cautioned that these credit amount examples are for specific cases and other retrofit scenarios could show significantly different results, both better or worse.

As noted previously, no estimates of credit amount-related quantities for the new heavy-duty vehicle purchase scenario are presented in this document. The wide variety of potential cases makes it difficult to pick one as being representative. However, the low-emission urban transit bus scenario should give the reader an order of magnitude estimate of the credit amount achievable for the case of credits from reduced-emission vehicles in the heavy heavy-duty category.

**Cost Effectiveness of Mobile Source Emission Reduction Credit Programs**

Table 2 provides an estimate of the cost effectiveness (in dollars per ton of credit created) associated with several of these mobile source emission reduction credit programs<sup>4</sup>. Table 2 shows that the accelerated retirement program provides the most cost effective ROG reductions, but is much more expensive for NOx reductions. Again, cost-effectiveness was not determined for the ZEV purchase, retrofit, or new heavy-duty vehicle purchase credit scenarios.

Table 2: Illustration of Cost Effectiveness			
Emission Reduction Credit Program	Cost per Ton		
	ROG	NOx	ROG + NOx
Accelerated Retirement of Old Cars <sup>A</sup>	\$4,700	\$18,000	\$ 3,700
Low-emission Transit Buses (Methanol M100)	NC <sup>B</sup>	\$14,000 <sup>C</sup>	NC <sup>B</sup>
Low-emission Transit Buses (CNG)	NC <sup>B</sup>	\$2,700 <sup>C</sup>	NC <sup>B</sup>

Note A: For Pre 1972 vehicles, purchased for \$700 plus a \$100 administrative fee.

Note B: Not Calculated - Transit buses emit relatively low amounts of ROG; thus, this program would not provide for ROG mobile source emission reduction credits.

Note C: Cost effectiveness based on purchasing 200 new buses.

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<sup>4</sup> The information in Table 2 is extracted from Chapters 5 and 6. See these chapters for the details on calculations.

## Conclusions

The ARB staff have reached the following general conclusions regarding the implementation of mobile source emission reduction credit programs in California. More specific conclusions are contained in Chapter 12 of the guidelines.

1. Opportunities exist to create and use mobile source emission reduction credits. The creation of these credits provides districts and industry with an additional mode of flexibility in meeting air quality goals.
2. Districts wishing to establish mobile source emission reduction credit programs are encouraged to adopt regulations covering the generation and use of credits which are consistent with these guidelines. Districts should use great care in designing mobile source emission reduction credit programs so that they do not create false credits that would exacerbate air quality problems.
3. Any regulation adopted to create and use mobile source emission reduction credits needs to ensure that the credits meet the following criteria: surplus, real and quantifiable, enforceable, and with an established life span.
4. Relative to many existing control programs, mobile source emission reduction credits can produce cost-effective emission reduction credits.
5. At this time the best uses of mobile source emission reduction credits appear to be:

allowing industry an alternative method of obtaining emission reductions otherwise required by district rules

offsetting emission increases from temporary sources

providing a source of additional emission reductions for use in market-based emission reduction trading programs

potentially using credits as mitigation of emissions from stationary sources through an extended life credit program

providing a substitution for meeting average vehicle ridership requirements

improving air quality

# 1. INTRODUCTION

This document provides local air pollution control and air quality management districts (districts) with the Air Resources Board's (ARB or "Board") guidelines for the development and implementation of mobile source emission reduction credit programs.

Mobile source emission reduction credits are created when reductions in emissions from cars, buses, and other mobile sources exceed the reductions required by federal, state, or local laws, including any rules and programs. Mobile source emission reduction credit programs will, therefore, need to be carefully designed so that they do not exacerbate a district's air quality problem. The ARB supports mobile source emission reduction credit programs because they can provide flexibility to industry in meeting various requirements for emission reductions. These opportunities are especially desirable because districts are looking for new alternatives to satisfy emission reduction requirements or to offset increases in emissions from new and expanding commercial and industrial facilities.

Specific programs include the following: a program to remove older often higher emitting vehicles from the fleet by accelerating their retirement through a voluntary buy back program, voluntary purchase of low-emission transit buses instead of new diesel buses, a program to purchase zero-emission vehicles instead of new conventional vehicles, two programs for reducing emissions by retrofitting existing vehicles, and voluntary purchase of new, reduced-emission heavy-duty vehicles instead of more conventional vehicles.

The ARB strongly encourages the districts to use these guidelines whenever applicable. However, these guidelines are not binding regulations and do not preclude the development of other programs for mobile source emission reduction credits by the districts. These guidelines have been in development since early 1992, with the present version adding the new chapter on new, reduced-emission heavy-duty vehicle purchase credits to the document which was first approved by the Board in February 1993. In developing these guidelines, we received numerous written comments and held public consultation meetings to address questions and gather additional comments from interested parties.

## **Background Information on the ARB's Motor Vehicle Program**

In California, mobile sources<sup>5</sup> account for about 60 percent of all ozone forming emissions<sup>6</sup> and for over 90 percent of all carbon monoxide emissions (CO) from all sources. As in the past, the ARB continues to develop and implement a comprehensive motor vehicle emissions control program. Some of the major elements of the motor vehicle program include stringent certification and emissions

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<sup>5</sup> Mobile sources include vehicles such as passenger cars, trucks, buses, trains, ships, motorcycles, and construction and farm equipment.

<sup>6</sup> Reactive organic gases (ROG) and oxides of nitrogen (NOx) react in the presence of sunlight to form ozone.

standards that will decrease ROG emissions by 80 percent and NOx emissions by 50 percent<sup>7</sup> over time. As a larger and larger percentage of zero-emission vehicles (ZEVs) are introduced into the fleet, the ARB anticipates substantial additional reductions between 2000 and 2010. Other important State motor vehicle programs include in-use compliance, inspection and maintenance, emissions warranties, and clean and reformulated fuel regulations. Similar motor vehicle emissions programs are being implemented for off-road vehicles and engines. Because mobile sources are the leading cause of urban air pollution, achieving additional emission reductions from mobile sources is attractive. However, it is important that the creation of a mobile source emission reduction credit program meets existing air quality requirements and does not sacrifice the programs already in place.

### **Background on Other Emission Reduction Credit Programs**

In 1977, the concept of emission reduction trading was introduced in the federal Clean Air Act. As a result, districts developed and implemented New Source Review programs which included the concept of offsets. New Source Review programs regulate the siting of new industrial sources of air pollution and the expansion of existing industrial sources. Offsetting means a new company can build, or an existing company can expand, emission producing activities only if it secures emission reduction credits (offsets) from another existing company with the end result being no net increase in emissions.

Since the adoption of the emission trading concept in New Source Review rules, considerable interest has been expressed in expanding the concept of emission reduction trading to programs other than New Source Review. The creation and use of mobile source emission reduction credits presents an opportunity to provide flexibility to industry to meet air quality goals. The concept is that a company can have the flexibility to comply with the specific requirements of a district rule or regulation, or it can comply by supplying mobile source emission reduction credits that ensure there is no net increase in emissions. The guidelines in this document are intended to be used in designing emission reduction credit trading programs that use mobile source emission reductions.

### **Potential Benefits of Mobile Source Emission Reduction Credits**

Mobile source emission reduction credit programs provide several benefits including generation of emission reductions at a competitive or lower cost than other strategies, especially when emission reductions are limited from stationary sources, or helping districts to attain the state and federal ambient air quality standards. Mobile source emission reduction credits may also alleviate the problem that industry has in finding emission reduction credits to mitigate emission increases. Additionally, the development of mobile source emission reduction credit programs may encourage the advancement of technologies that increase the emission reductions possible from mobile sources, such as the advancement of electric powered vehicles and fuel cell technology.

### **Purpose of Guidelines**

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<sup>7</sup> When 1990 model year light and medium duty vehicles are replaced with the models sold in 2000.

The purpose of these guidelines is to provide the districts with guidance on establishing mobile source emission reduction credit programs. These guidelines ensure that district programs will comply with the regulations and policies established by the state and local districts, and will be consistent with state and federal law. Specifically, these guidelines present information on how mobile source emission reduction credits are generated, possible uses of the credits, and the criteria which must be met for reductions to qualify as credits. The ARB is supportive of mobile source emission reduction credits provided that such credits are in excess of the reductions otherwise required by or committed to in air quality plans, laws, or regulations. In addition, the ARB is interested in providing incentives to improve air quality and in encouraging uniformity among districts' programs throughout the state.

## **2. AUTHORITY TO DEVELOP MOBILE SOURCE EMISSION REDUCTION CREDIT PROGRAMS**

This chapter discusses the authority of the Air Resources Board and local districts to develop and implement mobile source emission reduction credit programs as well as the legal limitations on those programs.

### **ARB Authority**

#### **Guidelines on Mobile Source Emission Reduction Credit Programs**

For many years the ARB has produced guidance documents on a variety of air quality issues. The ARB's authority to issue guidelines is derived from the provisions of the Health and Safety Code (H&S Code) which direct the ARB to coordinate efforts to attain and maintain ambient air quality standards (H&S Code section 39003), to provide assistance to the districts (H&S Code section 39605(a)), to coordinate, encourage, and review the efforts of governmental agencies as they relate to air pollution (H&S Code sections 39500 and 41500), and to do such acts as may be necessary for the proper execution of the powers and duties granted to and imposed upon the ARB (H&S Code section 39600).

It should be noted that ARB guidelines are not formal regulations of the ARB. This means that while the ARB strongly encourages districts to follow ARB guidelines, districts are not legally obligated to do so. Although districts may create their own mobile source emission credit programs which do not follow ARB Guidelines, all the provisions of the Health and Safety Code must be adhered to. Further, it should be clearly understood that the ARB has the responsibility to ensure that the requirements of state and federal law are met by the districts.

#### **Oversight Authority**

As the agency governing the state's air resources, the ARB has the oversight authority to ensure that the districts are meeting their legal responsibilities, including the responsibility to make expeditious progress toward attainment of the state and federal ambient air quality standards by the earliest practicable date (H&S Code sections 39002 and 41500-41504).

In fulfilling its obligations set forth in the Health and Safety Code, the ARB will review mobile source emission reduction credit programs to assure that statutory mandates are met. If the ARB determines that such mandates are not met, the ARB can act to amend a district rule or regulation after it has assumed the district's powers (H&S Code sections 39002 and 41504). While the Board must assume district authority on a case by case basis, it is anticipated that such actions would be made only if the district program allows use of false "credits" that do not represent genuine emission reductions, or if the credits are not "surplus", thereby interfering with the district's expeditious

progress toward attainment of air quality standards. However, this is not a mechanism that the Board desires to use, and ARB staff will work closely with any district that creates a mobile source emission reduction credit program to ensure that the district program is adequate.

The ARB must also make a determination whether a mobile source emission reduction credit rule submitted by the district as a revision to the federal State Implementation Plan (SIP) meets all the requirements under state and federal law (H&S Code sections 39602, 40910-40926, 41500, 41500-41505, and 41650-41652). Any action by the Board to amend a rule, formally disapprove a rule as a SIP revision, or disapprove an air quality attainment plan must be taken at a noticed public hearing held pursuant to the Health and Safety Code. Finally, the ARB may perform periodic district program evaluations to ensure that the districts develop programs that provide expeditious progress towards attaining the state ambient air quality standards.

## **District Authority**

### **Authority to Adopt Mobile Source Emission Reduction Credit Programs**

As a general matter, districts have the primary responsibility to regulate emissions from stationary sources, while the ARB has the responsibility to regulate emissions from mobile sources. (H&S Code sections 39002, 40000, and 40702). In light of this traditional division of authority under state law, the question has arisen as to whether districts have the legal authority to adopt mobile source emission reduction credit programs.

The ARB has the sole authority and mandate to set motor vehicle emission standards (H&S Code sections 39002, 39500, and 40000). Under this authority the ARB has adopted exhaust emission standards, engine emission standards, and evaporative emission standards, for new and used motor vehicles (see Title 13, California Code of Regulations, section 1950 et seq.). However, districts may adopt regulations which focus on the use of motor vehicles. This authority derives from the districts' general authority to regulate nonvehicular sources ( H&S Code sections 39002, 40717 and 40702), to adopt indirect source control measures and transportation control measures (H&S Code sections 40716, 40717, 40910, and 40918-40920), and to establish emission reduction credit banking systems (H&S Code sections 40709-40713). Since each district has also been granted broad powers to "... adopt rules and regulations and do such acts as may be necessary and proper to execute the powers and duties granted to, and imposed upon, the district ..." (H&S Code section 40702), it is reasonable to conclude that a district has the power to adopt a properly crafted mobile source credit program to be used as a component of the district's rules, regulations, and banking program.

It is also worth mentioning that the California Legislature has recognized that, in meeting the goals of the California Clean Air Act (the "Act"), it is important to provide the regulated community with flexibility and reasonable alternatives. Recently enacted H&S Code section 40919(f) (AB 2783; Stats. 1992, ch. 945) now requires districts, in implementing the requirements of the California Clean Air Act, to endeavor to provide flexibility and alternative strategies in implementing district transportation control measures and low-emission vehicle fleet rules. To fulfill these statutory mandates, one possible option districts may wish to consider is the use of mobile source emission reduction credits.

## **Legal Criteria that Must Be Met by District Mobile Source Emission Reduction Credit Programs**

Under the requirements of the California Clean Air Act, districts have the legal obligation to make expeditious progress to attain and maintain the state and federal ambient air quality standards by the earliest practicable date (H&S Code sections 40910 and 40913). The majority of the districts in the state are also subject to the planning requirements of the Act (H&S Code 40910 et seq.), and have been unable to achieve the required reduction of 5 percent or more per year emission reduction for each nonattainment pollutant or its precursors (H&S Code section 40914). The legal effect of these requirements is that most districts in the state are also required to include "every feasible measure" in their attainment plans ((H&S Code sections 40914(b) and 41503.1)

In adopting programs that use mobile source emission reduction credits for meeting their legal obligations, the districts cannot adopt any rule, including a mobile source emission reduction credit rule, that would significantly interfere with the district's ability to expeditiously achieve and maintain ambient air quality standards or meet other legal requirements of the California Clean Air Act. In addition, any mobile source emission reduction credit program, designed to be used as part of a district emission reduction credit banking system, must meet the criteria specified in H&S Code sections 40709-40713. Among other requirements, these sections explicitly provide that all banking and offset credits must be in excess of the emission reductions required by any federal, state, or district regulation (H&S Code section 40709). Finally, districts must ensure that their local regulations do not interfere with the progress of California's statewide mobile source emissions control and fuels programs (H&S Code 39002 and 40001).

### **3. GUIDELINES FOR PROGRAM DEVELOPMENT**

This chapter stresses the important elements that the districts should incorporate in mobile source emission reduction credit programs. It recommends that the districts adopt specific rules governing the issuance and use of mobile source emission reduction credits. In addition, prior to implementation the districts should clearly establish procedures for program implementation that ensure the criteria for mobile source emission reduction credits are met.

#### **Mobile Source Emission Reduction Credit Program Options**

Districts are encouraged to consider the use of mobile source emission reduction credits to provide regulated sources additional flexibility. Possible uses include delayed compliance with a prohibitory rule, substitution for meeting average vehicle ridership requirements, or offsets for stationary sources under New Source Review. The uses of mobile source emission reduction credits are discussed in more detail in Chapter 4. It is recommended that specific rules be developed and adopted to identify exactly when credits can be used, and how credits can be created.

The districts have at least two options for development of mobile source emission reduction credit rules. One option is to incorporate all mobile source emission reduction credit provisions into specific rules so that the creation and use of credits is defined within each rule. For example, a district prohibitory rule which allows a delayed compliance option could include a component for generating and certifying mobile source emission reduction credits to be used specifically for that rule. This method would be useful to a district which chooses to limit the use of mobile source emission reduction credits to a few specific applications.

A second option would be to develop and implement a general mobile source emission reduction credit rule for the creation and certification of mobile source emission reduction credits. Regardless of the use, the credits would be processed through this general rule. Once certified, the mobile source emission reduction credit would be available for use with whatever rules are specified by the district. This method would be most useful to a district which chooses to allow use of mobile source emission reduction credits for many different rules.

#### **Mobile Source Emission Reduction Credit Criteria**

Regardless of whether districts choose to develop one general mobile source emission reduction credit banking rule or make specific amendments to rules to contain a mobile source emission reduction credit option, districts need to ensure that mobile source emission reduction credits meet several fundamental criteria. The four criteria that all emission reduction credits (regardless of their source) must meet are:

1. The reductions are not required by law, regulation, or otherwise assumed to occur as part of a regional air quality plan. These reductions must be surplus.
2. The reductions are real and quantified to an acceptable degree of certainty.
3. The actions that produce the credits are enforceable and legally binding.
4. The life of the reduction must be reasonably established and commensurate with the proposed use of the credit.

### **Surplus Mobile Source Emission Reductions**

To be surplus, credits must go beyond reductions required by local, state, or federal regulations, or measures contained in district air quality attainment plans. For example, under ARB's low emission vehicle regulations, a manufacturer can use the sale of zero-emission vehicles (ZEVs) in one year to offset the sale of higher emitting vehicles in future years and meet the required fleet average emission standards. If the purchaser of those vehicles is also granted mobile source emission reduction credits through a ZEV purchase program, the emission reductions would be counted twice. Therefore, the district mobile source emission reduction credits program could not grant credit for these ZEVs, unless the vehicle manufacturer is willing to sell or transfer their rights to use ZEVs to meet ARB's low emission vehicle standards.

Furthermore, the districts need to consider limiting the credit in a mobile source emission reduction credit program when a regulation, which would require the same reduction, is scheduled for adoption in the near-term (current planning cycle of the districts). If a measure that will result in a reduction in mobile source emissions is scheduled for adoption by a local district or the ARB, or is included in the district's air quality attainment plan and relied upon for progress toward attainment, credit should not be granted for reducing mobile source emissions down to the level specified in the measure because these emission reductions would not be considered surplus. Only emission reductions beyond those identified in near-term measures should be eligible as credits.

### **Quantification of Mobile Source Emission Reduction Credits**

Quantifying the actual emission reductions achieved from mobile sources is more difficult than for most industrial sources. To determine emission reduction credits from on-road vehicles, information is needed on the number of miles driven, the vehicle usage patterns, the emission rates for both the baseline and replacement vehicles or configurations, and the number of years the reductions will occur. Chapters 5 through 10 present guidelines for quantifying these factors and calculating the resulting emission reductions. These guidelines provide acceptable methods for quantifying emission reductions from the five programs discussed.

## **Effects on the Value of Credits**

The users and sellers of emission reduction credits share a common concern regarding the value of credits when they are generated. Both want assurance that once the credit has been officially issued as a credit certificate by the district, its value will not change. Examples of circumstances which could change the value of a credit are: new calculation procedures, updated emission factors, or changes in state mandated emission standards for motor vehicles.

It is suggested that the value of the credit issued by the district should not change once a district credit certificate is issued. This approach will provide confidence and stability in a mobile source emission reduction credit program and market. The ARB staff recommends that the districts specify in their regulations how credits will be affected by such changes in quantification methods. Districts should use the best information currently available to quantify the credit, but once issued, mobile source emission reduction credits should retain constant value throughout the life of the credit.

One variation to this recommendation is the case where credits are generated by low-emission urban transit buses over a long period of time to be used as mitigation for a long-term stationary source project. Over a period of 20 to 30 years, motor vehicle emission standards could change significantly, thus affecting the amount of credit available. Changes in emission standards should be accounted for as credits are generated throughout the life of the project. To ensure protection for credits purchased through a long-term credit agreement at the start of the project, an "extended life" credit plan could be used. The extended life credit program builds-in protection against changing emission standards by discounting credits generated in later years of the program. This approach will provide the stationary source an up-front guarantee of the amount of the credit, while also providing the district protection from granting too much credit if the vehicle emission standards become more stringent. A detailed discussion of this concept is presented in Chapter 6.

## **Time Span for Life of Mobile Source Emission Reduction Credits**

The lifespan of mobile source emission reduction credits varies depending upon the type of emission reductions used to generate the credit. For example, credits generated from the purchase of low-emission buses can last up to 12 years, credits generated from the purchase of ZEVs can last up to 10 years, and the life of credits from the accelerated retirement older vehicles can last 3 years. Credits based on vehicle retrofits will have different lifetimes depending on the specifics of the particular case. Because the life span of mobile source emission reduction credits is finite, it is important to know when the credits actually start.

It seems clear that the credit should start on the day the emission reducing activity occurs (e.g., an older car is taken out-of-service) and should last the time span calculated for each type of credit. However, from an administrative standpoint, tracking different lifespans for each event on a daily basis is overly burdensome. The ARB recommends the following procedure to lessen requirements for administrative tracking of each action creating emission reduction credits.

District rules could provide a mechanism to define the beginning of the lifespan of the credit. Districts could allow emission reductions which began within a calendar quarter to be calculated on

a quarterly basis and deposited into an emission reduction credit bank. For example, in an accelerated retirement operation, if vehicles are retired on five separate days within a quarter, the emission reductions associated with all five events would be summed for that quarter and a single emission reduction credit would be deposited into the bank.

Once the mobile source emission reduction credits are generated for the quarter, an additional 90 days but no more than 1 year would be allowed to sell the credit with its full lifetime before the lifespan of the credit begins to diminish. The credit would expire at the end of the calculated lifespan plus the selling period. This procedure guarantees a selling period which retains full useable life of the credit, but does not preserve the credit significantly beyond its expected life.

The ARB staff recommends that language be included in district rules and regulations clarifying the use of credits on an annual basis. The annual amount of credit cannot be saved for use in a subsequent year, nor can a source sum credits from more than one year of the credit life to use at one time. For instance, if an accelerated retirement program produces 10 tons/year of credits, a source cannot use 5 tons per year for the first 2 years and 20 tons per year in the final year. Similarly, a source cannot use all 30 tons of credits during the first year and none in the subsequent 2 years. A source is allowed to use only the same amount of credit for each year of the credit life period, in the example above, 10 tons/year.

### **Enforcement of Mobile Source Emission Reduction Credits**

Enforcement is an essential element of a mobile source emission reduction credit program. Compliance plans and periodic assessments are needed to ensure that the activities that produce credits occur as planned and promised. The ARB recommends that any mobile source emission reduction credit rule adopted by the districts require compliance plans which specify conditions for continued acceptance of the credits. A district program should include such aspects as:

- steps needed for application submission and approval of mobile source emission reduction credit programs (including what types of reductions are eligible for mobile source emission reduction credit application)

- types and format of required record keeping and reporting

- how and when assessments will be performed

- mechanisms for invalidation of credits

Record keeping will be essential to determine if the assumptions used to calculate credits were realistic and reasonable. At a minimum, it is critical that records necessary to quantify actual emission reductions be retained on site and made available to the district personnel upon request. These types of records would be valuable to the district in evaluating calculation procedures for future applications.

The success of a mobile source emission reduction credit program is directly tied to the ability to ensure that the activities that were expected to produce reductions actually occur. For example, the district should verify that ZEVs purchased as part of a mobile source emission reduction credit

program are driven to the extent projected by the credit program. If the ZEVs are not driven as much as projected, it is likely that other higher polluting vehicles will be driven more, resulting in lesser emission reduction benefits. Similarly, the district should verify that low-emission transit buses purchased in order to generate mobile source emission reduction credits are not placed on lower mileage routes than those used to calculate emission reductions. If a district finds that the emission reductions for a particular application are not occurring, procedures should be available to modify or even invalidate the credit.

### **Ownership and Liability of Mobile Source Emission Reduction Credits**

When a transaction takes place between a seller of a credit and a buyer, questions of ownership and liability arise. In any mobile source emission reduction credit program, the district rule and the mobile source emission reduction credit certificate should clearly state which party is responsible for ensuring that the emission reducing activities actually take place as described in the mobile source emission reduction credit application. In addition, the district should describe exactly what action, by which party, will constitute a violation of the rule for the purpose of assessing penalties under H&S Code sections 42400 *et seq.* The rule should specify that the district has the right to conduct inspections on both parties to the transaction to determine whether the mobile source emission reduction credits are in compliance with an approved application. As part of the purchase contract and operating permit, the seller should guarantee that the emission reduction credit has not been previously promised or sold to another party for mitigation of emissions.

The following explains how ownership and liability could be addressed under a mobile source emission reduction credit program. First, if the buyer of the credit is required to have an operating permit, the permit should specify which party, the buyer or seller of credits, is responsible for ensuring that the credits meet the criteria specified in the rule. For example, the operating permit could indicate the buyer's responsibility for the credit. A purchase contract between buyer and seller could indicate that in case of an invalid emission reduction credit, the seller is liable for remedying the lack of credits that might occur at any time during the period of the contract.

The above arrangement would give the district power to enforce against the buyer of an invalid credit. The buyer could then bring a civil suit against the seller for violation of the purchase contract if the district voids the credit.

### **Use of Mobile Source Emission Reduction Credits in the Air Basin Where Generated**

The ARB recommends that in designing a mobile source emission reduction credit program districts include safeguards to ensure that their credits are used within the air basin in which they originate. Without such safeguards it would be difficult if not impossible to demonstrate that there would not be a detrimental effect on air quality from the source using the credits. This point is important because mobile sources (unlike stationary sources) are capable of moving out of the air basin. If mobile source emission reduction credits are used to offset permanent emissions which remain within the air basin, the district must ensure that mobile source emission reductions also occur within the air basin.

For example, as outlined in Chapter 5 for accelerated retirement of older vehicles, registration within the air basin for at least one year would provide some assurance that the retired vehicle would have had emissions in the local area. For longer term emission reductions such as the use of low-emission buses, transit agencies should be required to track the location and use of buses.

The location of the source using the mobile source emission reduction credits as mitigation is another consideration. As with other stationary source offsets, the local air quality impact of the emitting source is critical. Because the location of mobile sources cannot be fixed on a modeling grid, it is extremely difficult to analyze the impact of using mobile source emission reduction credits. As a safeguard, a reasonable offset ratio should be assigned to the use of mobile source emission reduction credits to address the differences in distribution of emission reductions and the source of permanent emissions. The district should determine an appropriately conservative distance offset ratio to account for this uncertainty.

### **Mobile Source Emission Reduction Credit Certificate and Registry**

#### **Certificate**

Once a mobile source emission reduction credit has been evaluated by the district in accordance with the district mobile source emission reduction credit rules and has been determined to meet the rule requirements, a mobile source emission reduction credit certificate may be issued to the person or persons who created the emission reduction credit. An emission reduction credit certificate becomes a valuable instrument, like a stock certificate. The credit can be sold to another party, used by the creator of the credit, or held for future use or sale. Beyond the specified selling period, the credit will begin to diminish in time value according to the calculated lifespan of the particular credit.

It is recommended that districts require mobile source emission reduction credit certificates to contain the following information:

- certificate identification number
- date of issuance
- amount of emission reduction
- pollutant or pollutants reduced
- time period the credit is valid
- owner of the credit
- person or persons responsible for maintenance of the credits
- statement regarding possibility of invalidation and liability

#### **Tracking System**

Since numerous credit transactions can occur which may be used for various purposes, districts need a mechanism to track all credit activity. For example, some credits will be used immediately to delay compliance of a prohibitory rule and their lifespan will begin to diminish immediately. However, the company may comply within a period which is shorter than the mobile source credit life and therefore may not have used up all of the lifespan of the credit. The remaining life of that particular credit would become re-eligible for sale and must be tracked and identified.

Other credits may not be sold immediately, but instead be held and sold at a later date. If they are held too long, the lifespan value of the credit will begin to diminish according to the credit's calculated lifespan. All credits must be accounted for and their value must be tracked through some type of tracking system.

It is recommended that districts develop and implement a tracking system for mobile source emission reduction credits which at a minimum contains the following:

- certificate identification number
- project file number/name
- source of emission reduction
- type of pollutant
- amount of pollutant
- beginning and expiration date of credit
- status of credit (being used, being held)
- program/rule number processed under

## **Registry**

In addition to tracking emission reduction credit activity districts can provide a valuable service to buyers and sellers of mobile source emission reduction credits by publishing information about credit availability. Prospective buyers need to know what is available for purchase and sellers need to have a mechanism for advertising the availability of their credits for sale.

It is recommended the district maintain a registry of mobile source emission reduction credits and make that information available to the public. The registry should at a minimum provide the following information for all credits currently available for sale:

- type of pollutant
- amount of pollutant
- time period the credit is valid
- person to contact to purchase credit

If the person or persons who created the emission reduction credit do not intend to sell the credit, they may request to be omitted from the registry.

## **4. USES OF MOBILE SOURCE EMISSION REDUCTION CREDITS**

This chapter discusses the potential uses for mobile source emission reduction credits. Emission reductions from mobile sources that are achieved through programs such as those identified in the following chapters have a variety of uses. Ultimately, the allowable use of the mobile source emission reduction credit would be determined by the districts based on their desire to provide additional flexibility to sources subject to regulation.

### **Providing Offsets to Mitigate Emissions From Temporary Sources**

The life of an individual mobile source emission reduction credit varies based upon the manner in which the emission reductions were created. In the examples cited, mobile source emission reduction credits can be expected to last about three years for the accelerated vehicle retirement program, about 12 years for the low-emission transit bus program and 10 years for the ZEV program. Life for retrofit credits is highly variable but such programs are expected to generate credits with lifetimes significantly less than 12 years. Credit life for new heavy-duty vehicle purchase credits will be variable depending on the specific category of vehicle involved. Because of the limited life of some mobile source emission reduction credits, one obvious use of mobile source emission reduction credits is to mitigate emissions from temporary sources. For example, some district New Source Review rules require that emissions from construction equipment or drilling operations be mitigated. The temporary nature of construction equipment and drilling operations may match the limited term nature of these credits.

### **Delaying Compliance with Emission Regulations**

Mobile source emission reduction credits may also provide regulated businesses the opportunity to develop flexible compliance programs for stationary, transportation and indirect sources. These programs could match well with delaying compliance with transportation control measures, such as average vehicle ridership (AVR) requirements. Delaying compliance dates for industrial sources would also match well with the temporary nature of mobile source emission reduction credits.

### **Market-Based Permit Programs for Longer Life Credits**

Some mobile source emission reduction credits have a relatively long life and are suited for mitigating emissions on a more permanent basis. In a market-based trading program, mobile source emission reduction credits could be used to mitigate longer term emission increases. Under such programs, businesses would be required to reduce emissions from within their facilities or seek emission credits from others in a free market system. Some businesses could include vehicles as a source of potential emission reductions. These mobile source emission reduction credits could be

used to satisfy the required decrease in emissions set forth in the program or become available to other sources in the market. The South Coast Air Quality Management District is in the process of developing a Regional Clean Air Incentives Market (RECLAIM) and envisions the use of mobile source emission reduction credits in the trading program; however, the details of the program are still under development.

### **Mitigation of Long-Term Projects**

Mobile source emission reduction credits with relatively long lifespans could be used to mitigate emissions from stationary sources over periods of time greater than the lifespan of individual credits if a long-term contract for the generation of credits over an extended period of time is agreed to. Through an "extended life" credit plan as discussed in Chapter 6, a stationary source could enter into an agreement to create mobile source emission reduction credits throughout the life of the source to mitigate its emissions.

### **Air Quality Benefit**

Finally, mobile source emission reduction credits could be used by a district to speed progress in improving air quality. The districts, working in conjunction with various state agencies and concerned environmental groups, could pool their resources together to purchase mobile source emission reduction credits and donate those credits to achieve cleaner air.

A second option districts may consider to achieve an air quality benefit from a mobile source emission reduction credit program would be to require mobile source emission reduction credits to be used at a greater than 1:1 ratio. For example, a 1.2:1 ratio would require a source which emits 100 lbs/day of pollutant to supply 120 lbs/day of credits. The extra 20 lbs/day of emission reductions could result in a net air quality benefit. This approach is similar to a greater than 1:1 offset requirement in many district New Source Review rules.

## 5. GENERATION OF EMISSION REDUCTION CREDITS THROUGH THE ACCELERATED RETIREMENT OF OLDER VEHICLES

This chapter presents guidelines for generating emission reduction credits by retiring older, high-emitting vehicles sooner than they would otherwise be retired through normal attrition.

### **Introduction**

Recent on-road testing and results from emission models indicate that a small number of vehicles account for a disproportionate amount of the motor vehicle emissions. Many, although not all, of these very dirty vehicles are older vehicles that have less emission control equipment than more recent models. One means of reducing the impact from these dirty vehicles is to remove these vehicles from service through an accelerated retirement program.

It should be noted that participation in accelerated vehicle retirement programs is voluntary on the part of car owners. Such programs are unlikely to attract collectible classic cars which are generally worth considerably more than the price that would be offered through an accelerated retirement program. While older cars are not the only high-emitting vehicles on the roads, the ARB's analysis of accelerated retirement of vehicles focuses on older vehicles because they are more likely to be sold at a relatively low price. Some newer cars with high mileage and poorly maintained emission control systems may also be large contributors to mobile source emissions (if they cannot be repaired under the California Smog Check program cost limit). Such vehicles, however, often retain a high dollar value and therefore may be too expensive for an accelerated retirement program to purchase in a cost effective manner. It is expected that these vehicles will be addressed under the enhanced Smog Check program, now required in many areas of California. Additionally, the ARB may develop guidelines for generating credits by testing and repairing newer, high-emitting vehicles that have a higher value than the price that can be offered through an accelerated retirement program.

An early retirement program must require that credits be allowed only for emission reductions that are surplus to the emission reductions required by federal, state, and local regulations. Currently, the ARB has adopted progressively more stringent motor vehicle emission standards that will be implemented through the turn of the century. Emission reductions associated with the natural turnover of the older fleet to these newer, cleaner models have been factored into local air pollution control district attainment plans. Hence, in order to satisfy the surplus requirement, any vehicle retirement program must accelerate the retirement of these dirty vehicles and not just retire vehicles that would have been retired very soon anyway. Because of this, the emission reductions are only surplus on a short-term basis.

## **Program Guidelines**

In order for an accelerated vehicle retirement program to produce real credits, the program must (1) purchase vehicles that would actually be driven in the program area, (2) target vehicles that would not otherwise be immediately retired and permanently dismantle the vehicles, and (3) accurately assign the emission reductions generated. This next section identifies these major elements of an accelerated retirement program and specifies the corresponding guidelines.

### **Eligibility of Vehicles**

Any accelerated retirement program must ensure that it generates real emission reductions because other emission sources may eventually use the credits generated through the program to allow them to increase real emissions. One way to guard against false credits is to restrict the type of vehicle admitted into the program. An accelerated retirement program must avoid accepting vehicles that have not been driven recently or have been imported into the district for the sole purpose of being sold to the accelerated retirement program or both.

Current law, as specified in Revenue and Tax Code Section 6262 mandates that any 1975 or subsequent model-year vehicle brought into California must pay a \$300 smog impact fee at the time of registration, unless the vehicle is an Environmental Protection Agency certified California vehicle. This law will have the effect of discouraging the importation of such vehicles from other states or Mexico for the purpose of selling to an accelerated retirement program. This statute will not, however, prevent the movement of vehicles within the state from one local air district to another, nor will it prevent the importation of pre-1975 vehicles. Accordingly, to minimize the chance that a program would grant credit for inoperable vehicles or vehicles from outside the program area or both, the ARB staff have developed the following guidelines.

To guarantee that the program generates real credits, it is recommended that the program operator must:

Obtain proof that the vehicle is currently registered with the Department of Motor Vehicles (DMV) in the district where the program is conducted and has been registered there for at least one year;

Obtain the pink slip from the owner;

Ensure that the vehicle has been driven under its own power to the dismantling site and has not been so affected by collision or other damage as to make its continued operation very unlikely or impossible; and

Ensure that, at a minimum, the vehicle contains the following: functional lighting equipment, functional brakes, exhaust system, bumpers, doors, fenders, side and quarter panels, hood, trunk lid, windows, mirrors, windshields, seats, instrumentation, and gauges.

### **Dismantling the Vehicles**

Proper dismantling of the vehicles provides another safeguard to ensure real credits. To this end, the program operator should render the vehicles inoperable. In their 1990 SCRAP program, Unocal chose to completely crush the vehicles they purchased. Although such an approach provides a simple way to ensure that the vehicle is never driven again, it has the undesirable effect of limiting the availability of spare parts to car collectors and undermines the business efforts of auto dismantlers. Accordingly, the ARB has developed a list of minimum required actions to ensure that an accelerated retirement program permanently disables all vehicles.

To ensure that the vehicle is never driven again, the program operator should:

At time of purchase, destroy the Vehicle Identification Number (VIN) and license plates. Districts will have to confer with the DMV to determine the proper procedures for electronically "scrapping" the vehicles;

At time of purchase, permanently destroy the cylinder block of all vehicles except, as determined by the district in collaboration with antique and collector car interests, engines that have value for the purposes of restoring collector cars; and

Within three months of purchase, crush the rest of the vehicle, including the body/frame structure. (Removal of reusable components, e.g., doors, fenders, bumpers, and disassembled engine components is allowed.)

### **Calculation of Emission Credits**

This section describes in detail the methodology for the credit calculation as well as the factors used. The calculation procedure incorporates a set of assumptions and data derived from the ARB's emission inventory models. These are consistent with the assumptions used in the ARB inventory, and reflected in each area's current plans. The emission rates and annual mileage rates from these models are based on data from a number of individual vehicles and therefore represent the "average" vehicle. An accelerated retirement program will likely attract vehicles which emit at levels both above and below the average emission level for any given model-year group. Similarly, replacement vehicles will also have a wide range of emissions both above and below the average. Therefore, for the purpose of calculating credits, it is appropriate to use average emission rates and average annual mileage rates.

Possible emission reduction benefits from a program are calculated by subtracting the emission rate for the "average fleet" replacement vehicle, from the emission rate for the average retired vehicle, and multiplying by the average annual mileage of the retired vehicle. This difference is then multiplied by the number of vehicles retired by the program. (Please note that numbers in the following tables have been rounded for presentation purposes. However, all available significant figures were used for intermediate calculations. Therefore, using table values for calculations may not give the same end results due to round-off error.)

#### **Per Vehicle Emission Reduction Calculation**

To calculate the emission reduction for the accelerated retirement of one vehicle, use Equation 1 and the emission rates and mileage rates presented below.

Equation 1:

Per Vehicle Emission Reduction (grams/year)=

$$[(EX_{ret} + EVAP_{ret}) - (EX_{rep} + EVAP_{rep})] \times Mile_{ret}$$

Where:

- $EX_{ret}$  = average exhaust emission rate for retired vehicle, grams/mile
- $EVAP_{ret}$  = average evaporative emissions from retired vehicles, grams/mile
- $EX_{rep}$  = average exhaust emission rate for replacement vehicle, grams/mile
- $EVAP_{rep}$  = average evaporative emissions from replacement vehicles, adjusted for lower retired vehicle mileage, grams/mile  
(i.e., multiply by  $\frac{MILE_{rep}}{MILE_{ret}}$ )
- $MILE_{ret}$  = average annual mileage of retired vehicle, miles/year

### Emission Rates

The appropriate emission rates for retired and replacement vehicles are presented in Table 3. Table 3 shows the estimated average annual emission rates for each model year group. The emission rates are calculated from the ARB's draft mobile source emission inventory model EMFAC7F/BURDEN7F and are applicable to passenger cars and light-duty trucks<sup>8</sup>. The reactive organic gas (ROG) emissions include both evaporative and exhaust emissions. Note that retirement of vehicles in model-year groups with emissions below the fleet average produces no benefit.

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<sup>8</sup> These factors reflect the best available estimates of the actual "on-the-road" emissions from vehicles statewide under conditions (mostly temperature related) that produce adverse air quality situations. The estimates will vary somewhat from area to area. Specific estimates for each region will be provided when region specific rules are developed.

Table 3: Emission Rates Used to Calculate the Emission Reduction Benefits from Accelerated Retirement Programs				
Model -Year Group	Emission Rates, grams/ mile			
	ROG		NO <sub>x</sub>	CO
	Exhaust	Evap.		
Pre-1972	9.6	2.8	4.0	69.5
1972-74	7.6	2.1	3.8	46.4
1975-81	2.6	1.3	3.0	36.1
1982-92	0.6	0.3	0.9	10.1
New 1993	0.2	0.1	0.4	3.3
Fleet Average for 1993	1.0	0.4	1.2	13.6

#### Mileage Rates

The average annual mileage for retired and replacement vehicles is presented in Table 4. Table 4 shows the estimated average annual mileage by model-year groups calculated from EMFAC7F/BURDEN7F (Draft) using projected total annual vehicle-miles-traveled in 1993 for each model-year group, combining both passenger cars and light-duty trucks. Although mileage rates do increase on average for newer cars, this analysis assumes that the transportation needs of the individuals who retire their vehicles will remain unaltered. The ARB staff assumes that the individual will maintain approximately the same travel patterns using the replacement vehicle as he or she had using the retired vehicle.

Table 4: Average Annual Mileage of Model-Year Groups	
Model-Year Group	Annual Mileage
Pre-1972	4,900
1972-74	5,300
1975-81	6,400
1982-92	11,000
New 1993	14,500
Fleet Average in 1993	10,100

### Example Emission Reduction Credit Calculation

The emission reduction credit generated by the early retirement of one vehicle can be calculated through the use of Equation 1, and the values found in Tables 3 and 4. For example, the ROG emission reduction credit for a pre-1972 vehicle would be calculated as follows.

From Table 3:

exhaust emissions from the retired pre-1972 vehicle = 9.6 g/mile  
evaporative emissions from the retired pre-1972 vehicle = 2.8 g/mile

exhaust emissions from an average replacement vehicle = 1.0 g/mile  
evaporative emissions from an average replacement vehicle = 0.4 g/mile

From Table 4:

Mileage rate for a pre-1972 vehicle = 4,900 miles/year

First, adjust the evaporative emissions from the replacement vehicle to account for the lower retired vehicle mileage.

$$\text{EVAP}_{\text{rep}} = 0.4 \text{ g/mi} \times \frac{(10,100 \text{ miles/yr})}{(4,900 \text{ miles/yr})} = 0.8 \text{ g/mi}$$

Then using Equation 1, the ROG emission reduction credit for each pre-1972 vehicle is:

$$\begin{aligned} &= [(9.6 \text{ g/mile} + 2.8 \text{ g/mile}) - (1.0 \text{ g/mile} + 0.8 \text{ g/mile})] \times 4,900 \text{ miles/yr} \\ &= 52,000 \text{ grams/year} \\ &= 110 \text{ pounds per year} \end{aligned}$$

Table 5 shows the annual emission reduction that can be expected by the early retirement of a vehicle in each age class. These values were generated by the methodology previously described for ROG, NO<sub>x</sub>, and CO.

Table 5: Emission Reductions per Vehicle Retired (Pounds per Year)			
	ROG	NO <sub>x</sub>	CO
Pre-1972	110	30	600
1972-74	93	30	380
1975-81	32	25	320

Table 6 shows the net emission reductions generated by retiring 10,000 vehicles in 1992 using the mathematical calculations specified above. The table illustrates the impact that the different age class of the vehicle makes on the total potential credit value.

Table 6: Possible Reductions from Implementation of an Accelerated Vehicle Retirement Program in 1993			
	Emission Reductions in Tons per Year		
	ROG	NO <sub>x</sub>	CO
Accelerated Retirement of 10,000 Pre-1972 Vehicles	570	150	3,000
Accelerated Retirement of 10,000 1972-1974 Vehicles	460	150	1,900
Accelerated Retirement of 10,000 1975-1981 Vehicles	160	130	1,600

### **Credit Life**

Based on DMV data, the ARB staff estimates that the average remaining life of vehicles 15 years old or older is 6 years. To be certain that real emission reductions are realized, however, this analysis assumes an average remaining life of 3 years for vehicles participating in an accelerated retirement program. It is inevitable that any large-scale accelerated retirement program will necessarily purchase a significant number of vehicles that would have been retired in the year purchased, or maybe the following year, even without a program. It is also logical that the best maintained older vehicles in the fleet, those with the longest remaining life, will not be attracted to the program, because their value to their owner far exceeds the likely asking price to be offered. The remaining vehicle life should, therefore, be conservatively estimated in order to realize real emission reduction benefits. Thus, maximum credit lifetime of 3 years is strongly recommended.

### **Enforcement**

Any accelerated retirement program must include adequate record keeping and monitoring to ensure that the activities that produce credits actually occurred. Such record keeping includes maintaining a log of the registration forms, pink slips and vehicle identification numbers. Proof that the engine was destroyed at the time of purchase and that the vehicle frame was crushed within three months after vehicle purchase is also required. Districts need to conduct periodic inspections of vehicle retirement sites to guarantee that all the dismantling requirements are fully enacted.

### **Issues**

## **Potential Supply of Vehicles for Retirement**

The potential level of credits available to a retirement program operator will be dependent on the number of older vehicles registered in each district, the price that credit seekers are willing to pay, and the number of owners willing to sell their vehicle at the price offered by the program operator. For example, based on an analysis of DMV registration data, in 1993, there will be approximately 720,000 pre-1972 vehicles statewide and 280,000 pre-1972 vehicles in the South Coast region. Not all of these vehicles would be available to the program, however. Some vehicles will be worth more than the price offered and others will be collector vehicles. If a program were expanded to include all pre-1980 vehicles, the potential supply would grow dramatically, to approximately one half of the state's 20 million light duty vehicles.

## **Testing**

During its vehicle retirement program, Unocal conducted emissions testing on 74 of the retired vehicles, using the Federal Test Procedure (FTP). The ARB staff worked with Unocal to identify vehicles to test and conducted the FTP on 43 of those vehicles, with the remaining vehicles tested by an independent lab. The test results, adjusted for in-use emissions, showed that, on average, the vehicles emitted approximately 25 grams/mile ROG, 3 grams/mile NO<sub>x</sub>, and 100 grams/mile CO.

Comparing these results to Table 3 indicates that the vehicles Unocal tested emitted ROG and CO at significantly higher rates than an average pre-1972 vehicle. In fact, the Unocal vehicles emitted twice as much ROG as the average vehicle emission figures specified in Table 3. By offering \$700 per vehicle, Unocal ensured that it was attracting worse than average vehicles. Over time, as the worst cars are removed from the road, average and better than average vehicles will be attracted to accelerated retirement programs. The ARB guidelines must account for such trends and, as a result, have not used the Unocal figures for baseline calculations.

If, however, an operator believes that the vehicles attracted to a particular accelerated retirement program emit higher than average levels, that operator could propose to institute a testing program. However, ARB staff have considered the issues related to programs which would grant emission reduction credits based on vehicle test results and are concerned that significant problems could arise in such programs. Areas of concern include: (1) a potential for vehicle owners (or test mechanics) to tamper with the vehicle prior to testing in order to maximize emissions and hence increase the size of the credit, (2) inconsistent or erroneous testing procedures, and (3) the high costs of testing.

Proponents of programs that would use vehicle testing as opposed to the ARB calculation method need to address at least these issues and should work with ARB staff to ensure that the program yields accurate, quantifiable, and enforceable emission reduction credits.

## **Potential Cost Effectiveness - A Few Scenarios**

The cost effectiveness of a program is calculated by dividing the total emissions benefit into the total cost of the program to give a \$/ton figure. For purposes of illustration, this guideline document lays out the possible cost-effectiveness of an accelerated retirement under five different scenarios. Market forces will determine the purchase prices of used cars for an accelerated retirement program,

so each scenario assumes a different purchase price to provide a potential range of outcomes. The market value will be determined by a host of variables including other stationary source regulatory requirements and the number of businesses conducting accelerated retirement programs. Thus, the cost-effectiveness figures reflect an estimate of the possible cost of generating a credit but do not include any estimate of the market value of the credit.

Table 7 illustrates what the cost-effectiveness would be if 10,000 vehicles were purchased for a per vehicle cost of \$500, \$700, and \$1,000. This table provides a picture of the possible price range within which reasonably cost-effective reductions of ROG and NOx could be achieved. The table omits computations of CO, as emission reduction credits for CO are not in high demand.

Table 7: Cost-Effectiveness for the Purchase of 10,000 Vehicles <sup>A</sup>			
Cost per Vehicle	\$500	\$700	\$1000
Total Program Cost (in millions)	\$6	\$8	\$11
Pre-1972 Vehicles <sup>B</sup> (tons ROG + NOx)	2,200	2,200	2,200
1972-1974 Vehicles <sup>B</sup> (tons ROG + NOx)	1,800	1,800	1,800
1975-1981 Vehicles <sup>B</sup> (tons ROG + NOx)	870	870	870
Pre-1972 Vehicles (\$/ton ROG + NOx)	\$2,800	\$3,700	\$5,100
1972-1974 Vehicles (\$/ton ROG + NOx)	\$3,300	\$4,400	\$6,000
1975-1981 Vehicles (\$/ton ROG + NOx)	\$6,900	\$9,200	\$13,000

Note A: Includes an administrative cost of \$100 per vehicle

Note B: Over 3 years

From the results of this particular analysis, it appears that an accelerated retirement program for older vehicles provides reasonably cost-effective reductions for a three-year period. These figures are comparable to other stationary source control measures indicating that an accelerated retirement program could offer a potential cost savings to a stationary source, albeit for a limited period of time.

## **6. GENERATION OF EMISSION REDUCTION CREDITS THROUGH THE PURCHASE OF LOW-EMISSION BUSES**

This chapter presents guidelines for generating mobile source emission reduction credits through the purchase and operation of low-emission buses in lieu of standard diesel buses. The generation of credits from these cleaner buses is expected to be especially important in districts with few industrial emitters that could be cleaned up or shut down and used as sources of emission reduction credits. The following sections will describe a likely scenario, presenting ARB's calculation guidelines, enforcement requirements and concerns. In addition, cost estimate examples will be presented for rough cost-effectiveness evaluation.

### **Introduction**

Urban transit buses serve every major metropolitan area of California and each travels an average of over 40,000 miles every year. They provide essential services to people traveling within the cities they serve and are an integral part of efforts to reduce air pollution. As existing transit buses are replaced, or new ones are added to handle the increased ridership, opportunities exist to create emission reduction credits by buying new buses that use fuels or engines that are cleaner than required by current standards. Also, because bus chassis tend to last for many years, opportunities exist to reduce emissions when their diesel engines are replaced with low-emission engines instead of rebuilt diesels. Another opportunity exists through the use of electric buses, where bus emissions are completely eliminated.

The majority of existing urban transit buses are currently powered by diesel engines. While the number of diesel buses compared to automobiles is very small, oxides of nitrogen (NO<sub>x</sub>) emissions from individual buses are relatively high. In an effort to meet ARB standards for particulate emissions from transit buses, some engine manufacturers have certified methanol (M100) and compressed natural gas (CNG) bus engines. These engines emit about one-half the NO<sub>x</sub> of a comparable new diesel engine. This reduction in NO<sub>x</sub> emissions opens the opportunity to create NO<sub>x</sub> emission reduction credits. On the other hand, because all new bus engines, including diesels, are subject to a very stringent particulate matter (PM) standard, there is little difference in PM emissions regardless of the fuel used. Therefore, little opportunity exists to generate PM credits by purchasing new, clean fuel buses instead of diesel buses.

The amount of credit available through purchasing low-emission buses will decrease as ARB adopts more stringent emission standards for heavy-duty vehicles in the future. Programs designed to generate emission reduction credits must require that credits only be allowed for emission reductions that are surplus to federal, state and local regulations. Currently, there is a window of opportunity to generate credits based on existing heavy-duty emission standards. As these standards are tightened in the future, and manufacturers are required to produce buses with lower emissions, fewer credits will be available.

Emission reduction credits could potentially be generated by retrofitting existing buses, although the life of the credits would be different. Also, it may be possible to gain credit by converting other heavy-duty urban fleets (such as garbage trucks) to cleaner fuels or technologies. Heavy-duty vehicle retrofit credit program possibilities are discussed in Chapter 9. Programs for generating credits through the purchase of new heavy-duty vehicles other than urban transit buses are presented in Chapter 10.

### **Program Guidelines**

The guidelines presented in this chapter are designed to allow districts and program operators to calculate emission reductions resulting from the purchase and operation of clean buses. The scenario considered herein begins with a transit agency faced with the need to purchase new buses, possibly due to simultaneous retirement of a large number of worn-out vehicles. The agency could buy new buses that meet the current applicable emissions standards, or it could opt for low-emission buses that emit below the current standards for new buses by a significant amount. For the latter case, the difference in emissions would constitute an emissions reduction that could be used or sold as credits.

At present, diesel-fueled buses are capable of emission levels only slightly below the current NOx emission standard. So the agency would have to purchase buses that operate on an alternate fuel (such as methanol, natural gas or electricity) if it wanted to generate credits by purchasing "clean" buses. At present, such alternate fueled buses are more expensive to purchase and operate than conventional diesel-powered buses. The extra funding required for low-emission bus purchase and operation could potentially be obtained from the sale of credits for the emission reductions.

According to the following guidelines, the amount of the emission reduction credit is based on the difference between the certification standards of the two bus types involved. In addition, the credit life is based on the expected operating life of the substitute low-emission bus being purchased.

### **Pollutants for Which Credits Can be Granted**

NOx is the only pollutant considered in these guidelines as a reasonable candidate for credit generation. NOx emissions from diesel vehicles equipped with a particulate trap are very close to the current certification standard. Particulate matter (PM), reactive organic gas (ROG) and carbon monoxide (CO) levels from current diesel/trap engines are already quite low. This means that any PM, ROG or CO emission reductions from alternate fuel engines would be small. Due to the lack of extensive data regarding in-use emissions, the uncertainties associated with the lifetime PM, ROG and CO emission values of alternate fueled buses are quite large. This greatly reduces the confidence that credits generated for these three pollutants meet the "real and permanent" criteria for emission reduction credits. Therefore, no credits have been estimated for pollutants other than NOx. (Please see the additional information provided on greenhouse gas emissions, vehicle evaporative emissions, and fuel distribution system emissions in the "Issues" part of this analysis.)

### **Calculation of Credits**

The following sections describe the factors and procedures used to calculate the emission reduction credit associated with purchasing a low-emission bus.

#### Calculation of Vehicle Emission Rates

The magnitude of the NO<sub>x</sub> emission reduction is calculated based on the difference between the regulatory urban bus emission standard for NO<sub>x</sub> (the "ceiling" standard) and a low-emission (or "credit") standard, to be discussed below. A conversion factor is used to convert the emission standard to a gram per mile emission rate. It is necessary to use standards rather than actual measured emission levels to calculate the emission reduction credit to ensure that production variability and emission control system deterioration are taken into account. The credit standard establishes an enforceable level with which buses that are purchased to generate credits must comply. (A detailed discussion of compliance responsibility for the duration of vehicle life will be discussed below).

#### Certification Standards

The current urban bus emission standard for NO<sub>x</sub> is 5.0 gram/bhp-hr. This is the ceiling standard used for credit calculations. In June 1993, the Board approved a staff proposal to adopt a new NO<sub>x</sub> standard of 4.0 gram/bhp-hr for urban transit buses, to become effective in 1996, in fulfillment of Senate Bill number 135 (Boatwright, 1991). Federal law establishes a 4.0 gram/bhp-hr standard nationwide in 1998. Once the lower NO<sub>x</sub> standard becomes effective, credits will be calculated based on the lower ceiling standard.

The credit standard, to which a potential low-emission bus engine must be certified in order to generate credit, may be selected by the engine manufacturer from the multi-tier values presented in Table 8.

Table 8: Allowable Urban Bus NOx Low-Emission Certification Standards		
Type	Current (gram/bhp-hr)	Future (gram/bhp-hr)
Ceiling Standard	5.0	4.0 <sup>A</sup>
Credit Standard	3.5	----
	3.0	----
	2.5	2.5
	2.0	2.0
	1.5	1.5
	1.0	1.0
	0.5	0.5
	0	0

Note A: To be implemented in 1996

This multi-tier approach is used to allow the engine manufacturer and purchasing agency the maximum flexibility possible in certifying and selecting an engine family. These standards are also contained in the low-emission transit bus regulations approved by the Board in June 1993.

It is apparent from this table that the highest credit standard is well below the applicable ceiling standard. An engine must be significantly cleaner than the ceiling standard to assure that a real emission reduction is achieved.

#### Conversion Factor

Since bus emission certifications are based on engine dynamometer testing, as opposed to chassis dynamometer testing, it is necessary to use a conversion factor (CF) to convert the engine's emission rates in gram/bhp-hr to the gram/mile values needed in subsequent credit calculations. This conversion factor is calculated from engine brake specific fuel consumption, fuel density and vehicle fuel economy (miles per gallon or miles per standard cubic foot). The values used for calculations are presented in Table 9.

Table 9: Emission Conversion Factors	
Fuel	CF (bhp-hr/mile)
Diesel	4.3
Methanol	4.3
Natural Gas	4.1

The conversion factor given for diesel was calculated based on non-trap-equipped engine and vehicle data. However, this value should provide sufficient accuracy for trap-equipped vehicle calculations and will therefore be used in the sample calculations in this document.

These conversion factors will be updated in the future as more data for alternate-fueled buses becomes available. As other types of alternate-fueled engines and other types of vehicle propulsion systems (e.g., fuel cells) reach production status, appropriate conversion factors for them will also be developed. The ARB should be contacted for the latest conversion factor values when credit calculations are made.

### Credit Life

Credit life has been determined based on the typical useful life of urban transit buses. Currently, little durability data is available to indicate the useful life of alternate fueled buses, such as methanol- or CNG-fueled vehicles. The Federal Transit Administration (FTA) uses a 12-year lifespan to determine its prorated interest in buses purchased with the aid of FTA grants. This is used as the typical lifespan of a diesel bus. Since methanol and CNG vehicles are usually derived from diesel powered bus technology, they are assumed to have a similar lifespan. Therefore, credits generated by purchasing methanol or natural gas fueled buses are assumed to have a baseline lifespan of 12 years. For the case of electric trolley buses, the FTA uses an 18-year lifespan. Therefore, credits generated by purchasing electric trolley buses have an 18-year baseline lifespan.

Length of credit life other than these baseline values may be used if the vehicle operator can justify the longer vehicle life and explicitly commits to operate the low-emission bus for that period of time. The remainder of this document assumes the diesel baseline lifespan.

The 12-year lifespan accumulated vehicle mileage used for emission reduction calculations is 500,000 miles. This assumes the bus engine will be rebuilt once to new-engine condition (and new-engine, zero-mile emission levels) at about vehicle mid-life (roughly 290,000 miles.) For electric trolley buses, the 12-year/500,000 mile life is prorated to 750,000 miles at 18 years.

## Replacement Bus Credit Ratio

Credits are granted on a ratio of one low-emission bus replacing one standard bus. If a proponent agency clearly demonstrates that it is replacing more than one standard diesel bus with a low-emission bus, then ARB will consider a replacement ratio other than 1:1. The proponent must consider such factors as route and ridership differences in its comparison.

Similarly, utilizing two small, low-emission buses to replace a larger, higher-emitting bus does not result in double the credit amount. In order to receive credit for small buses, a case-by-case analysis will be required.

## Calculation Procedure

The following procedure is used to calculate the amount of credit to be generated by low-emission bus procurement. These guideline procedures will be illustrated with specific examples in the "Program Benefits and Cost" section later in this chapter.

Step 1: Calculate the gram/mile equivalent emission rate for the ceiling standard vehicle and the credit standard vehicle. This is done by multiplying the appropriate standard from Table 8 (based on the applicable ceiling standard and the chosen engine's credit certification level) by the proper conversion factor from Table 9.

Step 2: Calculate vehicle lifetime emissions. For both the ceiling standard and credit standard vehicles, multiply the gram/mile results of Step 1 by the 500,000-mile vehicle lifetime. Convert measurement units from grams to tons.

Step 3: Calculate the lifetime pollutant reduction. Subtract the Step 2 lifetime tonnage result for the credit standard engine from that of the ceiling standard engine. This is the lifespan emission tonnage reduced per bus. Note that this is not an annualized, tons per year value. To determine the annual tons per year divide the lifetime tons value by 12.

## **Credit Emissions Testing and Compliance Responsibility**

In order to generate credits by purchasing low-emission buses, operation of the buses must result in real emission reductions throughout the credit life. A means of verifying that low emissions are maintained throughout the bus life is needed to ensure that real emission reductions occur.

Historically, urban buses have not been routinely tested for in-use emissions compliance since many studies have shown that heavy-duty diesel engines are stable with respect to emissions deterioration over time. However, as low-emission engines that use alternate fuels and add-on control equipment, such as catalytic converters, are developed and put into use, emission deterioration rates may increase significantly. The district should require the implementation of an appropriate in-use testing program to ensure that the reduced emission levels associated with low-emission buses which participate in a credit program are maintained in customer use. The cooperation of the credit-generating transit agency and the credit user is expected in any effort deemed necessary to verify in-use compliance. At a minimum, it may be necessary for a small number of buses to be made available for chassis dynamometer emission tests, along with the funds

necessary to conduct the tests. The parties seeking credits must demonstrate that they have plans and contracts in place to meet these obligations before credit can be granted. ARB staff will work with all involved parties to ensure that an effective testing program is implemented. As with any ARB-certified vehicle, ARB has the authority to recall low-emission buses that do not comply with the emission standard to which they are certified.

### Compliance During Certified Engine Life

For credit generation purposes, the engine manufacturer must obtain ARB certification of the low-emission engine to one of the credit standards listed in Table 8. To certify an engine to a credit standard, the engine manufacturer must demonstrate through the normal certification procedures that the engine emits below the level of the chosen credit standard. The engine manufacturer must also accept responsibility for the in-use emissions of the engine-family up to 290,000 miles of use and make repairs if the engine-family systematically exceeds the credit standard certification level. The engine manufacturer must provide the appropriate factors to correlate chassis and engine dynamometer test results.

During the first 100,000 miles of engine life, the manufacturer must provide a warranty to cover a specific engine's emission control equipment, as is required by current certification procedures. During this period, the manufacturer is responsible for the repair of any faulty piece of engine or emission control equipment that causes emissions to exceed the credit certification standard. For the period between 100,000 miles and 290,000 miles (the accepted upper limit to an engine's useful life), the manufacturer has responsibility for systematic or design defects common to an entire engine-family.

In the past, responsibility for random, non-systematic parts failure in the period between 100,000 and 290,000 miles has not been formally assigned to anyone. But in order to generate credits, the vehicle operator must accept responsibility for maintaining the vehicle to proper, low-emission operation conditions throughout the life of the vehicle.

### Compliance After Rebuild

While engine life is considered complete at 290,000 miles, most engines are rebuilt and put back into operation to yield at least a 500,000-mile total vehicle life. It is assumed that a rebuild restores an engine to zero-mile conditions (and new engine certification levels) and that emissions therefore remain below the certification level throughout the remainder of the vehicle life. To generate credits, the vehicle operator must take responsibility for engine emissions compliance during the post-rebuild period. The engine must be rebuilt to the original equipment manufacturer's specifications, including all equipment on the emissions critical parts list. The operator must also maintain each individual vehicle so that emission control equipment failures are readily detected and corrected. Vehicles with rebuilt engines should be included in the in-use testing program required by the district. To detect systematic errors in the rebuild process, the ARB, at its discretion, may test some of the rebuilt fleet in each engine family to determine post-rebuild emissions levels. If ARB determines that such testing is necessary, the operator must make vehicles available to ARB for emissions testing.

In summary, at all times during the life of an individual vehicle responsibility must be taken for ensuring in-use compliance with the applicable credit certification standards.

## Extended Life Credit Generation

For a variety of reasons, several organizations have expressed interest in permitting long-term stationary sources with shorter term mobile source emission reduction credits. Because low-emission bus credits have a long life relative to the life of other mobile source emission reduction credits, they can potentially be used to generate credits that apply to a 25- to 30-year stationary source project. These are called "extended life" credits. To use bus credits for such a purpose, an operator must agree to purchase and operate a predetermined number of low-emission buses at periodic intervals over the life of the permitted project. The total amount of credit can be projected over the extended period based on purchase plans and applicable ceiling and credit standards. When the plan indicates that a bus will be purchased, the planned emission reduction, on a tons per year basis, is added to the cumulative total of credits. At the end of the projected bus life, the annual emission reduction is subtracted from the cumulative total of credits. As shown in Figure 1, the cumulative credits over time would show a ramp up from zero, a leveling off during the midlife region and a slow ramping down to zero at the end of the extended life credit period.

The total extended life credit period must equal or exceed the life of the project utilizing the credits. However, buses need not be acquired over the entire period since some credits remain available for up to 12-years after the last bus has been purchased. ARB staff have developed the following guidelines for generating credits over an extended life:

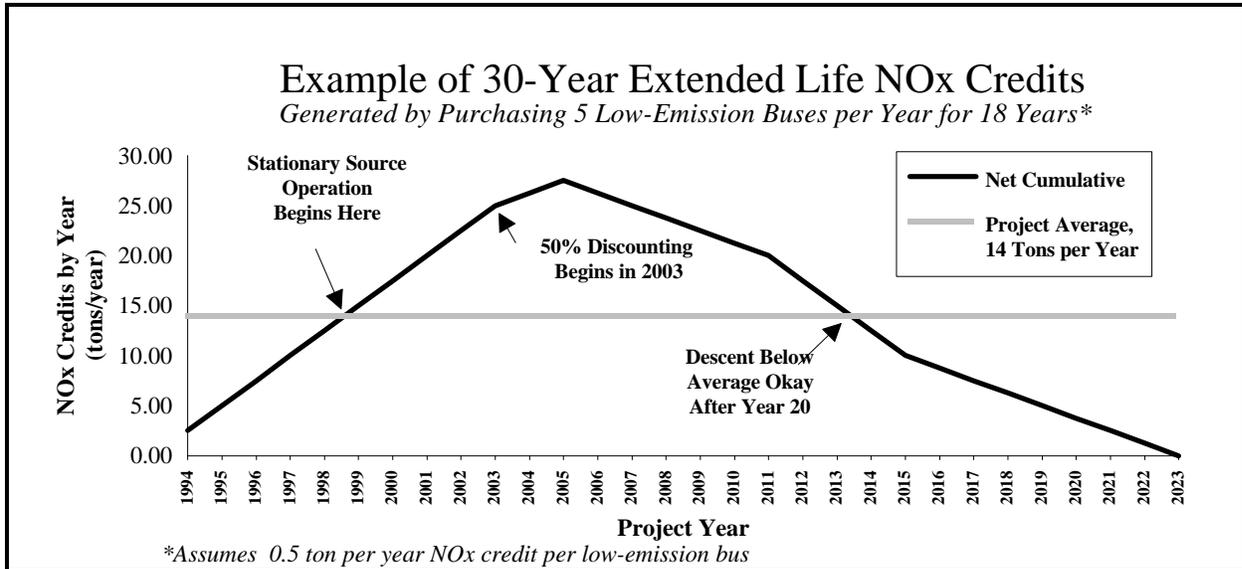
- 1) The credit calculation for each individual bus purchased is conducted according to the guidelines presented in this document. Individual bus credit life is 12 years unless demonstrated otherwise as described in the Credit Life section, above. The applicable ceiling and credit standards are presented in Table 8.
- 2) A plan for purchasing buses is developed. The amount of individual bus credit to be granted is calculated, taking into account all expected future emission standards that are known at the time that the extended credit plan is developed.
- 3) The credit amount that can be used to offset emissions from a stationary source is the average value of the individual bus credits generated over the extended credit lifetime.
- 4) A stationary source which uses extended life, low-emission bus credits to meet emission offset requirements cannot commence operations until the cumulative amount of credit generated equal or exceeds the required offset level.
- 5) Individual bus credits projected to be generated in the year 2003 and later based on existing standards are adjusted downward by 50 percent before being included in the cumulative or lifetime average credit calculations. Future changes in California heavy-duty emission standards will likely result in decreases in ceiling emission standards. This approach helps to compensate for situations in which actual emission reductions are lower than originally planned based on standards in effect at the time the plans were conceived.
- 6) Once the permitted stationary source begins operation, the sum of available credits at any point in time must not fall below the lifetime average except during the last third of the extended credit period (e.g., years 21 through 30 of a thirty year period).

- 7) Should bus purchases fall behind the required schedule, the credit user is obligated to procure compensating offsets from alternate sources.

**FIGURE 1**

**Issues**

**Retrofit Conversions**



The conversion of existing buses to low-emission configurations also has potential for generating mobile source emission credits. Some operators have retrofitted existing diesel buses to operate on natural gas, methanol, and other alternate fuels. The amount of emission reductions from these conversions varies from case to case and is not readily predictable based on current data and experience. However, guidelines for heavy-duty retrofit scenarios are included in Chapter 9.

**Greenhouse Gas Emissions**

There is increasing concern today about the environmental effects of greenhouse gas, primarily carbon dioxide (CO<sub>2</sub>) and methane (CH<sub>4</sub>), emissions. Switching to alternate fuels can result in changes in these emissions from bus operations. Table 10 presents the results of estimates of CO<sub>2</sub> emissions from the ceiling standard and credit standard buses considered in this document. This table conservatively assumes that all the carbon in the fuel is completely oxidized to CO<sub>2</sub>.

Table 10: CO <sub>2</sub> Emissions Over 500,000 Mile Lifetime			
	Diesel/Trap	Methanol	CNG
CO <sub>2</sub> (total C conversion) <sup>A</sup>	1660 Tons	1520 Tons	1170 Tons
CO <sub>2</sub> Change vs. Diesel	-----	-8%	-27%

Note A: CO<sub>2</sub> Emissions from CNG bus calculated by assuming total carbon conversion and subtracting CO<sub>2</sub> equivalent of CH<sub>4</sub> emissions.

Table 11 examines the effects of methane (CH<sub>4</sub>) emissions from natural gas-fueled buses. The results assume that methane is not oxidized by catalytic converters. The calculations are based on reported CNG engine test data indicating a total hydrocarbon emission rate of 5.5 g/bhp-hr, 85 percent of which is methane.

Table 11: Consideration of CNG Methane Emissions Over 500,000 Mile Lifetime	
Typical CH <sub>4</sub> Emissions	11 Tons
Effective CO <sub>2</sub> Emissions <sup>A</sup>	220 Tons
Total Effective CO <sub>2</sub> <sup>B</sup>	1390 Tons
Change vs. Diesel	-16%

Note A: Due to CH<sub>4</sub>, assuming CH<sub>4</sub> has 20 times the greenhouse effect of CO<sub>2</sub> on a weight basis.

Note B: Includes direct CO<sub>2</sub> emissions of 1170 tons.

These two tables indicate that low-emission CNG- and methanol-fueled buses have lower greenhouse gas exhaust emission rates than standard diesel buses. Therefore, the possibility of accelerating the global warming effect by substituting alternate fuels for diesel is minimal.

### Vehicle Evaporative Emissions

It is important for air quality purposes to avoid an increase in evaporative emissions when credit-generating alternate-fueled buses are used in lieu of standard diesel buses.

Diesel vehicles have traditionally been considered to have negligible evaporative emissions, due primarily to the relatively low Reid Vapor Pressure (RVP) of diesel fuel. Because of this, diesel buses currently are not required to utilize evaporative emissions control equipment. CNG- fueled buses require no evaporative emission controls since they use closed fuel systems to contain the pressurized gas. However, methanol buses use an open fuel system. Therefore, methanol-fueled vehicles could have significant evaporative emissions in the absence of adequate control equipment.

At present, all light-, medium-, and heavy-duty vehicles are required to meet a two gram per test diurnal evaporative emission standard. Effective in 1995, all vehicles will be required to control their running loss evaporative emissions to a level of 0.05 gram/mile or less of ROG. Utilizing these figures, and assuming one diurnal test represents one day of bus operation, a methanol powered bus would have evaporative emissions of about 0.04 tons ROG or 0.02 tons "organic material hydrocarbon equivalent" (OMHCE) over its lifespan. Therefore, evaporative emissions from methanol-fueled buses can be assumed to be negligible (compared to the exhaust emission levels) as long as the evaporative control equipment functions properly.

### **Distribution System Evaporative Emissions**

Use of alternate-fueled buses will result in an increase in losses from the respective statewide alternate fuel distribution systems. Natural gas distribution utilizes a sealed pressurized system. ARB emission inventory data indicate that escaped ROG attributable to the transport of CNG fuel for one CNG bus would amount to less than 0.1 tons over the lifetime of the bus. Methanol is a liquid that is stored in tanks and, during storage and transfer, it is subject to evaporative losses. To estimate methanol distribution system losses, it is assumed that the losses can be scaled to gasoline distribution system losses on a per gallon of fuel basis. Using ARB's emission inventory for gasoline distribution system losses, adjusting for the lower RVP of methanol and the expected gallons used per bus, and putting the results in terms of OMHCE, ARB staff estimates losses of about 0.2 tons OMHCE per bus over the bus lifetime. Therefore, increases in CNG and methanol fuel distribution system losses can be considered negligible, relative to the exhaust emissions of the bus.

### **Program Benefits and Costs**

To aid the Board in determining the usefulness of low-emission bus credit programs, some approximate cost-effectiveness information is presented here. This section presents the calculations that provide such information for two example cases: NOx credits generated through the purchase of a low-emission methanol bus and those generated through the purchase of a low-emission CNG bus. It should be emphasized that this program is not limited to these two technologies. Other bus types with the potential for low emissions, such as liquefied natural gas (LNG), liquefied petroleum gas (LPG), fuel cells, electric and even clean diesel engines, are eligible if they can be certified to one of the applicable credit standards.

ARB staff has estimated the costs associated with purchasing and operating low-emission buses. These costs are used with the credit calculation steps presented in the previously delineated calculation procedures to estimate cost-effectiveness. Numerical results are presented only as a demonstration of the calculation procedure and may not be fully representative of the values that will be obtained in any particular case. This is due to the variable nature of the assumed quantities involved.

(Please note that numbers in the following tables have been rounded for presentation purposes. However, all available significant figures were used for intermediate calculations. Therefore, using table values for calculations may not give the same end results due to round-off error.)

### **Costs Will Vary from Case to Case**

The following discussion of prices, costs and cost effectiveness is highly specific to the particular case being examined. Results are dependent on a number of variables that can change dramatically from case to case. The intent in this document is solely to demonstrate that at least one set of circumstances exists under which low-emission bus credits can be cost effective. No attempt is made to demonstrate or optimize relative cost effectiveness between different technologies. Proponents of programs to generate low-emission bus credits are **strongly** urged to perform their own case-specific analyses to determine the benefits of various technologies as applied in their own unique situation.

### Lifetime NOx Reductions

The NOx ceiling standard used in these examples is 5.0 gram/bhp-hr., based on a trap-equipped diesel bus. The credit standard used is 2.5 gram/bhp-hr. The results of the Steps 1, 2 and 3 calculations, (set out in the "Calculation of Credits" section) for methanol, CNG, and electric buses are presented in Table 12.

Table 12: Lifetime NOx Reduction per Bus				
	Diesel/Trap (ceiling std.)	Methanol (credit std.)	CNG (credit std.)	Electric Trolley (credit std.)
NOx Standard (gram/bhp-hr)	5.0	2.5	2.5	0.0
Conversion Factor (bhp-hr/mile)	4.3	4.3	4.1	N/A
Equivalent Emission Rate (gram/mile)	21.5	10.7	10.3	0.0
Lifetime Mileage (miles)	500,000	500,000	500,000	750,000
NOx Emitted Over Lifetime (tons)	11.8	5.9	5.6	0.0
NOx Reduction Over Lifetime vs. Diesel Ceiling (tons)	----	5.9	6.2	17.7

Note: These are emissions reductions over the entire credit life, and are not annualized to tons/year values.

### Fuel Price Assumptions

Fuel price assumptions are based on the best currently available price information for all fuels. Due to the variable nature of fuel prices, future prices are not reflected in this analysis. Increases or decreases in the price will affect the relative cost-effectiveness of the methanol and CNG bus purchase scenarios.

The diesel fuel price used, \$0.75/gallon, is the anticipated pre-tax price of fuel, including transportation, which meets the low aromatic/low sulfur standards that went into effect in 1993.

The pre-tax price range used for methanol is \$0.42/gallon to \$0.50/gallon with a transportation cost of \$0.02/gallon subsequently added on. These are the maximum and minimum fuel prices for the California Energy Commission's California Methanol Fuel Reserve. The Reserve was established to assure a supply of fuel for methanol-fueled motor vehicles during their public introduction period. These prices were actually attained in the period from the last quarter of 1990 through the first quarter of 1993.

Natural gas is priced by the therm. It is metered by volume and the higher heating value (HHV, therms per standard cubic foot) is used as a conversion factor. The price charged by individual utilities requires approval by the California Public Utilities Commission (CPUC). The CPUC currently allows Natural Gas Vehicle rate structures that provide natural gas at rates similar to those charged to a high volume industrial user. These rates range from \$0.30/HHV therm to \$0.35/HHV therm depending on the supplying utility. The utilities have indicated that the future price of natural gas for vehicular use should remain comparable to that charged to standard industrial users, although firm price projections are not currently available. The present analysis uses this range for its low and high price scenarios.

Transit agencies are exempt from state and federal excise taxes on fuel. Sales taxes are neglected in this analysis due to their variable nature.

### **Fuel Economy Assumptions**

To convert fuel costs from a per unit basis to the more useful per mile basis, some knowledge of miles per gallon, or miles per therm as applicable, is needed. The best available data indicate that values of 3.3 miles/gallon for a trap-equipped diesel bus and 1.4 miles/gallon for a methanol bus are reasonable.

For natural gas vehicles, a fuel economy of 2.1 miles/LHV (lower heating value) therm is reasonable. Dividing this value by the HHV to LHV ratio of 1.1 gives a fuel economy of about 1.9 miles/HHV therm. This provides units consistent with the fuel price units given above.

### **Infrastructure Cost Assumptions**

Methanol and natural gas both have storage and dispensing characteristics significantly different from each other and from diesel fuel. For instance, a gallon of methanol has less than 45 percent of the energy content of a gallon of diesel fuel so a methanol bus requires about twice the volume of fuel that a diesel bus requires. In addition, methanol is corrosive and must be contained in corrosion resistant tanks, using special plumbing, pumps, etc. Storage of natural gas at ambient temperature requires compressors and strong pressure vessels. These characteristics require the transit agency

to install a fuel-specific infrastructure simultaneously with the procurement of alternate fueled low-emission buses. This is an additional cost over that required if diesel buses are procured (assuming the transit agency already has a diesel fueling infrastructure in place).

Estimates of refueling infrastructure costs vary. For example, compressed natural gas system equipment procurement and installation estimates range from \$1.5 million to \$3.5 million for a system with sufficient capacity to handle up to 200 buses. The variability results from factors such as gas supply pressure, ancillary building modification requirements, etc. An average cost of \$2.5 million is used for this analysis. Similarly, a 200-bus capacity methanol infrastructure is estimated to range in price from \$700,000 to \$1.5 million.

To examine the feasibility of a low-emission bus credit program for both small and large transit agencies, calculations are presented below for a 10-bus system and a 200-bus system. The infrastructure estimates are significantly lower for the smaller system: a flat \$141,000 for methanol and \$270,000 to \$675,000 for CNG. (It may be cost effective for a small agency to service vehicles at fuel supplier or third party facilities but this case is not examined here.)

### **New Bus Costs**

A diesel fueled bus with a particulate trap costs approximately \$225,000. A methanol powered low-emission bus currently costs in the range of \$240,000 to \$250,000, and one fueled by CNG is priced from approximately \$250,000 to \$260,000. These numbers will vary with such factors as the quantity of buses purchased in a single order, the number of orders a manufacturer receives, etc.

### **Infrastructure Operation Costs**

Once a particular refueling infrastructure is installed, there are costs associated with its operation. Since there is essentially no difference between the cost to pump diesel and the cost to pump methanol, no operational costs are assigned to these two refueling configurations. However, the natural gas system compressors require electricity to compress the natural gas from the low supply pressure to the 3,000 to 3,600 psi on-board storage pressure. This gives a significant operating cost differential vs. diesel or methanol operations.

For a small, 10-bus transit agency, compressor operating costs are estimated to range from about \$20,000/year to \$28,000/year, while the same costs for a 200-bus transit agency would range from about \$200,000/year to \$380,000/year. These estimates cover electrical power consumption and compressor maintenance, both of which decrease on a per standard cubic foot basis as the number of vehicles serviced goes up. This effect is due to higher compressor efficiencies for larger compressors and to maintenance economies of scale.

### **Calculation and Summary of Operational and Capital Costs**

Vehicle fuel costs are easily determined from the above data. First, determine vehicle fuel costs per mile by dividing the unit fuel cost by the fuel economy in miles per fuel unit (gallons, therms, etc.) Other per mile operating costs can be added as necessary. Next, multiply by annual mileage to get annual fuel consumption per bus. This process is performed for both the ceiling standard bus and the credit standard low-emission bus. Table 13 shows the sample calculation results.

Table 13: Individual Bus Fuel Cost Summary 500,000 Mile, 12-Year Lifetime					
	Diesel/Trap	Methanol	Methanol	Natural Gas	Natural Gas
		(low)	(high)	(low)	(high)
Fuel Cost	\$0.75 (per gallon)	\$0.44 (per gallon)	\$0.52 (per gallon)	\$0.30 (per HHV therm)	\$0.35 (per HHV therm)
Fuel Economy	3.3 (mile/gallon)	1.4 (mile/gallon)	1.4 (mile/gallon)	1.9 (mile/HHV therm)	1.9 (mile/HHV therm)
Fuel Cost per Mile	\$0.26	\$0.31	\$0.37	\$0.16	\$0.18
Annual Fuel Cost	\$11,000	\$13,000	\$15,000	\$6,600	\$7,700

Note: The diesel fuel cost per mile also contains a \$0.03/mile cost for particulate trap core replacement.  
Methanol fuel cost contains \$0.02/gallon for transport.

To estimate fleet procurement and operational costs, first multiply the purchase price of a ceiling standard bus by the total number of buses purchased and repeat for the credit standard bus. Then take the net present value of the lifetime expenditures for annual fuel costs and annual infrastructure operating costs, utilizing appropriate inflation and discount rates. (A 3% annual rate of inflation and a 10% annual discount rate were used in these examples.) Finally, add these discounted values to the total bus purchase and infrastructure capital costs. (Capital costs were assumed to be paid up front so no amortization was applied.) Then calculate the alternate fuel incremental cost vs. diesel cost by the appropriate subtraction. Tables 14 and 15 present these calculations for a small and a large transit agency, respectively.

Table 14: Capital and Operational Costs for a Small Agency  
 10 Buses, 12-Year and 500,000 Mile Lifetime

	Diesel	Methanol	Methanol	Natural Gas	Natural Gas
		(low)	(high)	(low)	(high)
New Bus Purchase Cost	\$225,000	\$240,000	\$250,000	\$250,000	\$260,000
Bus Purchase Cost, Total	\$2.25 million	\$2.4 million	\$2.5 million	\$2.5 million	\$2.6 million
Refueling Infrastructure Installation Cost	-----	\$140,000	\$140,000	\$270,000	\$680,000
Infrastructure Operating Cost Rate	-----	-----	-----	\$2,000/ bus/year	\$2,800/ bus/year
Annual Fuel Costs	\$110,000	\$130,000	\$150,000	\$66,000	\$77,000
Net Present Value	\$3.1 million	\$3.6 million	\$3.8 million	\$3.4 million	\$4.1 million
Incremental Lifetime Cost Over Diesel	-----	\$480,000	\$760,000	\$350,000	\$1 million

Table 15: Capital and Operational Costs for a Large Agency 200 Buses, 12-Year and 500,000 Mile Lifetime					
	Diesel	Methanol	Methanol	Natural Gas	Natural Gas
		(low)	(high)	(low)	(high)
New Bus Purchase Cost	\$225,000	\$240,000	\$250,000	\$250,000	\$260,000
Bus Purchase Cost, Total	\$45 million	\$48 million	\$50 million	\$50 million	\$52 million
Refueling Infrastructure Installation Cost	-----	\$700,000	\$1.5 million	\$1.5 million	\$3.5 million
Infrastructure Operating Cost Rate	-----	-----	-----	\$1,000/ bus/year	\$1,900/ bus/year
Annual Fuel Cost	\$2.1 million	\$2.6 million	\$3.1 million	\$1.3 million	\$1.5 million
Net Present Value	\$62 million	\$69 million	\$76 million	\$63 million	\$70 million
Incremental Lifetime Cost Over Diesel	-----	\$7.4 million	\$14 million	\$1.6 million	\$8.7 million

The emission reduction cost-effectiveness can now be determined. Multiply the lifespan emission reduction from Table 12 by the number of buses purchased and then divide into the incremental cost. These results are presented in Tables 16 and 17 below for the small and large agencies, respectively.

Table 16: NOx Reduction Cost Effectiveness for a Small Agency 10 Buses, 12-Year and 500,000 Mile Lifetime				
	Methanol	Methanol	CNG	CNG
	(low)	(high)	(low)	(high)
Incremental Cost vs. Diesel (from Table 14)	\$480,000	\$760,000	\$350,000	\$1 million
Lifetime NOx Reduction (from Table 12) x no. of Buses	59 Tons	59 Tons	62 Tons	62 Tons
Cost-Effectiveness (\$/ton)	\$8,000	\$13,000	\$5,700	\$16,000

Table 17: NOx Reduction Cost-Effectiveness for a Large Agency 200 Buses, 12-Year and 500,000 Mile Lifetime				
	Methanol	Methanol	CNG	CNG
	(low)	(high)	(low)	(high)
Incremental Cost vs. Diesel (from Table 15)	\$7.4 million	\$14 million	\$1.6 million	\$8.7 million
Lifetime NOx Reduction (from Table 12) x no. of Buses	1180 Tons	1180 Tons	1240 Tons	1240 Tons
Cost-Effectiveness (\$/ton)	\$6,300	\$12,000	\$1,300	\$7,000

Finally, to examine the effects of the different tier levels, Table 18 presents the NOx reduction quantities for each of those levels. Cost-effectiveness calculations are not presented due to the lack of vehicle procurement cost information for the different levels of emission technology involved.

Table 18: Estimates of Lifetime NOx Reduction per Bus by Each Credit Standard Level						
	5 gram/bhp-hr ceiling			4 gram/bhp-hr ceiling		
Credit Standard (gram/bhp-hr)	Methanol (tons)	CNG (tons)	Electric Trolley	Methanol (tons)	CNG (tons)	Electric Trolley
3.5	3.5	3.9	-----	-----	-----	-----
3.0	4.7	5.1	-----	-----	-----	-----
2.5	5.9	6.2	-----	3.5	3.9	-----
2.0	7.1	7.3	-----	4.7	5.1	-----
1.5	8.3	8.4	-----	5.9	6.2	-----
1.0	9.5	9.6	-----	7.1	7.3	-----
0.5	10.6	10.7	-----	8.3	8.4	-----
0.0	11.8	11.8	17.7 <sup>A</sup>	9.5	9.6	14.2 <sup>A</sup>

Note A: Based on 18 year/750,000 mile lifetime.

It is apparent from this table that purchasing the lowest emitting bus possible provides significant increases in the amount of credits that can be generated. It is also readily seen that there is incentive for credit generation to occur before the ceiling standard is reduced in 1996. Whether it is cost-effective to use these factors to increase credit levels cannot be determined without further bus cost information.

## **7. GENERATION OF EMISSION REDUCTION CREDITS THROUGH THE PURCHASE OF ZERO-EMISSION VEHICLES**

This chapter presents guidelines for generating emission reduction credits by purchasing zero-emission vehicles.

### **Introduction**

Widespread use of zero-emission vehicles, or ZEVs, has the potential to significantly improve air quality. ZEVs have no direct emissions, and they do not have emission control systems that can deteriorate in customer use. The ARB, as part of the Low-Emission Vehicle (LEV) regulations that were adopted in September 1990, requires major manufacturers to produce a minimum number of ZEVs for sale in California starting in 1998. This chapter provides program guidelines for generating mobile source emission reduction credits by purchasing ZEVs and addresses some of the key issues associated with such a program. The general concept is to give people an extra incentive to buy a ZEV instead of an "emitting" vehicle. Through such a program, an entity that is interested in generating emission reduction credits could assist an individual or company that is interested in purchasing a ZEV by offsetting a portion of the purchase price.

Emission reduction credit programs must ensure that credits can only be allowed for emission reductions that are in excess of the emission reductions required by federal, state and local regulations. Because manufacturers are already required to produce a minimum number of ZEVs under ARB's LEV regulations, the guidelines are designed to provide credits for the purchase of ZEVs while ensuring that the credits granted are surplus to the LEV regulation requirements.

The LEV regulations require vehicle manufacturers to meet an increasingly stringent fleet average emission standard for non-methane organic gas (NMOG) emissions, for model years from 1994 through 2003. Additionally, beginning in model-year 1998, major vehicle manufacturers are required to produce a minimum number of ZEVs, and will likely use the zero NMOG emissions associated with the ZEVs to help them meet the required fleet average NMOG emission standards. These regulations allow manufacturers that produce ZEVs prior to the 1998 time frame, or in excess of the mandated percentages, to earn credits which can be used to comply with aspects of the ARB's LEV regulations. Credits may be banked for use in future years or sold to other manufacturers. Credits retain their full value until 1998, after which time they are depreciated in each year they are not used. Although the ZEV mandate does not apply to medium-duty vehicles, manufacturers may also earn credits for producing medium-duty ZEVs. The following guidelines ensure that any emission reduction credits granted to stationary sources or others affected by district rules for the purchase of a ZEV are surplus to the manufacturer credit system contained in ARB's LEV regulations.

## **Program Guidelines**

To ensure that ZEV purchase programs achieve real emission reductions, the program operator must ensure that the vehicle manufacturer does not use the ZEVs produced for purchase through the program in the calculation of its fleet average NMOG emission rate, bank the emission credits associated with the ZEVs for future use, or sell the credits to another major manufacturer. This is done by purchasing or otherwise acquiring from the vehicle manufacturer the rights to these credits. The manufacturer can, however, use the ZEVs to satisfy the minimum production requirement in the LEV regulations, i.e., two percent in 1998 increasing to ten percent in 2003. The program operator must also ensure that a ZEV is actually purchased in the district where the credit is granted.

## **Calculation of Credits**

The following sections describe the factors and procedures used to calculate the emission reduction credit associated with purchasing a ZEV.

### **Baseline Vehicle Emissions**

Emission reductions associated with the purchase of a ZEV are calculated based on the difference between the average emission rate of a new, emitting vehicle and a ZEV. ARB staff believes it is likely that a person who would purchase a ZEV would probably purchase a new emitting vehicle if the ZEV were not available. At this time, it appears that the cost of ZEVs will be comparable to the cost of a new, emitting vehicle. Thus, a person in the market for a used vehicle probably wouldn't be able to afford a ZEV. For this reason, ARB staff believe it is appropriate to calculate emission reductions associated with ZEVs based on the difference between emissions from a new, emitting vehicle and a ZEV.

The ARB staff assumes that an "average" new car has emissions equal to the average model year emission rates for the year in question. For the purposes of these guidelines, this average new car is called the "baseline" vehicle. The baseline vehicle emission rates are intended to reflect the mix of vehicles available for purchase in the program year. For the purpose of this evaluation, the non-methane organic gas (NMOG), oxides of nitrogen (NOx), and carbon monoxide (CO) emission rates for the baseline vehicle are based on average in-use exhaust emission rates assuming a ten-year, 100,000-mile useful life. NMOG will be considered equivalent to reactive organic gases (ROG) for the purposes of using ZEV credits to offset ROG emissions. Table 19 shows the vehicle mix used to calculate the baseline vehicle emission rates for model years 1996 through 2003. This vehicle mix is the same as that assumed in the ARB's emissions inventory which models how manufacturers will choose to meet the required fleet average NMOG emission rates.

Table 19: Vehicle Mix Used to Calculate Average Emission Rates <sup>A</sup>					
Model Year	NMHC <sup>B</sup> 0.25	TLEV 0.125	LEV 0.075	ULEV 0.040	ZEV 0.000
1996	80%	20%			
1997	73%		25%	2%	
1998	48%		48%	2%	2%
1999	23%		73%	2%	2%
2000			96%	2%	2%
2001			90%	5%	5%
2002			85%	10%	5%
2003			75%	15%	10%

Note A: TLEV = transitional-low-emission vehicle, LEV = low-emission vehicle, ULEV = ultra-low-emission vehicle, ZEV = zero-emission vehicle. The numbers below each vehicle classification reflect the applicable g/mi NMOG standard for those vehicles.

Note B: Non-methane hydrocarbon (NMHC) is the equivalent of NMOG.

Table 20 shows the baseline vehicle gram per mile emission rates over a 10 year, 100,000-mile useful life for model years 1996 through 2003. These emission rates are calculated from ARB's draft mobile source emission inventory model, EMFAC7F/BURDEN7F, for the South Coast Air Basin (SCAB). Because these emission rates are very similar to those that would be generated for other areas of the state, they are applicable statewide.

Table 20: Emissions from a Baseline Vehicle in the SCAB for Each Calendar Year (average over 100,000 miles)				
Model Year	Ex+RL NMOG <sup>A</sup> (g/mi)	Evap NMOG <sup>B</sup> (g/day)	NOx (g/mi)	CO (g/mi)
1996	0.41	2.0	0.60	2.9
1997	0.28	1.7	0.52	2.7
1998	0.22	0.91	0.44	2.5
1999	0.17	0.91	0.36	2.3
2000	0.11	0.91	0.30	2.1
2001	0.11	0.91	0.29	2.1
2002	0.11	0.91	0.29	2.1
2003	0.10	0.91	0.28	1.9

Note A: Exhaust plus running loss emissions

Note B: Evaporative emissions

### Exhaust, Evaporative, and Running Loss Emission Reductions

The lifetime exhaust, evaporative, and running loss emission reduction benefit associated with the purchase of a ZEV rather than a baseline vehicle is calculated as follows:

(emission rate of baseline vehicle not purchased because a ZEV was purchased instead) x  
(100,000-mile life)<sup>9</sup> x (number of ZEVs purchased)

Emission rates are subject to periodic updates. If there are significant changes in the emission rates, the ARB staff will update these guidelines.

Using the above equation and emission rates from Table 20, Table 21 provides an example of the lifetime exhaust, evaporative, and running loss emission reductions that could be achieved in the SCAB over a ten-year period if a ZEV is purchased instead of a baseline vehicle in each of the years 1996 through 2003.

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<sup>9</sup> Assumes ZEV and baseline vehicle both have a ten-year, 100,000-mile life.

Table 21: Lifetime Exhaust, Evaporative and Running Loss Emission Reductions from the Purchase of a ZEV Instead of a Baseline Vehicle, by Calendar Year (per vehicle, assuming a ten-year, 100,000-mile life)<sup>A</sup>

Model Year	Lifetime Emissions (pounds)		
	NMOG	NO <sub>x</sub>	CO
1996	110	130	640
1997	75	110	610
1998	56	97	550
1999	43	80	510
2000	32	65	470
2001	31	64	470
2002	31	64	460
2003	29	61	420

Note A: numbers rounded

### Other Emissions and Emission Reductions

There are increases in powerplant emissions associated with generating the electricity used in electric vehicles (EVs). The ARB estimates the following powerplant emissions in the South Coast Air Basin attributable to one EV assuming a 10 year, 100,000 mile lifetime: ROG = 0.09 lbs/year, NO<sub>x</sub> = 0.8 lbs/year, and CO = 1.4 lbs/year. These emissions are negligible compared to tailpipe emission reductions and therefore are not subtracted from the emission reduction credit.

In addition to exhaust, evaporative, and running loss emission benefits, there are emission benefits associated with reducing gasoline marketing emissions. The ARB estimates gasoline marketing emission reductions to be approximately 22 pounds of ROG prior to 1996 and 20 pounds of ROG from 1996 forward (due to the introduction of Phase 2 gasoline) per EV over a 10 year, 100,000-mile lifetime. This estimate is based on ARB's emission inventory and Caltrans and Motor Vehicle Manufacturers Association data.

Credit Calculation

The credit associated with the purchase of a ZEV (assuming it is surplus to the ARB's LEV regulations) rather than a baseline vehicle is calculated as follows:

$$\begin{aligned} & \text{ZEV Credit} \\ & = \\ & \text{Exhaust, Evaporative, and Running Loss Emission Reductions} \\ & + \\ & \text{Gasoline Marketing Emission Reductions} \end{aligned}$$

Table 22 provides an example of the emission reductions that could be achieved over a 10 year period if a ZEV is purchased instead of a baseline vehicle in 1996 through 2003 in the SCAB. The emission reductions are based on the data shown in Table 21 and include gasoline marketing emission reductions.

Table 22: Total Emission Reductions from the Purchase of a ZEV Instead of a Baseline Vehicle, by Calendar Year (per vehicle, assuming a 10 year, 100,000-mile life) <sup>A</sup>			
Model Year	Lifetime Emissions (pounds)		
	NMOG	NOx	CO
1996	130	130	640
1997	95	110	610
1998	75	97	550
1999	65	80	510
2000	51	65	470
2001	51	64	470
2002	51	64	460
2003	49	61	420

Note A: numbers rounded

Because the ZEVs are displacing the newest, cleanest vehicles, the per-vehicle emission benefits, including gasoline marketing emissions, are not high. For example, in 1996, about 1,900 ZEV purchases are required to generate 25 tons/year of combined NMOG and NOx emission credits in the SCAB (although these credits last for 10 years). In 2003, 4,500 ZEV purchases are required to generate 25 tons/year of combined NMOG and NOx emission credits.

## Credit Life

Emission credits generated by purchasing a ZEV instead of an average new emitting vehicle, or "baseline" vehicle, have a ten-year life. This corresponds to the expected life of the ZEV.

## Enforcement

Thorough record keeping is the primary enforcement mechanism. To ensure that the emission benefits claimed are real, quantifiable and surplus, the following records are needed:

Manufacturer records indicating the Vehicle Identification Numbers (VIN) for the ZEVs which will not be counted in the manufacturers fleet average NMOG emission rate;

Records indicating the VIN of each ZEV purchased for which credit is granted.

Because the ARB is responsible for enforcing the LEV regulations and ensuring that vehicle manufacturers meet the required fleet average NMOG emission standards, these records must be provided to the ARB's Mobile Source Division to ensure that emission reductions are not double-counted.

## Other Options

Mobile source credits can also be generated by retiring older vehicles and replacing them with ZEVs. The guidelines for this type of program are the same as the accelerated retirement program described in Chapter 5, "Accelerated Retirement of Older Vehicles." However, instead of replacing retired vehicles with emitting vehicles, they are replaced with ZEVs.

Since the retired vehicle is replaced with a ZEV, the credit generated has a ten-year life. Credit for the first three years is calculated as the difference in emissions between the car being retired and the ZEV. After three years the remaining seven years of credit is calculated based on emission reductions from the purchase of a ZEV instead of an average new vehicle. The emission reduction benefit is calculated as follows:

First three years:

$(3 \times \text{emission rate of the average retired-age vehicle} \times \text{average annual mileage for the retired-age vehicle}) + (30\% \text{ of the gasoline marketing emission reductions})$

The remaining seven years:

$70\% \times (\text{the possible 10 year emission reductions from the purchase of a ZEV instead of an emitting vehicle, by calendar year, as shown in Table 21} + \text{gasoline marketing emission reductions})$

No credits can be granted unless the manufacturers do not use the ZEVs purchased in the credit program to meet the fleet average NMOG emission standard required by the LEV regulations.

Table 23 provides an example of possible emission reductions that could be available for retiring a pre-1972 vehicle and replacing the vehicle with a ZEV in 1996 in the SCAB.

Table 23: Possible Emission Reductions Over a 10-Year, 100,000-Mile Lifetime			
Accelerated Retirement of a Pre-1972 Vehicle and Replacement with a ZEV in 1996			
	ROG	NO <sub>x</sub>	CO
3 Year Total Possible Emissions Reductions from Retired Vehicle (pounds)	410	130	2300
7 Year Total Possible Emissions Reductions from Avoided Purchase of Emitting Vehicle (pounds)	90	90	450
Total Emission Reduction over 10 Years (pounds)	500	220	2700

## **Issues**

### **Double-Counting - LEV Regulations**

ZEVs used to generate mobile source credits must provide emission benefits in excess of those provided by the low-emission vehicle regulations. Manufacturers can count ZEVs used to generate mobile source credits toward their mandatory ZEV sales requirement (two percent in 1998 increasing to ten percent in 2003). However, such ZEVs cannot be included in manufacturers' calculations of fleet average NMOG emission rates. Vehicle manufacturers cannot sell or bank emission credit for such ZEVs. This applies whether the ZEVs are sold prior to 1998, in 1998, or later years. Such a provision is necessary to avoid double-counting of the emission benefits.

Double-counting is a concern for legal and air quality related reasons. Credits can only be allowed for emission reductions that are in excess of the emission reductions already required by existing regulations. The LEV regulations require manufacturers to meet an increasingly stringent fleet average NMOG standard each year. If a manufacturer includes a ZEV in its fleet average NMOG standard, banks, or sells credit for that ZEV to another manufacturer for the purpose of meeting the fleet average standard, then that ZEV is not providing emission reductions in excess of those required by the LEV regulations.

Additionally, each district estimates emission reductions in the district based on the adoption and implementation of the LEV regulations. Thus, any emission reductions that result from the LEV regulations have already been included in the district's Air Quality Management Plan (AQMP). Emission reductions from a ZEV used to meet the requirements of the LEV regulations have, therefore, already been included in each district's AQMP and are not surplus.

### **Cost-Effectiveness**

The cost-effectiveness of a ZEV program cannot be calculated until the costs of ZEVs can be better quantified.

### **ZEV Mobility**

Although it is possible to ensure that credit for a ZEV is only given if the ZEV is initially operated in a particular area, it is not possible to ensure that the ZEV will continue to be operated in that particular area throughout the life of the ZEV. However, in the initial years, only certain areas will be equipped to accommodate ZEVs. It is likely that ZEVs will stay in these areas. Even as the number of areas equipped to accommodate ZEVs increases, it is reasonable to assume that the number of ZEVs that leave an area will approximately equal the number of ZEVs that enter an area. For this reason, credit is given in the district in which the ZEV is operated at the time of purchase for the full 10-year, 100,000-mile life of the credit.

## **8. GENERATION OF EMISSION REDUCTION CREDITS THROUGH RETROFITTING PASSENGER CARS, LIGHT-DUTY TRUCKS, AND MEDIUM-DUTY VEHICLES TO REDUCE EMISSIONS**

### **Introduction**

Retrofitting vehicles has the potential to reduce emissions beyond what is required by federal, state, and local regulations. Vehicles can be retrofitted to use alternative fuels, or gasoline vehicles can be retrofitted with add-on devices to reduce emissions. If retrofitted vehicles emit less than what the original equipment vehicles emit, then there would be an emission reduction benefit. This document provides program guidelines for generating mobile source emission reduction credits by retrofitting passenger cars, light-duty trucks, and medium-duty vehicles.

The amount of credit a retrofitted vehicle generates would be based on the Tier 1 or low-emission vehicle (LEV) standard to which the retrofitted vehicle is certified. The Air Resources Board (ARB) approved the LEV regulations in September 1990, which establish new classes of passenger cars, light-duty trucks, and medium-duty vehicles with increasingly stringent certification standards. The passenger car and light-duty truck classes of vehicles, listed here in order of increasingly stringent standards, are: transitional low-emission (TLEV), low-emission (LEV), ultra-low-emission (ULEV), and zero-emission (ZEV) vehicles. As of late 1995, medium-duty vehicles are divided into three classes, LEV, ULEV and super-ultra-low-emission-vehicles (SULEV). With the exception of ZEVs, each new class of vehicle reduces non-methane organic gases (NMOG) by approximately 50 percent. In addition, the oxides of nitrogen (NO<sub>x</sub>) standard for the LEV and ULEV classes and the carbon monoxide (CO) standard for the ULEV class are approximately 50 percent lower than the current standards. The SULEV emission standards are half of those of the ULEV category for all pollutants. Zero-emission vehicles must have zero exhaust emissions.

For vehicles retrofitted to meet ZEV standards, credit would only be generated if the ZEVs are not used by major auto manufacturers to meet the ZEV requirements of the low-emission vehicle regulations. Emission reductions used to generate credits must be surplus, that is, such emission reductions may not be used to meet local, state, or federal requirements. Clearly, if a major auto manufacturer uses retrofitted ZEVs to meet the annual fleet average standard and these same ZEVs are used to generate mobile source emission reduction credits, the emission benefits associated with the low-emission vehicle regulations, which require the manufacturer to meet the fleet average standard, are reduced. This would not be allowed in any mobile source emission reduction credit program.

The amount of credit available will depend on the certification standard the vehicle meets before and after a vehicle is retrofitted, and on the remaining life, in miles, of the vehicle being retrofitted. The following guidelines will ensure that emission reduction credits are only granted for retrofitted vehicles that have significantly lower emissions than existing vehicles for the entire remaining vehicle life.

The ARB staff did not include a cost-effectiveness evaluation in this guideline document. Preliminary cost evaluations indicate that the capital and operating costs of retrofitting existing vehicles to low-emission configurations can be high, depending on the particular scenarios and technology involved in any individual case. The staff recommends that retrofit credit program participants carefully analyze the costs involved before selecting a retrofit technology for use. The ARB will assist in this effort whenever possible.

### **Program Guidelines**

The guidelines presented in this section are designed to allow districts and program operators to calculate emission reductions resulting from retrofitting passenger cars, light-duty trucks, and medium-duty vehicles. According to the following guidelines, the amount of credit is based on the difference in emissions before and after a vehicle is retrofitted and the number of miles the vehicle, once retrofitted, will travel. The credit life is based on the expected remaining life of the retrofitted vehicle.

### **Pollutants for Which Credits Can be Granted**

Reactive organic gas (ROG), NO<sub>x</sub>, and CO credit can be generated from this program. The ROG credit would be based on the NMOG or non-methane hydrocarbon (NMHC) certification standard plus hydrocarbon (HC) emissions associated with evaporative, running loss and gasoline marketing emissions from passenger cars, light-duty trucks, and medium-duty vehicles. For the purposes of calculating credits in this paper, the amount of ROG credit is considered to be equivalent to the expected emission reductions in the exhaust NMOG or NMHC plus the evaporative and fuel-related HC from retrofitting a vehicle. When calculating ROG credits for a proposed program, the ARB should be contacted to obtain the latest conversion factors associated with converting NMOG, NMHC and HC emission reductions to ROG credits. The amount of NO<sub>x</sub> and CO credit is equal to the expected emission reductions in NO<sub>x</sub> and CO from retrofitting a vehicle. Credit for particulate matter (PM) will not be available because the amount of PM associated with gasoline vehicles is so small that any benefits from retrofits would be insignificant.

### **Regulatory Background and Framework**

#### **Alternative Fuel Retrofit Regulations**

Credit will only be granted for vehicles retrofitted following the certification and compliance test procedures in the California Certification and Installation Procedures for Alternative Fuel Retrofit Systems for Motor Vehicles Certified for 1994 and Subsequent Model Years and for All Model Year Motor Vehicle Retrofit Systems Certified for Emission Reduction Credit (retrofit certification procedures), that were approved by the ARB on July 27, 1995. Each kit must meet the applicable in-use standards and warranty requirements.

#### **Low-Emission Vehicle and Clean Fuel Regulations**

Low-emission certification standards were established in the Low-Emission Vehicle and Clean Fuel regulations that were adopted by the ARB in September of 1990. These regulations established exhaust emission standards for passenger cars, light-duty trucks, and medium-duty vehicles. (The

Board adopted modifications to the medium-duty standards at its September 1995 hearing.) These standards and the tier 1 emission standards establish an enforceable level to which vehicles that are retrofitted to generate credits must comply. The credit-generating standards for passenger cars, light-duty trucks, and medium-duty vehicles are shown in Tables 24, 25, and 26. Light-duty vehicles are defined as passenger cars and light-duty trucks. Light-duty trucks are divided into the two weight classes shown in Tables 24 and 25. Medium-duty vehicles are divided into five weight classes, as shown in Table 26. Each weight class of light-duty trucks and medium-duty vehicles must meet specific certification standards. (Details on weight classes, certification standards, etc., can be found in Title 13 of the California Code of Regulations (CCR).)

Beginning in 1995, vehicles that weigh 8,501 pounds to 14,000 pounds, currently classified as heavy-duty vehicles, will be reclassified as medium-duty vehicles. The regulations allow some of these vehicles the option of certifying to engine emission standards. For the purpose of generating credits, the same test procedures used to certify the original engines must be used to certify the retrofitted engines to credit-generating standards.

To account for product and installation variability, the amount of credit is calculated based on the difference between the certification standards before and after the vehicle is retrofitted. Basing the credit amount on the certification standards after the vehicle is retrofitted rather than actual emission levels is necessary so that existing ARB enforcement mechanisms included in the retrofit certification procedures and the low-emission vehicle and clean fuel regulations can be utilized. These regulations apply to vehicles that are certified to the standards listed in Tables 24, 25 and 26, therefore, the enforcement mechanisms also apply only to retrofitted vehicles certified accordingly.

Table 24: Certification Standards for Passenger Cars and Light-Duty Trucks that Weigh < 3751 lbs			
Category	NMOG <sup>A</sup>	CO	NO <sub>x</sub>
Tier 1 Standards	0.25 (NMHC)	3.4	0.4
TLEV	0.125	3.4	0.4
LEV	0.075	3.4	0.2
ULEV	0.040	1.7	0.2
ZEV	0	0	0

Note A: adjusted for ozone reactivity

Table 25: Certification Standards for Light Trucks that Weigh > 3750 lbs			
Category	NMOG <sup>A</sup>	CO	NO <sub>x</sub>
Tier 1 Standards	0.50 (NMHC)	9.0	1.0
TLEV	0.16	4.4	0.7
LEV	0.100	4.4	0.4
ULEV	0.050	2.2	0.4
ZEV	0	0	0

Note A: adjusted for ozone reactivity

Table 26: Certification Standards for Medium-Duty Vehicles

Table 26: Certification Standards for Medium-Duty Vehicles									
LEV				ULEV			SULEV		
Weight Class	NMOG <sup>A</sup>	NO <sub>x</sub>	CO	NMOG <sup>A</sup>	NO <sub>x</sub>	CO	NMOG <sup>A</sup>	NO <sub>x</sub>	CO
0-3,750 lbs	0.125	0.4	3.4	0.075	0.2	1.7	na	na	na
3,751-5,750 lbs	0.160	0.7	4.4	0.100	0.4	2.2	0.050	0.2	2.2
5,751-8,500 lbs	0.195	1.1	5.0	0.117	0.6	2.5	0.059	0.3	2.5
8,501-10,000 lbs <sup>B</sup>	0.230	1.3	5.5	0.138	0.7	2.8	0.069	0.35	2.8
>10,001-14,000 lbs <sup>B</sup>	0.300	2.0	7.0	0.180	1.0	3.5	0.09	0.05	3.5

Note A: Adjusted for ozone reactivity

Note B: Included as medium-duty vehicles in 1995

### Additional Framework Necessary to Ensure Emission Reductions

To help ensure that the emission reductions associated with retrofitting vehicles are achieved throughout the vehicles' useful life, additional requirements upon the retrofit kit manufacturer and provisions granting the ARB authority to evaluate retrofit kits are necessary. Retrofit kit manufacturers would need to provide the name(s) and location(s) of assembly line(s), fabrication facility(ies), and test facility(ies), where the retrofit kit is manufactured and tested. This information would be submitted upon application for certification of a retrofit kit to one of the credit-generating standards in Tables 24, 25 or 26. The Executive Officer of the ARB reserves the right to require an ARB approved engineering analysis of any retrofit device that is certified to a credit-generating standard. The retrofit certification procedures include this provision.

### **Calculation of Remaining Mileage**

Once the difference between the certification standards before and after a vehicle is retrofitted has been determined, it is multiplied by the remaining mileage of the vehicle. The remaining mileage of the vehicle is simply the number of miles the retrofitted vehicle is expected to travel after it has been retrofitted. To calculate the remaining life of a retrofitted vehicle, the mileage on the odometer at the time the vehicle is retrofitted is subtracted from the useful life for that vehicle.

The useful life, as defined in the CCRs, is 100,000 miles for passenger cars and light-duty trucks and 120,000 miles for medium-duty vehicles. The CCRs establish California's authority over vehicle emissions for the useful life. This means that the retrofit kit manufacturer is responsible for the proper functioning of emissions-related equipment up to the point that the odometer reads 100,000 miles or 120,000 miles, whichever is appropriate.

The ARB staff realizes that some light- and medium-duty vehicles are driven farther than 100,000 miles or 120,000 miles. However, retrofitted vehicles are only required to meet certification

standards for the vehicles' useful life and the ARB has no enforcement authority once a vehicle exceeds this mileage.

### **Calculation of Emission Credits**

This section describes in detail the methodology for the credit calculation as well as the factors used. If a retrofitted vehicle is certified to credit-generating standards, credit may be granted for the difference in exhaust emission standards before and after the vehicle is retrofitted. In addition to exhaust emission reductions, there may be evaporative, running loss, and fuel marketing emission reductions associated with retrofitting a gasoline vehicle to use a non-volatile fuel. Retrofitting a vehicle to use a non-volatile fuel would eliminate the evaporative, running loss and marketing emissions associated with using gasoline. This section will describe how to calculate credits for exhaust emission reductions, evaporative, running loss and marketing emission reductions, and provide an example calculation of the emission credits associated with retrofitting a specific vehicle.

#### Credit Calculation for Exhaust Emission Reductions

Conventional vehicles retrofitted to meet credit-generating vehicle exhaust standards would generate credit for the difference between the certification standards before and after the vehicle is retrofitted. The ARB staff recognizes that there may be some additional emission benefits associated with vehicles retrofitted to low-emission vehicle exhaust standards due to the fact that low-emission vehicles deteriorate at a lower rate than conventional vehicles. However, because there is no data that indicates that vehicles retrofitted to low-emission vehicle exhaust standards deteriorate at the same rate as original engine manufacture low-emission vehicles, credit will not be based on deteriorated emission rates.

The credit associated with exhaust emission reductions from a retrofitted vehicle is calculated as follows:

$$\begin{aligned} &\text{Retrofit Vehicle Credit=} \\ &(\text{Certification Standard of Original Vehicle} - \\ &\text{Certification Standard of Retrofitted Vehicle}) \\ &\times (\text{100,000 miles or 120,000 miles, whichever is applicable} - \\ &\text{Odometer Reading of Vehicle After Retrofit Equipment Installed}) \end{aligned}$$

For cases in which credit is generated for retrofitted dual-fuel vehicles, it will be incumbent upon the district regulating the credit generation to ensure that such vehicles primarily use clean fuel and that credit is only generated for the number of miles driven using clean fuel.

Beginning in 1995, vehicles that weigh 8,501 pounds to 14,000 pounds, currently classified as heavy-duty vehicles, will be reclassified as medium-duty vehicles and some will be allowed the option of certifying to engine emission standards. If vehicles using engines certified to the optional engine emission standards are subsequently retrofitted to credit-generating standards, the credit-generating

calculation procedure would be similar to the heavy-duty vehicle credit-generating calculation procedure.

### Additional Emission Reductions

In addition to exhaust emission reductions achieved from retrofitting a vehicle, there may be fuel evaporative, running loss and marketing HC emission reductions. These emission reductions would be added to exhaust emission reductions for the purpose of calculating credits. Running loss and evaporative HC emissions associated with gasoline vehicles are available from the ARB staff upon request. Lifetime fuel marketing HC emissions associated with gasoline vehicles, primarily due to refueling, are estimated to be 23 pounds prior to 1996 or 20 pounds after 1996 (once Phase 2 gasoline is introduced).

Credit for fuel evaporative, running loss, and marketing emission reductions associated with retrofitting vehicles to use a non-volatile fuel would be calculated as follows:

[Evaporative + Running Loss + Marketing Emissions  
Over the Lifetime of the Vehicle being Retrofitted]

X

(100,000 miles or 120,000 miles, whichever is applicable -  
Odometer Reading of Vehicle After Retrofit Equipment Installed)

÷

(100,000 miles or 120,000 miles, whichever is applicable)

### **Example of Evaporative, Running Loss & Marketing Emission Reduction Credit Calculation**

(1993 gasoline passenger car retrofitted to use a fuel that has  
no associated fuel evaporative, running loss, or marketing emissions)

- o Remaining Life = 90,000 miles
- o Evaporative emissions = 2 grams per day HC (16 pounds HC over a 10-year life)
- o Running loss emissions = 0.25 grams per mile HC (55 pounds HC over 100,000 mile life)
- o Marketing emissions = 23 pounds HC over vehicle life

### **Total Credit over**

**Remaining Life** = (16 + 55 + 23) lbs HC X  $\frac{90,000 \text{ miles}}{100,000 \text{ miles}}$  = 85 lbs HC

### Example of Potential Emission Reduction Credits

Table 27 illustrates the emission reductions possible from a passenger car or light-duty truck that weighs less than 3,751 pounds retrofitted as a dedicated alternative fuel vehicle that has no associated evaporative, running loss and marketing emissions and is certified to one of the low-emission vehicle standards. The emission reductions would depend on the number of miles the vehicle will drive after

it has been retrofitted, certification standard before being retrofitted, and certification standard after being retrofitted. The emission reductions shown in Table 27 are based on a vehicle with a remaining life of 90,000 miles that was originally certified to 0.25 grams per mile (g/mi) NMOG and 0.4 g/mi NOx standards.

Table 27: ROG + NOx Emission Reductions from Vehicles Retrofitted to Use a Fuel with No Associated Evaporative, Running Loss and Marketing Emissions <sup>A,B</sup> (pounds)			
	Retrofitted Vehicle Class <sup>C</sup>		
	TLEV	LEV	ULEV
<u>Total</u> Emission Reductions from a 90,000-mile Remaining Retrofitted Vehicle Life <sup>D</sup>	110	160	170
<u>Annual</u> Emission Reductions from a 90,000-mile (9 year) Remaining Retrofitted Vehicle Life <sup>E</sup>	12	18	19

Note A: ROG + NOx are combined in this table for example only, not as an illustration of interpollutant trading. The ARB supports interpollutant trading only with substantial technical basis.

Note B: Emission reductions include evaporative, running loss and marketing emission reductions. See section entitled Additional Emission Reductions above for details. The total emission reductions would be significantly lower if retrofitting the vehicle did not result in the elimination of evaporative, running loss and/or marketing emissions.

Note C: The retrofitted vehicle meets the passenger car and light-duty truck (0-3,750 pounds) standards required for each class. All original engines are assumed to have been certified to the 0.25 g/mi NMHC and 0.4 g/mi NOx standards currently required in California.

Note D: The total emission reductions from a vehicle that has an expected remaining life of 90,000 miles. The 90,000 miles figure is based on an the odometer reading at the time of retrofit of 10,000 miles. See section entitled **Calculation of Remaining Mileage** above for details.

Note E: The number of years is determined by dividing the remaining life of the vehicle, 90,000 miles, by the estimated annual mileage of 10,000 miles/year. See section entitled **Credit Life** below for details.

## **Credit Life**

Credit life is determined based on the typical useful life of light- and medium-duty vehicles, 100,000 miles and 120,000 miles respectively, over approximately 10 years. For the purposes of these guidelines, the ARB staff assumed that light- and medium-duty vehicles travel approximately 10,000 miles per year (100,000 miles divided by 10 years) and 12,000 miles per year (120,000 miles divided by 10 years) respectively. This assumption is used to determine the credit life. Once the remaining mileage is determined, as described above, it is divided by an annual mileage of 10,000 miles or 12,000 miles, whichever is appropriate, to determine the credit life.

The ARB staff recognizes that the assumption that vehicles travel an evenly distributed number of miles over a 10-year period does not represent actual vehicle use patterns. The ARB's inventory indicates that, on average, actual annual mileage decreases as a vehicle ages. However, for simplicity, the ARB staff recommends using an even distribution of miles over the life of a retrofitted vehicle, 10,000 or 12,000 miles per year, whichever is applicable, to determine credit life. A retrofit program proponent may use the actual mileage estimated for an average vehicle, or a different assumption regarding the distribution of miles over the life of a retrofitted vehicle. However, if the proponent uses an assumption other than an even distribution, proof would be required that the vehicle travelled according to the new assumption. In addition, the total miles travelled over the life of the retrofitted vehicle could not exceed the useful life for the vehicle (100,000 or 120,000 miles, whichever is applicable).

## **Enforcement**

The retrofit certification procedures include methods of enforcement to ensure that vehicles retrofitted to credit-generating standards actually meet and maintain those standards. The procedures require each vehicle to be tested by the Bureau of Automotive Repair after the retrofit kit has been installed. In addition, each kit must meet the applicable in-use standards and warranty requirements.

Local air pollution control districts are responsible for ensuring that emission reduction credits are real and quantifiable. To aid the districts in this effort, persons purchasing and selling credits would need to provide to the district:

- o On an annual basis, vehicle identification numbers and proof of registration for retrofitted vehicles to ensure that retrofitted vehicles are not permanently transferred outside of the district before the credit life is over.
- o Proof of compliance with the ARB's retrofit certification standards.

## **Issues**

### **National Energy Policy Act (NEPA) Fleet Requirements**

The NEPA requires fleets to purchase a certain number of alternative-fuel vehicles each year. The NEPA primarily applies to government fleets, however, in later years large fleets with central refueling capabilities may be required to purchase a certain number of alternative-fuel vehicles. If a fleet meets the NEPA requirements by retrofitting vehicles to credit-generating standards, credit could be granted for these vehicles only if the local district does not count the emission reductions associated with these vehicles in its air quality management plan.

## **9. GENERATION OF EMISSION REDUCTION CREDITS THROUGH THE RETROFIT OF HEAVY-DUTY VEHICLES AND ENGINES TO LOW-EMISSION CONFIGURATIONS**

### **Introduction**

Heavy-duty diesel trucks and urban buses emit significantly more oxides of nitrogen (NO<sub>x</sub>) on a per-vehicle basis than any other category of motor vehicle in California. Opportunities exist to reduce these and other heavy-duty vehicle emissions by converting engines to configurations that have emissions significantly below the applicable pre-conversion emission standards. These reductions can be used to generate emission reduction credits. The following guidelines examine the potential to create emission reduction credits by converting a vehicle's existing engine via kits and add-on equipment ("retrofitting").

Programs designed to generate emission reduction credits must comply with current Federal Emission Trading Policy which requires that credits only be allowed for emission reductions that are surplus to federal, state and local regulations. The United States Environmental Protection Agency (U.S. EPA) has adopted regulations requiring newly-overhauled transit bus engines operated in urban areas to meet particulate matter (PM) emissions standards more stringent than required by the original engine certification. The California legislature has directed the Air Resources Board (ARB or Board) to consider adopting similar regulations, but applied to all heavy-duty diesel vehicles. However, the Board determined in October 1994 that no action on retroactive urban bus standards and regulations, beyond the above-noted U.S. EPA regulations, needs to be taken at the present time.

The amount of credit available through conversion of heavy-duty trucks and buses to low-emission configurations will decrease as the ARB adopts more stringent emission standards for heavy-duty vehicles in the future. Currently, there is a window of opportunity to generate credits by retrofitting vehicles that were originally certified to the higher emission standards in effect in past years. As vehicles that were originally certified to these higher emission standards are retired, and as emission standards are tightened in the future, fewer credits will be available.

Although it is heavy-duty engines that are regulated for emissions and not the vehicles themselves, this chapter will make several references to vehicle based criteria, such as when relating credit life to vehicle life (rather than to engine life.) Where a point of discussion is unique to engine related parameters, the context should make that clear.

### **Program Guidelines**

The guidelines presented in this chapter are designed to allow districts and program operators to calculate emission reductions resulting from the conversion of heavy-duty trucks and buses to low-emission configurations. As used herein, the heavy-duty designation includes those vehicles and engines originally certified in the heavy-duty category, as indicated on the original certification Executive Order (EO), and not in the light-duty or medium-duty classifications. The guidelines in this chapter consider a fleet operator faced with the opportunity to convert a large number of similar heavy-duty vehicles simultaneously, perhaps during engine overhaul. The operator could simply

rebuild them to meet the original engine emission standards, a conventional rebuild, or opt to convert them to a configuration that has emissions significantly below those standards. For the latter case, the difference in emissions would constitute an emissions reduction that could be used or sold as credits. Ideally, conversion is timed to coincide with engine overhaul to ensure that engine wear and deterioration are not factors in the emissions of the converted engine.

These guidelines are intended to apply to all types of on-road, heavy-duty vehicles. Conversions can take the form of add-on hardware such as particulate traps or oxidation catalytic converters retrofitted to existing vehicles. Vehicles may also be converted from gasoline or diesel operation to allow operation on alternative fuels such as methanol, natural gas or liquefied petroleum gas. However, exchanging a vehicle's old engine for a newer, lower-emission engine ("repowering") is not considered to be a retrofit for purposes of generating credits according to these guidelines. Such replacement engines are considered new engines and would have to be certified to a new engine low-emission standard in order to generate credits. Chapter 10 contains additional guidelines that cover credit generation procedures for new, replacement engines emitting significantly below the ceiling standards.

Finally, the use of fuel additives does not conform to the common notion that a retrofit involves hardware modifications. Therefore, additives cannot be used to generate credits unless used as part of a package that includes significant hardware changes to the vehicle. To address concerns about enforceability, the hardware changes should require the use of the additive for proper engine performance and driveability.

According to the following guidelines, the amount of the emission reduction credit for each pollutant is based on the difference between the original certification standards under which the base engine was certified when new, and the credit standard to which the converted engine is certified. Credit life is based on the expected remaining operating life of the vehicle before it is retired from service or before the next engine overhaul is required, whichever occurs first.

The ARB staff did not include a cost-effectiveness evaluation in this guideline document. Preliminary cost evaluations indicate that the capital and operating costs of retrofitting existing engines and vehicles to low-emission configurations can be high, depending on the particular scenarios and technology involved in any individual case. The staff recommends that retrofit credit program participants carefully analyze the costs involved before selecting a retrofit technology for use. The ARB staff will assist in this effort whenever possible.

### **Pollutants for Which Credits Can Be Granted**

NO<sub>x</sub> is the primary pollutant of interest when considering heavy-duty engine emission credit generation. However, the ARB staff is aware that older diesel engine emission levels for PM are well above what could be achieved with current technology. It is also acknowledged that Otto-cycle heavy-duty engines can emit significant amounts of carbon monoxide (CO) and hydrocarbons (HC) that can be reduced with proper modifications. Therefore, credits will be allowed for all four of these pollutants where the conversion can be demonstrated to significantly reduce emissions and remain effective over the entire credit life. However, credits cannot be granted for any retrofit if the conversion results in an increase in any regulated pollutant emissions by an amount of 10% or more, or by the magnitude of the test variability, whichever is larger, above its pre-conversion level (except

formaldehyde as discussed next). The pre-conversion level is taken to be the emission level determined during the original engine certification process.

For those engines with negligible formaldehyde emission levels, such as gasoline engines, any increase in that pollutant would violate the above 10% restriction. Therefore, formaldehyde emissions from any 1993 and earlier model year (MY) converted engines should remain at or below the standards applicable to the 1993 model year. Engines from the 1994 or later MY should meet the formaldehyde standard for that model year.

## **Calculation of Credits**

The following sections describe the factors and procedures used to calculate the emission reduction credit associated with converting a heavy-duty vehicle to a low-emission configuration.

### Calculation of Vehicle Emission Reductions

The magnitude of the pollutant emission reduction is calculated based on the difference between the pollutant "ceiling" standard and a low-emission (or "credit") standard. It is necessary to use standards rather than the actual measured emission levels in order to ensure that equipment and installation variability and emission control system deterioration are taken into account. Standards establish enforceable levels with which converted vehicles and engines used to generate credits must comply.

#### Ceiling Standards:

The ceiling standard to be used for credit calculation for each pollutant of interest is the certification standard to which the engine was originally certified when first placed into service by its manufacturer (except as noted below). The numerical values (based primarily on engine type and model year) are available from ARB.

Some engines were originally certified to a combined HC+NO<sub>x</sub> standard rather than to a separate HC standard and a separate NO<sub>x</sub> standard. Currently, ARB will not consider allowing credits for combined pollutants. In these cases, the individual ceiling standards for each of these pollutants will be based on the combined certification standard as pro-rated by the original emission certification values of each pollutant, as shown on the certification Executive Order. Table 28 provides an example of this determination process:

Table 28: Example HC+NOx Ceiling Standard Determination	
HC+NOx certification std.	6.0 gram/bhp-hr
HC certification value	0.5
NOx certification value	5.3
HC+NOx certification value	5.8
HC portion of value	8.6 %
NOx portion of value	91.3 %
HC ceiling std.	0.5 gram/bhp-hr
NOx ceiling std.	5.5

Since there were no heavy-duty diesel PM standards before the 1987 model year (MY), the ceiling standard for converted engines of earlier model years will be the 1987 MY PM standard of 0.6 g/bhp-hr.

Finally, some existing engine types emit certain pollutants at significantly lower levels than the applicable emission standard. The primary example of this is the case of CO emissions from diesel engines. At present, the CO standard for heavy-duty diesel engines is 15.5 gram/bhp-hr while typical diesel emission rates for CO are as low as 2.0 to 3.0 gram/bhp-hr. For cases such as this, the ceiling standard will be the original emission certification value for that engine, instead of the engine certification standard. Another example is that of HC emissions from diesel engines, which generally are a small percentage of the applicable standard. For HC credit calculations based on conversions of such engines, the ceiling standard will also be the original emission certification value. In contrast, NOx emissions from diesel engines are typically at levels only slightly below the applicable certification standard. Therefore, NOx emission reductions are calculated using the original engine certification standard as the ceiling standard.

#### Credit Standards:

The credit standard to which a low-emission engine conversion must be certified depends partly on the applicable ceiling standard. For NOx, the maximum credit standard will be at least 25% below the applicable ceiling standard, rounded to the next lower half-gram increment. Lower credit standards would range from this maximum value down to 0.0 in half-gram increments. As an example, Table 29 presents the allowable NOx conversion credit standards for a 1987 model year diesel-fueled truck or bus.

Table 29: 1987 MY Heavy-Duty Diesel-Fueled Vehicle NOx Retrofit Credit Certification Standards	
Ceiling Standard:	6.0 gram/bhp-hr
Credit Standards:	4.5
	4.0
	3.5
	3.0
	2.5
	2.0
	1.5
	1.0
	0.5
	0.0

This multi-tier approach is used to allow the vehicle operator to have flexibility in selecting an appropriate engine conversion option.

Similarly, the maximum PM credit standard will be 25% below the applicable ceiling standard, rounded to the next lower 0.05 gram/bhp-hr increment, decreasing to zero in 0.05 gram/bhp-hr increments. Total hydrocarbon (THC) and non-methane hydrocarbon (NMHC) credit standards will start 25% below the applicable ceiling standard, rounded to the next lower 0.2 gram/bhp-hr increment and decreasing to zero in 0.2 gram/bhp-hr increments. Finally, CO credit standards will start 25% below the applicable ceiling standard, rounded to the next lower 5 gram/bhp-hr increment, decreasing in 5.0 gram/bhp-hr increments. Example credit standards for these pollutants are presented below in Tables 30, 31, and 32.

Table 30: 1987 MY Heavy-Duty Diesel-Fueled Vehicle PM Retrofit Credit Certification Standards	
Ceiling Standard:	0.60 gram/bhp-hr
Credit Standards:	0.45
	0.40
	0.35
	0.30
	0.25
	0.20
	0.15
	0.10
	0.05
	0.00

Table 31: 1987 MY Heavy-Duty Gasoline-Fueled Vehicle THC Retrofit Credit Certification Standards, GVWR Over 14,000 lbs.	
Ceiling Standard:	1.9 gram/bhp-hr
Credit Standards:	1.4
	1.2
	1.0
	0.8
	0.6
	0.4
	0.2
	0.0

Table 32: 1987 MY Heavy-Duty Gasoline-Fueled Vehicle CO Retrofit Credit Certification Standards, GVWR Over 14,000 lbs.	
Applicable Standard:	37.1 gram/bhp-hr
Credit Standards:	25.0
	20.0
	15.0
	10.0
	5.0
	0.0

It is apparent from these tables that the highest credit standard for each pollutant is significantly below the ceiling standard. An engine must be significantly cleaner than the ceiling standard to ensure that a real emission reduction is achieved. These credit standards will be presented to the Board in the near future for its approval of incorporation into regulation.

Credit Certification

Details of the regulations governing alternative fuel retrofit conversions and their certification are contained in the document California Certification and Installation Procedures for Alternative Fuel Retrofit Systems for Motor Vehicles Certified for 1994 and Subsequent Model Years and for All Model Year Motor Vehicle Retrofit Systems Certified for Emission Reduction Credit dated July 27, 1995 (hereafter referred to as the retrofit certification procedures). For purposes of generating emission reduction credits, the conversion kit or other hardware used should be certified to a credit standard (discussed above) according to the procedures in the retrofit certification procedures.

The preferred test procedure for retrofit system certification is the procedure originally used to certify the target engine when new. (In general, this would be an engine dynamometer test.) This will ensure a valid comparison of the credit certification results to the ceiling standard for credit calculation purposes. (As noted previously, the use of standards is necessary to allow for hardware and test variability and equipment deterioration.) If desired, the kit or hardware manufacturer may utilize the optional certification test procedure clause of the retrofit certification procedures to certify the kit or hardware/engine model combination using other procedures. It would be necessary, however, that the applicant demonstrate a valid correlation between the proposed test method and the original test procedure used to certify the engine to the ceiling standard. This is necessary since credits are based on a comparison to the original certification standards. Test procedures should be developed in consultation with the responsible district and ARB staff.

For heavy-duty retrofits that result in a vehicle with the capability to run on either of two fuels (dual fuel operation), the system should be certified separately on each fuel. The hardware should be certified to an appropriate credit standard during operation solely on the cleaner of the two fuels. At a minimum, the hardware should be certified to the ceiling standard while operating solely on the other fuel.

For the case of retrofit hardware, produced by an original engine manufacturer, which upgrades an old engine to the identical configuration of a new engine, the manufacturer may use the new engine certification test data in the retrofit hardware certification application process. For these purposes, the term "identical" means that all engine parts on the retrofitted engine which affect emissions, such as pistons, cylinder heads, etc., must be of the same design and construction as those on the new engine. Engine calibration, including injection timing, must also be identical. This avoids the need to conduct duplicate certification testing on identical engines.

Older engines were originally certified on fuel which, depending on the particular case, was not as clean as currently available fuels. Also, starting in October, 1993, diesel fuel sold in California will be required to meet reduced aromatic hydrocarbon and sulfur content levels relative to fuel sold in previous years, and relative to Federal fuel (diesel fuel sold in other states). If adequate supplies of the fuel used to originally certify an engine are not available for certifying a diesel-fueled retrofit of that engine, the system manufacturer should use the approved U.S. EPA certification diesel fuel. Since operation on such a fuel will likely produce decreased PM emissions relative to the original certification diesel fuel, the retrofit hardware manufacturer should apply appropriate adjustment factors for PM emissions that adjust for the reduced aromatic hydrocarbon and sulfur content. This adjustment is necessary since the portion of the PM emission reductions that is due to the use of the cleaner diesel fuel is not surplus to existing requirements and, therefore, cannot be used to generate credits. The ARB should be contacted for the necessary adjustment factors prior to testing.

To help ensure that the emission reductions associated with retrofitting vehicles are achieved, additional requirements upon the retrofit system manufacturer and provisions granting the ARB authority to evaluate retrofit systems are necessary. Retrofit system manufacturers would need to provide the name(s) and location(s) of assembly line(s), fabrication facility(ies), and test facility(ies), where the retrofit system is manufactured and tested. This information would be submitted upon application for certification of a retrofit system. Additionally, the Executive Officer of the ARB reserves the right to require an ARB approved engineering analysis of any retrofit device that is certified to a low-emission standard.

### Credit Life

Duration of the credit life is dependent on the expected vehicle life remaining until the vehicle is retired or the engine is next expected to be overhauled, whichever occurs first. The numerical value of the life in calendar years and vehicle miles should be determined from historical fleet records of similar vehicles in similar operation with similar histories. For example, if at the time of conversion, a transit agency's records indicate that it typically operates 12-year-old urban transit buses for another 3 years and 100,000 miles before retirement or overhaul, the credit life for such converted buses would be 3 years and 100,000 miles. Historical records should be available to support the lifetime claims. If the engine is subsequently overhauled to the condition of a newly converted engine, the

credit life may be renewed, subject to any U.S. EPA or ARB requirements for emission reductions at overhaul time.

### Conversion Factor

Since heavy-duty vehicle emission standards are based on units of grams/bhp-hr, it is necessary to use a conversion factor to convert these and related data to the gram/mile values needed in credit calculations. These conversion factors are usually calculated from brake specific fuel consumption, fuel density and vehicle fuel economy (miles per gallon for liquid fuels or miles per standard cubic foot for gaseous fuels) although other methods may also be used. Since retrofitted heavy-duty vehicles are not commonplace, ARB has not developed specific conversion factors for them. The credit applicant should submit an appropriate and justified conversion factor value when applying for credits based on commonly accepted data and methodology. This submitted value is subject to district and ARB approval.

### Calculation Procedure

The following procedure is used to calculate the amount of credit to be generated by conversion of heavy-duty vehicles to low-emission configurations. The procedure will be illustrated with a specific example.

Step 1: Determine the gram/mile emission rate for the ceiling standard configuration and the credit standard configuration. This is done by multiplying the ceiling standard and the credit standard by the applicable conversion factors.

Step 2: Calculate vehicle lifetime emissions. For both the ceiling standard and credit standard configurations, multiply the gram/mile results of Step 1 by the applicable credit lifetime mileage. Convert measurement units from grams to tons.

Step 3: Calculate the lifetime pollutant reduction. Subtract the Step 2 lifetime tonnage result for the credit standard configuration from that of the ceiling standard configuration. This is the lifetime emission reduction tonnage per bus. Note that this is not an annualized, tons-per-year value.

As an example, the case of a 1981 DDC 6V-92 transit bus engine is considered. The original certification standards and emission test levels are as follows:

Table 33: 1981 DDC 6V-92 Transit Bus Engine Certification		
	HC (g/bhp-hr)	HC+NOx (g/bhp-hr)
emission standard	1.0	6.0
emission level	0.7	6.0

Following the guidelines previously given for determining separate NOx and HC ceiling standards for an engine subject to a combined HC+NOx certification standard provides the results shown in Table 34.

Table 34: 1981 DDC 6V-92 Transit Bus Engine Ceiling Standards	
HC (g/bhp-hr)	NOx (g/bhp-hr)
0.7	5.3

For the case of NOx credits, following the steps above for a bus certified to a credit level of 2.5 g/bhp-hr and using a typical transit bus conversion factor of 4.3 bhp-hr/mile for both the pre- and post-conversion calculations, the values given in Table 35 would result.

Table 35: Example NOx Credit Calculations	
Ceiling Standard Configuration	22.8 g/mile
Credit Standard Configuration	10.8 g/mile
Credit Life	3 years/100,000 miles
Ceiling Lifetime Emissions	2.5 tons
Credit Lifetime Emissions	1.2 tons
Lifetime NOx Reduction	1.3 tons

Many heavy-duty vehicles, such as line-haul trucks, travel over routes that cross district boundaries on a frequent basis. Since credits should not be granted in one district for emission reductions actually generated in another, the individual district granting credits should provide for pro-rating the credit amount by the mileage actually driven within that district. The district rule should provide for the determination and verification of the appropriate in-district mileage on a case-by-case basis.

For the case of vehicles retrofitted with dual-fuel systems, it will be incumbent upon the district regulating credit generation to ensure that such vehicles primarily operate using the clean fuel. Credits should only be granted for mileage operated on the clean fuel.

## **Enforcement**

In order to generate credits by converting heavy-duty vehicles to low-emission configurations, the operation of those vehicles must result in real emission reductions throughout the credit life. A means of verifying that low emissions are maintained throughout the credit life is needed to ensure that real emission reductions occur.

The district should develop requirements for appropriate records to be kept by the vehicle operator. These records should be in addition to those maintained by the retrofit system manufacturer and installer, as required by the retrofit certification procedures. Operator records should contain such data as vehicle identification numbers, vehicle registration information, retrofit hardware model and serial numbers, miles traveled under the different credit conditions (in-district vs. out-of-district, clean fuel vs. conventional fuel for dual-fuel vehicles, etc.), maintenance and repair dates, and service information, etc. These records should be retained and updated throughout the vehicle's credit life and should be readily available for the district's inspection.

Historically, heavy-duty vehicles have not been routinely tested for in-use emissions compliance since many studies have shown that heavy-duty diesel engines are stable with respect to emissions deterioration over time. However, as low-emission engines that use alternative fuels or add-on control equipment, such as catalytic converters, are developed and put into use, emission deterioration rates may increase significantly. The district should require the implementation of an appropriate in-use testing program to ensure that the reduced emission levels associated with credit-generating retrofits are maintained during the credit life. The retrofit certification procedures contain requirements for in-use compliance testing during the retrofit system useful life that would be applicable to conversion equipment certified under those regulations for credit generation. For purposes of generating credits, the retrofit system useful life will be measured starting from the time of installation, regardless of the mileage on the vehicle at that time. The district should require the vehicle operator to maintain each individual vehicle so that failures in components that would cause increases in engine emissions are readily detected and corrected. If vehicle operation continues to generate credits beyond the useful life of the retrofit hardware, the vehicle operator should be responsible for testing costs. Should any testing indicate an increase in emissions from converted heavy-duty engines used to generate credits, repairs should be made immediately. If defects occur such that emissions cannot be returned to the applicable credit standard level, the district should take whatever steps it deems necessary to correct the situation. Such steps should include possible revocation of credits.

The retrofit certification procedures put the liability for retrofit system in-use testing, during the retrofit hardware useful life, onto the system manufacturer. However, for engines which are retrofit with an upgrade kit to the identical configuration of an engine which has undergone the new engine certification process, the retrofit system manufacturer will not be liable for the in-use testing requirements of the retrofit certification procedures. Since the new engine on which the upgraded engine is based is already subject to new engine in-use testing requirements, retrofit in-use testing requirements would be redundant and therefore unnecessary.

In summary, at all times during the credit life, responsibility must be taken for ensuring in-use compliance with the applicable credit certification standards.

### **Other Air Quality Issues**

After tailpipe emissions are considered, the primary air quality issues that could arise regarding conversion of heavy-duty vehicles and engines to alternative fuels are potential increases in greenhouse gas emissions, vehicle evaporative emissions and fuel distribution system evaporative emissions. This subject was presented and discussed in Chapter 6 of this document. Those analyses, based on a comparison of new alternative fuel buses vs. new diesel buses, indicate that no significant increases in evaporative emissions or equivalent greenhouse gases would occur.

For the case of retrofits of existing vehicles, it is assumed that vehicle retrofits not involving operational changeover to a different fuel will not result in significant changes in greenhouse gas or evaporative emissions.

A greenhouse gas analysis for heavy-duty vehicle alternative fuel retrofits, assuming similar pre- and post-conversion energy-based fuel consumption, indicates that effective greenhouse gas emissions tend to decrease moderately for conversion from diesel or gasoline to methanol or natural gas. Specific values for the decreases would depend on the nature of the individual case being considered.

The vehicle evaporative emission analysis results reported in Chapter 6 were based on the assumption that the new methanol buses would be equipped with evaporative control systems designed to meet present or near future standards. CNG buses have sealed, pressurized fuel systems with no evaporative emissions and diesel buses have negligible evaporative emissions due to the inherently low vapor pressure of diesel fuel. The same conditions hold for any gaseous-fueled vehicle or any diesel vehicle, respectively, not just for buses. Therefore, conversion of any liquid-fueled vehicle to operation on gaseous fuel should result in a significant decrease in vehicle evaporative emissions. But conversion from diesel to another liquid fuel would necessitate the addition of an evaporative emission control system to avoid significant increases in evaporative emissions.

Evaluation of evaporative emissions from conversion of a gasoline-fueled vehicle to operate on another liquid fuel, such as methanol, is inconclusive because of the need to consider fuel tank size and shape and other installation specifics. The conversion hardware should be properly designed to prevent increased evaporative emissions.

## **10. GENERATION OF EMISSION REDUCTION CREDITS THROUGH THE PURCHASE OF NEW, REDUCED-EMISSION HEAVY-DUTY VEHICLES**

This chapter presents guidelines for generating mobile source emission reduction credits through the purchase and operation of reduced-emission heavy-duty vehicles. It is an extension and expansion of those guidelines presented in Chapter 6, "Generation of Emission Reduction Credits Through The Purchase of Low-Emission Buses". For information on generating credits through the purchase of clean urban buses and engines, the reader is referred to that chapter. For generating credits through the purchase of new, clean heavy-duty vehicles other than urban buses, the guidelines in this chapter should be used.

### **Introduction**

Heavy-duty trucks and urban buses emit significantly more oxides of nitrogen (NO<sub>x</sub>) on a per-vehicle basis than any other category of motor vehicle in California. There are opportunities to reduce these and other heavy-duty vehicle emissions by replacing existing vehicles with new vehicles powered by reduced-emission engines. These reductions can then be used to generate emission reduction credits. The following guidelines enhance the potential to create emission reduction credits by the purchase of new, reduced-emission heavy-duty vehicles while simultaneously safeguarding air quality. Emission reduction credit programs would be developed and implemented by the local air pollution control districts and air quality management districts (districts) following the Air Resources Board's (ARB or Board) guidelines.

Programs designed to generate emission reduction credits must comply with the current Federal Emission Trading Policy, which requires that credits only be allowed for emission reductions that are surplus to federal, state, and local regulations. This chapter presents guidelines to extend the applicability of the emission reduction credit program in a similar manner to all new, reduced-emission heavy-duty vehicles. The guidelines in this document are very similar to those approved by the ARB for urban buses, but broader in scope to accommodate a variety of operating scenarios.

The State Implementation Plan (SIP), approved by the Board in November 1994, is the state's basic blueprint for reaching air quality attainment goals in many areas of California. Several of the mobile source measures in the SIP call for major reductions of emissions from on-road heavy-duty vehicles operating in the state. The requirements of such SIP measures may conflict in some instances with the desire of vehicle operators to generate mobile source credits in accordance with these guidelines. Since emission reductions used as mobile source emission reduction credits have little or no direct beneficial effect on air quality, this conflict could hamper the SIP attainment goals. Care must be exercised to ensure that any mobile source credit programs developed are balanced with reasonable progress toward air quality attainment.

The amount of credit available through the use of these guidelines will decrease as the ARB adopts more stringent emission standards for heavy-duty vehicles in the future. Currently, there is an opportunity to generate credits based on existing heavy-duty emission standards. As those emission standards are tightened in the future, and manufacturers are required to produce engines with lower emissions, fewer opportunities for credits will be available.

## **Program Guidelines**

The guidelines presented in this chapter are designed to allow air pollution control districts and credit program operators to calculate emission reductions resulting from the purchase and use of reduced-emission heavy-duty vehicles in lieu of vehicles that just meet the emission standards. As used in this document, the heavy-duty designation includes those vehicles with a gross vehicle weight (GVW) greater than 14,000 pounds and engines certified in the heavy-duty category, as indicated on the certification Executive Order (EO), and not in the light-duty or medium-duty classifications. The heavy-duty category also can be broken into light heavy-duty (14,001 to 19,499 pounds GVW), medium heavy-duty (19,500 through 33,000 pounds GVW) and heavy heavy-duty (over 33,000 pounds GVW). The guidelines presented here consider a fleet operator faced with the need to replace a large number of heavy-duty vehicles simultaneously, possibly due to retirement of a large number of worn-out vehicles. The operator could buy new vehicles that meet the current applicable emissions standards, or opt for reduced-emission vehicles that emit below the current standards by a significant amount. For the latter case, the difference between the emission standards to which the two types (current-standard and reduced-emission) of engine were certified would constitute an emission reduction that could be used or sold as credits.

At present, diesel-fueled engines are capable of emission levels only slightly below the current NOx emission standard. To generate credits by purchasing "clean" vehicles instead, the fleet operator likely would have to procure vehicles that operate on an alternative fuel (such as methanol, natural gas or electricity). Generally, using such alternative fueled vehicles is more expensive than using conventionally powered vehicles, either because of increased capital costs for the engines themselves, the cost of fuel, the additional fueling infrastructure cost, or combinations of these factors. The extra funding required for reduced-emission vehicle purchase and operation could potentially be obtained from the sale of credits for the emission reductions.

According to the following guidelines, the amount of the emission reduction credit is based on the difference between the certification standards of the current-standard engine and reduced-emission engine. In addition, the credit life is based on the expected operating life of the substitute reduced-emission vehicle being purchased.

The ARB does not include a cost-effectiveness evaluation in this guideline document. However, the capital and operating costs for reduced-emission vehicles can be calculated in a manner similar to the costs described in the February 1993 emission reduction credits document. Potential credit program participants will analyze the costs involved and the value of the potential emission reductions in determining whether to participate in an emission reduction credits program.

## **Pollutants for Which Credits Can Be Granted**

NOx is the only pollutant considered in these guidelines as a reasonable candidate for credit generation. NOx emissions from diesel vehicles are very close to the current certification standard. Particulate matter (PM), reactive organic gas (ROG), and carbon monoxide (CO) levels from current diesel engines are already quite low. This means that any PM, ROG or CO emission reductions from the use of reduced-emission engines would have to be even smaller (indeed, some alternative fuel engines show increases in CO emissions relative to the diesel engine from which they are derived). Due to the lack of extensive data regarding in-use emissions, the relative uncertainties associated with

the lifetime PM, ROG and CO emission values of alternative fueled heavy-duty vehicles are quite large. This greatly reduces the confidence that credits generated for these three pollutants meet the "real and permanent" criteria for emission reduction credits.

Although ROG and CO exhaust emissions from gasoline-powered vehicles are greater than the ROG and CO emissions from comparable diesel vehicles, and although there are evaporative and marketing emissions associated with the use of gasoline powered vehicles, it is not possible to determine which engine category (gasoline or diesel) would be appropriate as the basis for calculating emission reductions from the use of alternative fueled engines. Virtually all heavy heavy-duty engines are diesel engines, while light heavy-duty and medium heavy-duty engines can be gasoline powered or diesel powered. These two different types of powerplants are fungible to a great degree, and it would not be possible to make a determination on the type of "in-lieu" engine that was being replaced by an engine that was a candidate for earning emission reduction credits. Therefore, no credits should be granted for pollutants other than NOx.

### **Calculation of Credits**

The following sections describe the factors and procedures used to calculate the emission reduction credit associated with purchasing a reduced-emission heavy-duty vehicle.

#### **Calculation of Vehicle Emission Reductions**

The magnitude of the credit-generating emission reduction is calculated based on the difference between the "ceiling" standard and an optional reduced-emission (or "credit") standard, to be discussed below. A conversion factor is used to convert the emission standard to a gram per mile emission rate. It is necessary to use standards rather than actual measured emission levels in calculating the emission reduction credit to ensure that production variability and emission control system deterioration are taken into account. The credit standard establishes an enforceable level with which vehicles that are purchased to generate credits must comply. (A more detailed discussion of compliance responsibility for the duration of vehicle life is presented later in this appendix).

#### **Certification Standards**

The applicable mandatory emission standard should be used as the ceiling standard for credit calculations. The current mandatory heavy-duty vehicle emission standard for NOx is 5.0 gram/brake horsepower-hour (g/bhp-hr). This is the ceiling standard used for credit calculation examples in these guidelines. Federal law establishes a 4.0 gram/bhp-hr standard nationwide in 1998. The Board, in June 1995, adopted the standard to go into effect at the same time for California. Once the lower NOx standard becomes effective, credits will be calculated based on that lower ceiling standard. The credit standard, to which a potential reduced-emission engine must be certified to generate credits, may be selected by the engine manufacturer from the multi-tier optional standards presented in Tables 36 and 37. These optional standards were adopted by the Board in June 1995.

Table 36: Heavy-Duty <i>Diesel-Cycle</i> Engine NOx Optional Certification Standards		
Standard Type	1995-1997	1998-later
	(gram/bhp-hr)	(gram/bhp-hr)
Ceiling Standard:	5.0	4.0
Credit (Optional) Standard:	3.5	---
	3.0	---
	2.5	2.5
	2.0	2.0
	1.5	1.5
	1.0	1.0
	0.5	0.5

Table 37: Heavy-Duty <i>Otto-Cycle</i> Engine NOx Optional Certification Standards		
Standard Type	1995-1997	1998-later
	(gram/bhp-hr)	(gram/bhp-hr)
Ceiling Standard:	5.0	4.0
Credit (Optional) Standard:	2.5	---
	2.0	---
	1.5	1.5
	1.0	1.0
	0.5	0.5

This multi-tier approach is used to allow the engine manufacturer and purchaser the maximum flexibility possible in certifying and selecting an engine family. As noted previously, these standards were approved by the Board in June 1995 and are currently available for use in certifying reduced-emission engines.

These tables show that the highest credit standard in each category is well below the applicable ceiling standard. An engine must be significantly cleaner than the ceiling standard to assure that a real

emission reduction is achieved. It is of interest to note that there is no zero-emission optional standard included in these tables. The conventional certification procedures would not be applicable for use on a zero-emission heavy-duty vehicle, due to the nature of such a vehicle. However, zero-emission heavy-duty vehicle designs would be certified through other procedures, primarily based on engineering evaluations of the basic design, as opposed to measurements made during engine dynamometer runs. Zero-emission heavy-duty vehicles would be eligible to participate in the same credit and incentive programs as other reduced-emission heavy-duty vehicles.

### Credit Life

Duration of the credit life for a newly purchased vehicle is dependent on the expected vehicle life. Because there are so many different types of vehicles and applications that could be used to generate credits, it is impossible, a priori, to specify meaningful credit life values in these guidelines. Therefore, the expected vehicle/credit life should be determined by the credit proponent from historical fleet records of similar vehicles in similar operation with similar histories. Historical records should be available to support the lifetime claims. During the credit life, the responsible district should conduct periodic checks of each vehicle's operating records to ensure that the vehicle is being operated for the mileage and in the manner claimed in the pertinent credit application.

### Conversion Factor

A conversion factor (CF) is used to convert the emission rate expressed in terms of mass of pollutant per unit of engine work, to units of pollutant mass emitted per unit distance a vehicle is driven. A vehicle's emissions per mile are obtained by multiplying the emissions expressed as g/bhp-hr by the CF expressed as work (bhp-hr) expended per mile a vehicle travels.

The work required to move a heavy-duty vehicle over a given distance is a function of several factors, including the vehicle configuration and its load. For urban transit buses, this value is relatively well established because the duty requirements of most transit buses (stop-and-go, low speed driving) are similar. This is not the case for other heavy-duty vehicles. For example, heavy-duty trucks or charter buses may be used primarily on freeways with infrequent stops or idling, while trucks used in waste hauling or ready-mix concrete delivery might have completely different duty cycles and work per mile requirements. This lack of homogeneity makes it difficult to generalize the operation of heavy-duty vehicles. Since there are so many different types of heavy-duty vehicles and applications, the ARB has not developed specific conversion factors for all of them. The credit applicant should submit an appropriate and justified conversion factor value when applying for credits. This submitted value is subject to district and ARB approval. One possible approach to determining the conversion factor is to use the following formula:

$$CF = \frac{(fuel\ density)}{(vehicle\ fuel\ economy) \times (engine\ brake\ specific\ fuel\ consumption)}$$

where CF is the conversion factor in bhp-hr per mile, fuel density is in pounds per gallon for liquid fuels or pounds per standard cubic foot for gaseous fuels, vehicle fuel economy is in miles per gallon or miles per standard cubic foot, as appropriate, and engine brake specific fuel consumption is in pounds per bhp-hr. The engine and vehicle manufacturers should be consulted for these data. Other

sources for the conversion factor, such as actual engine dyno to chassis dyno correlation data, conceivably could be acceptable depending on such factors as how closely the test configurations correspond to the actual vehicle and engine configurations as well as on other factors.

### Calculation Procedure

The following procedure is used to calculate the amount of credit to be generated by reduced-emission heavy-duty vehicle procurement.

Step 1: Calculate the gram/mile equivalent emission rate for the ceiling standard vehicle and the credit standard vehicle. This is done by multiplying the appropriate standard from Table 36 or 37 (based on the applicable ceiling standard and the engine's credit certification level) by the appropriate conversion factor.

Step 2: Calculate vehicle lifetime emissions. For both the ceiling standard and credit standard vehicles, multiply the gram/mile results of Step 1 by the credit lifetime mileage. Convert measurement units from grams to tons.

Step 3: Calculate the lifetime pollutant reduction. Subtract the Step 2 lifetime tonnage result for the credit standard engine from that of the ceiling standard engine. This is the lifespan emission tonnage reduced per vehicle. Note that this is not an annualized, tons per year value. To determine the annual tons per year, divide the lifetime tonnage value by the vehicle life in years.

This process is summarized in the following equation:

$$\text{lifetime reduction} = \text{ceiling standard} \times CF_1 \times \text{lifetime mileage}_1 - \text{credit standard} \times CF_2 \times \text{lifetime mileage}_2$$

where subscript "1" refers to the conventional vehicle which is certified to the mandatory ceiling standard, and subscript "2" refers to the vehicle certified to the optional credit standard.

### **Repowering**

Repowering is the practice of replacing a vehicle's engine with another engine rather than rebuilding the existing engine. Repowering with a clean engine that meets the criteria presented in this document can provide for emission reduction credits. Emission reduction credits are calculated in the same way that credits are calculated for the purchase of an entirely new vehicle, that is, to qualify for credits the engine should be certified to one of the credit standards shown in Tables 36 and 37. The ceiling standard will be the mandatory standard in effect at the time the repowered engine is installed. Credits for repowered vehicles can be granted initially for the expected life of the engine, assuming the entire vehicle is expected to remain in service at least that long. These credits may be renewed at the time of rebuild. During the credit life, the responsible district should conduct periodic checks of each repowered vehicle's operating records to ensure that the vehicle is being operated for the mileage and in the manner claimed in the pertinent credit application.

## **Credit Emissions Testing and Compliance Responsibility**

To generate credits by purchasing reduced-emission vehicles, operation of the vehicles should result in real emission reductions throughout the credit life. A means of verifying that low emissions are maintained throughout the credit life is needed to ensure that real emission reductions occur.

Historically, heavy-duty vehicles have not been routinely tested for in-use emissions compliance since many studies have shown that heavy-duty diesel engines are reasonably stable with respect to emissions deterioration over time. However, as reduced-emission engines that use alternative fuels and add-on control equipment, such as catalytic converters, are developed and put into use, emission deterioration rates may increase significantly. The district that implements a credit program should require the implementation of an appropriate in-use testing program to ensure that the reduced emission levels associated with reduced-emission vehicles that participate in a credit program are maintained in customer use. The cooperation of the credit-generating vehicle operator and the credit user is expected in any effort deemed necessary to verify in-use compliance. At a minimum, it may be necessary for a small number of vehicles to be made available for chassis dynamometer emission tests, along with the funds necessary to conduct the tests. The parties seeking credits should demonstrate that they have plans and contracts in place to meet these obligations before credit can be granted. The ARB staff will work with all involved parties to ensure that an effective testing program is implemented. As with any ARB-certified vehicle, the ARB has the authority to recall reduced-emission vehicles that do not comply with the optional emission standards to which they are certified.

It is expected that more than one district could have similar credit programs. In this case, the combination of testing resources and results between districts for like engine families and vehicles could result in reduced test costs for all those involved. The ARB encourages participating districts to consider such pooling of resources.

### **Compliance During Certified Engine Life**

For credit generation purposes, the operator's vehicle should use a reduced-emission engine for which the engine manufacturer has obtained ARB certification to one of the optional standards listed in Table 36 or Table 37, as appropriate. To certify an engine to an optional standard, the engine manufacturer must demonstrate through the normal certification procedures that the engine emits below the level of the chosen optional standard throughout its statutory useful life. The engine manufacturer must also accept responsibility for the in-use emissions of the engine-family through the statutory useful life and be subject to recall if the engine-family systematically exceeds the credit standard certification level. (The statutory useful life mileage is 290,000 miles for heavy heavy-duty diesel and diesel-derived engines. It is 185,000 miles for medium heavy-duty diesel and diesel-derived engines. It is 110,000 for light heavy-duty diesel and diesel-derived engines, and for Otto-cycle heavy-duty engines except those derived from diesel engines. The useful life time period for NOx emissions is 8 years through 1997 and 10 years beginning in 1998. In practice, the end of the statutory useful life is determined by whichever of the mileage or time requirements is met first.)

In addition, during the first 5 years or 100,000 miles or 3,000 hours of operation of a heavy-duty diesel engine's life, or the first 5 years or 50,000 miles for the life of all other heavy-duty engines, the manufacturer must provide a warranty to cover each individual engine's emission control equipment,

as required by current certification procedures. During this period, the manufacturer is responsible for the repair of any faulty piece of engine or emission control equipment that causes emissions to exceed the credit certification standard.

In the past, responsibility for random, non-systematic parts failure in the period between the end of the emission control warranty and the end of the useful life has not been formally assigned to anyone. But to generate credits, the vehicle operator should accept responsibility for maintaining the vehicle to proper, reduced-emission operation conditions throughout the life of the vehicle, for any period and any failure not covered by the engine manufacturer.

#### Compliance After Rebuild

While engine life is considered complete at the end of the useful life period, many heavy-duty engines are rebuilt and put back into operation to yield a significantly higher mileage total vehicle life. It is assumed that a rebuild restores an engine to zero-mile conditions (and new engine certification levels) and that emissions therefore remain below the certification level throughout the remainder of the vehicle life. To generate credits, the vehicle operator should take responsibility for engine emissions compliance during the post-rebuild period. The engine should be rebuilt to the original equipment manufacturer's specifications, including all equipment on the emissions critical parts list. The operator should also maintain each individual vehicle so that emission control equipment failures are readily detected and corrected. Vehicles with rebuilt engines should be included in the in-use testing program required by the district. To detect systematic errors in the rebuild process, the district program should contain provision for the ARB, in cooperation with the district and vehicle operator, to test some of the rebuilt fleet in each engine family to determine post-rebuild emission levels. If ARB determines that such testing is necessary, the operator should make vehicles available to ARB for emissions testing.

In summary, responsibility should be taken for ensuring in-use compliance with the applicable credit certification standards at all times during the life of an individual vehicle.

#### Regional Emissions

A district that implements a program offering emission reduction credits for the purchase and use of reduced-emission heavy-duty vehicles should include in the requirements appropriate safeguards to ensure that the emission reductions occur within the district for which they were intended. An enforcement program to check records of routes and miles driven should be included in the rules that implement these guidelines. Heavy-duty vehicles that qualify for the appropriate credit programs in two or more districts may earn credits for travel in more than one of those districts, with district consent. The credits would be prorated according to miles driven in each area.

## **11. FUTURE PROGRAMS**

The purpose of this chapter is to identify various mobile source emission reduction credit options that have been discussed by various interested parties and identify future programs for which the ARB will provide guidance.

### **Future ARB Guidance**

The ARB staff is developing guidelines for the generation of credits based on conversion or replacement of off-road equipment or engines. The proposed guidelines will be presented to the Board for its approval in the near future.

### **Concepts for Mobile Source Emission Reduction Credits**

Many different concepts for generating mobile source emission reduction credits have been discussed by interested parties. These include:

Allowing credit for selling reformulated gasoline or diesel fuel which is significantly cleaner than ARB regulations require

Voluntary use of remote sensing to identify high-emitting vehicles, then repairing vehicles to lower emissions

Voluntary inspection and maintenance programs that achieve greater emissions reductions than the mandated Smog Check program

Implementing TCMs not otherwise required by regulations

As the need arises, and as time and staff resources permit, the ARB staff will examine these and other options for future programs. The ARB staff will select promising options and develop guidance for implementing mobile source emission reduction credit programs. Future guidance will be drafted in the same manner as this guidance document. Public consultation meetings will be held and interested parties will have an opportunity to provide comments during the development phase. The future guidance will be presented to the Board for conceptual approval.

## 12. CONCLUSIONS

The ARB staff have reached the following conclusions regarding the implementation of mobile source emission reduction credit programs in California.

### General Conclusions

1. Opportunities exist to create and use mobile source emission reduction credits. The creation of these credits provides districts and industry with an additional mode of flexibility in meeting air quality goals.
2. Districts wishing to establish mobile source emission reduction credit programs are encouraged to adopt regulations covering the generation and use of credits which are consistent with the ARB's guidelines. Districts should use great care in designing mobile source emission reduction credit programs so that they do not allow false credits that would exacerbate air quality problems.
3. Any regulation adopted to create and use mobile source emission reduction credits needs to ensure that the mobile source emission reduction credits meet the following criteria: surplus, real and quantifiable, enforceable, and with an established life span.
4. Relative to many existing control programs, mobile source emission reduction credits can produce cost-effective emission reduction credits.
5. At this time the best uses of mobile source emission reduction credits appear to be:  

taining emission reductions otherwise required by  
district rules

ding a source of additional emission reductions for use in market-based emission  
reduction trading programs
6. The ARB staff will examine other options for creating mobile source emission reduction credits and will provide guidance for implementing the most promising options.

7. District rules should reflect the changing nature of ARB's Mobile Source Emissions Program and should look to the ARB for up-to-date emission factors and calculation procedures as well as further guidelines for additional mobile source emission reduction credit generating methods.
8. Consideration should be given to using a portion of each mobile source emission reduction credit to improve air quality.

### Specific Conclusions

1. In an accelerated retirement of older vehicles program, increasing the removal of older, high-emitting cars through a voluntary accelerated retirement program is a cost-effective method of reducing ROG emissions. The likely range of costs for reducing such emissions appears to be comparable with other emission reduction strategies now in place. The amount of the emission reduction can vary considerably, and is a function of the age of the vehicle purchased, the replacement vehicle, the annual mileage of the retired vehicle, and the amount of money spent on the program.
2. If a large-scale accelerated retirement program is established, a component program should be implemented to prevent the importation of poorly maintained, older vehicles into the basin to either sell to the program or fill the increased market demand for older, inexpensive vehicles.
3. The voluntary purchase of low-emission transit buses can be a cost-effective method for reducing NOx emissions. However, because of the limited size of the urban bus fleets in California, only relatively modest amounts of credits may be available.
4. Mobile source emission reduction credits can be generated by purchasing ZEVs. These credits have a relatively long life of about a decade. However, such programs must be carefully designed to ensure that emission reductions are surplus to ARB's Low-Emission Vehicle regulations.
5. The purchase of low-emission light and medium-duty vehicles may not yield surplus emission reductions because existing ARB regulations require manufacturers to produce these vehicles to meet an increasingly stringent fleet average emission standard.
6. The purchase of ZEVs can provide ROG and NOx emission reduction credits--provided that the auto manufacturers agree not to use the vehicles sold to comply with the emission standards required as part of the ARB LEV regulations.
7. In a ZEV purchase program, the amount of available credits in the near-term is expected to be very small because of the currently limited availability of ZEVs and the lack of a wide spread infrastructure which would help convince consumers to purchase a ZEV.
8. The cost-effectiveness of a ZEV program cannot be calculated until the costs of ZEVs can be better quantified.
9. Potentially significant amounts of credits can be made available through light-, medium- and heavy-duty retrofit programs. Actual amounts depend on case specifics.

10. Credit life for credits derived from light- and medium-duty retrofits will be dependent on the unused portion of the 10 year/100,000 mile or 10 year/120,000 mile vehicle life, respectively, at time of retrofit. No fixed credit life can be set in these guidelines.
11. Credit life for credits derived from heavy-duty retrofits will be dependent on the typical life for the type of vehicle and application involved and the portion of that life remaining (up to the time of retirement or next overhaul). Credits can be renewed at overhaul time, potentially giving them a relatively attractive lifespan. No fixed credit life can be set in these guidelines.
12. The cost-effectiveness of retrofit credit programs can only be determined for specific cases. Costs will vary widely from case to case.
13. Reduced-emission heavy-duty vehicle procurement has the potential to generate significant amounts of NO<sub>x</sub> credits due to the high inherent NO<sub>x</sub> emission levels of conventional heavy-duty vehicles and to their high mileage accumulation rates. The details of an individual case will determine the final credit generation feasibility and cost effectiveness.