California Enhanced Inspection and Maintenance (I/M) Program Evaluation
TECHNICAL SUPPORT DOCUMENT
PART 1

This portion of the Technical Support Document (TSD) describes the approaches and methods that the Air Resources Board (ARB) used to calculate the emission benefits and cost effectiveness for the draft *Evaluation of the California Enhanced Vehicle Inspection and Maintenance (Smog Check) Program (April 2004)*. The final TSD will reflect any revisions in the final evaluation report. Methodologies are explained in each of the following chapters:

1.1 Total Statewide I/M Benefits for 2002
1.2 Enhanced I/M Benefits for 2002, 2005, and 2010
1.3 Cost Effectiveness of Smog Check in Enhanced Areas in 2002
1.4 Emission Benefits of Changing the 30-year Rolling Exemption
1.5 Cost Effectiveness of Changing the 30-year Rolling Exemption
1.6 Emission Benefits of Annual Inspection of Vehicles Over 15 Years Old
1.7 Cost Effectiveness of Annual Inspection of Vehicles Over 15 Years Old
1.8 Emission Benefits of Annual Inspection of Taxicabs
1.9 Cost Effectiveness of Annual Inspection of Taxicabs

Background. ARB staff used the EMFAC2002 emissions model to estimate the emission benefits presented in this document. EMFAC is a sophisticated mathematical model and computer program that divides on-road vehicles into thirteen classes including passenger cars, light- and heavy-duty trucks, buses, motor homes, and motorcycles. EMFAC can create an inventory for any calendar year from 1970 to 2040; each calendar year includes up to 45 vehicle model years. EMFAC includes vehicles that use gasoline, diesel fuel, and electricity as fuel sources. The model includes three exhaust processes (vehicle starts, running exhaust, and idling exhaust) and four evaporative processes (diurnal, hot soak, running losses, and resting losses).

EMFAC estimates emissions by multiplying a process rate, usually either grams per hour or grams per mile, by the number of vehicles or other unit of activity (such as vehicle miles of travel). EMFAC then expresses the product as tons per day (tpd) of emissions. EMFAC emission factors are derived from emissions test data for thousands of vehicles of varying ages and types. Emissions tests are conducted by ARB and the United States Environmental Protection Agency (U.S. EPA). Estimates of vehicle population in EMFAC are derived from Department of Motor Vehicles (DMV) registration data. Activity data (vehicle miles of travel (VMT) at various speeds) are typically obtained from local transportation planning agencies, such as councils of governments or metropolitan planning organizations. Other sources of input data are the California Department of Transportation, the Bureau of Automotive Repair (BAR), and instrumented vehicle surveys conducted by ARB and U.S. EPA.

The emission factors used in EMFAC are subject to a number of correction factors that adjust the base inventory to more accurately reflect emissions from real-world driving

conditions. These adjustments accommodate a wide range of vehicle speeds, varying ambient air temperatures, varying fuel composition, use of air conditioning, varying soak time between starts, relative humidity, and altitude. The EMFAC model also includes the impact of deterioration on vehicle emissions control systems as the vehicles age.

The EMFAC model includes the impact of the Smog Check vehicle inspection and maintenance program on emissions. EMFAC includes the impacts of each Smog Check program implemented, beginning with the first statewide biennial program introduced in 1984, and continuing through the basic BAR90 and enhanced I/M programs. EMFAC estimates the emissions impacts of the Smog Check program by modeling identification rate (the fraction of vehicles that fail their Smog Check inspections), repair effectiveness (how well failing vehicles are repaired), and vehicle deterioration (how emission rates of vehicles increase over time as they age). These factors are based on data collected in special inspection and maintenance test programs conducted by ARB. Model output is verified by comparison with roadside inspection data collected by BAR and ARB. Also reflected are changes in vehicle population and VMT by vehicle type that occur over time, and changes in emissions due to changes in emissions standards. Documentation for the EMFAC model is available online at http://www.arb.ca.gov/msei/msei.htm.

In this document, ARB staff has provided estimates for hydrocarbons (HC) or reactive organic gases (ROG), oxides of nitrogen (NOx), and carbon monoxide (CO) in tpd for various Smog Check program scenarios. To allow the reader to duplicate calculations, ARB staff provided emission estimates to the nearest 0.01 tpd in all preliminary calculations shown in this report. However, for each emission estimate calculation in the Joint Report to the Legislature, ARB staff carried all the decimal places and rounded the final number to appropriately reflect the actual precision of the calculations. Consequently, some numbers may not appear to add correctly due to rounding.

1.1 Total Statewide I/M Benefits for 2002 (Basic + Enhanced)

ARB staff used EMFAC2002 version 2.2, which was released April 23, 2003, to estimate the emission benefits of the Smog Check I/M program for the basic and enhanced I/M program areas for the 2002 summer season. To estimate the benefits of the statewide I/M program, ARB staff did the following:

1. Estimated the total fleet emissions of the default enhanced I/M program by running the model with the default enhanced I/M program in place.
2. Estimated the total fleet emissions of the basic BAR90 I/M program in the enhanced areas by turning off the enhanced I/M program so that only the basic BAR90 I/M program was in effect.
3. Subtracted the default enhanced I/M program emissions from the basic BAR90 I/M program emissions to determine the benefits of the default enhanced I/M program (See Table 1.1.1).

4. Calculated an off-model adjustment[1] to estimate benefits from an increase in the number of vehicles directed to test-only stations in 2002 not reflected in the default enhanced I/M program in EMFAC2002 (See Table 1.1.2).
5. Estimated the benefits of the basic BAR90 I/M program (See Table 1.1.3).
6. Calculated the benefits of the Evaporative System Test improvements (See Table 1.1.4).
7. Summed the total benefits from the enhanced I/M program (with off-model adjustments), the basic BAR90 I/M program, and the Evaporative System Test improvements (See Table 1.1.5).

Table 1.1.1 summarizes the results from the EMFAC2002 model runs to estimate the benefits of the default enhanced I/M program in EMFAC2002. The current basic BAR90 I/M program fleet emissions summarized in Table 1.1.1 included the added benefits of fuel cap testing and liquid leak checks.

Table 1.1.1

Statewide Enhanced I/M Benefits (default) Calendar Year 2002 Summer Season TPD			
	HC	NOx	CO
Total Fleet Emissions-Current Basic BAR90 I/M Program	914.63	1688.07	9357.05
Total Fleet Emissions-Default Enhanced I/M Program	864.50	1614.98	8713.82
Default Enhanced I/M Program Benefit	**50.13**	**73.09**	**643.23**

More Vehicles to Test-only Stations. The default enhanced I/M program in the model assumes that 15% of vehicles are directed to test-only stations. By the end of 2002, BAR was directing 36% of the vehicles to test-only stations. To be conservative, ARB staff assumed that the number of vehicles being directed to test-only in summer 2002 was approximately 20%. ARB staff adjusted the emissions modeled by EMFAC2002 to reflect the additional vehicles being directed to the enhanced I/M program.

ARB staff estimated the ROG, NOx, and CO benefits from increasing the percentage of vehicles directed to test-only by calculating the overall failure rates for 15% and 20% directed. Based on data from the BAR Executive Summary report for 3rd quarter 2002, test/repair stations have a failure rate of 9.9%. Based on data ARB staff received from BAR on December 16, 2002, the failure rate for vehicles randomly directed to test-only stations was 25.1% for fiscal year 2001/2002[2]. ARB staff used the failure rate for the randomly directed vehicles to avoid overestimation of benefits from use of the higher failure rate for the more-polluting "High Emitter Profile" vehicles. The emissions benefits

[1] Off-model adjustments are needed to account for certain program elements not included in the default Smog Check programs modeled in EMFAC2002.

[2] The difference in failure rates could result from several factors, including test/repair stations conducting pre-inspection repairs to reduce chances of failure prior to the officially recorded smog check inspections. Relative failure rates will be re-examined with more recent data prior to release of the final evaluation report.

were assumed to be proportional to the increase in the expected failure rate of going from 15% to 20% directed.

To calculate the expected increase in failure rate, ARB staff calculated the overall failure rate for 15% direction, 20% direction, and the fractional increase in benefits as shown below. ARB staff assumed that vehicles not directed to test-only would be tested at test/repair stations.

Overall failure rate for 15% directed = (9.9)(.85) + (25.1)(.15) = 12.18
Overall failure rate for 20% directed = (9.9)(.80) + (25.1)(.20) = 12.94
Fractional increase = (12.94 -12.18)/12.18 = 0.0624

The failure rate fractional increase is then multiplied by the emission benefit associated with the enhanced I/M program. Table 1.1.2 displays the additional benefits due to the increase in test-only direction from 15% to 20%.

Table 1.1.2

Enhanced I/M Program Area Off-Model Adjustment Additional benefits for 15 to 20% direction to Test-Only Stations Calendar Year 2002 Summer Season TPD			
	HC	NOx	CO
South Coast Air Basin	1.25	1.74	16.09
Coachella Valley	0.04	0.06	0.59
Ventura County	0.05	0.07	0.65
Antelope Valley Air District	0.03	0.04	0.38
San Joaquin Valley Air Basin	0.33	0.53	4.64
Sacramento Region	0.21	0.30	2.81
San Diego County	0.29	0.44	3.52
Total Additional Benefit for Directing More Vehicles to Test-Only Stations	**2.20**	**3.20**	**28.67**

Basic Program Benefits. ARB staff used the EMFAC2002 model version 2.2 to estimate statewide emission benefits of the basic BAR90 I/M program. ARB staff ran the EMFAC2002 model using the no I/M assumption to determine the fleet emissions as if the State had no I/M program. ARB staff then ran the EMFAC2002 with the default basic BAR90 I/M program. Table 1.1.3 shows the results from these analyses, including the basic BAR90 I/M program statewide emission benefits.

Table 1.1.3

Statewide Basic BAR90 I/M Program Benefits Calendar Year 2002 Summer Season TPD				
	HC Exhaust	HC Evap	NOx	CO
Total Fleet Emissions-No I/M Program	635.15	437.99	1769.46	10045.57
Total Fleet Emissions-Basic BAR90	560.23	437.98	1688.07	9357.05
Basic BAR90 I/M Program Emission Benefit	**74.92**	**0.01**	**81.39**	**688.52**

Evaporative Improvements. BAR implemented some enhanced I/M program improvements statewide instead of in enhanced areas only, including gas cap inspections for evaporative emission leaks and liquid fuel leak testing. Therefore, to determine the emission benefits, ARB staff ran the EMFAC2002 model version 2.2 for the basic BAR90 I/M program statewide with the evaporative emission system improvement option. Table 1.1.4 summarizes the net effects of the evaporative emission system improvements.

Table 1.1.4

Statewide Evaporative System Benefits Calendar Year 2002 Summer Season TPD				
	HC Exhaust	HC Evap	NOx	CO
Total Fleet Emissions: Basic BAR90 I/M Program	560.23	437.98	1688.07	9357.05
Total Fleet Emissions: Basic Including Statewide Evap System Improvements	560.23	354.40	1688.07	9357.05
Evaporative Test Improvement Benefit	**0**	**83.58**	**0**	**0**

Summation of Current Program Benefits. Table 1.1.5 sums the emission benefits from the basic BAR90 I/M program, the statewide evaporative test improvements, the EMFAC2002 default enhanced I/M program, and the off-model adjustment for the increase of vehicles sent to test-only, to total the statewide benefits of the Smog Check program.

Table 1.1.5

Total Statewide Emissions Benefits Calendar Year 2002 Summer Season TPD					
	Exhaust HC	Evap HC	Total HC	NOx	CO
Basic BAR90 I/M Program Emission Benefit	74.92	0.01	74.93	81.39	688.52
Evaporative Test Improvement Benefit	0	83.58	83.58	0	0
Default Enhanced I/M Program Benefit	50.13	0	50.13	73.09	643.23
Total Additional Benefit for Directing More Vehicles to Test-Only Stations	2.20	0	2.20	3.20	28.67
Total Statewide Smog Check Benefits	**127.25**	**83.59**	**210.84**	**157.68**	**1360.42**

1.2 Enhanced I/M Benefits for 2002, 2005, 2010

ARB staff used EMFAC2002 version 2.2 (released April 23, 2003) to analyze the emission benefits of the enhanced I/M program for the 2002, 2005, and 2010 summer seasons. To estimate the emission benefits of the enhanced area I/M program, ARB staff did the following:

1. Estimated the emission benefits of the basic BAR90 I/M program element in the enhanced I/M areas.
2. Estimated the emission benefits of the default enhanced I/M program element in the I/M enhanced areas.
3. Estimated the emission benefits of program elements in effect not included in the EMFAC2002 default enhanced I/M program.
4. Summed the applicable benefits for each calendar year.

Enhanced Area I/M Benefits in 2002. Based on information provided by BAR, 65% of the statewide vehicle population in 2002 was in enhanced I/M areas. ARB staff multiplied by 0.65 the basic BAR90 I/M program and statewide evaporative test improvement emission benefits previously calculated in Table 1.1.5 to determine the basic BAR90 I/M program benefit in the enhanced I/M program areas. ARB staff used the EMFAC2002 default enhanced I/M program and the test-only increase off-model adjustment from Table 1.1.5 for the remainder of the emission benefits. Table 1.2.1 summarizes the enhanced area I/M program benefits.

Table 1.2.1

Enhanced Area I/M Program Emission Benefits Calendar Year 2002 Summer Season TPD			
Enhanced Area Benefits	**HC**	**NOx**	**CO**
Benefits from Basic BAR90 I/M Requirements	48.70	52.90	447.54
Benefits from Evap Test Improvements	54.33	0	0
Benefits from Enhanced I/M Requirements (default + test-only)	52.33	76.29	671.90
Total Emission Benefit in Enhanced Areas	**155.36**	**129.19**	**1119.44**

Enhanced Area I/M Benefits in 2005 and 2010. For 2005 and 2010, ARB staff quantified the HC and NOx emission benefits of the basic BAR90 I/M program, the implemented Evaporative Test Improvements (gas cap testing and liquid leak check), and the default enhanced I/M program. Based on information provided by BAR, 87% of the statewide vehicle population in 2005 and 2010 will be subject to the enhanced I/M program. Table 1.2.2 displays the emission benefits.

Table 1.2.2

Enhanced Area I/M Program Emission Benefits Without Post 2002 Improvements Calendar Year 2005 and 2010 Summer Season TPD				
	2005		2010	
Enhanced Area Benefits	HC	NOx	HC	NOx
Benefits from Evaporative Test Improvements	75.36	0	64.96	0
Benefits of EMFAC Default Enhanced I/M Beyond Basic BAR90 I/M Program	71.88	114.26	53.66	96.72
Enhanced Emission Benefit Without Post 2002 Improvements	**147.24**	**114.26**	**118.62**	**96.72**

For 2005 and 2010, ARB staff also quantified the benefits of the improvements to the enhanced I/M program that were implemented or scheduled to be implemented in 2002 or later. Achieving full benefit from a Smog Check Inspection improvement requires that it be in place for at least one full I/M cycle (two years). ARB staff estimated the future benefits for these improvements in calendar years 2005 and 2010. The improvements that have been implemented or committed to implementation during 2002 or later years are:

- Adding areas to enhanced I/M.
- Increasing the percentage of vehicles directed to test-only stations to 36%.
- Loaded mode testing for gasoline trucks between 8,501 and 9,999 lbs. gross vehicle weight rating.
- Low pressure evaporative system testing.

Additional Areas. Table 1.2.3 lists the number of vehicles per air basin added to the I/M program due to new areas added to the enhanced I/M program. BAR provided ARB staff with the number of vehicles shown in Table 1.2.3. These new areas are not currently reflected in the EMFAC2002 model. "Full enhanced" refers to vehicles subject to all elements of the enhanced I/M program, including being directed to test-only stations. "Partial enhanced" refers to vehicles not subject to the test-only provisions.

Table 1.2.3

Summary of New Areas Added to Enhanced I/M Program

Area (Air District or Air Basin)	Approximate Number of Vehicles Added (estimated May 2002)			Date of Request by Air District	Date of Implementation
	Full Enhanced	Partial Enhanced	Total		
San Joaquin Unified APCD	322,000	519,000	841,000	04/19/01	05/01/02
Ventura County APCD	0	35,000	35,000	06/12/01	07/01/02
Sacramento Metro AQMD	0	33,000	33,000	09/27/01	07/01/02
South Coast AQMD	60,000	243,000	303,000	02/01/02	11/01/02
Placer County APCD	0	58,000	58,000	04/11/02	04/01/03
Yolo-Solano AQMD	38,000	33,000	71,000	12/12/01	04/01/03
San Francisco Bay Area	4,800,000	0	4,800,000	09/27/02	07/01/03-10/01/03
El Dorado County AQMD	19,000	73,000	92,000	04/16/02	12/01/03

ARB staff estimated the ROG and NOx benefits of these additional areas by first calculating a per-vehicle benefit for the enhanced I/M program as modeled by EMFAC2002 without the added areas. ARB staff calculated the total benefits for the added areas by multiplying the per-vehicle benefits for each county by the number of vehicles being added to enhanced I/M program in that county. The benefits for partial enhanced I/M areas were reduced by 30% to reflect the lower failure rates expected when vehicles go to test-and-repair stations.

For the San Francisco Bay Area, ARB staff assumed that the enhanced I/M program will be fully implemented by January 1, 2004. ARB staff estimated the benefits of enhanced I/M program in the Bay Area by running EMFAC2002 version 2.2, first with the default basic BAR90 I/M program, and then with the addition of an enhanced I/M program implemented on January 1, 2004. The enhanced I/M program that ARB staff modeled is the same as the program currently in place in other areas of the State.

The benefits modeled using EMFAC2002 are based on all vehicles in the Bay Area being included in the enhanced I/M program. In reality, there are several non-urbanized areas within the air basin that will remain in the basic BAR90 I/M program. BAR provided ARB staff with the estimated population split of 98.3% of vehicles in enhanced I/M and 1.7% in basic BAR90 I/M program areas. ARB staff reduced the EMFAC2002-derived benefits by 1.7% to reflect the actual number of vehicles subject to enhanced I/M program in the Bay Area. Table 1.2.4 summarizes the off-model emission benefit adjustment for added areas.

Table 1.2.4

Enhanced Program Area Off-Model Adjustment for Benefits of Added Areas Calendar Year 2005 and 2010 Summer Season TPD				
	2005		2010	
	HC	NOx	HC	NOx
San Joaquin Valley	3.23	5.43	2.32	4.50
Ventura County	.07	.10	.05	.08
Sacramento Region*	.85	1.39	.51	1.08
South Coast	.94	1.50	.54	1.14
Coachella Valley	.08	.13	.05	.09
San Francisco Bay Area	7.51	11.32	9.95	17.3
Total	**12.68**	**19.87**	**13.42**	**24.20**

*Includes portions of Yolo, Solano, and Placer Counties

More Vehicles to Test-only Stations. ARB staff estimated the ROG and NOx emission benefits for increasing vehicles directed to test-only by calculating the overall failure rates for 15% and 36% directed. Test/repair stations have a 9.9% failure rate based on data from the BAR Executive Summary report for 3rd quarter 2002. Based on data ARB staff received from BAR on December 16, 2002, the failure rate for vehicles randomly directed to test-only stations was 25.1% for fiscal year 2001/2002. ARB staff used the failure rate for the randomly directed vehicles to avoid overestimation of benefits from use of the higher failure rate for the more-polluting "High Emitter Profile" vehicles. The emissions benefits are assumed to be proportional to the increase in the failure rate of going from 15% to 36% directed.

To calculate the proportional increase in failure rate, ARB staff calculated the overall failure rates for 15% direction and 36% direction, then calculated the fractional increase in failure rate as the difference between the two overall failure rates, as shown below.

Overall failure rate for 15% = (9.9)(.85) + (25.1)(.15) = 12.18
Overall failure rate for 36% = (9.9)(.64) + (25.1)(.36) = 15.37
Fractional increase = (15.37-12.18)/12.18 = 0.262

The fractional increase in failure rate was multiplied by the benefit of enhanced I/M over basic BAR90 I/M to estimate the incremental benefit of going from 15% to 36% directed. ARB staff estimated the emission benefit for the South Coast Air Basin (SCAB) for both the 2005 and 2010 calendar years. ARB staff extrapolated the SCAB numbers to all enhanced areas statewide using an estimate that SCAB represents 48.5% of statewide enhanced (provided by BAR). Table 1.2.5 shows the additional benefits from increasing test-only direction from 15% to 36% for both the 2005 and 2010 calendar years.

Table 1.2.5

Enhanced Program Area Off-Model Adjustment Additional Benefits for 15 to 36% Direction to Test-Only Stations Calendar Year 2005 and 2010 Summer Season TPD				
	2005		**2010**	
	HC	**NOx**	**HC**	**NOx**
South Coast Air Basin	7.6	11.52	5.58	10.01
Remaining Enhanced Areas	8.07	12.23	5.93	10.63
Total	**15.67**	**23.75**	**11.51**	**20.64**

Heavy-duty Gasoline Trucks. BAR recently implemented loaded-mode testing for heavy-duty gas trucks (HDGT) between 8,501 and 9,999 pounds gross vehicle weight rating (GVWR). ARB staff estimated the benefits by changing the HDGT Smog Check program in the EMFAC2002 model from two-speed idle to acceleration simulation mode (ASM) loaded mode testing and calculated light heavy-duty 1 (LHDT1) benefits as the emission reduction for the LHDT1 vehicle class. EMFAC2002 model LHDT1 ASM benefits are based on light-duty truck ASM benefits. The LHDT1 class in EMFAC2002 includes trucks between 8,501 and 10,000 lb. GVWR. Since the 10,000-lb. trucks will not get loaded mode testing, ARB staff discounted the benefits by 18% to obtain the emission benefits for HDGT. BAR provided ARB staff with 2002 data that shows that 18% of trucks in the 8,501–10,000 lb. class are 10,000 lb. GVWR.

BAR has also informed ARB staff that not all 8,501–9,999 lb. trucks can be loaded-mode tested. In some cases, the physical size of the vehicle will not allow it to fit on a dynamometer, or the drive axle weight exceeds 5,000 lbs. Based on BAR roadside data, about 16% of HDGT cannot be loaded-mode tested. ARB staff reduced the emission benefit estimates by an additional 16% to account for these vehicles.

Using the above method, ARB staff estimated the emission benefit for SCAB for the 2005 and 2010 calendar years. For the 2005 calendar year, ARB staff assumed that HDGT testing would be implemented in 2004. For the 2010 estimate, ARB staff used an implementation date of 2008 to account for the benefits of one full program cycle before the 2010 attainment date for the SCAB. ARB staff extrapolated the SCAB numbers to all enhanced I/M areas statewide using an estimate that SCAB represents 48.5% of statewide enhanced (provided by BAR). Table 1.2.6 shows the emission benefits of HDGT loaded-mode testing.

Table 1.2.6

Enhanced Program Area Off-Model Adjustment Additional Benefit of Heavy-Duty Truck Loaded Mode Testing Calendar Year 2005 and 2010 Summer Season TPD				
	2005		2010	
	HC	NOx	HC	NOx
South Coast Air Basin	.18	.25	.15	.39
Remaining Enhanced Areas	.19	.28	.16	.41
Total	**.37**	**.53**	**.31**	**.8**

Low-pressure Evaporative Test. MOBILE6 was used to estimate the benefit of low pressure evaporative testing since it is not included in EMFAC2002. The effectiveness of the pressure test as modeled in MOBILE6 is based on the effectiveness for the two states (Arizona and Kentucky) that have successfully implemented the test. MOBILE6 was used to generate evaporative emission factors with gas cap testing only and with gas cap plus pressure testing for the national fleet. ARB staff applied the ratio of evaporative emission factors from the national fleet to the emissions for the I/M fleet in California (vehicles up to 14,000 lb. GVWR) in order to estimate benefits for the pressure test. By using this effectiveness to calculate benefits, ARB staff assumed no more benefit than currently achieved in other states.

ARB staff estimated the emission benefit for SCAB for both the 2005 and 2010 calendar years. ARB staff extrapolated the SCAB numbers to all enhanced I/M areas statewide using an estimate that SCAB represents 48.5% of statewide enhanced (provided by BAR). Table 1.2.7 shows the estimated emission benefits of the low-pressure evaporative test.

Table 1.2.7

Enhanced Program Area Off-Model Adjustment Additional Benefit of the Low Pressure Evaporative Test Calendar Year 2005 and 2010 Summer Season TPD		
	2005	2010
	HC	HC
South Coast Air Basin	1.41	1.12
Remaining Enhanced Areas	1.50	1.18
Total	**2.91**	**2.30**

Summation of Post-2002 Improvements. Table 1.2.8 sums the additional benefits of improvements in the enhanced I/M program for post-2002 improvements.

Table 1.2.8

Total Enhanced Program Area Off-Model Adjustment Additional Benefits of Post-2002 Improvements Calendar Year 2005 and 2010 Summer Season TPD				
	2005		**2010**	
	HC	**NOx**	**HC**	**NOx**
Benefits of Adding Areas to Enhanced I/M Program	12.68	19.87	13.42	24.20
Benefits of 15%-36% Direction to Test-Only Stations	15.67	23.75	11.51	20.64
Benefits of HDGT Loaded Mode Testing	0.37	0.53	0.31	0.80
Benefits of Low Pressure Evaporative Test	2.91	0	2.30	0
Total	**31.63**	**44.15**	**27.54**	**45.64**

Summation of Benefits. Table 1.2.9 totals the future emission benefits of the enhanced I/M program in California. The total benefit in Table 1.2.9 includes added areas, more vehicles to test-only, loaded mode testing for HDGT and low pressure evaporative test.

Table 1.2.9

Projected Emission Benefits of Enhanced I/M in Future Years Calendar Year 2005 and 2010 Summer Season TPD				
	2005		2010	
	HC	NOx	HC	NOx
Enhanced I/M Post 2002 Improvements	31.63	44.15	27.54	45.64
Enhanced Emission Benefit Without Post-2002 Improvements	147.24	114.26	118.62	96.72
Total Benefit	**178.87**	**158.41**	**146.16**	**142.36**

Additional Evaporative Benefits. In order to estimate the full impact of the recently implemented Smog Check enhanced I/M improvements, ARB staff added the emission benefit from Table 1.2.8 with Evaporative Test Improvement benefits of the added areas. The added areas Evaporative Test Improvement benefit was incorporated in Table 1.2.2, Benefits from Evaporative Test Improvements.

To estimate the Evaporative Test Improvement benefits for added areas, ARB staff:

1. Multiplied the Evaporative Test Improvement benefits previously estimated in Table 1.2.2 (75.36 tpd HC in 2005 and 64.96 tpd HC in 2010) by the ratio of the statewide enhanced I/M program percentage in 2002 over the statewide enhanced I/M program percentage in 2005 or 2010.
2. Subtracted the above value from the Evaporative Test Improvement benefits previously estimated in Table 1.2.2 (75.36 tpd HC in 2005 and 64.96 tpd HC in 2010).

The 2005 additional benefit = 75.36 tpd HC - 75.36 tpd HC X (0.65/0.87) = 19.06 tpd HC
The 2010 additional benefit = 64.96 tpd HC - 64.96 tpd HC X (0.65/0.87) = 16.43 tpd HC

Table 1.2.10 shows the emission benefits of the recently implemented Smog Check I/M improvements in enhanced I/M areas.

Table 1.2.10

Projected Emission Benefits of Enhanced I/M Improvements in Future Years Calendar Year 2005 and 2010 Summer Season TPD				
	2005		2010	
	HC	NOx	HC	NOx
Enhanced I/M Post 2002 Improvements	31.63	44.15	27.54	45.64
Evaporative Emission Benefits due to Added Enhanced I/M Areas	19.06	0	16.43	0
Total Benefit	**50.69**	**44.15**	**43.97**	**45.64**

1.3 Cost Effectiveness of Smog Check in Enhanced Areas in 2002

ARB staff estimated the cost effectiveness (CE) of the Smog Check program in enhanced areas in 2002 by determining the total cost of getting a Smog Check and dividing by the emission benefits per I/M cycle. ARB staff assumed the following are included in the cost of getting a Smog Check:

- Smog Check inspection cost for every vehicle.
- Smog Check certification fee for every vehicle.
- Repair costs for vehicles that fail the Smog Check inspection.

The Smog Check certification fee was $8.25 in 2002. ARB staff obtained the following information from the calendar year 2002 BAR Executive Summary report:

- Average enhanced I/M inspection cost = $45.83.
- Average enhanced I/M area initial failure rate = 15.6%.
- Average enhanced area repair cost = $143.18.
- Number of vehicles annually subject to initial tests in enhanced I/M areas = 7,210,771.

ARB staff calculated the total cost of Smog Check per I/M cycle by totaling the cost of all vehicles and the additional cost for vehicles that fail. The cost to inspect and certify all vehicles equaled the total number of vehicles for two years multiplied by the Smog Check inspection cost plus the certification fee:

2 X 7,210,771 vehicles X ($8.25 + $45.83)/vehicle = $779,916,991

The additional cost for failing vehicles equaled the failure rate multiplied by the number of vehicles for two years multiplied by the repair cost:

.156 X 2 X 7,210,771 vehicles X $143.18/vehicle = $322,120,716

Total cost = $779,916,991 + $322,120,716 = $1,102,037,707

The cost effectiveness equaled the total cost divided by the emission reductions over two years.

CE = $1,102,037,707 /((155 tpd ROG + 129 tpd NOx) X 2 X 365)
CE = $5317/ton

Table 1.3.1

Cost Effectiveness Estimate for Smog Check Program in Enhanced Areas Calendar Year 2002	
Enhanced area initial test failure rate (%)	15.6%
Total average ASM inspection cost - includes $8.25 certification fee ($/Test)	$54.08
Average Enhanced I/M repair cost ($/Vehicle)	$143.18
Average test cost per vehicle ($)	$76.42
# of vehicles subject to I/M	14,421,542
Total cost per I/M cycle ($)	$1,102,037,707
ROG+NOx benefits (tons/ I/M cycle)	207,273
Cost Effectiveness ($/Ton)	**$5,317/ton**

1.4 Emission Benefits of Changing the 30-year Rolling Exemption

ARB staff analyzed two options for changing the 30-year rolling exemption, exempting only pre-1976 model years and exempting only pre-1966 model years. The latter was calculated as an incremental benefit, i.e., the benefit of including 1966-1975 vehicles.

ARB staff used EMFAC2002 version 2.2 (4/23/03) to estimate the 2010 emission benefits of changing the 30-year rolling exemption for the enhanced I/M program area. In order to determine the emission benefits, ARB staff first estimated the change in vehicle population and then the associated emissions change. Since EMFAC2002 includes both basic BAR90 I/M and enhanced I/M program areas, ARB scaled the EMFAC2002 output to reflect just enhanced I/M areas. Based on information provided by BAR, 87% of the statewide vehicle population in 2010 would be subject to enhanced I/M.

To estimate the emission benefits of replacing the 30-year rolling exemption with a pre-1976 exemption, ARB staff:

1. Ran EMFAC2002 for the entire State with the existing 30-year rolling exemption in 2010. In 2010, the existing 30-year rolling exemption would include 1982 to 2006 model-year vehicles in the Smog Check inspection program.[3]

[3] In 2010, model years 2007, 2008, 2009, and 2010 are exempt from and do not receive any benefits from Smog Check. However, they are included in emissions comparisons.

2. Ran EMFAC2002 with the proposed pre-1976 exemption in 2010. In 2010, the pre-1976 exemption would add the 1976-1981 model year vehicles to the Smog Check inspection program.
3. Subtracted pre-1976 exemption emissions from the 30-year rolling emissions.
4. Estimated the Bay Area enhanced I/M emission benefits in 2010 using the same methodology above.
5. Added the Bay Area enhanced I/M emission benefits to the pre-1976 exemption benefits from task 3 above.
6. Multiplied the sum from task 5 by the proportion of the State that is enhanced in 2010.

Default EMFAC2002 assumes basic BAR90 I/M is in place in the Bay Area. Since the enhanced I/M program has been implemented in the Bay Area, ARB staff adjusted the 2010 output from EMFAC2002 to reflect the additional enhanced I/M program benefit less the basic BAR90 I/M benefit in the Bay Area. ARB staff made separate EMFAC2002 runs for the Bay Area to assess the impact of enhanced I/M program on exempt vehicles that are brought back into Smog Check. Table 1.4.1 displays the emission benefits of enhanced I/M in the Bay Area with the pre-1976 exemption and the additional benefit of no exemption. The benefits do not include the benefits from a low pressure evaporative test. BAR provided ARB staff with the assumption that 98.3% of Bay Area vehicles are in the enhanced I/M program in 2010.

Table 1.4.1

Additional Benefits Due to Enhanced I/M in Bay Area
Calendar Year 2010 Summer Season TPD

	Exh HC	Evap HC	Total HC	NOx
Basic with pre-1976 exemption	4.65	3.35	8.00	6.34
Enhanced with pre-1976 exemption	3.67	3.34	7.01	5.50
Pre-1976 benefits for Bay Area	0.98	0.01	0.99	0.84
Additional Enhanced Bay Area Benefits of Pre-1976 Exemption	**0.96**	**0.01**	**0.97**	**0.83**
Basic with pre-1966 exemption	10.49	7.51	18.00	13.43
Enhanced with pre-1966 exemption	9.20	7.52	16.72	12.31
Pre-1966 exemption benefits for Bay Area	1.29	-0.01	1.28	1.12
Additional Enhanced Bay Area Benefits of Pre-1966 Exemption	**1.27**	**-0.01**	**1.26**	**1.10**

Table 1.4.2 displays the emission benefits of replacing the 30-year rolling exemption with a pre-1976 exemption.

Table 1.4.2

Benefits of Replacing 30-Year Rolling Exemption with Pre-1976 Model Year Exemption (Retaining Model Years 1976-1981) Calendar Year 2010 Summer Season TPD				
	Exh. HC	Evap HC	Total HC	NOx
Emissions with current 30-year rolling exemption	263.45	242.32	505.77	1001.76
Emissions with pre-1976 exemption	261.62	242.02	503.64	999.11
Statewide benefits for Basic and Enhanced areas with Bay Area in Basic	**1.83**	**.30**	**2.13**	**2.65**
Bay Area Enhanced Benefits	.96	.01	.97	.83
Statewide benefits for Basic and Enhanced areas with Bay Area in Enhanced	2.79	.31	3.1	3.48
Benefits (Adjusted for just Enhanced Areas)	**2.43**	**.27**	**2.70**	**3.02**

To estimate the emission benefits of replacing the 30-year rolling exemption with a pre-1966 exemption, ARB staff:

1. Ran EMFAC2002 for the entire State with the existing 30-year rolling exemption in 2010. In 2010, the existing 30-year rolling exemption would include 1982 to 2006 model-year vehicles in the Smog Check inspection program.
2. Ran EMFAC2002 with the proposed pre-1966 exemption in 2010. In 2010, the pre-1966 exemption would add the 1966-1981 model year vehicles to the Smog Check inspection program.
3. Subtracted pre-1966 exemption emissions from the 30-year rolling emissions.
4. Estimated the Bay Area enhanced I/M emission benefits in 2010 using the same methodology above.
5. Added the Bay Area enhanced I/M emission benefits to the pre-1966 exemption benefits from task 3 above.
6. Multiplied the sum from task 5 by the proportion of the State that is enhanced in 2010.

Table 1.4.3 displays the emission benefits of replacing the 30-year rolling exemption with a pre-1966 exemption.

Table 1.4.3

Benefits of Replacing 30-Year Rolling Exemption With a Pre-1966 Model Year Exemption (Retaining Model Years 1966-1981) Calendar Year 2010 Summer Season TPD				
	Exh. HC	Evap HC	Total HC	NOx
Emissions with current 30-year rolling exemption	263.45	242.32	505.77	1001.76
Emissions with pre-1966 exemption	256.14	239.06	495.2	995.59
Statewide benefits for Basic and Enhanced areas with Bay Area in Basic	7.31	3.26	10.57	6.17
Bay Area Enhanced Benefits	1.27	-0.01	1.26	1.10
Statewide benefits for Basic and Enhanced areas with Bay Area in Enhanced	8.58	3.25	11.83	7.27
Benefits (Adjusted for just Enhanced Areas)	**7.46**	**2.83**	**10.29**	**6.33**

Table 1.4.4 displays the incremental emission benefits of the pre-1966 exemption over the pre-1976 exemption.

Table 1.4.4

Benefits of Adding 1966-1975 Model Year Vehicles to the Program Calendar Year 2010 Summer Season TPD				
	Exh. HC	Evap HC	Total HC	NOx
Benefits of pre-1966 Exemption	7.46	2.83	10.29	6.33
Benefits of pre-1976 Exemption	2.43	.27	2.70	3.02
Benefits for Enhanced I/M Areas	**5.03**	**2.56**	**7.59**	**3.30**

1.5 Cost Effectiveness of Changing the 30-year Rolling Exemption

ARB staff estimated the cost effectiveness of changing the 30-year rolling exemption by determining the number of vehicles applicable to each option and the total cost of getting a Smog Check per vehicle. This total cost was divided by the emission benefits per I/M cycle.

To determine the number of vehicles for each option, ARB staff used EMFAC2002 version 2.2 (April 23, 2003) for the 2010 calendar year. To adjust the 2010 statewide numbers to just the enhanced areas, ARB staff used an adjustment factor of 87% for enhanced areas. BAR data showed that the Smog Check population would be 87% enhanced, 10% basic, and 3% change of ownership. Table 1.5.1 provides the vehicle population numbers used for the CE calculations.

Table 1.5.1

Vehicle Population Calendar Year 2010 Summer Season TPD		
	Statewide	Enhanced Areas
Total number in current Smog Check Program (1982-2006 model-years)	18,435,595	16,038,968
Total number 1966-1981 model-years	665,783	579,231
Total number 1966-1975 model-years	276,107	240,213
Total number 1976-1981 model-years	389,676	339,018

ARB staff assumed the following are included in the cost of getting a Smog Check inspection:

- Smog Check inspection cost for every vehicle.
- Repair costs for vehicles that fail the Smog Check inspection.

To determine the number of failing vehicles, ARB staff calculated an average failure rate based on data contained in the BAR Executive Summary report for Fiscal Year 2001-2002. This report lists initial test failure rates by model year. ARB staff used these data to calculate a simple average of the failure rates for model years 1976 through 1981. Since we do not have data on pre-1976 model years, ARB staff assumed that they will have a similar failure rate to 1976-81 vehicles. Table 1.5.2 displays the failure rates for each model year.

Table 1.5.2

I/M Failure Rate Fiscal Year 2001-2002 From BAR Executive Summary Report	
Model-Year	% Fail on Initial Test
1976	29.1
1977	28.9
1978	29.3
1979	31.0
1980	31.1
1981	33.9
Average of MY 76-81	**30.6**

ARB staff used inspection and repair costs from BAR's calendar year 2002 Executive Summary report:

- Average enhanced I/M inspection cost = $45.83
- Average enhanced I/M area repair cost = $143.18

To determine the CE of the pre-1976 exemption, ARB staff calculated the total cost of Smog Check per I/M cycle by totaling the cost of all vehicles and the additional cost for

vehicles that fail. The cost of all vehicles equaled the total number of vehicles for one I/M cycle multiplied by the Smog Check inspection cost:

339,018 vehicles X $45.83/vehicle = $15,537,195

The additional cost for failing vehicles equaled the failure rate multiplied by the number of vehicles multiplied by the repair cost:

.306 X 339,018 vehicles X $143.18/vehicle = $14,853,423

Total cost = $15,537,195 + $14,853,423 = $30,366,358

The CE equaled the total cost divided by the emission reductions over one I/M cycle (two years).

CE = $30,366,358/((5.72 tpd ROG + NOx) X 2 X 365)
CE = $7,268/ton

Table 1.5.3

Cost Effectiveness Estimate for Pre-1976 Exemption Calendar Year 2010	
Initial test failure rate (%)	30.6%
Total average ASM inspection cost	$45.83
Average Enhanced I/M repair cost ($/Vehicle)	$143.18
Average test cost per vehicle ($)	$89.57
# of vehicles subject to I/M	339,018
Total cost per I/M cycle ($)	$30,366,358
ROG+NOx benefits (tons/ I/M cycle)	4178
Cost Effectiveness ($/Ton)	**$7,268/ton**

Consumer/Industry Impact of Pre-1976 Exemption
To determine cost impacts for consumers and industry, ARB staff calculated the additional annual inspection cost for the consumer, the additional annual repair cost for the consumer, and the annual revenues generated for the Smog Check inspection industry in calendar year 2010.

Additional Inspection Cost = (339,018 vehicles/2 years in biennial cycle) X $45.83
Additional Inspection Cost to Consumers = $7,768,597

Additional Repair Cost = (339,018 vehicles/2 years in biennial cycle) X .306 X $143.18
Additional Repair Cost to Consumers = $7,426,711

Additional Revenue to Industry = $7,768,597 + $7,426,711 = $15,195,308

To determine the CE for pre-1966 exemption, ARB staff calculated the total cost of Smog Check per I/M cycle by totaling the cost of all vehicles and the additional cost for

vehicles that fail. The cost of all vehicles equaled the total number of vehicles for one I/M cycle multiplied by the Smog Check inspection cost:

579,231 vehicles X $45.83/vehicle = $26,546,157

The additional cost for failing vehicles equaled the failure rate multiplied by the number of vehicles multiplied by the repair cost:

.306 X 579,231 vehicles X $143.18/vehicle = $25,377,894

Total cost = $26,546,157 + $25,377,894 = $51,882,603

The CE equaled the total cost divided by the emission reductions over one I/M cycle (two years):

CE = $51,882,603/((16.62 ROG + NOx) X 2 X 365)
CE = $4,277/ton

Table 1.5.4

Cost Effectiveness Estimate for pre-1966 Exemption Calendar Year 2010	
Initial test failure rate (%)	30.6%
Total average ASM inspection cost	$45.83
Average Enhanced I/M repair cost ($/Vehicle)	$143.18
Average test cost per vehicle ($)	$89.57
# of vehicles subject to I/M	579,231
Total cost per I/M cycle ($)	$51,882,603
ROG+NOx benefits (tons/ I/M cycle)	12,130
Cost Effectiveness ($/Ton)	**$4,277/ton**

1.6 Emission Benefits of Annual Inspection for Vehicles Over 15 Years Old

ARB staff used EMFAC 2002 version 2.2 (released April 23, 2003) to analyze the benefits of annual inspections for vehicles over 15 years of age.[4] ARB staff assumed that the annual inspections for vehicles over 15 years old would be implemented in January 2004, and that all other aspects of the current enhanced I/M program, including the 30 year rolling exemption for older vehicles, would remain in place. For 2005, ARB staff assumed model years 1977 through 1990 would be subject to the annual inspections, and for 2010, model years 1982 through 1995 would be subject to the annual inspections.

[4] In EMFAC2002, a new vehicle is counted as model year one, and a 15-year-old vehicle is counted as model year 16. This analysis addresses vehicles for model years 16 and older (e.g., model years 1995 and previous in calendar year 2010).

To estimate the benefits, ARB staff:

1. Estimated the statewide benefits of annual inspections by using the I/M module in the model to switch between biennial and annual inspections for the model years that would be included in a rolling requirement.
2. Estimated the additional benefits of enhanced I/M in the Bay Area.
3. Adjusted the benefits to reflect the enhanced I/M areas.

Table 1.6.1 summarizes the results from EMFAC2002 for the current program and implementation of the annual inspection element.

Table 1.6.1

Statewide Benefits of Annual Inspections for Vehicles Over 15 Years Without Adjustments for Bay Area and Enhanced I/M Calendar Year 2005 and 2010 Summer Season TPD				
	2005		2010	
	ROG	NOx	ROG	NOx
Emissions with Current Smog Check Program	267.92	389.75	250.00	372.71
Emissions with rolling annual inspection for vehicles over 15 years old	258.99	376.78	241.33	355.31
Default Benefit w/o adjustments	**8.93**	**12.97**	**8.67**	**17.4**

The statewide default in EMFAC2002 reflects basic BAR90 I/M in the Bay Area. Since enhanced I/M is currently being implemented in the Bay Area, ARB staff adjusted the estimate of benefits for annual inspections to reflect enhanced I/M in the Bay Area. ARB staff made separate EMFAC runs for the Bay Area to assess the impact of enhanced I/M on the benefits of rolling annual inspections in that region. The resulting Bay Area adjustments are shown in Table 1.6.2.

Table 1.6.2

Bay Area Enhanced Benefits of Annual Inspections for Vehicles Over 15 Years Calendar Year 2005 and 2010 Summer Season TPD				
	2005		2010	
	ROG	NOx	ROG	NOx
Emissions for Basic with rolling annual inspection for vehicles over 15 years old	52.38	72.90	49.53	71.05
Emissions for Enhanced with rolling annual inspection for vehicles over 15 years old	49.64	68.82	47.35	67.24
Bay Area Benefit	**2.69**	**4.01**	**2.14**	**3.75**

Since EMFAC2002 includes both basic BAR90 I/M and enhanced I/M program areas, ARB staff adjusted the EMFAC2002 output to reflect just enhanced I/M areas. ARB staff used an adjustment factor of 87% for enhanced I/M areas. BAR data showed that the Smog Check population would be 87% enhanced, 10% basic, and 3% change of ownership. Table 1.6.3 includes the adjustment and the enhanced I/M benefits of requiring annual inspections for vehicles older than 15 years.

Table 1.6.3

Emission Benefits for Requiring Annual Inspections for Vehicles Over 15 Years Old Calendar Year 2005 and 2010 Summer Season TPD				
	2005		2010	
	ROG	NOx	ROG	NOx
Default Benefit w/o Adjustments	8.93	12.97	8.67	17.4
Bay Area Benefit	2.69	4.01	2.14	3.75
Total Statewide Benefit	11.62	16.98	10.81	21.15
Adjustment for Enhanced Portion of State	(1.51)	(2.21)	(1.41)	(2.75)
Annual Inspection Benefits (Adjusted for Enhanced Areas)	**10.11**	**14.77**	**9.40**	**18.40**

1.7 Cost Effectiveness of Annual Inspection of Vehicles Over 15 Years Old

ARB staff estimated the CE of requiring annual instead of biennial testing of vehicles older than 15 model years by determining the number of affected vehicles and the total cost of getting a Smog Check per vehicle. This total cost was divided by the emission benefits per I/M cycle. ARB staff calculated a CE separately for the current biennial program and the proposed annual program based on the benefits of each program beyond basic BAR90 I/M. ARB staff took the difference in the CE between these two programs to be the incremental cost per ton for the annual program. We multiplied the incremental cost per ton by the tons of benefit for the annual program over the basic BAR90 I/M program, to get a total incremental cost for the annual program. Next, we divided the total incremental cost by the incremental benefits of the annual program over the biennial program to get the CE of the incremental benefits in dollars per ton.

To determine the number of vehicles affected by an annual inspection of vehicles over 15 years older, ARB staff used EMFAC2002 version 2.2 (4/23/03) for the statewide 2005 and 2010 calendar years for the applicable model-year range. Table 1.7.1 provides the vehicle population numbers used for the CE calculations.

Table 1.7.1

Vehicle Population Over 15 Years Old Calendar Year 2005 and 2010 Summer Season TPD	
	Enhanced Areas
Total number applicable vehicles in 2005 1977-1990 model years	4,392,052
Total number applicable vehicles in 2010 1982-1995 model years	5,393,351

ARB staff assumed the following are included in the cost of getting a Smog Check inspection:

- Smog Check inspection cost for every vehicle.
- Repair costs for vehicles that fail the Smog Check inspection.

The annual inspection failure rate was estimated by taking the failure rate for the biennial program and proportionally increasing it by the ratio of annual benefits over biennial benefits, then dividing by two to get an average failure rate per year.

Table 1.7.2 lists initial test failure rates by model year. ARB staff used these data to calculate a simple average of the failure rates for model years 1974 through 1987.

Table 1.7.2

Biennial Inspection Failure Rate I/M Failure Rate Calendar Year 2002			
Model Year	**# of Vehicles**	**Failure Rate**	**Weighted Ave. Failure Rate**
1974	5304	30.04%	0.39%
1975	4959	35.64%	0.43%
1976	7525	34.44%	0.64%
1977	11283	34.52%	0.96%
1978	13751	35.63%	1.20%
1979	16969	38.32%	1.60%
1980	12189	38.87%	1.16%
1981	16000	41.39%	1.63%
1982	20027	41.01%	2.02%
1983	26965	40.37%	2.67%
1984	49966	41.06%	5.04%
1985	63252	38.76%	6.02%
1986	73487	34.74%	6.27%
1987	85570	34.39%	7.23%
Model Year 74-87	**407247**		**37.2**

To estimate an annual fail rate consistent with the benefits predicted by EMFAC2002, ARB staff:

1. Calculated an average biennial failure rate for vehicles over 15 years old based on data provided by BAR for calendar year 2002.
2. Multiplied the average biennial failure rate by the ratio of the annual benefits divided by the biennial benefits.
3. Divided by 2, since to get the same benefit, the percent vehicles required to fail in one year would be one half that required to fail over two years.

Biennial failure rate to achieve annual benefits = 37.2 X (50.68/40.57) = 46.5
Annual inspection failure rate = (46.5)/2 = 23.3%

Table 1.7.3 provides the comparison of the benefits for the biennial and annual programs. ARB staff used EMFAC2002 version 2.2 (4/23/03) to estimate the ROG benefits for the summer season in 2005. ARB staff assumed the rolling annual inspection is implemented in January 2004. Since these values do not include the incremental benefit of enhanced I/M in the Bay Area, ARB staff calculated this benefit by subtracting the default benefit without adjustments (Table 1.6.3) from the annual inspection benefits adjusted for enhanced I/M areas (Table 1.6.3) to get an incremental benefit of 1.18 tpd ROG. We added the incremental Bay Area benefit to the benefits of annual inspection to get the adjusted benefits shown in Table 1.7.3.

Table 1.7.3

Program Comparison for Vehicles Over 15 Years Old Calendar Year 2005 Summer Season TPD	
	ROG
Emissions with Basic Program	308.49
Emissions with Biennial Enhanced Program	267.92
Benefits of Biennial Enhanced Program	**40.57**
Emissions with Basic Program	308.49
Emissions with annual inspection for vehicles over 15 years old	258.99
Benefits of Annual Inspection	**49.50**
Incremental Enhanced I/M Benefit in Bay Area of annual inspection for vehicles over 15 years old	1.18
Benefits of Annual Inspection Adjusted for just Enhanced Areas (Including Enhanced in the Bay Area)	**50.68**

ARB staff estimated the Calendar Year 2005 CE for the incremental benefits beyond the current biennial program for annual inspection of vehicles over 15 years old. The average enhanced I/M inspection cost of $45.83 per test and average enhanced I/M repair cost of $143.18 per vehicle used to calculate CE are based on data published in BAR's CY 2002 Executive Summary report.

To determine the CE of biennial and annual testing for vehicles over 15 years old, ARB staff calculated the total cost of Smog Check per I/M cycle by totaling the cost of all

vehicles and the additional cost for vehicles that fail. For biennial testing, the cost of all vehicles equaled the total number of vehicles for two years multiplied by the Smog Check inspection cost:

4,392,052 vehicles X $45.83/vehicle = $ 201,287,743

The additional cost for failing vehicles equaled the failure rate multiplied by the number of vehicles for two years multiplied by the repair cost:

.372 X 4,392,052 vehicles X $143.18/vehicle = $233,933,690

Total cost = $201,287,743 + $233,933,690 = $435,533,586

The CE equaled the total cost divided by the emission reductions over two years.

The ROG emission benefit from biennial enhanced I/M, 40.57 tpd, is specified in Table 1.7.3. Using the same methodology as shown in Table 1.7.3, the NOx benefit was calculated as 62.03 tpd.

CE = $435,533,586/((40.57 tpd ROG + 62.03 tpd NOx) X 2 X 365)
CE = $5,815/ton

Table 1.7.4

Cost Effectiveness Calculation for Biennial Inspection of Vehicles Over 15 Years Old Calendar Year 2005	
Initial test failure rate (%)	37.2%
Total average ASM inspection cost	$45.83
Average Enhanced I/M repair cost ($/Vehicle)	$143.18
Average test cost per vehicle ($)	$99.16
# of vehicles subject to I/M	4,392,052
Total cost per I/M cycle ($)	$435,533,586
ROG+NOx benefits (tons/ I/M cycle)	74,898
Cost Effectiveness ($/Ton)	**$5,815/ton**

Using the same methodology as shown above for the biennial program, ARB staff calculated the CE of the annual inspections for vehicles over 15 years old. ARB staff calculated the total cost of Smog Check per I/M cycle by totaling the cost of all vehicles and the additional cost for vehicles that fail. The cost of all vehicles equals the total number of vehicles for one year multiplied by the Smog Check inspection cost:

4,392,052 vehicles X $45.83/vehicle = $201,287,743

The additional cost for failing vehicles equaled the failure rate multiplied by the number of vehicles for one year multiplied by the repair cost:

.233 X 4,392,052 vehicles X $143.18/vehicle = $146,522,983

Total cost = $201,287,743 + $146,522,983 = $347,604,427

The CE equaled the total cost divided by the emission reductions over one year.

The ROG emission benefit from annual enhanced I/M, 50.68 tpd, is specified in Table 1.7.3. Using the same methodology as shown in Table 1.7.3, the NOx benefit was calculated as 76.80 tpd:

CE = $347,604,427/((50.68 tpd ROG + 76.80 tpd NOx) X 365)
CE = $7,470/ton

Table 1.7.5

Cost Effectiveness Calculation for Annual Inspection of Vehicles Over 15 Years Old Calendar Year 2005	
Initial test failure rate (%)	23.3%
Total average ASM inspection cost	$45.83
Average Enhanced I/M repair cost ($/Vehicle)	$143.18
Average test cost per vehicle ($)	$79.18
# of vehicles subject to I/M	4,392,052
Total cost per I/M cycle ($)	$347,604,427
ROG+NOx benefits (tons/ I/M cycle)	46,532
Cost Effectiveness ($/Ton)	**$7,470/ton**

To determine the incremental cost of the annual inspection over biennial inspection of vehicles over 15 years, ARB staff:

1. Calculated the incremental cost effectiveness.
2. Calculated the incremental cost per I/M cycle.
3. Calculated the cost effectiveness of the incremental benefit.

Incremental CE = $7,470 – $5,815 = $1,655/ton

Incremental Cost per I/M Cycle = $1,655/ton X 46,532 tons/I/M cycle = $77,018,506

CE = $77,018,506/((10.11 tpd ROG + 14.77 tpd NOx) X 365)
CE = $8,479/ton

Table 1.7.6

Cost Effectiveness Calculation of Incremental Benefits of Annual over Biennial Inspection of Vehicles Over 15 Years Old Calendar Year 2005	
Incremental Cost of Annual Program ($/Ton)	$1,655
Total incremental cost per I/M cycle	$77,018,506
ROG+NOx benefits (tons/ I/M cycle)	9,083
Cost Effectiveness ($/Ton)	**$8,479/ton**

Consumer/Industry Impact of Annual Inspection of Vehicles Over 15 Years Old
To determine the annual consumer/industry impact, ARB staff calculated the additional inspection cost for the consumer, the addition repair cost for the consumer, and the revenues generated for the Smog Check inspection industry.

Additional Inspection Cost = (4,392,052 vehicles/2 years in biennial cycle) X $45.83
Additional Inspection Cost to Consumers = $100,643,872

Additional Repair Cost = (4,392,052 vehicles/2 years in biennial cycle) X .233 X $143.18
Additional Repair Cost to Consumers = $73,261,492

Additional Revenue to Industry = $100,643,872 + $73,261,492 = $173,905,364

1.8 Emission Benefits of Annual Inspection of Taxicabs

Estimates of the benefits of inspecting high annual mileage vehicles are based on results from inspections of taxicab fleets in the San Francisco and Los Angeles areas in 2002. ARB conducted over 1600 inspections on 1992-2002 model year taxicabs. A subset of taxis equipped with on-board diagnostics type II (OBD II) and tested under the Federal Test Procedure (FTP) was used to analyze benefits.

To calculate the emissions benefits for annual testing of taxicabs, ARB staff:

1. Estimated the emission benefits on per vehicle basis from annual testing.
2. Calculated the average failure rate from random inspections.
3. Estimated the annual average mileage per taxicab.
4. Applied the benefits to the entire taxicab fleet.

In the taxicab study (ARB Project 2R0202), failure rates varied from 22% for scheduled inspections to 39% for random inspections. ARB staff chose to use the failure rate for the post-1996 taxicabs equipped with OBD II that received a random inspection because it represented the vehicles that ARB tested using the FTP and would not be affected by pre-inspection repairs. Table 1.8.1 shows the results of the inspections for taxicabs equipped with OBD II malfunction indicator lights.

Table 1.8.1

Taxicab MIL Status (OBD II Vehicles)		
MIL ON	144	34%
MIL OFF	275	66%
Total Taxicabs	419	100%

ARB staff procured forty-three 1996 and newer OBD II equipped vehicles for emission testing at ARB's Haagen-Smit Laboratory (HSL). All the taxicabs were equipped with a malfunction indicator light (MIL). The emission tests were conducted following the Federal Test Procedure (FTP). Of the 43 taxicabs brought in for testing, 15 failed the Smog Check inspection because the OBD II MIL was "ON." ARB staff tested the failed vehicles, repaired the failed vehicles so the MIL light was OFF, and then re-tested them after the repair. Table 1.8.2 shows the average emissions data for the 15 vehicles in grams per mile (GPM) for the vehicles that failed after their repairs, and the emission benefits of the repairs.

Table 1.8.1

Taxicab FTP Testing Results			
HSL FTP Testing Results	HC GPM	NOx GPM	CO GPM
FTP Results pre-repairs MIL ON	0.307	0.710	5.070
FTP Results post-repairs MIL OFF	0.123	0.211	2.005
Emission Benefits of Repair	**0.184**	**0.499**	**3.065**

The project also tracked the mileage of 241 taxicabs, which accumulated 4,767 miles per month. ARB staff extrapolated this to 57,999 miles per year. California's taxicab fleet is estimated at 20,000 vehicles.

ARB staff calculated the emission reductions from more frequent inspections of taxicabs statewide as the product of the statewide number of taxicabs, the assumed failure rate, the emission reductions per repair, and each vehicle's annual mileage:

HC Benefits = 20,000 X (0.34 failure) X (0.184 GPM) X (57,999 miles/year) X (0.0005 tons/453.9 grams) X (1year/365 days) = **0.2 tpd HC**

NOx Benefits = 20,000 X (0.34 failure) X (0.499 GPM) X (57,999 miles/year) X (0.0005 tons/453.9 grams) X (1year/365 days) = **0.6 tpd NOx**

CO Benefits = 20,000 X (0.34 failure) X (3.065 GPM) X (57,999 miles/year) X (0.0005 tons/453.9 grams) X (1year/365 days) = **3.6 tpd CO**

Extension of Benefits to All High Annual Mileage Vehicles. Smog Check test data for 2002 indicated that 3% of the fleet accumulated 25,000 miles or more per year. To estimate an upper bound of benefits from more frequent inspections for the Smog Check fleet as a whole, staff multiplied this number of vehicles by the taxicabs' failure rate, emission reductions per repair, and annual mileage:

HC Benefits = 559,174 vehicles X (0.34 failure) X (0.184 GPM) X (57,999 miles/year) X (0.0005 tons/453.9 grams) X (1year/365 days) = **6.1 tpd HC**

NOx Benefits = 559,174 vehicles X (0.34 failure) X (0.499 GPM) X (57,999 miles/year) X (0.0005 tons/453.9 grams) X (1year/365 days) = **16.6 tpd NOx**

CO Benefits = 559,174 vehicles X (0.34 failure) X (3.065 GPM) X (57,999 miles/year) X (0.0005 tons/453.9 grams) X (1 year/365 days) = **102.0 tpd CO**

ARB staff recognizes that both the miles driven and driving patterns by the larger fleet of high annual mileage vehicles may not match those of taxicabs, and that actual benefits are likely to be somewhat lower than shown in this calculation.

1.9 Cost Effectiveness of Annual Inspection of Taxicabs

ARB staff used the emission benefits calculated in the previous section and estimates of the cost of additional inspections and failures to calculate the cost effectiveness of annual testing of taxicabs.

ARB staff obtained the inspection and repair costs used for the calculations from BAR's calendar year 2002 Executive Summary Report, and used the OBD II vehicle failure rate from ARB's taxicab fleet study.

Inspection cost: $45.83
Repair cost: $143.18
Taxicab OBD II failure rate: 34.0%

ARB staff calculated the total cost of Smog Check per I/M cycle by totaling the cost of testing all vehicles and the additional cost for vehicles that fail. The cost for all vehicles equaled the total number of vehicles multiplied by the Smog Check inspection cost:

20,000 vehicles X $45.83/vehicle = $916,600

The additional cost for failing vehicles equaled the failure rate multiplied by the number of vehicles multiplied by the repair cost:

.34 X 20,000 vehicles X $143.18/vehicle = $973,624

Total cost = $916,600 + $973,624 = $1,890,224

The CE equaled the total cost divided by the annual emission reductions:
CE = $1,890,224/(292 tons per year ROG + NOx)
CE = $6,473/ton

Table 1.9.2

Cost Effectiveness Estimate for Annual Testing of Taxicabs Calendar Year 2002	
Initial test failure rate (%)	34.0%
Total average ASM inspection cost	$45.83
Average Enhanced I/M repair cost ($/Vehicle)	$143.18
Average test cost per vehicle ($)	$94.51
# of vehicles subject to I/M	20,000
Total cost per I/M cycle ($)	$1,890,224
ROG+NOx benefits (tons/ I/M cycle)	189.8
Cost Effectiveness ($/Ton)	**$9,959/ton**

Consumer/Industry Impact of Annual Inspection of High Mileage Vehicles
To determine the consumer/Industry impact, ARB staff calculated the additional inspection cost for the consumer, the addition repair cost for the consumer, and the revenues generated for the Smog Check inspection industry.

ARB staff estimated that approximately 3% of the fleet (560,000 vehicles) are considered high mileage vehicles and accumulate over 25,000 miles annually. Since not all high mileage fleets are OBD II only, ARB staff used the overall average failure rate from our taxicab study, which was 27%.

Additional Inspection Cost = (560,000 vehicles/2 years in biennial cycle) X 45.83
Additional Inspection Cost to Consumers = $12,832,400

Additional Repair Cost = (560,000 vehicles/2 years in biennial cycle) X .27 X 143.18
Additional Repair Cost to Consumers = $10,824,408

Additional Revenue to Industry = $12,832,400 + $10,824,408 = $23,656,808