# THE EXEMPTION OF ADDITIONAL VEHICLES FROM SMOG CHECK

# TECHNICAL SUPPORT DOCUMENT

**RELEASE DATE: April 2, 2003**

**THE STATE OF CALIFORNIA**
**AIR RESOURCES BOARD**

# 1. ENVIRONMENTAL IMPACTS

This section of the report summarizes the emissions impacts of exempting five- and six-year old vehicles from the Smog Check Program in enhanced areas. Key assumptions and the modeling approach used in the analysis are also presented.

## 1.1 Introduction

As amended under AB2637, Section 44011(a)(4)(B) of the California Health and Safety Code provides for newer vehicles to be exempted from the state's Inspection and Maintenance (I/M) program for an additional two years (for the first six years instead of just four years) beginning January 1, 2004. However, this extension of the model year exemption is contingent upon a finding by the Air Resources Board that it will not prohibit the state from meeting State Implementation Plan (SIP) commitments.

Analysis of currently available data from several different sources was performed to estimate the loss in emission benefits expected to occur as a result of extending the new vehicle exemption; both exhaust and evaporative emissions impacts were considered in the evaluation. The analysis focused on those areas of the state with Enhanced I/M Acceleration Simulation Mode (ASM) testing already in place or expected by January 2004 (and thus includes the San Francisco Bay Area).

The first step in the analysis was to establish baseline emission factors versus vehicle age that reflect the current I/M program. This was based on an evaluation of "random roadside" emissions data collected by the Bureau of Automotive Repair (BAR) in which vehicles were pulled over at various locations throughout the state and given an emissions test. Emission rates of vehicles 5 and 6 years old were then adjusted to reflect a non-I/M case. Comparing the fleet-average emissions of the non-I/M scenario (for 5- and 6-year old vehicles) to the baseline case provided an estimate of the percentage increase in emissions as a result of exempting 5- and 6-year old vehicles. These percentage increases were applied to the baseline ton per day emissions results calculated by the EMFAC2002 model to determine the statewide impact of exempting five- and six-year old vehicles from the Smog Check program. This is similar to the approach that staff used in the July 2000 evaluation of the Smog Check II program.[1]

## 1.2 Baseline Emission Factors – Exhaust Emissions

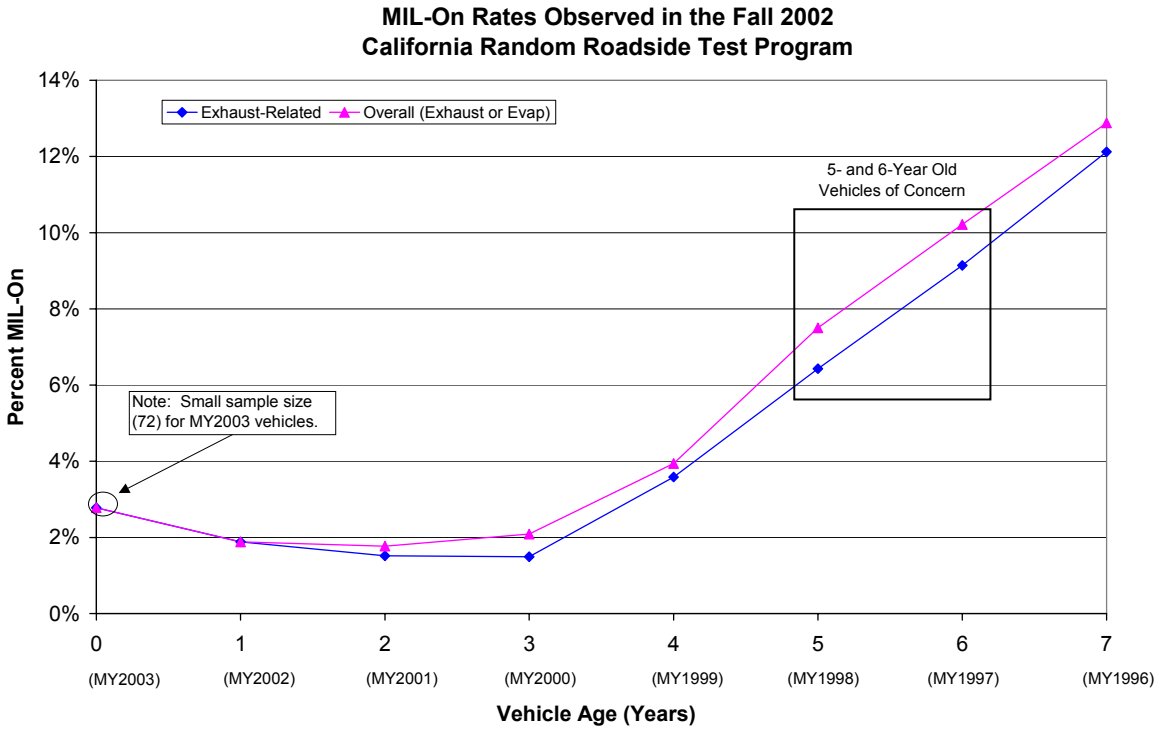
As noted above, random roadside data collected by BAR were used to establish the baseline hydrocarbon (HC), carbon monoxide (CO), and oxides of nitrogen (NOx) emission factors for this evaluation. Those data, which were collected during calendar years 2000 through 2002, consist of approximately 13,000 test records. However, because the roadside test consisted of the steady-state ASM test that is used in the Enhanced Smog Check program, it was necessary to adjust those data to reflect stop-and-go driving as reflected in the Federal Test Procedure (FTP) for light-duty vehicles. This was done with correlation equations that predict FTP scores based on a vehicle's performance on the ASM test. The correlation equations used in this analysis were

developed from a sample of nearly 2,000 vehicles that had received both FTP and ASM tests at ARB's Haagen-Smit Laboratory. The methodology used to develop the correlation equations was consistent with the approach used in the July 2000 Smog Check II Evaluation,[2] but was updated with additional data on newer vehicles.

The roadside data were analyzed as a calendar year 2002 fleet. Thus, five and six year old roadside vehicles refer to 1998 and 1997 model years, respectively. Because the roadside data were collected at various locations in California over a period of two to three years, some of the vehicles had not been subject to the ASM test procedure. Thus, those vehicles were removed from the database so that the baseline factors would reflect average emissions from vehicles that had been subject to the Smog Check II program. This approach was used for 1996 and older model year vehicles to reflect "After I/M" emissions. Note that for the five- and six-year exemption analysis, a "No I/M" case was also required only for vehicles six years old and newer. Thus, there was no need to develop a non-I/M estimate for the 1996 and older model year vehicles.

As a result of small sample sizes for 1997 and newer model year vehicles, a slightly different approach was used to establish After-I/M and No I/M emission rates. In a separate roadside test program conducted during the fall of 2002, BAR pulled over a random sample of approximately 2,000 1996 and newer model year vehicles equipped with second-generation On-Board Diagnostic systems (OBD II). In that program, the vehicle computer was queried to determine the presence of diagnostic trouble codes (DTCs), and the condition of the malfunction indicator light (MIL) was recorded (i.e., whether or not the MIL was "commanded on," and therefore indicative of the presence of an emissions control system problem). A summary of the exhaust-related and overall MIL-on rates as a function of model year is shown in Figure 1.1 for this test program.

**Figure 1.1**



As observed in Figure 1.1, there is a fairly moderate MIL-on rate for vehicles that are three-years old and newer (i.e., less than 2% except for model year 2003 vehicles in the figure; however, that is a result of the small sample size for those vehicles in this particular test program). After three years of age, the MIL-on rates increase substantially. This pattern is consistent with data from other programs, and it is thought to be a result of the expiration of the 3-year, 36,000-mile "bumper-to-bumper" warranty. For example, Table 1.1 summarizes overall MIL-on rates as a function of vehicle mileage for vehicles in the Arizona I/M program and the Wisconsin I/M program. Both programs show a large increase in MIL-on rates beyond about 40,000 miles, consistent with the failure rates observed in the California roadside data shown in Figure 1.1. (Note that the Arizona and Wisconsin data were not used in the emissions calculations that follow; they are presented here for comparison to the California roadside MIL-on rates.)

**Table 1.1**
Summary of MIL-On Rates vs. Vehicle Mileage in the
Arizona and Wisconsin I/M Programs

| Mileage Interval | Arizona Program | | Wisconsin Program | |
|---|---|---|---|---|
| | Ave Odom. | MIL-On | Ave Odom. | MIL-On |
| 0 - 25,000 | 16,900 | 2.2% | 14,400 | 0.4% |
| 25,000 - 50,000 | 40,300 | 2.3% | 37,000 | 1.1% |
| 50,000 - 75,000 | 63,300 | 4.0% | 60,700 | 2.9% |
| 75,000 - 100,000 | 86,800 | 6.3% | 85,400 | 5.6% |
| 100,000 - 125,000 | 111,100 | 10.6% | 110,600 | 8.2% |
| > 125,000 | 152,000 | 15.4% | 150,500 | 12.0% |

Using the MIL-on rates observed in the California OBD II roadside data collected in the fall of 2002 (i.e., Figure 1.1) in conjunction with: (1) the average emissions from the California ASM roadside data (converted to an FTP basis), and (2) FTP emissions from MIL-on vehicles tested in EPA[3] and U.C. Riverside[4] test programs, it was possible to estimate passing vehicle emission rates (reflecting After I/M emissions) for the 1997 and newer model year vehicles. The No I/M emission rates for this group of vehicles were based on 1999 to 2002 model year vehicles in the ASM roadside data that had not yet been through the I/M program. A flowchart of the analysis steps and data sources used to develop model-year specific FTP emission rates is shown in Figure 1.2, and the resulting FTP-based emission factors, incorporating the adjustments described above, are summarized in Table 1.2.

**Figure 1.2**

Flowchart of Analysis Steps and Data Sources Used to
Develop Model-Year Specific FTP-Based Emission Rates

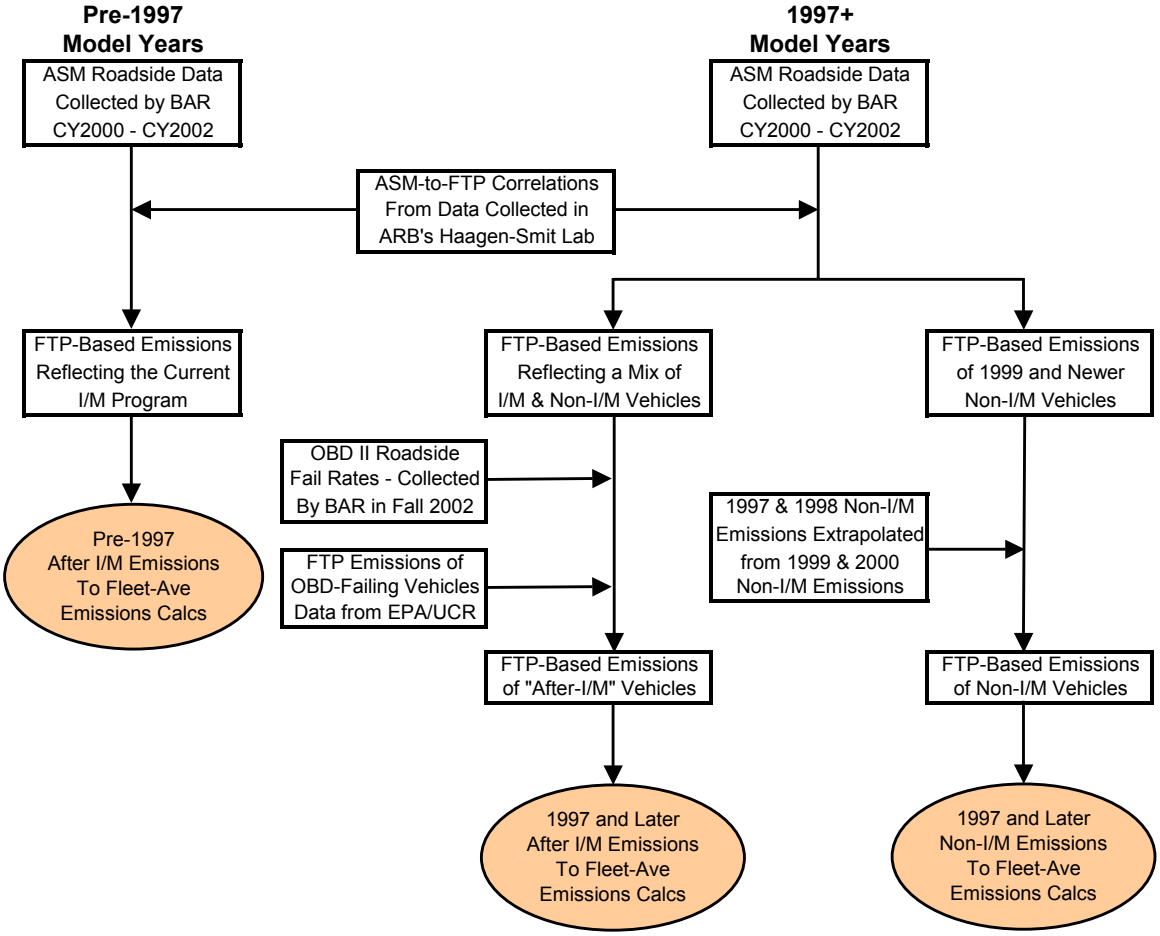


**Table 1.2**

**FTP-Based Emission Rates for the California Light-Duty Vehicle Fleet**
**Based on BAR Random Roadside Testing**

| Model Year | Age | EMFAC VMT Frac | No I/M Emissions (g/mi) | | | BAR-97 I/M Emissions (g/mi) | | |
|---|---|---|---|---|---|---|---|---|
| | | | HC | CO | NOx | HC | CO | NOx |
| 1971 | 32 | 0.0116 | | | | 10.25 | 123.49 | 3.52 |
| 1972 | 31 | 0.0014 | | | | 8.47 | 91.53 | 3.32 |
| 1973 | 30 | 0.0011 | | | | 8.38 | 90.30 | 3.05 |
| 1974 | 29 | 0.0016 | | | | 8.24 | 73.46 | 2.75 |
| 1975 | 28 | 0.0023 | | | | 3.85 | 49.83 | 2.92 |
| 1976 | 27 | 0.0028 | | | | 4.61 | 60.94 | 2.46 |
| 1977 | 26 | 0.0033 | | | | 4.16 | 44.33 | 2.30 |
| 1978 | 25 | 0.0026 | | | | 3.79 | 46.16 | 1.96 |
| 1979 | 24 | 0.0032 | | | | 3.00 | 33.24 | 1.91 |
| 1980 | 23 | 0.0041 | | | | 1.99 | 29.00 | 1.73 |
| 1981 | 22 | 0.0053 | | | | 1.66 | 24.75 | 1.62 |
| 1982 | 21 | 0.0092 | | | | 1.92 | 24.09 | 1.51 |
| 1983 | 20 | 0.0124 | | | | 1.56 | 21.49 | 1.49 |
| 1984 | 19 | 0.0167 | | | | 1.43 | 20.74 | 1.46 |
| 1985 | 18 | 0.0199 | | | | 1.31 | 18.16 | 1.34 |
| 1986 | 17 | 0.0236 | | | | 1.10 | 15.07 | 1.26 |
| 1987 | 16 | 0.0295 | | | | 0.96 | 13.31 | 1.14 |
| 1988 | 15 | 0.0305 | | | | 0.75 | 10.02 | 1.03 |
| 1989 | 14 | 0.0340 | | | | 0.63 | 8.64 | 0.91 |
| 1990 | 13 | 0.0325 | | | | 0.54 | 7.20 | 0.82 |
| 1991 | 12 | 0.0385 | | | | 0.49 | 6.88 | 0.74 |
| 1992 | 11 | 0.0439 | | | | 0.42 | 5.79 | 0.68 |
| 1993 | 10 | 0.0522 | | | | 0.33 | 4.88 | 0.55 |
| 1994 | 9 | 0.0482 | | | | 0.28 | 4.07 | 0.54 |
| 1995 | 8 | 0.0577 | | | | 0.21 | 3.20 | 0.44 |
| 1996 | 7 | 0.0592 | | | | 0.18 | 2.65 | 0.35 |
| 1997 | 6 | 0.0661 | 0.157 | 2.206 | 0.314 | 0.140 | 1.982 | 0.294 |
| 1998 | 5 | 0.0673 | 0.140 | 2.012 | 0.277 | 0.136 | 1.880 | 0.254 |
| 1999 | 4 | 0.0700 | 0.123 | 1.818 | 0.240 | 0.120 | 1.699 | 0.237 |
| 2000 | 3 | 0.0757 | 0.106 | 1.624 | 0.203 | 0.105 | 1.572 | 0.201 |
| 2001 | 2 | 0.0835 | 0.096 | 1.451 | 0.172 | 0.094 | 1.397 | 0.170 |
| 2002 | 1 | 0.0904 | 0.092 | 1.386 | 0.186 | 0.090 | 1.316 | 0.183 |

## 1.3 Baseline Emission Factors – Evaporative Emissions

Model-year specific evaporative emissions estimates, i.e., running loss, hot soak, diurnal, and resting loss emissions, were also calculated for individual model years. For this analysis, EPA's MOBILE6 model was used to estimate separate gram-per-mile emission rates for vehicles passing and failing a functional evaporative system check. MOBILE6 was used in this evaluation because it distinguishes between vehicles that pass and fail a functional evaporative system check, and BAR has indicated that it intends to incorporate an evaporative check in the Smog Check program in the future (in addition to the current gas cap check). Emissions estimates were also calculated independently for vehicles

subject to the enhanced evaporative test procedures versus those that were certified to the one-hour SHED test.

Once emission rates for passing and failing vehicles were determined, it was necessary to estimate in-use evaporative failure rates as a function of model year and vehicle age. For pre-1995 vehicles that were certified to the one-hour SHED test, pre-inspection evaporative system failure rates were based on data collected in the Arizona I/M program during the first I/M cycle after pressure testing had been implemented in that program;[5] gas cap only failures were also based on an analysis of Arizona I/M data to be consistent with the pressure test data. For 1995 and newer vehicles subject to the enhanced evaporative test procedures, pre-inspection failure rates were based on an analysis of the OBD II roadside data (Figure 1.1). Evaporative system failure rates were determined by reviewing the OBD II fault codes recorded for vehicles with the MIL on in the roadside test program. Table 1.3 summarizes the evaporative system defect rates from the roadside data. Because of the relatively small sample size of 1997 and 1998 model year vehicles (i.e., five- and six-year old vehicles), the two model years were combined to establish the evaporative system failure rates for these model years. Because of the phase-in of enhanced evaporative emission standards, few 1996 model year vehicles in the roadside data were certified to those standards.

**Table 1.3**
Summary of Evaporative System Defects in the Fall 2002 OBD II Roadside Test Program for Vehicles Certified to the Enhanced Evaporative Test Procedures

| Model Year | Vehicle Age | Average Odometer | Total Count | Evap-Related MILs MIL On | % MIL |
|---|---|---|---|---|---|
| 1996 | 7 | 101729 | 49 | 0 | 0.0% |
| 1997 | 6 | 104194 | 122 | 1 | 0.8% |
| 1998 | 5 | 75129 | 272 | 5 | 1.8% |
| 1999 | 4 | 61778 | 277 | 2 | 0.7% |
| 2000 | 3 | 43207 | 333 | 3 | 0.9% |
| 2001 | 2 | 31125 | 392 | 2 | 0.5% |
| 2002 | 1 | 16574 | 424 | 0 | 0.0% |
| 2003 | 0 | 6792 | 72 | 0 | 0.0% |
| 1997+1998 | | | 394 | 6 | 1.5% |

To account for the impact of an I/M test on failure rates of pre-enhanced evaporative vehicles, it was assumed that 90% of the identified pressure test failures were repaired and 95% of the identified gas cap failures were repaired. Vehicles certified to enhanced evaporative test procedures were assumed to have 95% of the defects identified by the OBD II system repaired. A summary of No I/M and After I/M evaporative emission rates for calendar year 2005 is shown in Table 1.4.

**Table 1.4**
Evaporative Emission Rates for "No I/M" and "After I/M" Scenarios

| Vehicle Age | Model Year | EMFAC VMT Frac | No I/M (g/mi) | After I/M (g/mi) |
|---|---|---|---|---|
| 25 | 1981+ | 0.0264 | 0.927 | 0.751 |
| 24 | 1982 | 0.0032 | 0.871 | 0.696 |
| 23 | 1983 | 0.0041 | 0.778 | 0.602 |
| 22 | 1984 | 0.0053 | 0.691 | 0.517 |
| 21 | 1985 | 0.0092 | 0.599 | 0.438 |
| 20 | 1986 | 0.0124 | 0.516 | 0.378 |
| 19 | 1987 | 0.0167 | 0.444 | 0.327 |
| 18 | 1988 | 0.0199 | 0.378 | 0.284 |
| 17 | 1989 | 0.0236 | 0.320 | 0.245 |
| 16 | 1990 | 0.0295 | 0.267 | 0.209 |
| 15 | 1991 | 0.0305 | 0.252 | 0.200 |
| 14 | 1992 | 0.0340 | 0.239 | 0.193 |
| 13 | 1993 | 0.0325 | 0.227 | 0.187 |
| 12 | 1994 | 0.0385 | 0.216 | 0.183 |
| 11 | 1995 | 0.0439 | 0.191 | 0.167 |
| 10 | 1996 | 0.0522 | 0.155 | 0.136 |
| 9 | 1997 | 0.0482 | 0.122 | 0.107 |
| 8 | 1998 | 0.0577 | 0.055 | 0.046 |
| 7 | 1999 | 0.0592 | 0.052 | 0.045 |
| 6 | 2000 | 0.0661 | 0.049 | 0.043 |
| 5 | 2001 | 0.0673 | 0.047 | 0.041 |
| 4 | 2002 | 0.0700 | 0.042 | 0.039 |
| 3 | 2003 | 0.0757 | 0.039 | 0.036 |
| 2 | 2004 | 0.0835 | 0.030 | 0.028 |
| 1 | 2005 | 0.0904 | 0.020 | 0.020 |

## 1.4 Model Year Exemption Results

Using the emission factors from Tables 1.2 and 1.4, fleet-average emissions were calculated by applying the EMFAC-based travel fraction for each model year to the emission rates for each model year. Summing over all model years results in an estimate of fleet-average emissions. To estimate the impacts of model year exemptions, the non-I/M emission rates were applied to the vehicle ages that were assumed to be exempt. Three cases were considered:

- The current 4-year exemption;
- A 5-year exemption; and
- A 6-year exemption.

In all cases it was assumed that the exempt vehicles would be subject to a change of ownership inspection. This was accounted for in the analysis based on a 17% annual change of ownership rate.

The fleet-average emission rates for the three scenarios outlined above were calculated, and the details of those calculations are presented in the spreadsheet listing in Appendix A. The percentage increases resulting from exempting five- and six-year old vehicles were applied to the baseline EMFAC2002 light-duty vehicle emissions for enhanced I/M areas. The results of this analysis are summarized in Table 1.5. As shown in the table, exempting five-year old vehicles is projected to increase ROG+NOx emissions in Enhanced I/M areas by 1.77 tons per day (tpd) in calendar year 2005, or about 0.2% of the light-duty vehicle ROG+NOx inventory. Exempting five- and six-year old vehicles is estimated to increase ROG+NOx emissions by 3.71 tpd in 2005, about 0.4% of the light-duty vehicle ROG+NOx inventory. Increased emissions for all ozone precursors using an emissions weighting scheme of ROG+NOx+(CO÷40) based on relative incremental reactivity between ROG and CO were also determined. Exempting five- and six-year old vehicles are estimated to result in a 4.04 tpd increase in "equivalent ozone-forming potential" emissions in 2005.

**Table 1.5**
Emissions Impacts from Extending the Current New Vehicle I/M Exemption from Four Years to Five and Six Years Based on EMFAC2002 Baseline Emissions

| | | Enhanced Area Emissions (tons per day) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Scenario | | ExhROG | EvpROG | TotROG | CO | NOx | ROG+NOx | ROG+NOx +CO/40 |
| Baseline 2005 Results | | 259.40 | 242.30 | 501.68 | 5012.83 | 506.77 | 1008.45 | 1133.77 |
| Baseline 2010 Results | | 166.70 | 193.96 | 360.66 | 3507.04 | 343.90 | 704.56 | 792.23 |
| Increase from Baseline: | | | | | | | | |
| CY2005 | Exempt 5 | 0.10 | 0.59 | 0.69 | 4.92 | 1.08 | 1.77 | 1.89 |
| | Exempt 5+6 | 0.52 | 1.19 | 1.70 | 13.12 | 2.01 | 3.71 | 4.04 |
| CY2010 | Exempt 5 | 0.06 | 0.47 | 0.54 | 3.44 | 0.73 | 1.27 | 1.36 |
| | Exempt 5+6 | 0.33 | 0.95 | 1.28 | 9.18 | 1.36 | 2.64 | 2.87 |

Note that similar reductions on a percentage basis are observed in Table 1.5 for calendar year 2010. However, those estimates should be re-evaluated once in-use data become available on LEV II vehicles. It is anticipated that the failure rates for those vehicles, particularly those certified to partial zero emission vehicle (PZEV) standards, will decrease relative to current technology vehicles. As a result, the estimates shown in Table 1.5 for 2010 may overstate the magnitude of the emissions increase associated with exempting five- and six-year old vehicles.

## 1.5 Cost-Effectiveness Estimates

Cost-effectiveness ratios for extending the model year exemption to either five or six model years were calculated by dividing the lost emission benefits by the cost to test and repair five and six year old vehicles under the I/M program. Since cost-effectiveness ratios are typically calculated when adding rather than relaxing an emission control strategy, the calculations were performed in "reverse order" in which it was assumed that six years were initially exempted. Costs and "gained" benefits from reducing the exemption first to five, then to four model years (from a six year exemption baseline) were applied to compute the cost-effectiveness ratios in a manner consistent with other control strategy analysis.

Average inspection and repair costs for ASM inspections in Enhanced I/M areas were combined with age-specific failure rates and I/M-subject statewide vehicle populations to compute annual costs on a statewide basis to currently test and repair five and six year old vehicles. The failure rates were based on OBD failure rates from BAR's Fall 2002 random roadside data. The cost and vehicle population data were obtained from BAR's published "Executive Summary" I/M statistical reports. These statewide estimates were discounted by a factor of 86% to reflect costs for Enhanced I/M areas only. The costs were further discounted by the Change of Ownership rate to reflect costs triggered by change of ownership inspections that will occur irrespective of model year exemptions. Retained benefits were assumed to exist for an entire two-year biennial I/M cycle.

Table 1.6 summarizes the cost effectiveness ratio calculations described above.

**Table 1.6**
Cost Effectiveness Ratio Calculation Summary
(Assumes a Six-Year Exemption Baseline)

| Parameter | Retain 6 Year Old Vehicles | Retain 5 & 6 Year Old Vehicles |
|---|---|---|
| Initial Test Failure Rate (%) | 10.2% | 8.9% |
| Average ASM Inspection Cost ($/Test) | $45.77 | $45.77 |
| Average ASM Repair Cost ($/Vehicle) | $143.18 | $143.18 |
| Average Test Cost Per Vehicle ($) | $60.37 | $58.44 |
| I/M Subject Vehicle Population (Enhanced Areas) | 1,039,478 | 2,078,955 |
| Total Annual Cost (millions) | $62.76 | $121.50 |
| ROG + NOx Only | | |
| Retained Benefits (tons/I/M cycle) | 1415.9 | 2708.5 |
| Cost Effectiveness Ratio ($/ton) | $44,324 | $44,858 |
| ROG + NOx + CO÷40 | | |
| Retained Benefits (tons/I/M cycle) | 1565.7 | 2948.2 |
| Cost Effectiveness Ratio ($/ton) | $40,084 | $41,211 |

It shows the cost effectiveness ratios based on gained benefits of both ROG and NOx and all ozone-weighted precursors (ROG + NOx + CO÷40). (The ratios based on ROG and NOx benefits are shown for consistent comparison with other ARB program cost-effectiveness calculations, which are based on ROG and NOx only.) Cost effectiveness ratios based on ROG and NOx were calculated as $44,324/ton and $44,858/ton for retaining six-year old vehicles and five and six year old vehicles, respectively. When CO benefits are included (and discounted by an ozone-weighting factor of 40) the respective ratios are $40,084/ton and $41,211/ton.

## 2. REFERENCES

[1] "Evaluation of California's Enhanced Vehicle Inspection and Maintenance Program (Smog Check II)," California Environmental Protection Agency, Air Resources Board, July 12, 2000.

[2] "Models for Estimating California Fleet FTP Emissions from ASM Measurements," Draft Report prepared by Eastern Research Group for the California Bureau of Automotive Repair, December 25, 1999.

[3] Gardetto, Edward and Ted Trimble. "Evaluation of On Board Diagnostics for Use in Detecting Malfunctioning and High Emitting Vehicles," U.S. Environmental Protection Agency, EPA420-R-00-013, August 2000.

[4] Durbin, Thomas, et. al. "Evaluation of the Effectiveness of On-Board Diagnostics II (OBD II) in Controlling Motor Vehicle Emissions," Center for Environmental Research and Technology, University of California-Riverside, May 2001.

[5] "Estimating Benefits of Inspection/Maintenance Programs for Evaporative Control Systems," U.S. Environmental Protection Agency, EPA420-P-99-031, November 1999.

# APPENDIX A

## Five and Six Year Exemptions Analysis Spreadsheet

**Sample Size and Average FTP Emissions (g/mi) by Model Year and I/M Status**
**Based on 2000-2002 California Random Roadside ASM Data Regressed to FTP Using New ERG Regressions and OBD Model Failing Vehicle Emissions to Generate No I/M Emissions**

| Model | | EMFAC | Data | No I/M Emissions (g/mi) | | | | | BAR-97 I/M Emissions (g/mi) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Age | VMT Frac | Source | ExhHC | EvpHC | TotHC | CO | NOx | ExhHC | EvpHC | TotHC | CO | NOx |
| 1971 | 32 | 0.0116 | Road-All | | | | | | 10.250 | 0.751 | 11.001 | 123.491 | 3.516 |
| 1972 | 31 | 0.0014 | Road-All | | | | | | 8.468 | 0.751 | 9.219 | 91.532 | 3.323 |
| 1973 | 30 | 0.0011 | Road-All | | | | | | 8.379 | 0.751 | 9.130 | 90.295 | 3.050 |
| 1974 | 29 | 0.0016 | Road-B97 | | | | | | 8.237 | 0.751 | 8.988 | 73.456 | 2.752 |
| 1975 | 28 | 0.0023 | Road-B97 | | | | | | 3.846 | 0.751 | 4.597 | 49.833 | 2.919 |
| 1976 | 27 | 0.0028 | Road-B97 | | | | | | 4.614 | 0.751 | 5.365 | 60.942 | 2.463 |
| 1977 | 26 | 0.0033 | Road-B97 | | | | | | 4.163 | 0.751 | 4.914 | 44.330 | 2.300 |
| 1978 | 25 | 0.0026 | Road-B97 | | | | | | 3.785 | 0.751 | 4.536 | 46.160 | 1.961 |
| 1979 | 24 | 0.0032 | Road-B97 | | | | | | 3.002 | 0.696 | 3.698 | 33.236 | 1.913 |
| 1980 | 23 | 0.0041 | Road-B97 | | | | | | 1.986 | 0.602 | 2.588 | 29.004 | 1.732 |
| 1981 | 22 | 0.0053 | Road-B97 | | | | | | 1.662 | 0.517 | 2.179 | 24.752 | 1.621 |
| 1982 | 21 | 0.0092 | Road-B97 | | | | | | 1.918 | 0.438 | 2.356 | 24.093 | 1.506 |
| 1983 | 20 | 0.0124 | Road-B97 | | | | | | 1.562 | 0.378 | 1.940 | 21.491 | 1.489 |
| 1984 | 19 | 0.0167 | Road-B97 | | | | | | 1.425 | 0.327 | 1.752 | 20.740 | 1.463 |
| 1985 | 18 | 0.0199 | Road-B97 | | | | | | 1.305 | 0.284 | 1.589 | 18.160 | 1.343 |
| 1986 | 17 | 0.0236 | Road-B97 | | | | | | 1.096 | 0.245 | 1.341 | 15.066 | 1.256 |
| 1987 | 16 | 0.0295 | Road-B97 | | | | | | 0.956 | 0.209 | 1.165 | 13.313 | 1.142 |
| 1988 | 15 | 0.0305 | Road-B97 | | | | | | 0.750 | 0.200 | 0.950 | 10.023 | 1.025 |
| 1989 | 14 | 0.0340 | Road-B97 | | | | | | 0.628 | 0.193 | 0.821 | 8.644 | 0.909 |
| 1990 | 13 | 0.0325 | Road-B97 | | | | | | 0.541 | 0.187 | 0.728 | 7.199 | 0.820 |
| 1991 | 12 | 0.0385 | Road-B97 | | | | | | 0.488 | 0.183 | 0.671 | 6.877 | 0.742 |
| 1992 | 11 | 0.0439 | Road-B97 | | | | | | 0.415 | 0.167 | 0.582 | 5.792 | 0.676 |
| 1993 | 10 | 0.0522 | Road-B97 | | | | | | 0.329 | 0.136 | 0.465 | 4.875 | 0.552 |
| 1994 | 9 | 0.0482 | Road-B97 | | | | | | 0.283 | 0.107 | 0.390 | 4.070 | 0.538 |
| 1995 | 8 | 0.0577 | Road-B97 | | | | | | 0.214 | 0.046 | 0.260 | 3.203 | 0.444 |
| 1996 | 7 | 0.0592 | Road-B97 | | | | | | 0.175 | 0.045 | 0.220 | 2.653 | 0.346 |
| 1997 | 6 | 0.0661 | OBD-Pass | 0.157 | 0.049 | 0.206 | 2.206 | 0.314 | 0.140 | 0.043 | 0.184 | 1.982 | 0.294 |
| 1998 | 5 | 0.0673 | OBD-Pass | 0.140 | 0.047 | 0.187 | 2.012 | 0.277 | 0.136 | 0.041 | 0.177 | 1.880 | 0.254 |
| 1999 | 4 | 0.0700 | OBD-Pass | 0.123 | 0.042 | 0.165 | 1.818 | 0.240 | 0.120 | 0.039 | 0.159 | 1.699 | 0.237 |
| 2000 | 3 | 0.0757 | OBD-Pass | 0.106 | 0.039 | 0.145 | 1.624 | 0.203 | 0.105 | 0.036 | 0.141 | 1.572 | 0.201 |
| 2001 | 2 | 0.0835 | OBD-Pass | 0.096 | 0.030 | 0.126 | 1.451 | 0.172 | 0.094 | 0.028 | 0.123 | 1.397 | 0.170 |
| 2002 | 1 | 0.0904 | OBD-Pass | 0.092 | 0.020 | 0.112 | 1.386 | 0.186 | 0.090 | 0.020 | 0.110 | 1.316 | 0.183 |
| | | 1.0000 | | | | | | | | | | | |

**After I/M Emissions (g/mi) by Model Year and Model Year Exemption Scenario**
**(emissions are discounted for change of ownership in exempt model years)**

| Model | | EMFAC | Data | Chg Owner%, Year 4 17.0% After Repr Flt (g/mi), Exempt 4 | | | | | Chg Owner%, Year 5: 17.0% After Repr Flt (g/mi), Exempt 5 | | | | | Chg Owner%, Year 6 17.0% After Repr Flt (g/mi), Exempt 6 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Age | VMT Frac | Source | ExhHC | EvpHC | TotHC | CO | NOx | ExhHC | EvpHC | TotHC | CO | NOx | ExhHC | EvpHC | TotHC | CO | NOx |
| 1971 | 32 | 0.0116 | Road-All | 10.250 | 0.751 | 11.001 | 123.491 | 3.516 | 10.250 | 0.751 | 11.001 | 123.491 | 3.516 | 10.250 | 0.751 | 11.001 | 123.491 | 3.516 |
| 1972 | 31 | 0.0014 | Road-All | 8.468 | 0.751 | 9.219 | 91.532 | 3.323 | 8.468 | 0.751 | 9.219 | 91.532 | 3.323 | 8.468 | 0.751 | 9.219 | 91.532 | 3.323 |
| 1973 | 30 | 0.0011 | Road-All | 8.379 | 0.751 | 9.130 | 90.295 | 3.050 | 8.379 | 0.751 | 9.130 | 90.295 | 3.050 | 8.379 | 0.751 | 9.130 | 90.295 | 3.050 |
| 1974 | 29 | 0.0016 | Road-B97 | 8.237 | 0.751 | 8.988 | 73.456 | 2.752 | 8.237 | 0.751 | 8.988 | 73.456 | 2.752 | 8.237 | 0.751 | 8.988 | 73.456 | 2.752 |
| 1975 | 28 | 0.0023 | Road-B97 | 3.846 | 0.751 | 4.597 | 49.833 | 2.919 | 3.846 | 0.751 | 4.597 | 49.833 | 2.919 | 3.846 | 0.751 | 4.597 | 49.833 | 2.919 |
| 1976 | 27 | 0.0028 | Road-B97 | 4.614 | 0.751 | 5.365 | 60.942 | 2.463 | 4.614 | 0.751 | 5.365 | 60.942 | 2.463 | 4.614 | 0.751 | 5.365 | 60.942 | 2.463 |
| 1977 | 26 | 0.0033 | Road-B97 | 4.163 | 0.751 | 4.914 | 44.330 | 2.300 | 4.163 | 0.751 | 4.914 | 44.330 | 2.300 | 4.163 | 0.751 | 4.914 | 44.330 | 2.300 |
| 1978 | 25 | 0.0026 | Road-B97 | 3.785 | 0.751 | 4.536 | 46.160 | 1.961 | 3.785 | 0.751 | 4.536 | 46.160 | 1.961 | 3.785 | 0.751 | 4.536 | 46.160 | 1.961 |
| 1979 | 24 | 0.0032 | Road-B97 | 3.002 | 0.696 | 3.698 | 33.236 | 1.913 | 3.002 | 0.696 | 3.698 | 33.236 | 1.913 | 3.002 | 0.696 | 3.698 | 33.236 | 1.913 |
| 1980 | 23 | 0.0041 | Road-B97 | 1.986 | 0.602 | 2.588 | 29.004 | 1.732 | 1.986 | 0.602 | 2.588 | 29.004 | 1.732 | 1.986 | 0.602 | 2.588 | 29.004 | 1.732 |
| 1981 | 22 | 0.0053 | Road-B97 | 1.662 | 0.517 | 2.179 | 24.752 | 1.621 | 1.662 | 0.517 | 2.179 | 24.752 | 1.621 | 1.662 | 0.517 | 2.179 | 24.752 | 1.621 |
| 1982 | 21 | 0.0092 | Road-B97 | 1.918 | 0.438 | 2.356 | 24.093 | 1.506 | 1.918 | 0.438 | 2.356 | 24.093 | 1.506 | 1.918 | 0.438 | 2.356 | 24.093 | 1.506 |
| 1983 | 20 | 0.0124 | Road-B97 | 1.562 | 0.378 | 1.940 | 21.491 | 1.489 | 1.562 | 0.378 | 1.940 | 21.491 | 1.489 | 1.562 | 0.378 | 1.940 | 21.491 | 1.489 |
| 1984 | 19 | 0.0167 | Road-B97 | 1.425 | 0.327 | 1.752 | 20.740 | 1.463 | 1.425 | 0.327 | 1.752 | 20.740 | 1.463 | 1.425 | 0.327 | 1.752 | 20.740 | 1.463 |
| 1985 | 18 | 0.0199 | Road-B97 | 1.305 | 0.284 | 1.589 | 18.160 | 1.343 | 1.305 | 0.284 | 1.589 | 18.160 | 1.343 | 1.305 | 0.284 | 1.589 | 18.160 | 1.343 |
| 1986 | 17 | 0.0236 | Road-B97 | 1.096 | 0.245 | 1.341 | 15.066 | 1.256 | 1.096 | 0.245 | 1.341 | 15.066 | 1.256 | 1.096 | 0.245 | 1.341 | 15.066 | 1.256 |
| 1987 | 16 | 0.0295 | Road-B97 | 0.956 | 0.209 | 1.165 | 13.313 | 1.142 | 0.956 | 0.209 | 1.165 | 13.313 | 1.142 | 0.956 | 0.209 | 1.165 | 13.313 | 1.142 |
| 1988 | 15 | 0.0305 | Road-B97 | 0.750 | 0.200 | 0.950 | 10.023 | 1.025 | 0.750 | 0.200 | 0.950 | 10.023 | 1.025 | 0.750 | 0.200 | 0.950 | 10.023 | 1.025 |
| 1989 | 14 | 0.0340 | Road-B97 | 0.628 | 0.193 | 0.821 | 8.644 | 0.909 | 0.628 | 0.193 | 0.821 | 8.644 | 0.909 | 0.628 | 0.193 | 0.821 | 8.644 | 0.909 |
| 1990 | 13 | 0.0325 | Road-B97 | 0.541 | 0.187 | 0.728 | 7.199 | 0.820 | 0.541 | 0.187 | 0.728 | 7.199 | 0.820 | 0.541 | 0.187 | 0.728 | 7.199 | 0.820 |
| 1991 | 12 | 0.0385 | Road-B97 | 0.488 | 0.183 | 0.671 | 6.877 | 0.742 | 0.488 | 0.183 | 0.671 | 6.877 | 0.742 | 0.488 | 0.183 | 0.671 | 6.877 | 0.742 |
| 1992 | 11 | 0.0439 | Road-B97 | 0.415 | 0.167 | 0.582 | 5.792 | 0.676 | 0.415 | 0.167 | 0.582 | 5.792 | 0.676 | 0.415 | 0.167 | 0.582 | 5.792 | 0.676 |
| 1993 | 10 | 0.0522 | Road-B97 | 0.329 | 0.136 | 0.465 | 4.875 | 0.552 | 0.329 | 0.136 | 0.465 | 4.875 | 0.552 | 0.329 | 0.136 | 0.465 | 4.875 | 0.552 |
| 1994 | 9 | 0.0482 | Road-B97 | 0.283 | 0.107 | 0.390 | 4.070 | 0.538 | 0.283 | 0.107 | 0.390 | 4.070 | 0.538 | 0.283 | 0.107 | 0.390 | 4.070 | 0.538 |
| 1995 | 8 | 0.0577 | Road-B97 | 0.214 | 0.046 | 0.260 | 3.203 | 0.444 | 0.214 | 0.046 | 0.260 | 3.203 | 0.444 | 0.214 | 0.046 | 0.260 | 3.203 | 0.444 |
| 1996 | 7 | 0.0592 | Road-B97 | 0.175 | 0.045 | 0.220 | 2.653 | 0.346 | 0.175 | 0.045 | 0.220 | 2.653 | 0.346 | 0.175 | 0.045 | 0.220 | 2.653 | 0.346 |
| 1997 | 6 | 0.0661 | OBD-Pass | 0.140 | 0.043 | 0.184 | 1.982 | 0.294 | 0.140 | 0.043 | 0.184 | 1.982 | 0.294 | *0.154* | *0.048* | *0.202* | *2.168* | *0.311* |
| 1998 | 5 | 0.0673 | OBD-Pass | 0.136 | 0.041 | 0.177 | 1.880 | 0.254 | *0.139* | *0.046* | *0.185* | *1.990* | *0.273* | *0.139* | *0.046* | *0.185* | *1.990* | *0.273* |
| 1999 | 4 | 0.0700 | OBD-Pass | *0.122* | *0.042* | *0.164* | *1.798* | *0.239* | *0.122* | *0.042* | *0.164* | *1.798* | *0.239* | *0.122* | *0.042* | *0.164* | *1.798* | *0.239* |
| 2000 | 3 | 0.0757 | OBD-Pass | *0.106* | *0.038* | *0.144* | *1.615* | *0.203* | *0.106* | *0.038* | *0.144* | *1.615* | *0.203* | *0.106* | *0.038* | *0.144* | *1.615* | *0.203* |
| 2001 | 2 | 0.0835 | OBD-Pass | *0.096* | *0.030* | *0.125* | *1.442* | *0.172* | *0.096* | *0.030* | *0.125* | *1.442* | *0.172* | *0.096* | *0.030* | *0.125* | *1.442* | *0.172* |
| 2002 | 1 | 0.0904 | OBD-Pass | *0.092* | *0.020* | *0.112* | *1.374* | *0.186* | *0.092* | *0.020* | *0.112* | *1.374* | *0.186* | *0.092* | *0.020* | *0.112* | *1.374* | *0.186* |

### Calculation of Percentage Impact on Fleet

| Scenario | MYs Exempt | | Fleet Emission Factor (g/mi) ExhHC | EvpHC | TotHC | CO | NOx |
|---|---|---|---|---|---|---|---|
| Exempt 4 | 1999+ | | 0.5677 | 0.1255 | 0.6932 | 7.5051 | 0.5950 |
| Exempt 5 | 1998+ | | 0.5679 | 0.1258 | 0.6938 | 7.5125 | 0.5963 |
| Exempt 6 | 1997+ | | 0.5688 | 0.1261 | 0.6950 | 7.5247 | 0.5974 |
| **% Change:** | | **4 to 5** | **0.039%** | **0.245%** | **0.076%** | **0.098%** | **0.212%** |
| | | **4 to 6** | **0.199%** | **0.490%** | **0.251%** | **0.262%** | **0.396%** |

### California Statewide Fleet Tonnages Under Current (4 MY Exempt) Program

Enhanced Fraction: 86%

| Calendar Year | Statewide Light-Duty Fleet Summer Season Emissions (tons/day) ExhROG | EvpROG | TotROG | CO | NOx | Enhanced I/M Area Light-Duty Fleet Summer Season Emissions (tons/day) ExhROG | EvpROG | TotROG | CO | NOx |
|---|---|---|---|---|---|---|---|---|---|---|
| 2005 | 301.63 | 281.74 | 583.35 | 5828.87 | 589.27 | 259.40 | 242.30 | 501.68 | 5012.83 | 506.77 |
| 2010 | 193.84 | 225.53 | 419.37 | 4077.95 | 399.88 | 166.70 | 193.96 | 360.66 | 3507.04 | 343.90 |

### Translation of Model Year Exemption Relative Impacts to Lost Emission Benefits

| Calendar Year | Emission Benefits Lost* 5 MY Exemption (tons/day) ExhROG | EvpROG | TotROG | CO | NOx | Emission Benefits Lost* 6 MY Exemption (tons/day) ExhROG | EvpROG | TotROG | CO | NOx | Total ROG+NOx+CO/40 Exempt5 | Exempt6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **2005** | **0.101** | **0.593** | **0.693** | **4.924** | **1.076** | **0.515** | **1.187** | **1.702** | **13.124** | **2.005** | **1.893** | **4.036** |
| **2010** | **0.065** | **0.475** | **0.539** | **3.445** | **0.730** | **0.331** | **0.950** | **1.282** | **9.182** | **1.361** | **1.356** | **2.872** |

*From a baseline of 4 newest model years exempt

### Cost Effectiveness Calculations

Enhanced I/M Area Costs and Failure Rates

| | 6 MY | 5&6 MY | |
|---|---|---|---|
| Initial Test Failure Rate: | 10.2% | 8.9% | *BAR Oct 2002-Jan 2003 Roadside MIL-On Rates* |
| Average Inspection Cost: | $45.77 | $45.77 | *CY2002 Executive Summary Report, ASM Avg Inspection Cost* |
| Average Repair Cost: | $143.18 | $143.18 | *CY2002 Executive Summary Report, Average Enhanced Area Repair Cost* |
| Average Per Vehicle Cost: | $60.37 | $58.44 | |
| Vehicles Tested Annually: | 1,039,478 | 2,078,955 | *CY2002 Executive Summary Report, 1st Test Volumes x 86% (accounts for SF) x (1-COO)* |
| Total Annual Cost (millions): | $62.76 | $121.50 | |

Cost Effectiveness (ROG+NOx)

| | **Exempt 6 to 5** | **Exempt 6 to 4** |
|---|---|---|
| Retained Benefits (tons/cycle): | **1415.9** | **2708.5** |
| C/E Ratio: | **$44,324** | **$44,858** |

Cost Effectiveness (ROG+NOx+CO/40)

| | **Exempt 6 to 5** | **Exempt 6 to 4** |
|---|---|---|
| Retained Benefits (tons/cycle): | **1565.7** | **2948.2** |
| C/E Ratio: | **$40,084** | **$41,211** |