

## Tracking Vehicles over Time in the Phoenix I/M Program

Tom Wenzel, Lawrence Berkeley National Laboratory

July 27, 1999

**14% of the cars tested in 1995 fail the I/M test. Of the cars that initially fail, 41% do not pass a subsequent I/M test by the end of March 1996. (Extending the time in which a vehicle can get a passing test through March 1996 results in 1400 vehicles switching from the No Final Pass category to the Final Pass category, and reduces the No Final Pass rate from 44% of all Initial Fails to 41%.) Approximately 4% of all Initial Fail vehicles are waived, so about 37% of the Initial Fails are not accounted for. (This waiver rate is from AZ DEQ, apparently based on analysis of the 2% random sample of vehicles.)**

41% of the cars tested in 1995 are not tested in 1997. This ranges from 38% of the cars initially passed in 1995, to 72% of the cars not passing by the end of March 1996. (That is, 62% of the cars that initially passed in 1995 were tested in 1997, while 28% of the cars that had no passing test were tested again in 1997). The fraction of cars tested in 1995 that were not tested in 1997 ranges from 61% of the MY81 cars to 35% of the MY94 cars. So the fleet of vehicles not tested in 1997 is older, and has higher average emissions by MY, than the fleet tested in both years.

Why are so many vehicles not tested two years later? Vehicles do not change their I/M test cycle if they are resold, or their registration lapses; the only way a vehicle's test cycle can change is if it is re-registered out of the state and then applies for registration in Arizona, an unlikely occurrence. Apparently Gordon-Darby tracked vehicles that were initially tested in 1996, and found that about 35% did not report for testing in 1998. They attribute this attrition to vehicles relocating out of the I/M area, rather than them avoiding the I/M program. Analysis of remote sensing data, however, indicates that many of these vehicles are still being driven in the Phoenix area. 12% of the fleet tested in both 1995 and 1997 were measured by remote sensors at least 2 years after their initial 1995 I/M test. 5% of the fleet tested in 1995 only were similarly measured by remote sensors. The ratio of the two percentages suggests that as much as 40% of the cars not reporting for testing in 1997 were still being driven in the Phoenix area in 1997.

This technique can also be used to determine what fraction of the vehicles never passing in 1995 are still being driven in the Phoenix area. Remember that 28% of the cars that had no passing test in 1995 were tested again in 1997. Of these cars, 8% were seen by remote sensors at least 2 years after their initial 1995 I/M test. In contrast, 2% of the cars that never passed 1995 testing, and did not report for testing in 1997, were seen by remote sensors at least 2 years after their initial 1995 I/M test. Again, the ratio of the two percentages suggests that 25% of the cars that never passed 1995 testing, and did not report for 1997 testing, were being driven in the Phoenix area in 1997. (This fraction appears to be higher, 40%, for LDTs.)

Of the 5,347 cars that were never passed in 1995 but returned for testing in 1997 (28% of the initial fails in the fleet tested in 1995 and 1997), 65% failed their initial test in 1997.

In the Phoenix program, vehicles that do not receive a passing result within 5 months of initial testing have their next test coded as an initial test. Of the 5,347 cars that did not pass through March of 1996, 656 (12%) had second initial tests in 1996; of these, 351 eventually passed in 1996 (54% of those with second initial tests in 1996, 6% of all that did not pass through March of 1996).

Of the cars that initially failed for any pollutant in 1995, one-half failed initial testing in 1997. The percent of repeat failures is much higher for older cars; the percent ranges from 54% for MY81 cars to under 5% for MY94 cars. One-half of the cars that failed initial testing in both 1995 and 1997 failed for the same combination of pollutants in each year. The percent of same type of failure is higher for newer cars; the percent ranges from 44% for MY81 cars to 62% for MY93 cars.

Of the cars tested in both 1995 and 1997, emissions increases between the two test years (due to emissions deterioration in properly functioning vehicles and emissions control malfunction in a relatively small number of vehicles) are greater (26% for HC, 39% for CO, 17% for NOx) than the emissions reductions between initial and final tests in 1995 (12% for HC, 15% for CO, 8% for NOx).

50% of the cars tested in 1997 were not tested in 1995 (223,000). These cars include 52,000 MY94 and older out of state cars newly registered in Arizona (23%), 40,000 MY95 cars exempted from testing in 1995 (18%), and 17,000 MY96 and newer cars voluntarily tested (8%). The remaining 114,000 cars (51%) are voluntary tests, or second initial tests of vehicles that never passed initial testing in 1996, or high emitters flagged by RSD for unscheduled I/M testing. The 1997 I/M results of this “migrating in” fleet is similar to the I/M results of the entire 1995 fleet, including the cars that are exported out of the area after 1995. That is, 15% fail initial testing, and 42% of initial failures do not receive a passing I/M test by the end of 1997. Of the cars that are tested in both 1995 and 1997, only 10% fail initial I/M testing, and 29% of these never receive a passing I/M test, even though this fleet is substantially older than the fleet first tested in 1997. The 1995 “migrating out” fleet has higher average emissions by MY and I/M result than the fleet tested in 1995 and 1997. The average emissions by MY and I/M result of the 1997 “migrating in” fleet is almost identical to those of the 1995 “migrating out” fleet.

Table 1 shows average emissions of the passenger car fleet tested in both 1995 and 1997, by initial and final I/M test in each year. The values are not weighted by annual VMT. Table 2 shows the percent change in emissions in each time period. The first row shows the initial reduction in emissions due to the 1995 I/M cycle. The second row shows the increase in emissions between the final I/M test in 1995 and the initial test in 1997, on the same vehicles. The increase is made up of three factors: insufficient repair of vehicles that failed in 1995; emissions malfunctions of vehicles that passed in 1995; and emissions deterioration due to two years of vehicle aging. The two-year increase in emissions between I/M cycles is the same or greater than the initial reduction due to the program. The third row shows the initial emission reduction from the I/M program in 1997. The last row shows the cumulative effect of two I/M cycles, by comparing the initial emissions in 1995 with the final emissions in 1997. For the car fleet that is tested in both

1995 and 1997, the effectiveness over two cycles of the I/M program is only 6% for HC, 3% for CO, and 1% for NOx. The reductions for the LDT fleet are 7% for HC, 2% for CO, and 0.1% for NOx.

Table 1. Unweighted Fleet Emissions (grams per mile), by I/M Test and Year, All Cars Tested in Both 1995 and 1997

	HC (gpm)	CO (gpm)	NOx (gpm)
1995 initial I/M test	0.57	7.7	1.25
1995 final I/M test	0.50	6.5	1.15
1997 initial I/M test	0.63	9.1	1.34
1997 final I/M test	0.54	7.5	1.24

Table 2. Percent Change in Unweighted Fleet Emissions, All Cars Tested in Both 1995 and 1997

	HC	CO	NOx
Effect of 1995 I/M program (1995 final divided by 1995 initial)	-12%	-15%	-8%
Effect of 2 years of deterioration (1997 initial divided by 1995 final)	26%	39%	17%
Effect of 1997 I/M program (1997 final divided by 1997 initial)	-15%	-18%	-8%
Cumulative effect of two I/M cycles (1997 final divided by 1995 initial)	-6%	-3%	-1%

The percentage changes are slightly different when vehicle emissions, expressed as tons per day, are weighted by annual vehicle miles traveled (using MOBILE6 annual VMT by vehicle type and model year), as indicated in Tables 3 and 4.

Table 3. Fleet Emissions Weighted by Annual VMT (tons per day), by I/M Test and Year, All Cars Tested in Both 1995 and 1997

	HC (tpd)	CO (tpd)	NOx (tpd)
Effect of 1995 I/M program (1995 final divided by 1995 initial)	4.11	55.40	9.29
Effect of 2 years of deterioration (1997 initial divided by 1995 final)	3.66	47.99	8.23
Effect of 1997 I/M program (1997 final divided by 1997 initial)	4.50	65.17	10.09
Cumulative effect of two I/M cycles (1997 final divided by 1995 initial)	3.88	54.37	9.06

**Table 4. Percent Change in Weighted Fleet Emissions, All Cars Tested in Both 1995 and 1997**

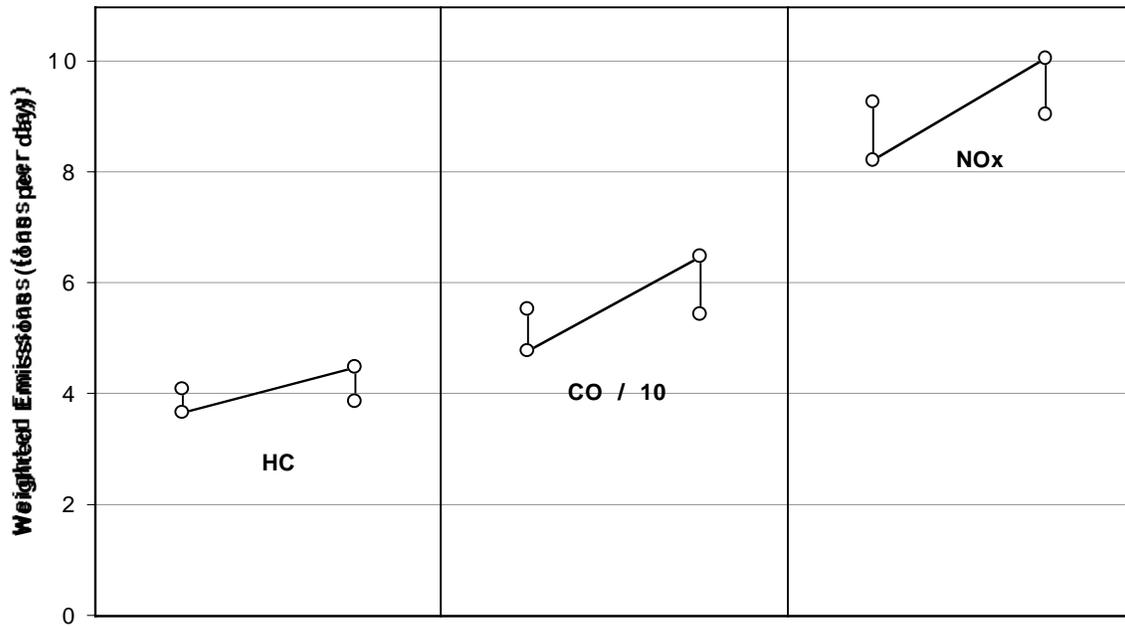
	HC	CO	NOx
Effect of 1995 I/M program (1995 final divided by 1995 initial)	-11%	-13%	-11%
Effect of 2 years of deterioration (1997 initial divided by 1995 final)	23%	36%	23%
Effect of 1997 I/M program (1997 final divided by 1997 initial)	-14%	-17%	-10%
Cumulative effect of two I/M cycles (1997 final divided by 1995 initial)	-6%	-2%	-2%

Figure 1 shows the weighted data in Tables 3 and 4. The figure indicates that the initial reduction from the first cycle of the Enhanced program is equivalent to the reduction from future cycles. (The Phoenix area had a Basic program in place prior to implementation of the Enhanced program, which could have muted the first year effect of the Enhanced program. On the other hand, subsequent cycles of the Enhanced program achieve roughly the same emissions reduction as the first cycle.) In addition, the effect of two years of emissions deterioration outweigh the effect of the I/M program; the after program emissions in 1997 are substantially higher than the after program emissions in 1995.

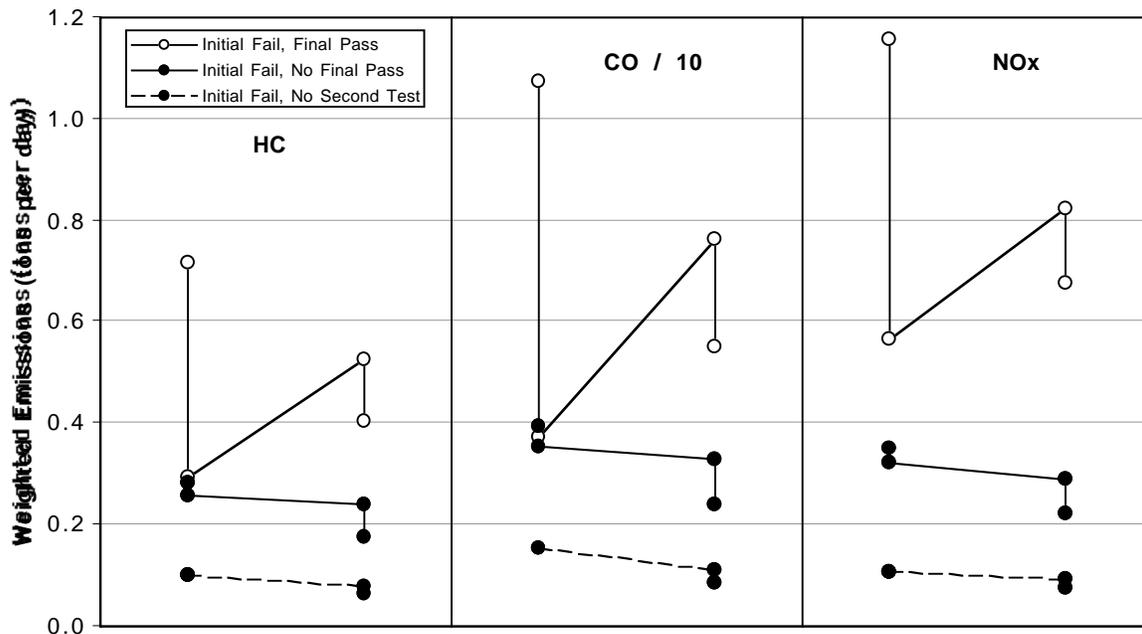
These curves present an optimistic estimate of the effect of the I/M program. This is because the analysis is limited to vehicles reporting for testing in both 1995 and 1997. About 40% of the cars reporting in 1995 did not report for testing in 1997; a fraction of these cars are surely still being driven in the I/M area (we estimate 40% based on remote sensing data, discussed above). The curves are based on 28% of the no final pass vehicles in 1995 returning for testing in 1997 (as observed in the I/M data, discussed above); this percentage is comparable to the 25% estimate of No Final Pass vehicles still being driven in the I/M area, derived from RSD data.

Figures 2 and 3 decompose Figure 1 into subfleets, based on each vehicle's 1995 I/M result. Figure 2 shows that the Initial Fail/Final Pass vehicle emissions are reduced dramatically, primarily due to repairs or adjustments. But from 1995 to 1997 their emissions nearly double, due to ineffective repair or adjustments that result in a passing test but no real emissions reduction. About half of the initial reduction, as measured by comparing first and last 1995 I/M tests, is lost. Emissions from the No Final Pass and No Second Test cars decrease between 1995 and 1997. A possible cause is that repairs or adjustments were made to these vehicles after their last 1995 I/M test that reduced their emissions. Another possibility is the emissions variability of high emitting vehicles (possibly due to intermittent malfunction of emissions controls); if tested again, many of these high emitters would exhibit lower emissions. As noted above, 65% of the cars that did not pass 1995 I/M testing failed their initial 1997 I/M test. Figure 3 shows the emissions of cars that initially passed in 1995.

**Figure 1. Fleet Emissions over Two I/M Cycles**  
*Passenger Cars tested in both 1995 and 1997, Arizona IM240*



**Figure 2. Fleet Emissions over Two I/M Cycles**  
*Passenger Cars tested in both 1995 and 1997, Arizona IM240*



**Figure 3. Fleet Emissions over Two I/M Cycles**  
*Passenger Cars tested in both 1995 and 1997, Arizona IM240*

