AirCare - Results and Observations in 2003 and 2004

(Abridged Version)

PACIFIC
VEHICLE TESTING
TECHNOLOGIES

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Executive Summary

AirCare helps to maintain good air quality in the Lower Fraser Valley of British Columbia by identifying the approximately 15% of vehicles that are producing more exhaust emissions than they should for their age and type. By requiring that these vehicles be diagnosed and repaired to restore their emissions to normal levels, the amount of smog-forming and toxic emissions being released into the air is substantially reduced. Since light-duty motor vehicles are collectively the largest source of carbon monoxide (CO), oxides of nitrogen (NO_x) and volatile organic compounds (VOC's) in the region, a program that addresses excess vehicle emissions is an important part of an effective air quality management plan.

AirCare data confirm that the advances in emission control effectiveness and durability that have occurred since the 1996 model year have resulted in a much-reduced failure rate for these vehicles. In recognition of the durability of the emission controls on new vehicles, the AirCare program provides a three-model year exemption for the newest model years. The three-model year exemption was implemented on January 1, 2004. Prior to this date, the new vehicle exemption was two model years. This change meant that approximately 70,000 fewer inspections were performed in 2004, but the effect on the number of excess-emitting vehicles identified was negligible.

In order for the AirCare program to work effectively, the vehicles identified in the inspection process as being abnormal emitters must be correctly diagnosed and repaired. The AirCare program was designed from the outset to include a certified repair industry, consisting of repair shops and repair technicians that meet program qualifications. During the reporting period, there was an average of about 450 repair shops and 1200 technicians that were AirCare certified. Vehicles repaired by certified facilities are eligible for a Conditional Pass on re-inspection. A Conditional Pass is technically a "Fail", but the vehicle owner is allowed to re-license the vehicle for up to one year. Vehicle owners that choose a certified repair shop can also limit the cost of their repairs to specified maximum limits that vary from $300 to $600 depending on the age of the vehicle. Regardless of the specifics, any vehicle that is repaired at a certified shop and has repair data transmitted from the shop to the program administration is eligible for a Conditional Pass. This means that motorists are guaranteed only one trip back to the inspection centre after visiting a repair shop. Although Conditional Passes detract from the environmental benefits of the program, the number of these types of test outcomes is declining year by year. Between 2003 and 2004, the number of Conditional Passes dropped from 6,338 to 4,603.

Due to the fact that the majority of the vehicles on the road are now either exempt from AirCare or required to be tested only every two years, the number of inspections performed each year is shrinking. Of the estimated 1.2 million light-duty vehicles registered in the Lower Fraser Valley, there were 648,304 (54% of the total fleet) tested at AirCare in 2004. Despite testing fewer vehicles, there were still 90,975 that failed. In 2004, there were 67,808 previously-failed vehicles that returned and passed a re-inspection. The change in emissions from the pre-repair to the post-repair state for these many thousands of vehicles is the mechanism by which AirCare generates emission reductions.

In order to quantify these reductions, it is necessary to have a large amount of data corresponding to different vehicle types and age groups as well as to different modes of failure. The AirCare program is well designed from this standpoint. The fact that the program has IM240 testing equipment in every inspection lane means that mass emission data can be obtained for virtually any vehicle. Vehicles are selected according to pre-defined criteria to create a sample of 8,000 vehicles per year that is representative of the AirCare-inspected fleet in the Lower Fraser Valley. Full-duration IM240 tests are then performed on these vehicles following their official AirCare test and the results are kept for analysis purposes. This sample of 8,000 is bolstered by a much larger dataset that occurs naturally for all 1992-and-newer vehicles that fail their initial inspection. Since all failing tests are full-duration IM240 tests, simply requiring all re-tests to be full-duration tests produces a large dataset of matched pre-repair and post-repair data. The combined sample used for this report consisted of over 60,000 test records.

The availability of this large dataset means that it was possible to characterize the emissions performance of the full range of vehicles that 1) passed their initial test, 2) failed in various modes, or 3) passed a re-inspection after failing. The matrix containing all of these stratifications appears in the full report. Overall, analysis of the mass emission data indicates that vehicles that fail inspection have emissions much higher than vehicles that passed on their first attempt, usually by a factor of two or more. Vehicles re-inspected after failing tended to have emission levels that were, on average, close to those of initially passing vehicles. Directly comparing the failing emission levels to re-inspection emission levels for 1992-and-newer vehicles showed reductions in the order of 60%-70% for most vehicle types. Looking strictly at tailpipe concentrations for 1991-and-older vehicles, failing vs. re-inspection data showed similarly large reductions in most cases.

The combination of an effective inspection process and a trained repair industry results in a program that is achieving close to theoretical maximum benefits (i.e. identifying and repairing 100% of the excess emitters). Two areas for improvement are the submission of repair data and the number of Conditional Passes being issued. In the two-year reporting period, there were 43,630 Repair Data Forms submitted by the certified repair industry compared to 97,304 vehicles that simply returned for re-inspection and passed with no repair data. Although it is assumed that almost all of these vehicles did receive some form of repair, without the data it is impossible to be certain. Despite the fact that it would be useful to get more repair data, 43,630 confirmed repairs is a substantial number. With regard to the Conditional Pass issue, the approximately 11,000 vehicles that received a Conditional Pass in the reporting period did not contribute much to the benefits of the program, but there is little evidence that the system is being abused in that it is rare for a vehicle to get more than one in its lifetime. The fact that the number of Conditional Passes issued is declining each year suggests that the situation may be improving on its own.

Introduction

Emissions Inspection and Maintenance (I/M) programs such as AirCare are intended to address the universal problem of excess emissions from light-duty vehicles. All vehicles intended for sale in Canada since 1971 have been required to comply with standards for tailpipe emissions at the time of manufacture. Vehicles with mechanically sound engines, tuned to factory specifications and with all their emission control devices present and working properly, will produce emissions that fall within a range that can be considered normal for their age and type. These are referred to as “normal emitters”. However, a minority of vehicles tends to have much higher emissions than normal and these vehicles are called “excess emitters”. The reasons for excess emissions can vary from lack of preventative maintenance to undetected component failure or possibly even deliberate disabling of emission control devices. Identifying the cause of the high emissions and making the necessary corrections will restore an excess emitter to normal performance levels. I/M programs are intended to identify the vehicles with the highest emissions and require that they be repaired.

A successful I/M program requires three main elements:

1. An inspection process that accurately identifies the excess emitters within the fleet. This is referred to as the “Excess Emitter Identification Rate”.
2. Once identified, the excess-emitting vehicles must be repaired as fully and effectively as possible to return their emissions output to the normal range. This is referred to as the “Repair Effectiveness”.
3. The program must be designed to minimize program avoidance and cheating that would allow excess emitting vehicles to evade testing and/or repair. This is referred to as the “Compliance Rate”.

A program that optimizes these three factors will generate significant emission reductions. The AirCare program has been designed to achieve optimum performance in these three critical areas. By electronically linking the need for AirCare testing to the vehicle licensing and insurance computer system, a high rate of program compliance has been achieved. The program also makes use of the best available testing procedures and equipment to ensure that excess-emitting vehicles are flagged in the inspection. Finally, by establishing a network of AirCare Certified Repair Centres, requiring repair technicians to meet certification requirements, establishing a Repair Effectiveness Index (REI) and providing ongoing technical support to the industry, the program has taken significant steps to ensure a high level of repair effectiveness.

AirCare Benefits

Direct Benefits From Vehicle Repairs

According to program statistics, there were 73,126 vehicles in 2003 and 67,808 vehicles in 2004 that were re-inspected and passed after failing their initial inspection. A further 6,338 and 4,603, respectively, received a Conditional Pass.

To quantify the emission benefits associated with these repairs, a rigorous calculation was performed, considering the initial failing test emission rate and the post-repair emission rate for each vehicle that was apparently repaired. This procedure relies on the availability of a large dataset of mass emission results derived from full-duration IM240 tests for the full range of vehicle ages, types and emission control technologies present in the in-use fleet. This database, known internally as Mass Emission Sample 5 (MES 5), comprises more than 60,000 records and provides IM240 emission rates in grams per kilometre (g/km) for various vehicle type and test status combinations. Vehicles in the database were divided into groups based on similar age and emission control technology. Passenger cars, light-duty trucks and heavy-duty trucks (greater than 3856 kg. GVWR and less than 5001 kg. GVWR) were treated separately. Within these groups, it was possible to calculate average emission rates for vehicles that initially passed, initially failed, passed after repair or received a conditional pass on re-inspection.

Total emissions attributable to the AirCare-tested fleet were then calculated by using the appropriate emission rate and the assumed annual kilometres travelled data for each individual vehicle. Two totals were calculated; one in which all of the vehicles that failed were assigned the emission rate for a failing vehicle and another in which the failed vehicles that passed or conditionally passed were assigned the emission rate corresponding to their final test result. The difference between the two calculations represents the net emission reduction attributable to repairs, assuming that each repaired vehicle operates for a full year at the emission rate implied by the re-inspection test result. However, the durability of repairs performed in response to an I/M failure is difficult to predict. Looking at the test history of vehicles that have failed in previous years suggests that some repairs last for two years or more while others may last less. Thus, it is common to discount repair benefits to some degree when reporting I/M benefits. For the purposes of this report, it is assumed that the full indicated benefits of repair lasts for six months on average. Although this may seem to be a simplistic assumption, it does at least recognize that repairs do deteriorate over time and likely produces a conservative estimate of benefits. The table below shows the overall effect on each emission: Hydrocarbon (HC), Carbon Monoxide (CO), and Oxides of Nitrogen (NO_x), from the repairs performed in 2003 and 2004.

Emission Benefits from Repair Performed in 2003 and 2004

	2003	2004
HC	13% (2035 tonnes)	13% (1820 tonnes)
CO	12% (22,414 tonnes)	12% (21,249 tonnes)
NO_x	6% (854 tonnes)	6% (826 tonnes)

The corresponding tonnages shown alongside the percentage values were calculated using the percent reductions applied to a Canadian adaptation of the U.S. EPA emission inventory model of the light-duty vehicle emission inventory referred as the MOBILE 6.2C computer model.

Vehicles Removed From Use

Some of the vehicles that fail an AirCare inspection are not repaired or re-tested. Although there are many possible reasons for this, frequently, the decision to not repair a vehicle is economic – either the owner does not have the financial resources to repair the vehicle or the value of the vehicle does not warrant the level of expense needed to repair it. For the purpose of this analysis, vehicles that failed and were not licensed after no less than 4 months and no more than 12 months from the date of a failing test result (i.e. fail in January – August, not re-licensed as of December 31st) are considered to be removed from use in that calendar year. There were 13,963 such vehicles attributed to the 2003 calendar year and 13,407 for the 2004 calendar year. If it were assumed that these vehicles would have continued to operate in the absence of an AirCare program, an emissions benefit can be claimed from taking them off the road. As in the case of the benefits due to repairs, a percentage difference was calculated based on the total grams of IM240-based emissions for the initially tested fleet and a similar calculation excluding the vehicles that appeared to be "Removed from Use". The next table shows the calculated Removed from Use benefits for both 2003 and 2004 based on the above numbers of vehicles and the last-recorded emission test result. The tonnage values were calculated by applying the percentage reductions to the MOBILE 6.2C estimated inventory.

Emission Benefits from Removed-from-Use Vehicles in 2003 and 2004

	2003	2004
HC	6.1% (992 tonnes)	6.4% (909 tonnes)
CO	5.1% (9806 tonnes)	5.4% (9482 tonnes)
NO_x	3.0% (452 tonnes)	3.1% (428 tonnes)

Although some portion of this group would have been retired anyway, it is impossible to determine from the data why a vehicle did not return for re-inspection. Regardless, the calculation has been performed to determine the total emissions attributable to these vehicles, even though only a portion of those benefits could be credited to the AirCare program. Due to the fact that these benefits are only partially attributable to the AirCare program, they have not been included in the estimate of program benefits.

Pre-AirCare Repairs

Some motorists may have repairs performed to their vehicles prior to its initial test in order to avoid the inconvenience of failing and having to have their vehicle re-inspected. In some cases, the vehicle may have received a Conditional Pass in its previous inspection and the motorist is aware that additional repairs are needed. In other cases, the decision to have work performed prior to the test may be strictly precautionary and it is possible that the vehicle would have passed without this work. In order to collect information on these pre-inspection repairs, PVTT introduced a system known as BIRD – Before-Inspection Repair Data. With BIRD, repair technicians could enter information about pre-inspection repairs and receive partial credit towards their Repair Effectiveness Index score. However, with only a few hundred BIRD repair forms submitted annually, insufficient data exists to calculate any benefits associated with pre-inspection repairs.

"With AirCare" Scenario Compared to "Without AirCare"

While it is possible to calculate the aggregate benefits of identifying and repairing thousands of excess-emitting vehicles each year, the true measure of the benefit of an inspection and maintenance program is most correctly defined as the difference between the amount of vehicle-generated pollutants that would have occurred in the Lower Fraser

Valley of British Columbia had the program not been implemented in 1992 compared to the amount produced with the program in operation.

This method of evaluation is analogous to the test group vs. control group in a typical scientific experiment. Unfortunately, however, there is no control group available for an analysis of the AirCare program benefits. Therefore, it is necessary to use the MOBILE 6.2C computer model to predict what the emissions inventory would have been had the AirCare program not been implemented. The computer model takes into account the growth in the vehicle population, the introduction of stricter emission limits for newer vehicles and the retirement of older vehicles from the fleet. In the absence of an I/M program, it is assumed that emissions from new vehicles will degrade as they age and accumulate mileage. Using the age distribution of the fleet, the annual mileage accumulation rate for each model year and the vehicle population, total emissions can be calculated.

The "With AirCare" scenario can be modeled to some degree using the emission factors available from MES 5. Calculations of IM240-based tested fleet grams calculated as of the start of consecutive calendar years (using initial test results) vs. the end of those years (using final-state test results) generate a sawtooth-shaped trend line that reflects the gains associated with I/M repairs offset by emission increases resulting from vehicles developing problems that will become apparent in the next inspection cycle. Joining the mid-point of each sawtooth defines a trend line that can be used to compare with the "No AirCare" scenario.

It is estimated by MOBILE 6.2C that the inventory of vehicle-generated HC, CO and NO_x in 2004 would have been 42% lower than it was in 1992, even in the absence of an AirCare program. However, the assessment of the current situation, based on the trend line described above, suggests that the actual light-duty vehicle emissions inventory in 2004 was actually 71% lower than in 1992. This implies that an additional 29% reduction has been achieved by repairing the excess emitters identified by AirCare inspections. As neither the "No AirCare" nor "With AirCare" calculations are precise, caution must be used in referencing these percentages, but they do provide an indication of the progress that has taken place since 1992.

Inspection Statistics

In 2003, there were 820,951 inspections performed. In 2004, the total declined to 778,908 inspections. This was largely due to a decision to increase the period of exemption for "new" vehicles to three years from two. Thus, in 2004, the 2002 model year vehicles did not require testing. It is estimated that exempting the 2002 model year accounted for a loss of approximately 70,000 inspections.

Due to the fact that vehicles may be tested more than once, the number of vehicles tested in any given calendar year is always less than the number of inspections. In 2003, there were 686,527 individual vehicles that received an initial AirCare inspection. In 2004, the number dropped to 648,304. The table on the following page summarizes the tailpipe emission and diesel opacity inspection data from 2003 and 2004.

In addition to the tailpipe tests summarized in the table, vehicles inspected at AirCare are subject to additional test requirements. For all vehicles, a fuel cap presence check is performed. For 1972-1995 model year vehicles, an additional functional test of the gas cap is performed to detect the potential for gasoline vapour leaks. For all gasoline-powered vehicles of model year 1975 or newer, a catalytic converter presence check is performed, but only vehicles from 1988 or newer will fail if the catalytic converter is missing. For vehicles of model year 1998 or newer, an interrogation of the on-board diagnostic system is performed, but the results do not influence the outcome of the inspection. The results of the various non-tailpipe tests are described in the bottom table.

Summary of Inspection Data in 2003 and 2004

	2003	2004
Inspections Performed	820,951	778,908
Vehicles Inspected	686,527	648,304
Failed Test for all Reasons Combined (Vehicles)	128,406 (98,277)	121,630 (90,975)
Failed Test for Emissions Only (Vehicles)	115,874 (86,961)	112,080 (82,124)
Tested According to ASM/Idle Test (Vehicles)	426,595 (348,290)	367,744 (300,389)
Failed ASM/Idle Test (Vehicles)	97,777 (75,397)	80,470 (61,599)
Tested According to IM240 Test (Vehicles)	343,739 (319,762)	365,230 (331,553)
Failed IM240 Test (Vehicles)	28,769 (21,455)	39,640 (28,205)
Failed Idle Test (Vehicles)	1,154 (826)	930 (667)
Diesel Vehicles Inspected (Vehicles)	14,057 (13,277)	12,430 (11,833)
Failed Diesel Opacity Inspection (Vehicles)	705 (598)	590 (504)
Failed Unloaded Diesel Opacity Inspection (Vehicles)	1 (1)	0 (0)

Observations of Non-Tailpipe Tests

	2003	2004
Gas Cap Pressure Tests Conducted	478,354	405,893
Failed Gas Cap Pressure Test	27,683	21,471
Failed Gas Cap Presence Test (% Fail)	1,178 (0.18%)	566 (0.09%)
1998 and Newer Vehicles Interrogated for OBD-II	137,518	141,286
Failed OBD- II Inspection* (% Fail)	6,102 (4.44%)	5,971 (4.23%)
Failed Catalytic Converter Presence Test (% Fail)	251 (0.05%)	259 (0.05%)
Catalytic Converter Advisories (1987 and Older Only)	6,867	4,294

* OBD-II inspections performed on an Advisory basis only.

Response to Failed Inspection

Vehicles that fail the AirCare inspection must subsequently achieve a Pass or obtain a Conditional Pass before they can be licensed and insured. For motorists needing time to complete repairs, a one-time, 3-month licensing policy is available.

As mentioned earlier, not all of the vehicles that fail return for re-inspection. However, most do return and pass. The table below summarizes the observed responses to a failed inspection in both 2003 and 2004.

Observations on Actions Taken after Failing Inspections

	2003	2004
Vehicles Not Returning for Re-inspection	13,963	13,407
Vehicles Repaired to Pass With Repair Information	24,173	19,457
Vehicles Re-Inspected to Pass Without Repair Information	48,953	48,351
Diesel Vehicles Passing Re-Inspection	556	475
Gas Cap Replacements	12,569	9,506
Vehicles issued Conditional Pass	6,338	4,603

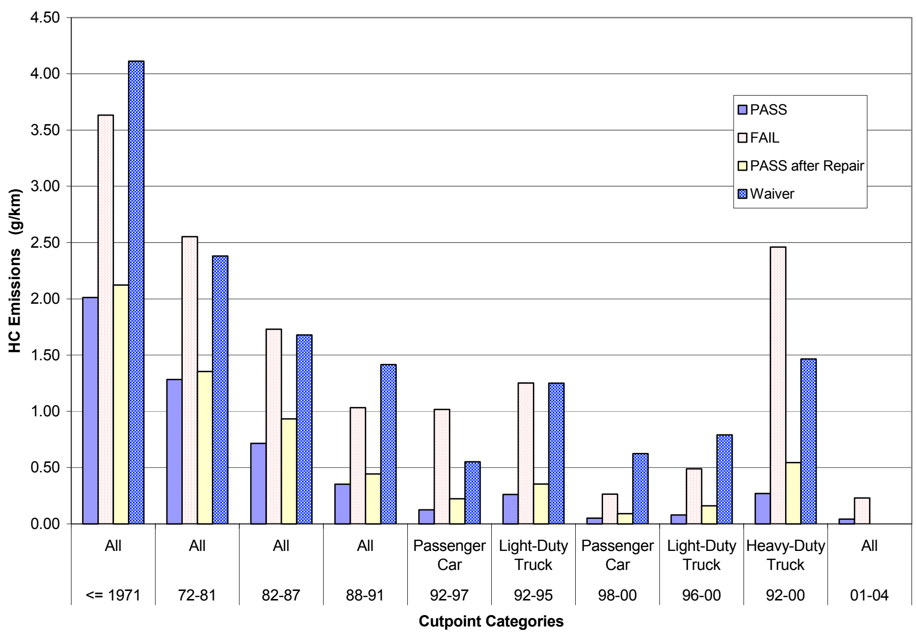
The table shows that the vast majority of vehicles that failed in either year did return and pass a re-inspection. There were 24,173 vehicles repaired to pass at AirCare Certified Repair Centres in 2003 and 19,457 in 2004. For these vehicles, data was submitted describing the nature of the repairs performed and the dollar amount spent. In both years, more than twice as many vehicles returned and passed a re-inspection with no associated repair data. These vehicles may have been repaired by non-certified repair facilities, by vehicle owners, by certified shops that did not submit repair data, and some may have passed without any repairs having been performed. As there was no information available to indicate what transpired between the initial fail and the subsequent pass, it is impossible to categorize these non-certified repairs. For the purpose of this analysis, however, it was assumed that any vehicle that was re-inspected and passed received some sort of repair that generated a reduction in emissions. Although this assumption may magnify the calculated program benefits, this effect is offset by not including any of the "Removed from Use" and BIRD benefits in the reported effectiveness numbers.

The values for the "Vehicles Not Returning for Re-inspection" in 2003 and 2004 are significantly lower than the numbers published in 2003 for calendar years 2001 and 2002. This discrepancy is due to the fact that the 2001 and 2002 numbers included thousands of vehicles that failed only for the reason of a missing or leaking gas cap. Gas cap re-tests are performed by the AirCare inspection centre manager to either visually confirm the presence of a gas cap or to test a replacement gas cap using a hand-held testing device. Rather than create a new test record for such re-inspections, an administrative process is used to enable the re-licensing of the vehicle. As such, a re-inspection does not appear in the database in such cases. The revised numbers for the vehicles that did not return for re-inspection in 2001 and 2002 are 16,228 and 17,008, respectively, not 22,604 and 24,335 as previously published.

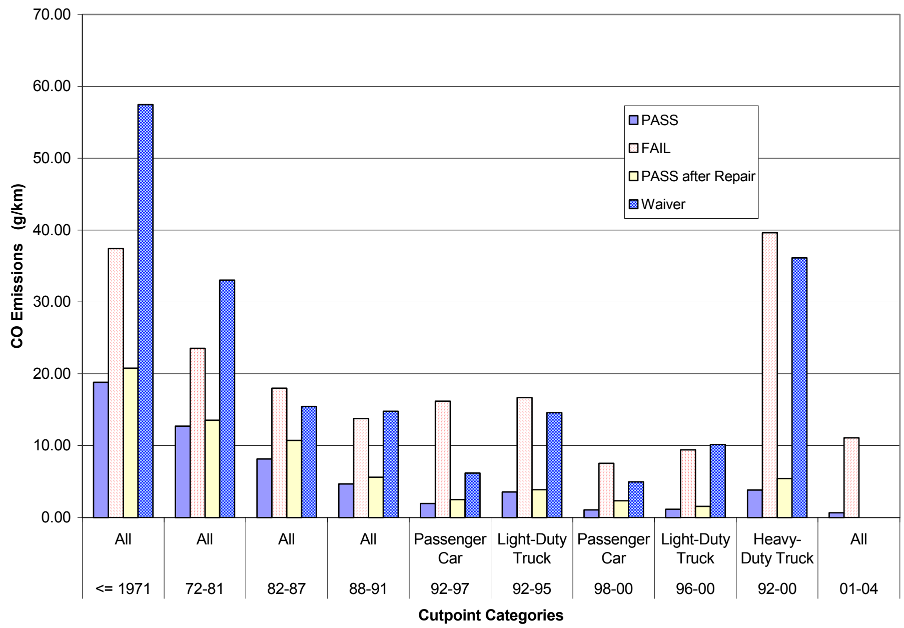
Effectiveness of Repairs

In previous reports on the effectiveness of AirCare, it was observed that the average emission levels of failing vehicles greatly exceed those of vehicles that passed the first time. Repaired vehicles that passed a re-inspection tended to have emission levels considerably lower than their initial test result but still slightly higher than those vehicles that initially passed. This effect has been observed in other I/M programs as well. The reasons for this are not fully understood but it may be related to incomplete repairs or irreversible effects on the engine and emission controls as a result of operating with an emissions-related fault. Since the goal of an I/M program is to reduce “excess” emissions, which is the difference in emissions between a failing vehicle and a normal vehicle of the same type, a failing vehicle that returns for re-inspection and achieves a result equal to or better than that of an initial-passing vehicle can be considered to have been repaired to 100% effectiveness.

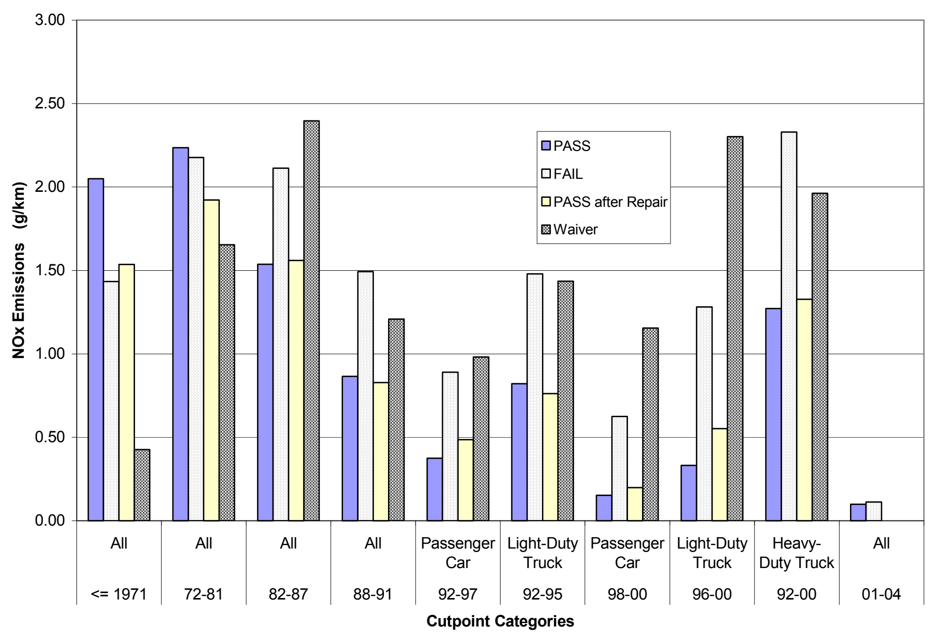
The following figures illustrate the relative relationships between first-time-pass, first-time-fail, repaired-to-pass, and repaired-to-conditional pass emission rates. The data used to create these charts is from a database of sample test results generated in the 2003-2004 period. Sample tests are full-duration IM240 tests performed on a stratified sample of the fleet in order to gather information about the relative emission levels of passing, failing and repaired vehicles. The tests are performed immediately following the mandatory test and have no effect on whether a vehicle passes or fails. For vehicles of the 1991 model year or earlier, the IM240 test provides mass emission data that would otherwise not be available from the ASM 2525/Idle test that constitutes the requirement for compliance.



HC Emission Factors by Model Year Group



CO Emission Factors by Model Year Group



NO_x Emission Factors by Model Year Group

In addition to the average initial pass and average initial fail readings, the preceding figures show two types of post-repair test results; “Repair to Pass” and “Repair to Waiver”. The latter type refers to vehicles that failed the re-inspection but had partial repairs performed at an AirCare Certified Repair Centre. For HC and CO, the average emissions output of a “Repair to Waiver” vehicle generally exceeds that of the “Fail” group. This is due to the fact that the “Repair to Waiver” group is a small subset of the “Fail” group that likely includes the highest emitters within that group.

Looking at the figures, it can be seen that the "Repaired to Pass" emission rate (3rd bar from the left in each grouping) is typically slightly higher than the "Initial Pass" vehicles (first bar in each grouping), although not in all cases. Another obvious trend is that the emission output of vehicles has been significantly reduced over time as a result of new emission control technology. In fact, the emission levels of failing vehicles in the newer segment of the fleet are often better than the passing vehicle levels of the older technology vehicles. Nevertheless, failing vehicles in any grouping have significant excess emissions that can be effectively reduced by proper repairs.

Another way of assessing the effect of repairs is to take the initial test results for each vehicle that failed and compare it to the final post-repair result. The next table shows the emission reductions indicated by this method for the portion of the fleet subject to IM240 testing.

Looking at the table, it is apparent that post-repair IM240 emission test results are typically 60% to 70% lower than the initial fail levels. It must be cautioned that while this method of depicting repair effectiveness is valid, it suffers from the fact that while all failing IM240 tests are full-duration IM240's, the post-repair results are frequently fast-pass IM240's. Although PVTT has developed and applied factors to generate reasonable approximations of full-duration test results from fast-pass data, there is not a direct correlation in this conversion. About mid-way through 2004, a change was implemented that resulted in all re-inspections being full duration tests. In future, it will be possible to rely more on this method of checking repair effectiveness, as both the pre-repair and post-repair test results will be derived from full-duration IM240 tests.

Average Emission Reductions for 1992-and-Newer Vehicles

Vehicle Type	Age Group	HC	CO	NOx
LDV	≥ 1998	71%	69%	96%
LDV	92-97	68%	67%	52%
LDT1	≥ 1996	68%	68%	64%
LDT2	≥ 1996	68%	65%	61%
LDT	92-95	61%	63%	56%
LDT3	≥ 1996	72%	72%	71%
LDT4	≥ 1996	72%	73%	65%
LDTH	92-95	67%	59%	44%
HDV	≥ 1992	68%	72%	26%
All	≥ 2001	84%	82%	70%

For vehicles of the 1991 model year or older, mass emission test data are available only from the sample test data set. The ASM/Idle test procedure used for these vehicles is a simpler test that relies on volumetric measurements of emission concentrations. Comparisons of failed and post-repair emission levels expressed on a percentage basis do not accurately reflect the degree to which emissions have been reduced in normal driving. Nevertheless, because some programs do publish results expressed in this manner, the next table is included.

Average ASM/Idle Emission Reductions By Pollutant and Test Mode

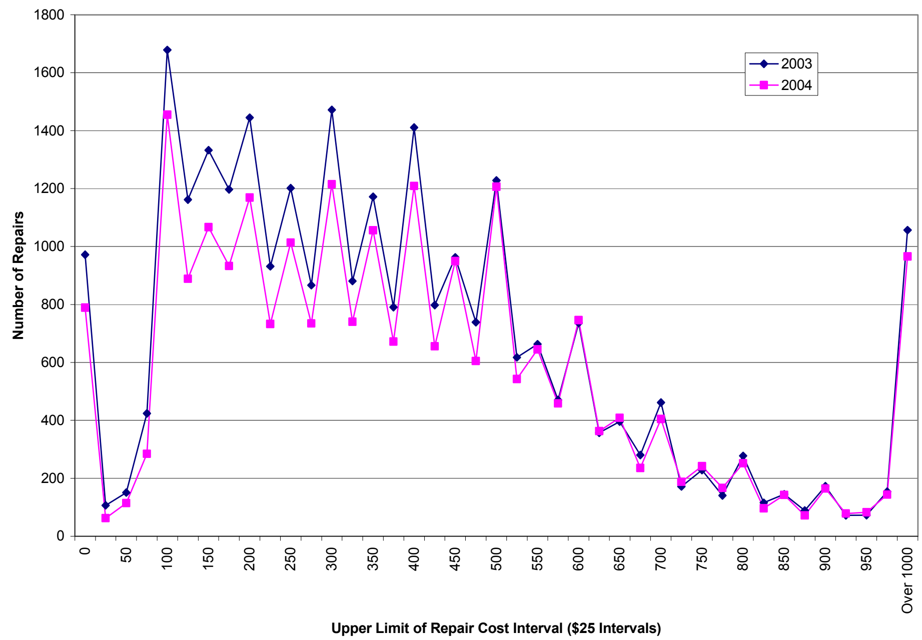
Vehicle Type	Age Group	ASM HC	ASM CO	ASM NOx	Idle HC	Idle CO
All	≤ 1971	55%	53%	-12%	66%	57%
P	1972-81	62%	69%	26%	74%	62%
T	1972-81	66%	63%	11%	78%	54%
P	1982-87	55%	72%	33%	73%	71%
T	1982-87	60%	71%	29%	77%	68%
P	1988-91	68%	86%	54%	83%	94%
T	1988-91	68%	87%	54%	82%	92%

The table shows that the post-repair emission levels are always lower than the initial fail levels in all but the case of NO_x for the 1971-and-older vehicles. This effect is expected as the typical failure mode in this age group is for excessive CO emissions. High CO emissions suppress NO_x formation, so correcting the excess CO results in a natural increase in NO_x emissions. Another conclusion from looking at this table is that repairs to 1987 and older vehicles tend to produce much smaller improvements in NO_x. This is attributable to the fact that new vehicle standards for 1987 and older vehicles represented only about a 30% reduction from pre-control emission levels. Therefore, the potential for lowering the NO_x emissions of these vehicles is limited.

Overall, regardless of which method is used to assess repair effectiveness, it is apparent that vehicles returning for re-inspection have much lower emissions than they did at the time of failure. This implies that the repair industry is doing a good job of identifying and correcting the faults that are causing the failures. Given that the test regimes used at AirCare are known to have a high excess emitter identification rate, this factor, combined with effective repairs indicates that the AirCare program is delivering close-to-optimum emission benefits.

Cost of Repairs

Repair cost data is submitted to AirCare by the certified repair industry whenever they complete a Repair Data Form. The Repair Data Form allows the collection of repair cost data, including taxes, as well as the estimated cost of a complete repair. The figure below shows the distribution of reported repair costs in 2003 and 2004. It can be seen that, according to the data submitted, a number of vehicles received thousands of dollars of repairs. The highest repair cost limit is $600. In 2004, there were 4,011 vehicles, out of a total of 23,962, for which the reported cost of repair was higher than $600. However, the 80^{th} percentile value was $576, suggesting that most of the repairs can be completed within the current repair cost limits.

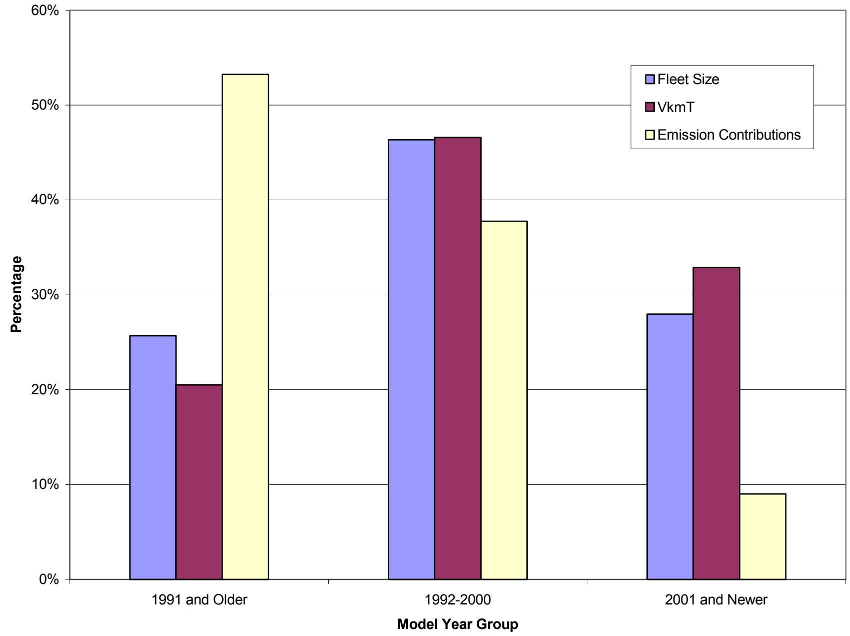


Distribution of Reported Repair Cost in 2003 and 2004

The average cost of an AirCare repair was $326 in 2003 and $350 in 2004. With 30,513 repairs performed at AirCare Certified Repair Facilities in 2003, the total amount spent on repairs is estimated to have been $11.05 million dollars in 2003. For 2004, there were 24,060 repairs for a total cost of $9.26 million. Nothing is known about the repair costs for the 48,953 vehicles that returned and passed with no data in 2003 or the 48,351 similar cases that occurred in 2004. If it were assumed that each of these vehicles incurred the same average repair cost as reported by AirCare Certified Repair Facilities, an additional expenditure of $17.72 million could be attributed to 2003 along with a further $18.71 million in 2004. Overall, the amount of money spent on repairs by motorists whose vehicles failed the inspection is comparable to the total amount spent on inspections. This has been a consistent trend since the program began.

Overall Emissions by Age Group

The amount of emissions produced by a vehicle fleet is a combination of the number of vehicles, the emission rate, and the annual distance driven or Vehicle Kilometres Travelled (VkmT). The oldest vehicles in the fleet (1991 and older) have the highest emissions output per vehicle but this is somewhat offset by lower population and distance-traveled factors. The newest vehicles (2001 and newer) have very low per-vehicle emissions output but there are large numbers of these vehicles and they tend to be driven greater distances each year than middle-aged or older vehicles. In the middle-aged portion of the fleet (1992-2000), the combination of significant population, relatively high emission rate (due to normal deterioration and a higher proportion of excess emitters in the group), and significant average kilometres driven per year provide the potential for substantial cumulative emission production. The following figure shows the relative levels of population, annual vehicle-kilometres travelled and percentage contribution to the overall fleet emission output for these three age groups:



VkmT Vs. Emissions Contribution by Model Year Group

The above graph shows that the 2001-and-newer vehicles comprise 28% of the vehicles in the fleet and 32% of the VkmT but contribute less than 10% of the overall emissions. The middle-aged group (1992-2000) represents 47% of the population and VkmT, accounting for about 38% of the total emissions. The 1991-and-older vehicles make up only 25% of the fleet and only 20% of the VkmT, but they produce about 53% of the overall emissions. As new vehicles continue to become cleaner and to stay clean for most of their useful lives, the impact of the oldest vehicles in the fleet on the total vehicle-generated emission inventory will continue to grow. For example, the relative emissions output of hydrocarbons from a 1967 model year vehicle (5.0 g/km) vs. a 2005 model that complies with U.S EPA Bin 5 standards (0.056 g/km) is 90:1. Therefore, even a small number of these older vehicles will produce equivalent emissions to a large number of newer vehicles.

Conclusions

- The AirCare program continues to identify more than 80,000 excess-emitting vehicles every year.
- Failing vehicles have significantly higher emissions output than passing vehicles of the same type.
- Repairs to failing vehicles appear to be effective as over 80% of the vehicles that failed subsequently passed a re-inspection. On average, the emissions output of repaired-to-pass vehicles is comparable to vehicles that initially pass, indicating that repairs are effectively addressing the excess emissions.
- The emission reduction attributable to repairs to failing vehicles each year represents about 12% of the total vehicle-generated inventory of HC and CO emissions and about 6% of total NO_x emissions.

- The number of Conditional Passes issued is declining each year, suggesting that a higher proportion of the failing vehicles are being repaired to pass.
- Most repairs can be performed within the current repair cost limits.
- There is reduced potential for I/M benefits for the newest vehicles in the fleet as there is less difference between passing and failing emission levels in this group. In addition, the emissions of failing newer vehicles are often less than the emissions of passing, older vehicles.
- Vehicles from the 1991 model year and older contribute more than 50% of all vehicle-generated emissions. As these vehicles are technologically limited to a higher emissions output than newer vehicles, eventual replacement of these vehicles will be the main source of emission reductions in the future.
- The repair industry continues to play a valuable role in the success of the program by performing effective repairs. However, the number of Repair Data Forms being submitted by the AirCare Certified Repair Facilities continues to drop each year. Although a large volume of repair data is supplied, only about 30% of repaired-to-pass vehicles have associated repair information entered into the data system.