AirCare - Results and Observations in 2005 and 2006

(Abridged Version)

PACIFIC
VEHICLE TESTING
TECHNOLOGIES

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EXECUTIVE SUMMARY

The AirCare program identifies vehicles that have excess exhaust emissions, and requires them to be repaired before they can be re-licensed. During 2005 and 2006, the program continued to make a major contribution to reducing vehicle-generated emissions in the Lower Fraser Valley of British Columbia. Although motor vehicle emissions have decreased significantly since AirCare began in 1992, motor vehicles continue to be one of the major sources of carbon monoxide (CO), nitrogen oxides (NOx) and volatile organic compounds (VOCs) in the region.

New vehicles now meet emissions standards that are significantly more stringent than those of 1992. AirCare has evolved to match the continuing developments in vehicle technology. In 1992, the new vehicle standard was known as Tier 0. Since then, the major developments have been Tier 1 in 1996; mandatory On-Board Diagnostics version II (OBD II) in 1998; and Tier 2 in 2003. This improved vehicle technology and durability, together with the effects of the AirCare program, is responsible for the decreasing contribution of motor vehicles to the region's emissions inventory. However, it is important to note that even the newest emission control technology is likely to fail eventually, and a periodic emissions inspection has proven to be effective in identifying the vehicles that have problems and need repair.

In 1992, the inspection procedure used by the program was known as the ASM2525/Idle test. In 2001, the AirCare program implemented the IM240 inspection for 1992-and-newer model year vehicles. The IM240 drive cycle simulates real world driving conditions with periods of acceleration, deceleration and idling. The test is similar to the federal government's certification test, and is more effective at finding problems with these vehicles.

AirCare originally required all vehicles to be inspected on an annual basis, and only the newest model year vehicles were exempt. However, when IM240 tests were introduced for 1992-and-newer vehicles, the test frequency was extended to a biennial schedule instead of an annual one. By 2006, the new vehicle exemption had increased to four model years, significantly reducing the number of inspections performed each year.

The emission reductions attributable to an Inspection and Maintenance program result from repairs made to vehicles that fail inspection. In order to enhance repair effectiveness, the AirCare program certifies both Repair Facilities and Repair Technicians. Certification provides the motoring public with access to repair shops capable of performing effective emission repairs. However, because the program has existed for almost 15 years, most repair technicians in the region have taken AirCare training as part of their apprenticeship courses, and the ability to do good emission repairs is now thoroughly established within the vehicle repair industry in general – not just the AirCare Certified facilities. As a consequence, the fraction of repairs performed at AirCare Certified Repair Centres has shown a steady decline.

One function that remains restricted to AirCare Certified Repair Centres and Technicians is the ability to qualify a vehicle for a Conditional Pass, which allows a vehicle to be re-licensed despite not passing a re-inspection. However, as the number of repairs performed at AirCare Certified Repair Centres has decreased, so has the number of Conditional Passes issued, resulting in an overall increase in the percentage of vehicles that achieve a full pass upon re-inspection.

AirCare Program data collection is extensive, and allows detailed analysis and modeling of the emission reductions attributable to the program, as well as many other analyses. These emission reductions have made a very significant contribution to overall mobile-source emission inventory reductions.

AIRCARE BENEFITS

DIRECT BENEFITS FROM VEHICLE REPAIRS

There were 48,019 vehicles in 2005 and 44,922 vehicles in 2006 that were re-inspected and passed after having failed their initial inspection. A further 2,650 and 2,153, respectively, received a Conditional Pass.

To quantify the emission benefits associated with these repairs, a calculation was performed, which considered the initial failing test emission rate and the post-repair emission rate for each vehicle that appeared to have been 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 6 (MES 6), comprises more than 90,000 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 eventually 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 the rest of the year at the emission rate implied by the re-inspection test result.

The table shows the overall effect on the inventory of Hydrocarbons (HC), Carbon Monoxide (CO), and Oxides of Nitrogen (NO_x), from the repairs performed in 2005 and 2006. The percentage reductions due to repairs in 2005 were 13%, 12% and 5% for HC, CO and NOx respectively. In 2006 the percentage reductions were 13%, 11% and 5%.

Effect of Repairs on In-Use Light-Duty Vehicles Mass Emissions Inventory (tonne/year)

	2005			2006		
	HC	CO	NO_x	HC	CO	NO_x
Base Inventory for Year	11,623	156,416	12,253	10,429	144,180	11,347
Reduction from Repairs	1,515	18,290	644	1,307	16,107	600
Inventory after Repairs	10,108	138,122	11,609	9,122	128,073	10,747
% Reduction from Base	13%	12%	5%	13%	11%	5%

VEHICLES REMOVED FROM USE AFTER FAILURE

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 even after 4 or more 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 8,282 such vehicles attributed to the 2005 calendar year and 7,858 for the 2006 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.

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.

Emission Benefits from Removed-from-Use Vehicles in 2005 and 2006

tonne/year	2005	2006
HC	761	685
CO	8,446	7,832
NO_x	365	337

PRE-AIRCARE REPAIRS

As described in the previous report, a system was established whereby repair technicians could report repairs performed prior to an AirCare inspection. The intention was to collect data on what types of repairs were being done in this situation, and possibly to derive a picture of how the program has influenced normal maintenance behaviour. This was because it is reasonable to assume that one of the long-term effects of the program is to change maintenance habits, and that repairs to some vehicles would be influenced by the existence of the program, but not actually related to a failing inspection. Moreover, anecdotal reports from the repair industry indicated that they did far more emission repairs than were ever reported through our existing data collection system. The industry asked that these pre-AirCare repairs be recognized in some manner. Consequently, a system was created that allowed such repairs to be reported, and gave credit towards technician recertification. However, the amount of data submitted has been pitiful, and no meaningful conclusions could be drawn. Therefore, the "Before Inspection Repair Data" (BIRD) system was discontinued at the end of 2006.

"WITH AIRCARE" SCENARIO COMPARED TO "WITHOUT AIRCARE"

Since the program began in 1992, the light-duty vehicle fleet in the Vancouver area has almost completely turned over. Very few of the vehicles that were in use in 1992 remain on the road, and the vehicles that replaced them are both cleaner and more durable in terms of staying clean without the need for periodic parts replacements or adjustments. This has meant that even in places that do not have inspection programs, the emissions inventory from light-duty vehicles is much lower now than it was in 1992, despite continuing fleet growth. The various charts later in this report show how just how little inventory contribution comes from newer vehicles, even though they constitute the majority of fleet. In the program area, the MOBILE model has been used to estimate the light-duty inventory in the default (imaginary) scenario in which an AirCare program was not implemented in 1992, yet all other factors remained constant. This has been the only available mechanism of establishing a "control" group against which the "with-AirCare" scenario can be compared. However, the MOBILE model has gone through a number of versions since 1992, and is now at version 6.2C. As the model is refined, estimates have moved up or down quite significantly, necessitating backcasts of historical scenarios whenever the model changed. This means that calculations of AirCare program benefits based on earlier versions of MOBILE (MOBILE 4C and 5C) cannot be compared accurately or plotted chronologically. A further complication is that the most recent published inventory for the region was for calendar year 2000, meaning that percentage reduction values for years later than 2000 must be calculated on the basis of extrapolated inventory estimates. All in all, the creation of a credible longitudinal analysis is fraught with problems. Regardless, an estimate has been calculated, with the result that the default (no AirCare ever) inventory of light-duty vehicle emissions in 2006 would have been about 46% lower than it was in 1992, simply as a result of better new vehicle technology and natural fleet turnover. Looking at longitudinal analyses of AirCare data which have been reported in this and previous reports, it appears that the "with-AirCare" 2006 inventory was about 76% lower than in 1992. The additional 30% reduction has to be attributed to the AirCare program.

INSPECTION STATISTICS

In 2005, there were 772,388 inspections performed. In 2006, the total declined to 631,408 inspections. This was largely due to a decision to increase the period of exemption for "new" vehicles to four years from three.

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 2005, there were 667,807 individual vehicles that received an initial AirCare inspection. In 2006, the number dropped to 534,026. Registration data suggest that there are about 1.3 million vehicles in the AirCare-eligible area, meaning that less than half are being inspected in any given year as a result of exemptions for newer vehicles and biennial inspections for the bulk of the fleet.

In addition to the tailpipe tests summarized in the first table, vehicles inspected at AirCare are subject to additional test requirements. For all vehicles, a fuel cap presence check is performed. For 1975-1995 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 presented in the lower table.

Summary of Inspection Data in 2005 and 2006

	2005	2006
Inspections Performed	772,388	631,408
Vehicles Inspected	667,807	534,062
Failed Test for all Reasons Combined (Vehicles)	95,889 (71,175)	90,236 (65,869)
Failed Test for Emissions Only (Vehicles)	87,743 (63,611)	83,512 (59,547)
Tested According to ASM/Idle Test (Vehicles)	306,531 (253,664)	256,765 (213,141)
Failed ASM/Idle Test (Vehicles)	64,167 (48,930)	52,353 (39,560)
Tested According to IM240 Test (Vehicles)	425,249 (395,302)	340,993 (305,334)
Failed IM240 Test (Vehicles)	30,365 (21,238)	36,458 (25,264)
Failed Idle Test (Vehicles)	890 (609)	1,018 (693)
Diesel Vehicles Inspected (Vehicles)	13,353 (12,901)	10,070 (9,678)
Failed Diesel Opacity Inspection (Vehicles)	464 (395)	404 (349)
Failed Unloaded Diesel Opacity Inspection (Vehicles)	1 (1)	3 (3)

Observations of Non-Tailpipe Tests

	2005	2006
Gas Cap Pressure Tests Conducted	334,148	297,482
Failed Gas Cap Pressure Test	18,234	14,208
Failed Gas Cap Presence Test (% Fail)	1,278 (0.18%)	791 (0.15%)
1998 and Newer Vehicles Interrogated for OBD-II	137,518	141,286
Failed OBD- II Inspection* (% Fail)	7,761 (3.35%)	8,613 (5.89%)
Failed Catalytic Converter Presence Test (% Fail)	272 (0.05%)	283 (0.06%)
Catalytic Converter Advisories (1987 and Older Only)	9,263	3,131

* 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.

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 2005 and 2006.

Observations on Actions Taken after Failing Inspections

	2005	2006
Vehicles Not Returning for Re-inspection	12,554	12,210
Vehicles Repaired to Pass With Repair Information	9,029	7,685
Vehicles Re-Inspected to Pass Without Repair Information	38,990	37,237
Diesel Vehicles Passing Re-Inspection	355	316
Gas Cap Replacements	12,569	6,659
Vehicles issued Conditional Pass	2,650	2,153

The table shows that the vast majority of vehicles that failed in either year did return and pass a re-inspection. There were 9,029 vehicles repaired to pass at AirCare Certified Repair Centres in 2005 and 7,685 in 2006. For these vehicles, data was submitted describing the nature of the repairs performed and the dollar amount spent. In both years, a much greater fraction of 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.

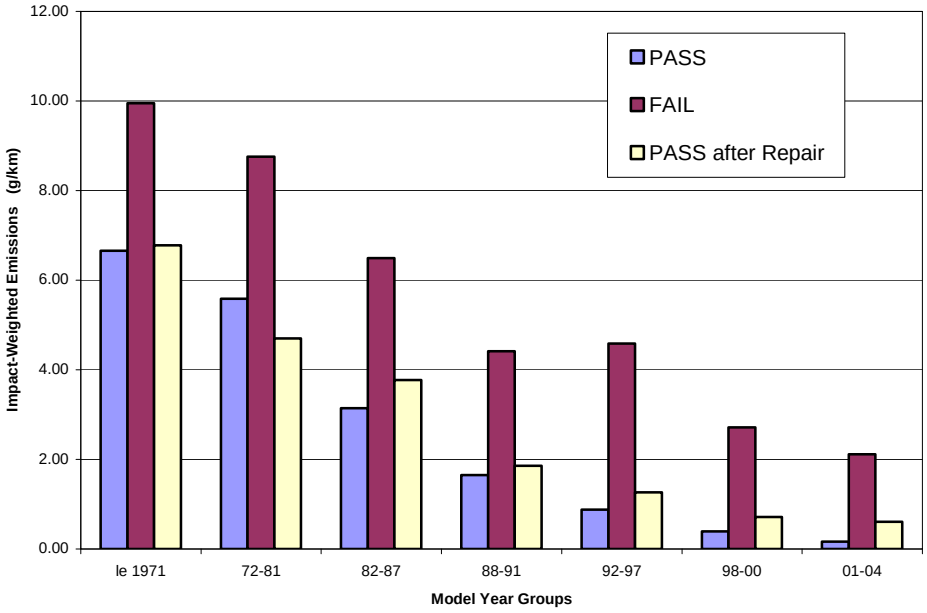
The values for the “Vehicles Repaired to Pass With Repair Information” in 2005 and 2006 are significantly lower, approximately one-third of the numbers published in 2005 for calendar years 2003 and 2004. The reasons for this are unknown but suggest a reduction in the repair industry’s perceived importance of submitting repair data.

EFFECTIVENESS OF REPAIRS

The following figure illustrates the relative emission rates for “first-time-pass”, “first-time-fail”, and “repaired-to-pass” vehicles of various age groups and types. The data used to create these charts is taken from a database of sample test results generated in the 2005-2006 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.

It can be seen that the "Repaired to Pass" emission rate 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.



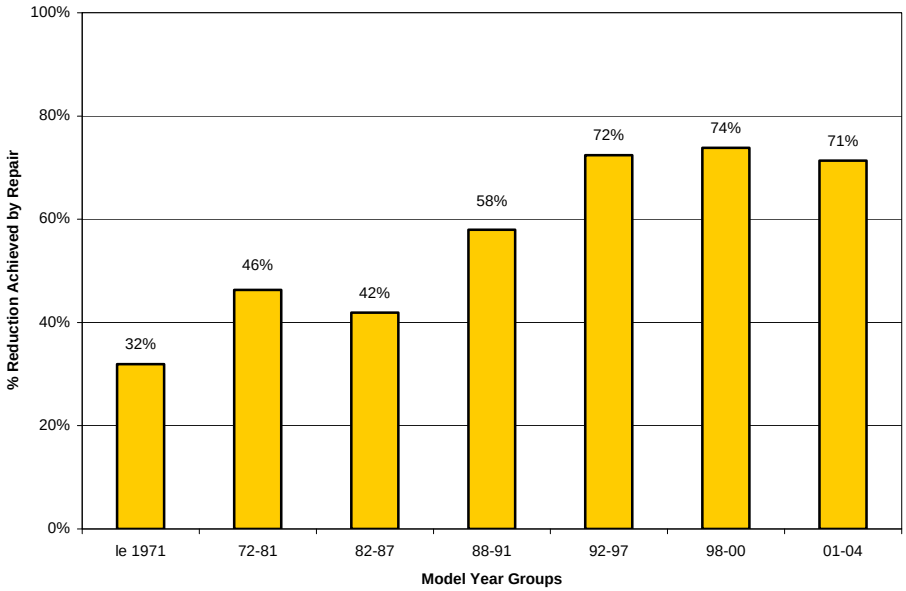
Impact-Weighted Emission Factors (= HC + CO/7 + NOx)

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 figure shows the emission reductions indicated by this method for the portion of the fleet subject to IM240 testing.

It is apparent that post-repair IM240 emission test results are typically more than 70% lower than their initial fail levels, whereas repairs to older vehicles do not deliver such a high percentage reduction. However, because the older vehicles have higher absolute emission output, a smaller percentage reduction may still correspond to a larger absolute emission reduction.

Overall, it is clear 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

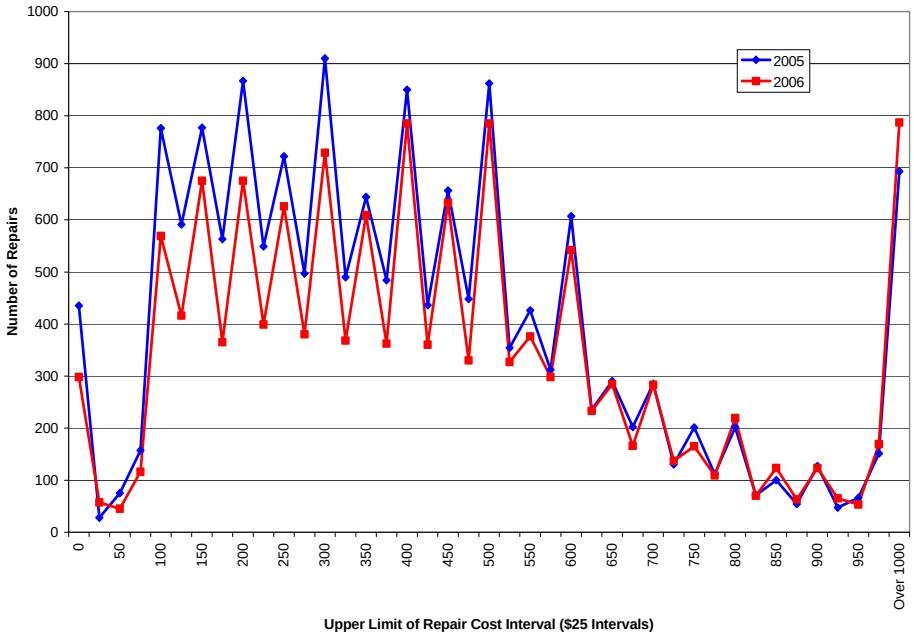
effective repairs indicates that the AirCare program is delivering close-to-optimum emission benefits.



Effect of Repairs % Reduction = (Failed - Repaired) / Failed

COST OF REPAIRS

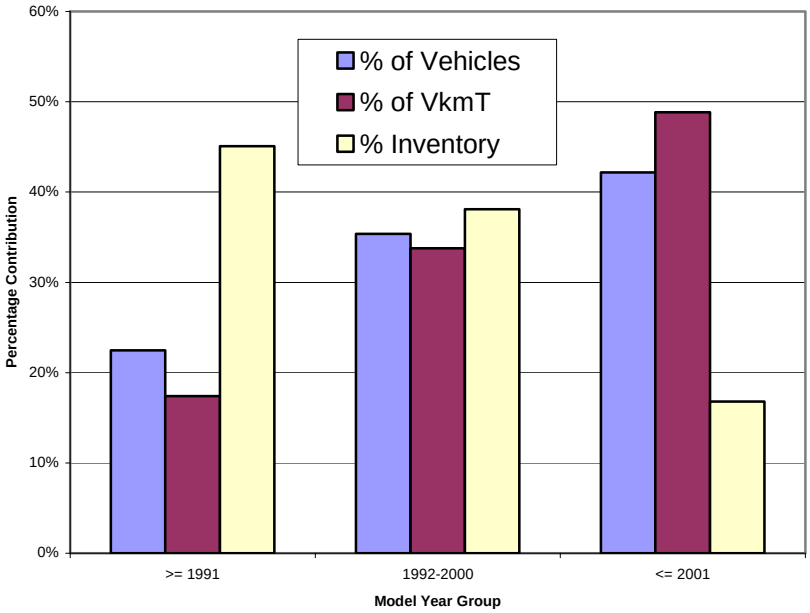
The distributions of repair costs in 2005 and 2006 had much the same profile as in previous years. However, the median cost has continued to increase each year - from $326 in 2003 and $350 in 2004, to $360 and $400 in 2005 and 2006. Medians have been used instead of means, because of the effect of extreme values, which indicate that many repairs are reported with zero cost, and many with costs somewhere over $1000. It should be borne in mind that the applicability this data is limited: the costs are those reported as part of the repair data submitted by the certified repair industry, but less than 20% of all repairs are reported in this way.



Distribution of Reported Repair Cost in 2005 and 2006

OVERALL EMISSIONS BY AGE GROUP

It may be that of all the figures and tables in this report, the following figure is most different from previous reports. It shows the relationships between the numbers of vehicles in each age group, their kilometres travelled, and their contributions to the light-duty emissions inventory. The replacement of older, higher emitting vehicles with newer, cleaner vehicles has reached a point where a very clear Pareto-type relationship is obvious. On the one hand, the numbers of vehicles and kilometres travelled increases steadily from the oldest to the newest age group. While on the other hand, the emissions inventory contributions decrease in much the same proportions. Vehicles from model years 2001 and newer constitute 42% of the fleet and contribute 49% of vehicle-kilometres-travelled, but only account for 17% of the total emissions. Vehicles from the 1991 and earlier model years comprise only 22% of the fleet and contribute 17% of the total vehicle-kilometres-travelled, but account for 45% of the total emissions.



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VkmT vs. Emissions Contribution by Model Year Group

CONCLUSIONS

- The AirCare program is delivering consistent, significant and worthwhile emission reductions each year.
- Vehicles returning for re-inspection have much lower emissions than they did when they failed inspection initially. Reductions on a percentage basis are even higher for new-technology vehicles than they are for older vehicles.
- As newer vehicles have become cleaner, particularly since the 2001 model year, the role of older vehicles in influencing regional air quality has become more important. AirCare serves as an important means of keeping emissions from these older vehicles in check while encouraging earlier retirement of vehicles with extensive mechanical problems.
- The amount of repair data submitted by Certified AirCare Repair Centres continues to decline significantly, despite a consistent rate of vehicles returning for re-inspection after failure. This implies that the vast majority of AirCare repairs are being performed by non-certified repair shops and that this is an increasing trend.
- The number of Conditional Passes issued each year continues to fall, reflecting the reduced role of the certified repair industry in the program and perhaps an increasing trend for vehicle owners to authorize full repair of their vehicle as opposed to seeking only a Conditional Pass.
- Median repair cost continues to increase each year but 50% of all reported repairs in 2006 cost less than $400.