dKC – de la Torre Klausmeier Consulting, Inc
1401 Foxtail Cove, Austin, TX 78704
Phone: 512-447-3077
Fax: 512-447-3116
E-mail: delaklaus@aol.com

Review of the British Columbia AirCare Program

Prepared by:

Rob Klausmeier
de la Torre Klausmeier Consulting, Inc.

Prepared for:

Ministry of Environment, Lands and Parks
Air Resources Branch
Victoria BC V8W9M1

September 15, 2000

1.0 Introduction and Summary

Background

In 1992, the Province of British Columbia implemented AirCare – a motor vehicle inspection/maintenance (I/M) program which requires vehicles to undergo emission tests; vehicles identified as high emitters must be repaired. When AirCare began it used the latest technology for performing emission tests on motor vehicles and it adopted the most stringent test criteria used at that time in North America. In 1994, a Steering Committee, which included British Columbia Ministry of Lands, Environment and Parks (MELP), Insurance Corporation British Columbia (ICBC), Greater Vancouver Regional District (GVRD), and Environment Canada, led an evaluation of AirCare which identified several improvements. In 1999, the Steering Committee (which now also includes the Fraser Valley Regional District and Translink) proposed a set of improvements to AirCare creating what is known as AirCare II. The goal of AirCare II is to provide the most cost effective I/M program for the next decade. The GVRD and the Translink[1] Boards approved the recommended design of AirCare II. To confirm this approach meets provincial goals, the Air Resources Branch of MELP contracted de la Torre Klausmeier Consulting (dKC) to provide an independent assessment of AirCare II, and to review previous evaluations of the original AirCare program.

Rob Klausmeier, dKC's principal investigator, performed the review for the Air Resources Branch. Rob is an international expert in motor vehicle I/M programs. Since 1977, he has performed over 100 studies of I/M programs. He has helped design enhanced I/M programs in Mexico, Thailand, Ontario, California, Oregon, Colorado, Delaware, Connecticut, Louisiana, Virginia, Illinois, Texas, Utah and the District of Columbia. He recently has evaluated I/M programs in Mexico, California, Colorado, Texas and Connecticut.

Summary of Results

Following are the key findings from dKC's review of AirCare:

Reported emission reductions for AirCare – AirCare continues to be one of the most effective I/M programs in North America. dKC believes that the methodology used by Translink to calculate emission reductions is reasonable. The methodology combines actual data from the AirCare program with independent emission test results from the CVS test cell at the AirCare Research Facility. Data from the AirCare program provides unbiased way of classifying passing and failing vehicles into different categories. The CVS test cell provides emission reduction estimates in grams per kilometer, which are a good indicator of how the AirCare program affects mass emission rates. Translink's estimated reductions of 27% for hydrocarbons (HC), 31% for carbon monoxide (CO), and 8.8% for nitrogen oxides (NOx) agree well with other evaluations of similar I/M programs.

[1] Since 1999, Translink has operated the Air Care office; Translink retained most of the original employees of the AirCare office.

Suggestions for additional analysis -- The reports prepared by Translink on the results of years 2 – 7 are among the most comprehensive reports prepared by an administering agency of an I/M program. dKC has a few suggestions for additional analysis that could be included in the next report evaluating the benefits of AirCare. The suggestions are listed below:

- **Calculate emission benefits in terms of reduction in ASM 2525 emission levels --** dKC recommends that Translink calculate the benefits for the AirCare program in ASM space, using the results of the ASM 2525 test that are performed on all vehicles tested.

- **Investigate effectiveness of certified repair facilities --** Translink should perform a detailed analysis of the effectiveness of individual certified repair facilities in repairing vehicles to determine if the Conditional waiver provision is being abused.

- **Determine the effectiveness of different types of repairs --** Translink should provide greater details on the effectiveness of different types of repairs in reducing emissions.

Assessment of the design of AirCare II – dKC agrees with most of the changes planned for AirCare II. dKC has the following comments on changes in the design of AirCare II:

- **Program Type and Operation** – dKC strongly concurs with plans to continue with a centralized contractor-operated program. It has been clearly demonstrated that centralized test-only stations provide much greater benefits than decentralized test-and-repair stations, and centralized tests are much less expensive.

- **Emission Test Procedure –** dKC agrees with the decision to adopt the IM240 test for 1992 and newer vehicles. dKC also agrees with the decision to continue with the ASM test for 1991 and older vehicles. dKC suggests that vehicles that are classified as marginal failures in the IM240 test (vehicles that have composite emission levels between 100% and 200% of the standards) receive a second transient emission test. dKC recommends using the IM147 test as the second chance test for marginal IM240 failures.

- **Test frequency –** dKC agrees with plans to change the inspection frequency from annual to biennial for 1992 and newer vehicles that pass the emission test. dKC also agrees that 1992 and newer vehicles failing the test that receive conditional waivers be tested on an annual basis until they pass. Furthermore, we agree that 1991 and older vehicles should continue to receive an annual emission test. dKC recommends making the biennial test requirement a function of vehicle age, e.g. greater than 10 years old, rather than vehicle model year.

- **Vehicle emission test standards –** dKC believes that Translink should perform additional analysis of failure rates with final IM240 standards before it finalizes

plans to adopt them. dKC is concerned that failure rates will be too high with final standards. dKC sees merit in Sierra Research's recommendation to establish a two-tier set of emission standards and require vehicles to meet the higher "gross polluter" standards before they can get a conditional waiver. As mentioned above, dKC suggests that Translink perform additional analysis of vehicles receiving conditional waivers to determine the extent to which certified technicians are abusing the waiver process. If waivers have significant long-term effects, AirCare should consider two-tiered emission standards.

- **Standards for Light-Duty Trucks –** dKC understands GVRD's desire to establish emission standards for light-duty trucks that are similar to standards for passenger cars, particularly vans and SUVs that are used like passenger cars. However, dKC would have concerns over high false failure rates if emission standards for light-truck are arbitrarily set to equal the standards for passenger cars.

- **Onboard Diagnostic (OBD) Tests –**At this point the Committee has not recommended performing OBD inspections on 1998 and newer vehicles, although Canadian vehicles are required to have these systems and the inspection lanes should have OBD inspection equipment. dKC recommends that at a minimum the OBD systems should be used to identify and screen-out vehicles that are very unlikely to fail an exhaust or gas cap pressure test. This could be done while the vehicle is waiting in line thereby increasing throughput. dKC further recommends that vehicles still covered by their warranty be required to pass the OBD inspection.

- **Enforcement of Repair Facilities –** dKC suggests that Translink establish a budget for monitoring licensed repair facilities that have a low Repair Effectiveness Index, if it is clear from the data that the Conditional waiver process is abused.

- **Additional Recommendations –** dKC recommends that the Steering Committee study the following changes, and adopt them if they increase the emission reductions and improve the cost effectiveness of AirCare:

    - Revise, if necessary, current exemptions from AirCare testing requirements

    - Consider regulation changes focussing on smoking gasoline vehicles ensuring that they are appropriately failed at AirCare and that the AirCare OnRoad program is able to test and ticket them and require remedial repairs and retesting.

    - Consider changes to AirCare testing area to provide more complete coverage of the Lower Fraser Valley (e.g. include Bowen Island, and Agassiz to Hope); consider conditions under which expansion beyond Lower Fraser Valley might occur. (e.g. to other urban growth regions with air quality problems).

Report Organization

This review first addresses previous evaluations of AirCare. The methodology used to estimate emission reductions is analyzed and reported results are compared with reductions estimated for other I/M programs. Then, dKC reviews and comments on the recommended elements of AirCare II.

2.0 Effectiveness of AirCare I

Each year since the beginning of AirCare, the AirCare office has evaluated the program on behalf of the AirCare Steering Committee, which includes British Columbia Ministry of Lands, Environment and Parks (MELP), Insurance Corporation British Columbia (ICBC), Greater Vancouver Regional District (GVRD), and Environment Canada; more recently the Fraser Valley Regional District and Translink are also members. The first evaluation was performed by Radian Corporation. Subsequent evaluations have been performed for the Steering Committee by the AirCare office, using a methodology similar to the one used by Radian but with several changes to correct for deficiencies in Radian's initial analysis.

The most recent evaluation of AirCare was performed on program year 7, which spans a period from September 1998 to August 1999. In the report "AirCare -- Evaluation of Benefit" which was published in July 2000 by Translink, the following emission reductions were estimated for the AirCare program at the end of year seven

- Hydrocarbons -- 26.9%
- Carbon Monoxide (CO) -- 31.0%
- Oxides of nitrogen (NOx) -- 8.8%

These reductions translated into the following tons per year reductions in the GVRD:

- HC -- 9,551 tons per year
- CO -- 105,974 tons per year
- NOx -- 1,682 tons per year

2.1 Review Of Emission Reduction Calculation Methodology

Description of Methodology – dKC reviewed the methodology used by Translink to estimate the benefits from AirCare after program year 7. The methodology used by Translink to calculate the emission reductions for AirCare is described in detail in the report prepared on Program Year 5, dated September 1998. Translink calculated the cumulative reductions in HC, CO and NOx emissions directly attributable to the AirCare program. The methodology is summarized below

- Translink calculated the incremental reduction resulting from each year of the AirCare program. The emission reductions for AirCare are calculated separately from the emission reductions for vehicle fleet turnover. Vehicle turnover is the replacement of older high emitting vehicles with newer vehicles that meet more stringent emission standards.

- Translink calculated the incremental emission reduction in each year by breaking down test results into different combinations of failure mode and vehicle technology. Translink developed emission estimates for 44 combinations of vehicle technology groups and emission test results. Emission test results were grouped into passing

initial test and several combinations of failure mode. Failure modes are defined as fail HC, fail CO, fail NOx, and combinations. Translink used the following technology classes:

- pre control vehicles,
- vehicles with basic mixture controls,
- vehicle with oxidation catalysts,
- pre 1988 passenger vehicles with 3 way catalysts,
- trucks with 3 way catalysts, and
- 1988 and later passenger vehicles with 3 way catalysts.

Based upon an analysis of AirCare program data, Translink determined the numbers of failing vehicles for each of the major technology classes.

- Again using data from the program Translink determined the percent of vehicles that are repaired in year one to pass the test that continue to pass the test in 2nd and subsequent years. This relationship is used to determine the on going emission reductions from repairing failed vehicles over the life of the program.

- The emission reductions from repairs are based upon data collected in Translink's constant volume sampling (CVS) test cell at the AirCare Research Facility. Translink determined emission rates before repairs and after 3 categories of repairs:

  - Conditional pass (vehicle was waived from compliance),
  - marginal pass (vehicles met standards but emitted at rates greater than those vehicles that passed the initial tests) and
  - vehicles that had "good" after repair emission levels (emission levels were similar to those for vehicles that passed the initial tests).

- Tonnes per year estimates of AirCare were generated by multiplying the estimated percent reductions times the "no I/M" inventory reported by GVRD.

Assessment of Methodology – dKC believes that the methodology used by Translink to calculate emission reductions is reasonable. The methodology combines actual data from the AirCare program with independent emission test results from the CVS test cell at the AirCare Research Facility. Data from the AirCare program provides unbiased way of classifying passing and failing vehicles into different categories. The CVS test cell provides emission reduction estimates in grams per kilometer, which is a good indicator of how the AirCare program affects mass emission rates.

By the end of year 7 over 1,000 CVS tests have been performed on vehicles that failed AirCare program standards and were subsequently repaired. Emission rates in grams per kilometer are available before and after repairs. Although the procurement of vehicles for the CVS facility is voluntary, vehicles were procured and subjected to the CVS test immediately after they received their official AirCare inspection and re-inspection.

Therefore, motorist inconvenience was minimized and accordingly potential procurement biases also were minimized.

As mentioned, Translink developed emission estimates for 44 combinations of vehicle technology groups and emission test results. Emission test results were grouped into passing initial test and several combinations of failure mode. Because there was limited data for certain combination of vehicle emission control technology and failure mode, Translink had to use engineering judgement on before and after repair emission levels for certain groups. In some cases, emission rates before and after repair are based upon vehicles with similar but not exactly the same failure modes.

dKC reviewed Translink's assumed emission rates before and after repair and found them to be reasonable estimates of the emission rates for the particular failure mode. It was beyond the scope of dKC's contract to independently calculate emission rates for the 44 combinations. dKC did compare assumed after repair emission rates with observed after repair rates for two of the technology groups. This comparison is shown on Table 1. We did not find any evidence that Translink arbitrarily used too high of a before repair emission rate or too low of an after repair emission rate, both of which would have increased the estimated emission reduction benefits for the program.

Emission rates for vehicles that pass the initial test are based upon a relatively small sample (45 vehicles) of vehicles tested in the CVS facility after passing their initial AirCare test. dKC compared the emission for passing vehicles that were assumed in Translink's analysis with the observed emission rates for passing vehicles in the CVS data set. Table 1 shows this comparison (results are shown on the P/P/P row on the table). Again it appears that Translink used reasonable assumptions on the emission rates for passing vehicles based on available CVS data.

dKC is concerned about the small sample size for the passing vehicle dataset. More data should be collected to support the passing vehicle emission rate for the newer technology classes of 3-way catalysts equipped vehicles. dKC is particularly concerned about the assumed emission rate for 1988 and later passenger vehicles with 3-way catalysts that passed the initial tests. Translink assumes that these vehicles emitted the following rates:

- 0.1 grams per kilometer HC
- 2.1 grams per kilometer CO
- 0.4 grams per kilometer NOx

Although the limited CVS data support the above assumptions, dKC believes they may be too low. The emission rates in particular the HC emission rates are lower than the certification standards for those vehicles (0.15 to 0.24 g/km). Using a higher assumed emission rate for passing vehicles lowers the calculated percent reduction benefits from the program. Therefore, it is important to confirm that the assumed emission rates for passing vehicles are correct.

Table 1 – Comparison of Observed vs. Assumed Emission Factors for AirCare Emission Reduction Analysis

Model Year Group	Initial Inspection Result			**Observed Emission Factors (gram/km)**			Assumed Initial Inspection Emission Factors (gram/km)			Assumed Emission Factors to achieve Conditional Pass (gram/km)			Assumed Emission Factors to achieve Pass (gram/km)			Assumed Emission Factors to achieve close to 'good' Pass (gram/km)		
	HC	CO	NOx	**HC**	**CO**	**NOx**	HC	CO	NOx	HC	CO	NOx	HC	CO	NOx	HC	CO	NOx
1988+ Cars	P	P	P	**0.1**	**2.4**	**0.4**	0.1	2.1	0.4									
	P	P	F	**All Fails Before**			0.4	5.4	1.4	0.5	4.1	1.5	0.2	2.8	1.0	0.3	4.1	0.7
	P	F	P	**0.8**	**12.1**	**0.9**	0.4	8.3	0.5	0.4	9.0	0.2	0.3	7.7	0.4	0.3	3.6	0.6
	P	F	F	**All Fails After**			0.4	8.3	1.4	0.4	8.3	1.4	0.3	5.5	1.3	0.3	3.6	0.6
	F	P	P	**0.4**	**6.3**	**0.7**	0.5	4.8	0.7	0.8	4.0	0.5	0.7	8.1	0.6	0.3	3.9	0.7
	F	P	F				0.8	8.1	1.8	0.6	7.2	1.4	0.4	5.5	1.3	0.2	3.2	0.8
	F	F	P				0.8	17.1	0.6	0.6	16.0	0.9	0.4	14.0	0.3	0.2	4.9	0.6
	F	F	F				1.2	22.7	1.9	0.6	16.0	1.0	0.5	14.0	1.3	0.2	2.5	0.6
1980-87 Cars and Trucks	P	P	P	**0.7**	**11.2**	**1.3**	0.8	10.7	1.6									
	P	P	F	**All Fails Before**			1.0	8.2	3.3	1.1	8.4	3.0	0.8	7.3	2.5	1.8	10.1	2.0
	P	F	P	**1.6**	**21.6**	**1.7**	2.0	34.8	1.4	1.9	31.3	1.4	1.9	31.3	1.4	1.3	17.2	1.8
	P	F	F	**All Fails After**			1.0	25.0	3.0	1.1	25.0	3.0	1.0	20.0	2.8	1.0	18.0	2.5
	F	P	P	**1.1**	**15.0**	**1.5**	2.6	14.6	1.9	2.0	22.6	2.0	1.8	20.0	2.4	1.6	19.0	1.6
	F	P	F				4.1	20.8	3.4	4.1	21.0	3.4	3.0	19.0	2.5	2.1	16.1	1.7
	F	F	P				1.9	26.2	1.6	1.8	34.3	1.1	1.5	18.2	1.2	1.3	14.2	1.7
	F	F	F				2.5	31.7	3.2	2.5	31.7	3.2	2.0	25.0	3.2	1.4	17.0	1.6

2.2 Comparison of reported emission reductions with other estimates of I/M effectiveness

California I/M Evaluation – dKC compared the emission reductions reported by Translink at the end of Program Year 7 with estimates derived from a recent evaluation of California I/M program. The evaluation of California's I/M program was based upon roadside test results on vehicles that were being driven in California. The California Bureau of Automotive Repair (BAR) routinely conducts up to 20,000 roadside emission tests each year with the goal of generating independent emission data to evaluate its I/M program. As part of this evaluation, BAR estimated the emission reductions for two types of inspection stations:

- test and repair stations similar to those in other decentralized I/M programs, and
- test-only stations that are prohibited from performing repairs.

BC's centralized inspection stations should be at least as effective as California's test-only stations in certifying compliance with emissions standards.

Table 2 shows the percent reduction in fleet emissions as determined by the ASM 2525 test for vehicles that were subjected to California enhanced I/M test for the first time. As shown, the emission reductions observed at test-only stations for all model year groups were much higher than the observed emission reduction for test and repair stations. The vehicle fleet certified at test-only stations saw the following reductions in ASM2525 emission levels:

- HC (% reduction in ASM 2525 levels) -- 34.4%
- CO (% reduction in ASM 2525 levels) -- 35.9%
- NO (% reduction in ASM 2525 levels) -- 22.2%

TABLE 2
Observed Emission Reductions in California Roadside Test Program by Station Type

Sequence	Station Type	Model Year Group		HC 5015 (ppm)	HC 2525 (ppm)	CO 5015 (%)	CO 2525 (%)	NO 5015 (ppm)	NO 2525 (ppm)
Percent Reduction	Test-Only	1974-1979		42.08%	44.68%	33.88%	34.23%	-2.41%	1.68%
		1980-1986		37.03%	37.00%	36.04%	34.62%	16.65%	19.84%
		1987-1991		12.90%	19.17%	37.78%	39.53%	31.24%	33.50%
		ALL		**31.65%**	**34.35%**	**36.11%**	**35.92%**	**19.31%**	**22.21%**
	Test-and-Repair	1974-1979		32.27%	32.70%	20.28%	12.95%	0.49%	5.12%
		1980-1986		13.58%	11.69%	16.04%	18.27%	2.24%	3.27%
		1987-1991		2.58%	5.13%	23.81%	26.83%	14.78%	14.48%
		ALL		**16.32%**	**16.88%**	**18.99%**	**19.31%**	**6.50%**	**7.65%**

* Value for "ALL" vehicles determined by weighting the model year group average emissions by Vehicle Fraction for the average roadside test date (July 1998).

Figure 1 shows emissions before and after repair by station type based on roadside test data. This figure shows data on 1980 to 1986 vehicles. As shown, vehicles certified at Test-Only stations have much lower after Smog Check emission levels, while their before Smog Check levels were almost identical to the Test-and-Repair category.

BAR used equations to convert emission during the 2-mode ASM tests to a grams per mile basis as determined by the federal test procedure (FTP). The emission reductions for test-only stations in grams per kilometer space were lower than those in ASM 2525 space but still were substantial. They are shown below:

- HC (% reduction in g/km) – 22.8%
- CO (% reduction in g/km) – 20.4%
- NOx (% reduction in g/km) – 12.1%

Note that the above reductions are for the first inspection cycle where the ASM test was used. They do not include the benefits of multi-year cycles that were included in the evaluation of AirCare emission reductions.

dKC Estimates of Benefits for One Program Cycle – Using data from the CVS test program, dKC calculated the emission reductions for one inspection cycle. This calculation used observed emission rates for 1988 and newer passenger vehicles that passed the initial tests. Other categories use Translink's assumed emission rates for passing vehicles. The emission reductions for failed vehicles were based upon average emission rates in the CVS data set before and after repairs. Table 3 shows the calculation of emission reduction benefits. Failed vehicles saw the following reductions in g/km emission rates:

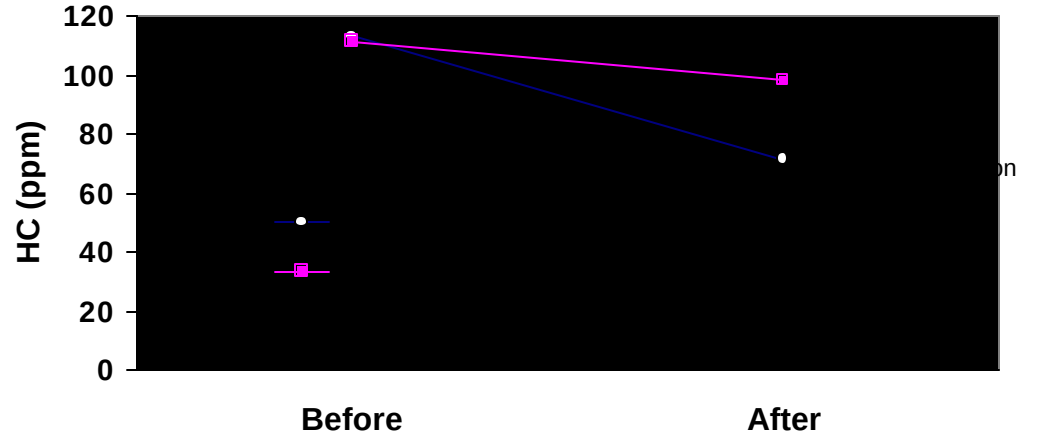
- HC -- 30 to 47% depending on model year group
- CO -- 28 to 48% depending on model year group
- NOx -- 10 to 23% depending on model year group

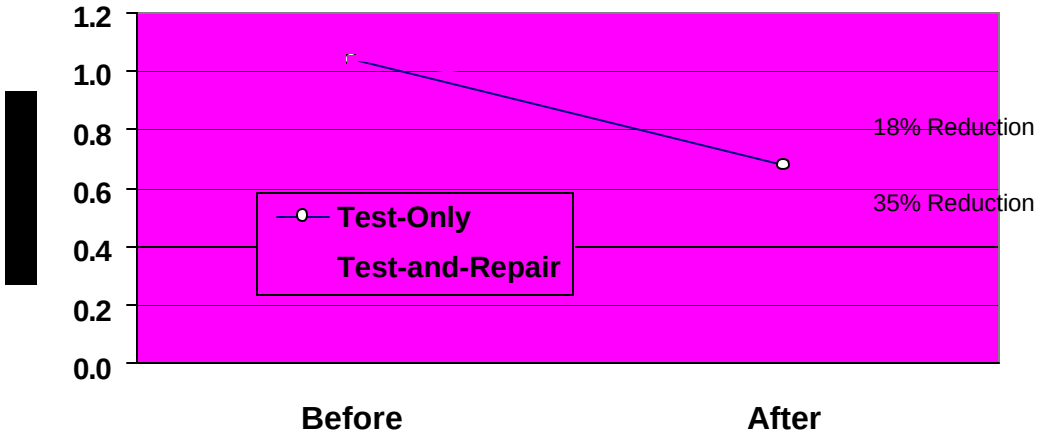
The overall fleet reductions from one inspection cycle are listed below:

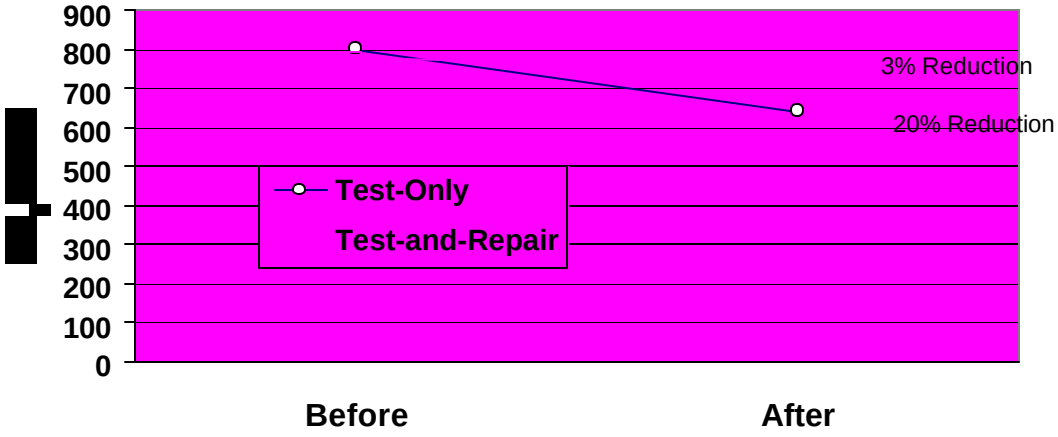
- HC -- 11 to 16% depending on model year group
- CO -- 11 to 12% depending on model year group
- NOx -- 2.7 to 3.1% depending on model year group

The above fleet emission reductions are approximately half of the reductions reported for the cumulative benefits at the end of year 7. dKC's independent estimates are only for one inspection cycle, not the multiple cycles that GVRD fleet has been subjected to. In addition, dKC's estimate does not include the effect of maintenance or repairs performed before the I/M tests. GVRD surveys document that motorists often prepare for the upcoming emission test by performing maintenance or repairs prior to having their vehicles tested.

FIGURE 1
Comparison of Roadside Emission Levels
Before and After Smog Check by Station Type
ASM 2525 for 1980-1986 Vehicles







2.3 Summary

In summary, Translink used a reasonable procedure to calculate the emission reduction benefits for AirCare. The reported emission reductions agree well with independent estimates when differences in the methodology are considered. In dKC's opinion, Translink has not over estimated the emission reduction benefits for AirCare.

2.4 Suggestions for Additional Analysis

The six reports prepared by Translink on the results of years 2 – 7 are among the most comprehensive reports prepared by an administering agency of an I/M program on the emission reductions for its I/M program. In addition to providing estimates of program benefits in percent reduction and tons per year terms, the reports provide several useful statistics characterizing the types of vehicles that failed the test, the cost of repairs, and fuel economy benefits of AirCare. dKC has a few suggestions for additional analysis that could be included in the next report evaluating the benefits of AirCare. The suggestions are listed below:

- **Calculate emission benefits in terms of reduction in ASM 2525 emission levels** -- Currently Translink bases the emission reduction estimates for the program on approximately 1000 CVS tests that were performed at the AirCare research facility. Although the CVS test provides a much more accurate measurement of on road vehicle emissions, the small sample size creates concerns over the statistical validity of the results. dKC recommends that Translink calculate the benefits for the AirCare program in ASM space, using the results of the ASM 2525 test that are performed on all vehicles tested. Translink should continue to break out the vehicles into the 44 combinations of vehicle technology types and failure mode, but instead of using grams per kilometer estimates for each combination, Translink should use average ASM levels.

- **Investigate effectiveness of certified repair facilities --** Translink should perform a detailed analysis of the effectiveness of individual certified repair facilities in repairing vehicles to determine if the Conditional waiver provision is being abused by some of the facilities.

- **Determine the effectiveness of different types of repairs --** Translink should provide greater details on the effectiveness of different types of repairs in reducing emissions. Details could include a distribution of repairs in terms of percent reduction in ASM emission and in grams per kilometer emission based upon CVS test results. Translink should collect independent data on the types of repairs that were and were not effective in reducing emissions.

Table 3. Calculated Emission Reductions for Year 7 Inspection Cycle

Model Year Group	Emissions Parameter g/km	Failed Vehicles		% reduction failed	Passing Vehicles	Fail rate	Fleet Emissions		% Reduction Fleet
		Before repair	After repair				Before	After	
1988+ Cars	HC	0.79	0.42	47.22%	0.1	6.00%	0.14	0.12	15.82%
	CO	12.13	6.30	48.04%	2.4	6.00%	2.98	2.63	11.72%
	NOx	0.92	0.71	23.05%	0.4	6.00%	0.43	0.42	2.95%
1980-87	HC	1.59	1.14	28.31%	0.6	20.00%	0.80	0.71	11.28%
	CO	21.57	15.01	30.42%	9.4	20.00%	11.83	10.52	11.09%
	NOx	1.71	1.49	13.27%	1.4	20.00%	1.46	1.42	3.11%
pre-1980	HC	3.13	2.20	29.84%	1.4	25.00%	1.83	1.60	12.74%
	CO	35.31	25.39	28.10%	18.3	25.00%	22.55	20.07	11.00%
	NOx	2.19	1.97	10.19%	2	25.00%	2.05	1.99	2.73%

3.0 Assessment of the Planned Improvements to be Implemented As Part of AirCare II

The Greater Vancouver Regional District (GVRD) contracted Sierra Research to review motor vehicle technology and I/M procedures and develop recommendations on the design of the next generation of AirCare, AirCare II. The Steering Committee reviewed Sierra's report and recommended that the GVRD Board adopt most of Sierra's suggested changes. On January 21, 1999 the Board adopted the Steering Committee's recommendations.

3.1 Recommendations Proposed By The Steering Committee

Following is a brief review of the recommended changes to AirCare that are to be included as part of AirCare II.

- **Program type and operation –** Continue to use a contractor-operated centralized testing program, with enforcement by registration denial.

- **Test procedure** – Change the test used for 1992 and newer vehicles from the steady-state ASM test currently in use at AirCare to a transient emission test following the IM240 emission test procedure. Vehicles older than the 1992 model year will continue to receive the ASM test. The IM240 test is to be performed using constant volume sampling (CVS) test equipment similar to the equipment used in the AirCare research facility for research (CVS) tests. Note that Sierra had suggested that all vehicles receive the I/M 240 test rather than just 1991 or newer models.

- **Vehicle type –** All vehicles less than 5000 kg GVW that are registered for on road operation with exception of motorcycles should receive the dynamometer based emission test.

- **Inspection frequency** – 1992 and newer vehicles that pass the inspection, either initially or after repairs, will be tested on a biennial basis (every two years). 1992 and newer vehicles that fail an AirCare test and receive a conditional pass will be tested annually until the vehicle fully complies with all AirCare emission limits. 1991 and older vehicles will continue to be tested annually regardless if they pass or fail the emission test. A commercial vehicle such as a delivery truck or taxi should be tested on a schedule based upon how many kilometers it is driven each year.

- **Vehicle emission standards** – The AirCare program should establish standards for each vehicle that provide the maximum emission reductions while avoiding problems with falsely failing vehicles. Light duty trucks including sport utility vehicles (SUVs) and vans should have standards as close as technically feasible to passenger cars of the same model year.

- **Functional emission test** – The Steering Committee proposed Sierra's recommendation of replacing underhood inspections with a functional gas cap test.

- **Vehicle exemptions --** Exempt at a minimum the first two model years from inspection requirements.

3.2 Recommendations Made By Sierra That Were Not Adopted

The Steering Committee did not propose every recommendation made by Sierra on how AirCare should be improved. Sierra recommendations that were not adopted are listed below:

- **Transient test for all vehicles –** The Committee chose to continue testing older vehicles (1991 and older model years) with the ASM test while Sierra had suggested that all vehicles receive transient emission tests.

- **Transient test type –** Sierra suggested that vehicles be tested by the IM147 test, which is the last 147 seconds of the IM240 test. The Committee chose to adopt the IM240 test instead.

- **OBDII Tests –** Sierra recommended to inspect 1998 and newer model year vehicles by interrogating the on board diagnostics (OBD) system rather than performing a tail pipe emission test. The Committee chose to continue with the tailpipe test for those vehicles.

- **Additional vehicle exemptions –** Sierra suggested that AirCare develop and use a low emitter profile model to exempt vehicles from inspection requirements during their first several years of operating life (assumed to be beyond 2 years).

- **Establish a two-tier structure for emission standards and repair procedures –** Sierra proposed a two-tier structure for emission standards. In order to pass the initial test you had to meet the most stringent standards. If the vehicle failed, Sierra proposed that Conditional waivers only be granted if the vehicle was below a gross emitter emission standard. Currently a vehicle can receive a Conditional waiver if it meets the repair cost requirements, regardless of the emission levels.

- **More effective enforcement of repair facilities –** Sierra suggested that Translink step-up its enforcement efforts on licensed AirCare repair facilities.

3.3 Assessment of AirCare Changes Proposed by the Committee

dKC reviewed the changes proposed for AirCare II. dKC also reviewed the changes that Sierra suggested that are not being proposed for adoption. Following are comments on each program element:

Program Type and Operation – dKC strongly concurs with plans to continue with a centralized contractor-operated program. It has been clearly demonstrated centralized test-only stations provide much greater benefits than decentralized test-and-repair

stations, and centralized tests are much less expensive. The results of the California roadside test program that were presented in the previous section show that vehicles that were certified by stations that only perform emission tests and do not perform repairs had twice the emission reductions as vehicles that were certified by test-and-repair stations. BC's network of centralized test-only stations should be even more effective than the decentralized test-only stations that were evaluated in California. The cost for an centralized inspection in BC ($25 to $48 CDN depending on test type) is much lower than the cost of decentralized inspections in California ($75 CDN).

Emission Test Procedure – dKC agrees with the decision to adopt a transient emission test for 1992 and newer vehicles. dKC also agrees with the decision to continue with the ASM test for 1991 and older vehicles. dKC does not share Sierra's concern that performing both types of emission tests in the same lane would be too difficult for the testing contractor. The ASM test has been demonstrated to be effective on 1991 and older model year vehicles. California's roadside test program showed that vehicles that were repaired to ASM test standards showed significant and durable benefits. Furthermore, the repair industry is familiar with repairing ASM failures.

dKC also agrees with the decision to adopt the IM240 test instead of the IM147 test. dKC agrees with Sierra that the IM147 test provides the same emission reduction benefits at a given error of commission rate (false fail rate) as the IM240 test. However, dKC recommends that AirCare use the IM240 test for the following reasons:

- With either the IM147 or IM240 test most vehicles will fast pass in the first 30 seconds, so the IM240 test will only be slightly longer on the average than the IM147 test.

- To date, most transient emissions data collected in the US is based on the IM240 test cycle. If BC were to use the IM147 test instead of the IM240 test, comparisons with results other US programs would be limited to Arizona which has recently started using the IM147 test.

dKC shares Sierra's concerns over false failure rates. We suggest that vehicles that are classified as marginal failures in the IM240 test (vehicles that have composite emission levels between 100% and 200% of the standards) receive a second transient emission test. Data collected in Arizona's IM240 program found that second chance tests significantly reduced false fail rates. dKC recommends that the Committee consider using the IM147 test as the second chance test for marginal IM240 failures.

dKC agrees with Sierra's recommendation and accordingly plans to change from a visual underhood inspection to a functional gas cap test. Data indicate that a functional gas cap test achieves significant reductions in evaporative HC emissions.

Vehicle Type – dKC agrees with plans to require all vehicles less than 5000 kg GVW registered for on-road operation to be tested, with the exception of motorcycles.

Test frequency – dKC agrees with plans to change the inspection frequency from annual to biennial for 1992 and newer vehicles that pass the emission test. Furthermore, we agree that 1991 and older vehicles should continue to receive an annual emission test. It has been documented that emission control deterioration (how much vehicle emissions increase as the vehicle ages) is greater for older model vehicles, suggesting older vehicles have greater benefits from annual tests than newer vehicles. dKC believes that the Committee should consider making the biennial test requirement a function of vehicle age, e.g. greater than 10 years old, rather than vehicle model year. For example, by the year 2007, a 1992 vehicle will be tested every two years despite being 15 years old.

dKC strongly agrees with plans that vehicles failing the test that receive conditional waivers be tested on an annual basis until they pass.

Vehicle emission test standards – dKC believes that Translink should perform additional analysis of failure rates with final IM240 standards before it finalizes plans to adopt them. dKC analyzed data on full-length IM240 tests (as opposed to fast-pass tests) that were conducted in Colorado during the first three months of 1997[2]. Failure rates with final standards were calculated. They are shown on Table 4 and Figure 2. Failure rates exceed 30% for vehicles more than 5 years old. Colorado enforces relative loose HC and NOx cutpoints (the program is primarily for CO), so failure rates in BC with final cutpoints should be lower than in Colorado. Still, they should be investigated before they are adopted.

dKC sees merit in Sierra's recommendation to establish a two-tier set of emission standards and require vehicles to meet the higher "gross polluter" standards before they can get a Conditional waiver. However, dKC believes there is sufficient motivation for owners of vehicles receiving conditional waivers to properly repair their vehicles prior to their next annual test. As mentioned above, dKC suggests that Translink perform additional analysis of vehicles receiving Conditional waivers to determine the extent to which certified technicians are abusing the waiver process. If Conditional waivers have significant long-term effects, the Committee should consider two-tiered emission standards.

dKC understands GVRD's desire to establish emission standards for light-duty trucks that are similar to standards for passenger cars, particularly vans and SUVs that are used like passenger cars. dKC would have concerns over high false failure rates if emission standards for light-truck are arbitrarily set to equal the standards for passenger cars. Light-trucks standards should have the same stringency as passenger cars, not greater stringency.

Initial New Car Exemptions – dKC agrees with plans to exempt new vehicles for the first two years. This plan will not reduce emission benefits for the program. Exempting the next two years (i.e., the first 4 years) would cause only a slight reduction in benefits, but would not allow motorists to take advantage of the vehicle's emission control

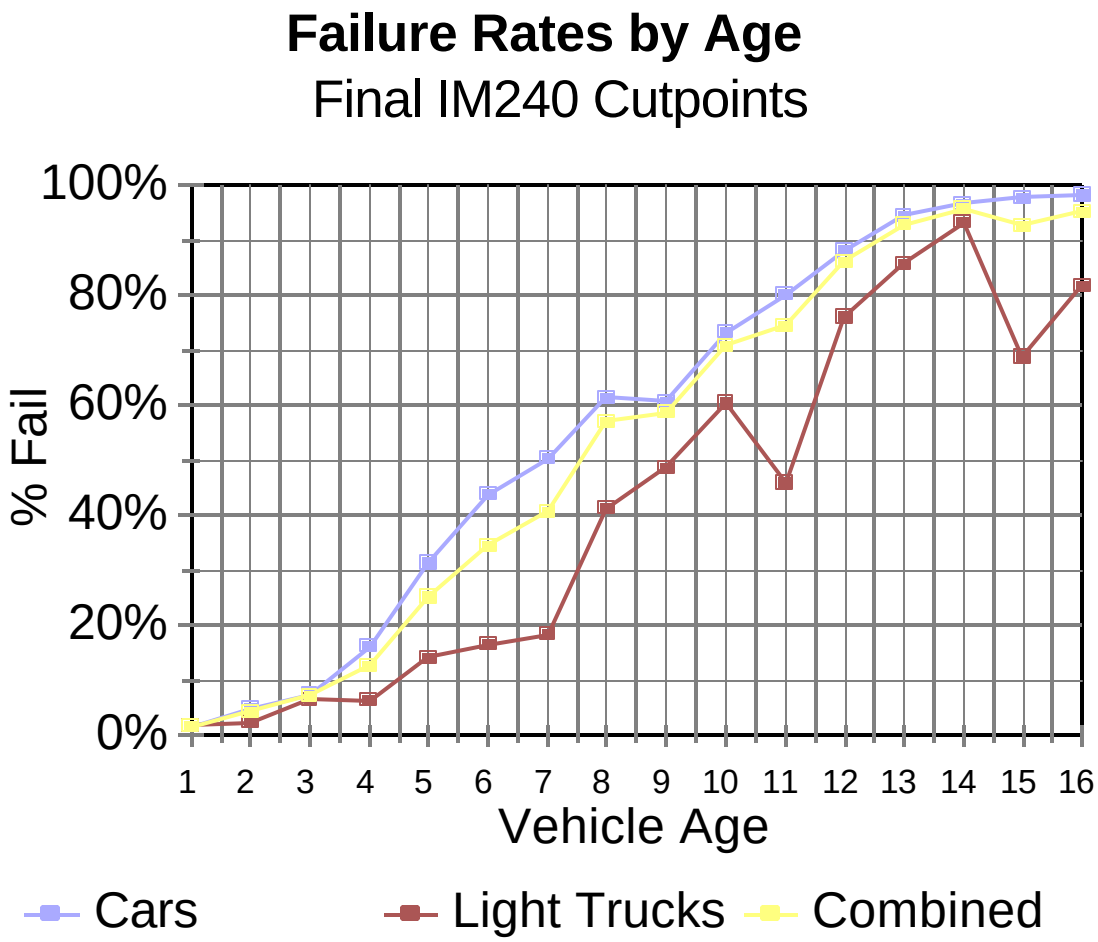
[2] During this period Colorado suspended fast-pass tests in order to develop fast-pass algorithms appropriate for the new standards that were adopted on January 1, 1997.

warranty. High use vehicles such as taxis should be exempted for a period appropriate for their use levels.

Table 4 – Projected Failure Rates in Colorado with Final IM240 Standards

Model Year	Age	% Failing Final Standards		
		Cars	Light Trucks	Combined
1982	16	98.36%	82.78%	95.52%
1983	15	97.83%	71.75%	93.43%
1984	14	96.59%	93.56%	95.80%
1985	13	94.43%	86.05%	92.91%
1986	12	89.60%	77.73%	87.61%
1987	11	81.75%	45.98%	75.93%
1988	10	74.93%	61.50%	72.34%
1989	9	62.27%	49.58%	60.21%
1990	8	64.85%	44.24%	60.44%
1991	7	51.90%	19.33%	42.15%
1992	6	46.44%	17.71%	36.62%
1993	5	32.78%	14.92%	26.37%
1994	4	17.19%	6.45%	13.34%
1995	3	7.98%	7.31%	7.84%
1996	2	5.10%	2.96%	4.67%
1997	1	1.87%	1.68%	1.78%
All		63.77%	39.34%	58.03%

Figure 2


Failure Rates by Age
Final IM240 Cutpoints
100%
80%
60%
40%
20%
0%
% Fail
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Vehicle Age
Cars
Light Trucks
Combined

Onboard Diagnostic (OBD) Tests – Sierra recommended that 1998 and newer vehicles be inspected by plugging-in and interrogating the OBD system. An inspection of the OBD system could conceivably require much less time than a tailpipe emission test, even for vehicles that fast-pass. In addition, the OBD system is much more sensitive than an IM240 test at detecting deterioration in emission control system performance. At this point the Committee has not recommended performing OBD inspections on 1998 and newer vehicles, although Canadian vehicles are required to have these systems and the inspection lanes should have OBD inspection equipment. dKC recommends that at a minimum the OBD systems should be used to identify and screen-out vehicles that are very unlikely to fail an exhaust or gas cap pressure test. This could be done while the vehicle is waiting in line thereby increasing throughput. dKC further recommends that vehicles still covered by their warranty be required to pass the OBD inspection.

More Effective Enforcement of Repair Facilities – Sierra expressed concern over the lack of a comprehensive enforcement program for AirCare licensed repair facilities. Sierra suggested that Translink be much more proactive in monitoring the performance of licensed repair facilities. Currently Translink, extensively analyzes data on retest performance and publishes a repair effectiveness index (REI). dKC suggests that Translink establish a budget for monitoring licensed repair facilities that have low REIs, if it is clear from the data that the Conditional waiver process is abused.

Additional Recommendations – dKC recommends that the Steering Committee study the following changes, and adopt them if they increase the emission reductions and improve the cost effectiveness of AirCare:

- Revise, if necessary, current exemptions from AirCare testing requirements.

- Consider regulation changes focussing on smoking gasoline vehicles, ensuring that they are appropriately failed at AirCare and that the AirCare OnRoad program is able to test and ticket them and require remedial repairs and retesting.

- Consider changes to AirCare testing area to provide more complete coverage of the Lower Fraser Valley (e.g. include Bowen Island, and Agassiz to Hope); consider conditions under which expansion beyond Lower Fraser Valley might occur. (e.g. to other urban growth regions with air quality problems).

3.4 Summary

dKC agrees with most of the changes planned for AirCare II. dKC suggests that the Committee consider making minor changes to its policies concerning emission test procedures, emission standards, OBD inspections and enforcement of repair facilities. dKC also recommends several other issues be evaluated in terms of their impact on the overall effectiveness of AirCare (current exemptions, treatment of smoking gasoline vehicles, and geographic coverage).