Grande Prairie

Vehicle Emissions Testing Clinic

June 5th and 6th 2012

Final Report

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Summary

A voluntary emissions-testing clinic was held in Grande Prairie on June 5th and 6th 2012. A total of 101 vehicles were tested, most of which were light-duty trucks and passenger cars. One motorcycle was tested. However, almost all were less than 10 years old, and this might not be truly representative of the entire in-use fleet in Grande Prairie.

The results of the tire pressure testing component of the clinic suggested that drivers in Grande Prairie are already aware of the importance of regularly checking and adjusting tire pressures.

There were a significant number of vehicles continuing in operation with the MIL (Check Engine Light) illuminated, but with no plan to either diagnose or address whatever problem was causing it to be turned on.

Despite the high incidence of illuminated MILs, the tailpipe HC and CO emissions data suggest that vehicles continue to have low HC and CO emissions, with very little deterioration from their as-new performance. But it must be understood that the tailpipe test used in the clinic did not measure emissions under load, and did not measure NOx. Also, many of the problems indicated by the illuminated MILs were with evaporative emission control systems, which obviously have no impact on tailpipe readings. The low HC and CO readings are due to the technological improvements made by vehicle manufacturers over the last 10 or 20 years. Both the effectiveness and durability of emission control systems have improved significantly, meaning that vehicles remain in compliance with emission standards as long as no major components or sensors fail. Older vehicles have a higher likelihood of having excessive emissions because of greater wear and tear imposed on systems that were somewhat less durable to begin with. However the high incidence of MIL illumination in vehicles over about five years old is cause for concern, because the On-Board Diagnostic (OBD) system is checking performance over the vehicle's full range of operating conditions, and includes many functional tests on operational aspects that have no immediate effect on tailpipe concentrations. The MIL is the first indication of a problem that if left unresolved will usually cause significant increase in emissions once the in-built fall-back control strategies are no longer able to cope with the problem.

All of the organizational and technical aspects of the clinic went very well, and it was well received by the drivers who came for testing. This may have been their first time to see emissions testing being done. Such exposure to the idea of taking vehicle emissions seriously is valuable in itself. It also makes the idea more familiar for next time there is a clinic in Grande Prairie. Unfortunately the weather did not co-operate, with continuous rain for both days, and this definitely reduced the number of vehicles tested, especially those of the general public.

Introduction

Until 2005 Environment Canada conducted regular emission testing clinics for in-use light-duty vehicles at various locations across the country. We do not know whether Environment Canada ever conducted a clinic in Grande Prairie.

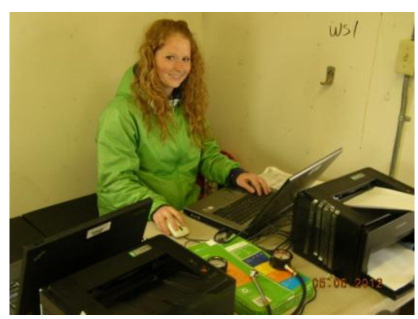
In early 2011 the Peace Airshed Zone Association (PAZA) contacted Pacific Vehicle Testing Technologies (PVTT), which manages the British Columbia AirCare Program, about running a clinic. The basic concept and intent would be the same as for those conducted by EC. PVTT has previously conducted such clinics in various locations in British Columbia, the Yukon and Alberta. These clinics also included On-Board Diagnostic (OBD) inspection as well as the two-speed idle (TSI) tailpipe test, gas cap pressure test, Emission Controls Systems (ECS) tampering inspection, and diesel smoke opacity measurement.

The local organization and public information campaign were all carried out by PAZA.

The clinic was held in the parking lot of the Canfor Mill on Highway 40.







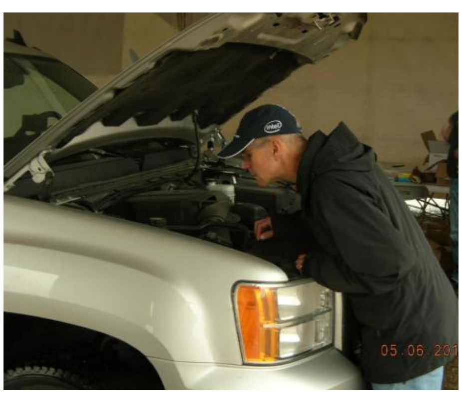
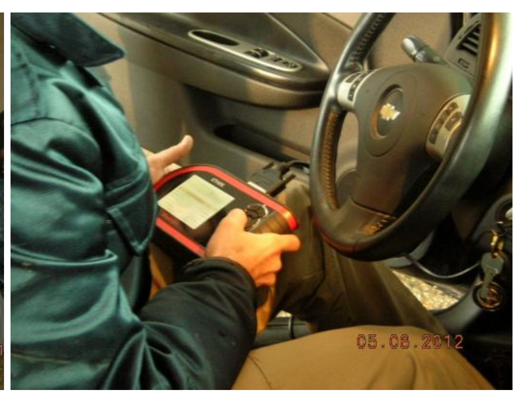
Equipment and Testing

- **Tire Pressures** were checked using mechanical gauges. All four pressures were recorded; then, in consultation with the vehicle owner and after checking any information on the vehicle decals, the tires that needed it were adjusted upward or downward to the correct pressure as needed.


- **Gas Caps** on all 1997 and older vehicles were removed and pressure-tested using Waekon hand-held testers they were also tested on 1996 and newer vehicles if there were OBD trouble codes that indicated evaporative system leaks . Diesel caps were not tested because diesel vehicles do not have evaporative emission controls. Most gas caps from 1998 and newer vehicles were not tested, because their sealing ability is regularly checked by the vehicle's OBD system.



- **Emission Control System** components were checked on 1997-and-older model year vehicles for evidence of tampering or removal. In most cases, the components to be checked were as indicated on the underhood emissions decal. Typical ECS components checked were: Catalytic Converter; Positive Crankcase Ventilation (PCV) valve; Exhaust gas Recirculation (EGR) valve; Air Injection System (AIS); and Evaporative Canister.

- **OBD Inspection** was performed using an OTC Genisys scanner, Snap-On Solus scanner, or Snap-on Ethos scanner connected to the Diagnostic Link Connector (DLC). It also included visual Key-On Engine-Off (KOEO) and Key-On Engine-Running (KOER) Malfunction Indicator Lamp (MIL) checks. All monitors were recorded as 'ready', 'not ready', or 'not supported'. The MIL command status was checked, and any Diagnostic Trouble Codes (DTCs) were noted.


- **The Tailpipe Test** for non-diesel vehicles consisted of a Two-Speed Idle test: a high-idle at 2500 rpm, followed by a curb idle (foot off the accelerator). Concentration measurements of, Hydrocarbons (HC), Carbon Monoxide (CO), Carbon Dioxide (CO2), and Oxygen (O2) were taken using Vetronix portable 5-gas analysers. [The fifth gas measured is Oxides of Nitrogen (NOx), but NOx is only emitted in meaningful quantities when an engine is under load, so the values were not recorded.] The cutpoints used to determine PASS or FAIL for the curb idle test were the same as those used for idle tests in the AirCare program, and are functions of the vehicle type, its age, and its engine size. They range from 70 ppm to 250 ppm HC and from 0.36% to 2.50% CO. For the 2500 rpm, high-idle test, the pass/fail limits were set at 220 ppm for HC and 1.2% for CO, consistent with U.S. EPA guidelines for such a test.



- **Smoke Opacity** of diesel exhaust was measured using a Wager full-flow Opacimeter using the SAE J1667 Snap Acceleration Test procedure.

Vehicles Tested

The total number of vehicles tested was 101. This is not a huge number, but it would be interesting to know how the profile of these vehicles compares to the overall profile for vehicles operating in Grande Prairie. Many of the vehicles tested are registered to company head offices that are often in some other city, but the vehicles do usually operate in and around Grande Prairie. Often it is possible to get a picture of how representative the tested sample is from registration data, but in this case the pertinent information would have to be the vehicle's usual location of use, which might not be available from registration and licensing data.

In the following sections, 'heavy truck' refers to trucks over 3,757 kg (8,500 lb) GVWR.

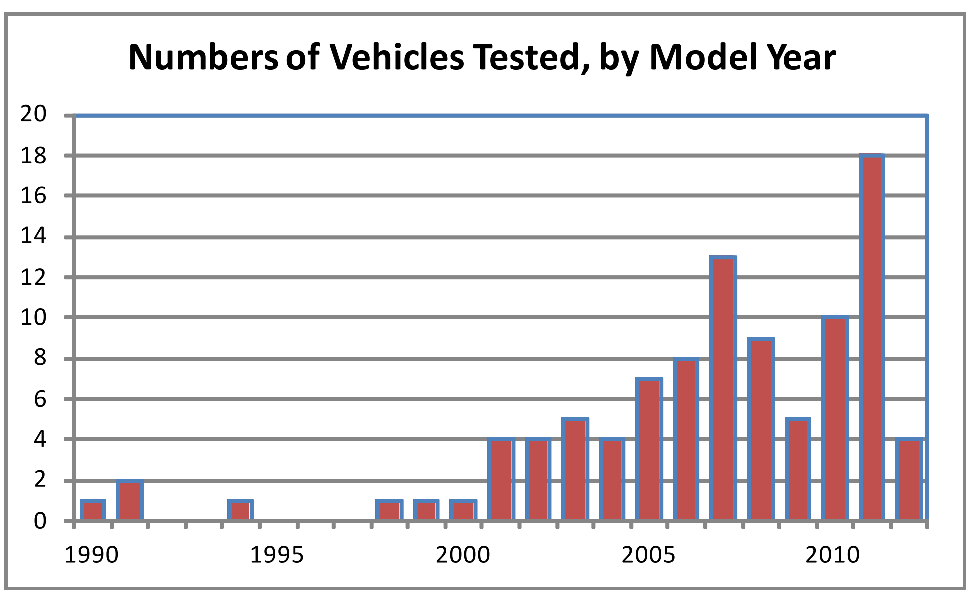
Vehicle Types and Fuel

10	gasoline passenger vehicles
75	gasoline light trucks
5	gasoline heavy trucks
10	diesel heavy trucks
1	motorcycle

Model Years

Passenger vehicle	median model year = 2004, (range from 1991 to 2011)
Light gasoline truck	median model year = 2007, (range from 1994 to 2011)
Heavy gasoline truck	median model year = 2011, (range from 2007 to 2011)
Heavy diesel truck	median model year = 2004, (range from 1990 to 2011)

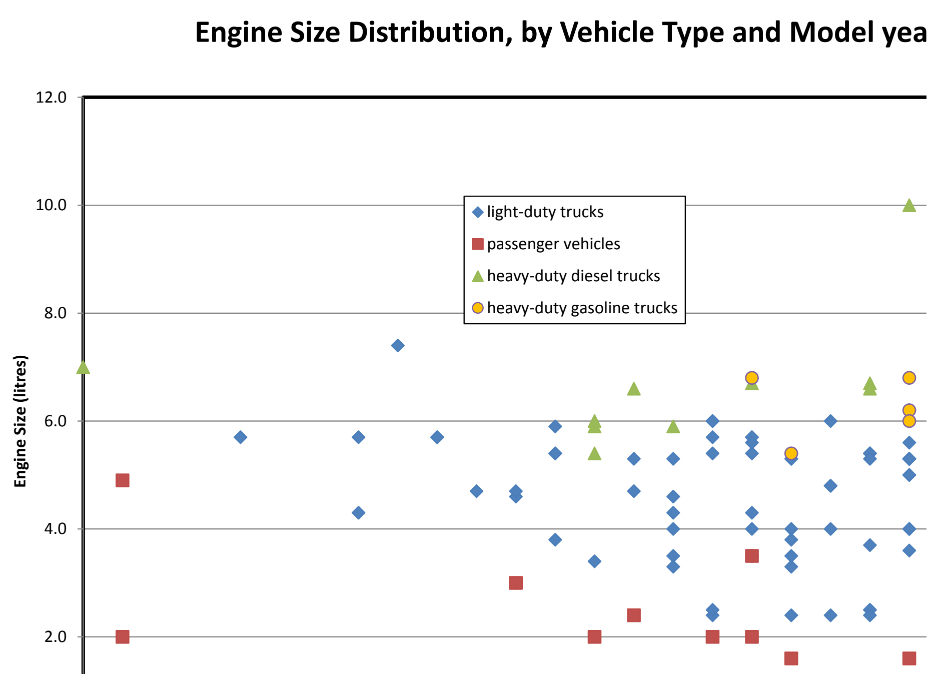
The model year distribution can be seen in the following chart. This is a very different profile to what we have seen in clinics elsewhere, and it may not be representative of the in-use fleet. Our normal expectation is for the average age of in-use vehicles to be about 8 years, and other clinics have attracted more participation from vehicles that are older than average. The vehicles tested in Grande Prairie were almost all newer than the 2000 model year. It is not impossible that this is a true reflection of the vehicles in use in the area, but the explanation may be that this age profile is simply more indicative of what work vehicles the participants were driving on the day.



Engine Size

Passenger	mean=2.5L, (range from 1.6 to 4.9)
Light gasoline truck	mean=4.7L, (range from 2.4 to 5.7)
Heavy gasoline truck	mean=6.2L, (range from 5.4 to 6.8)
Heavy diesel truck	mean=6.7L, (range from 2.4 to 5.7)

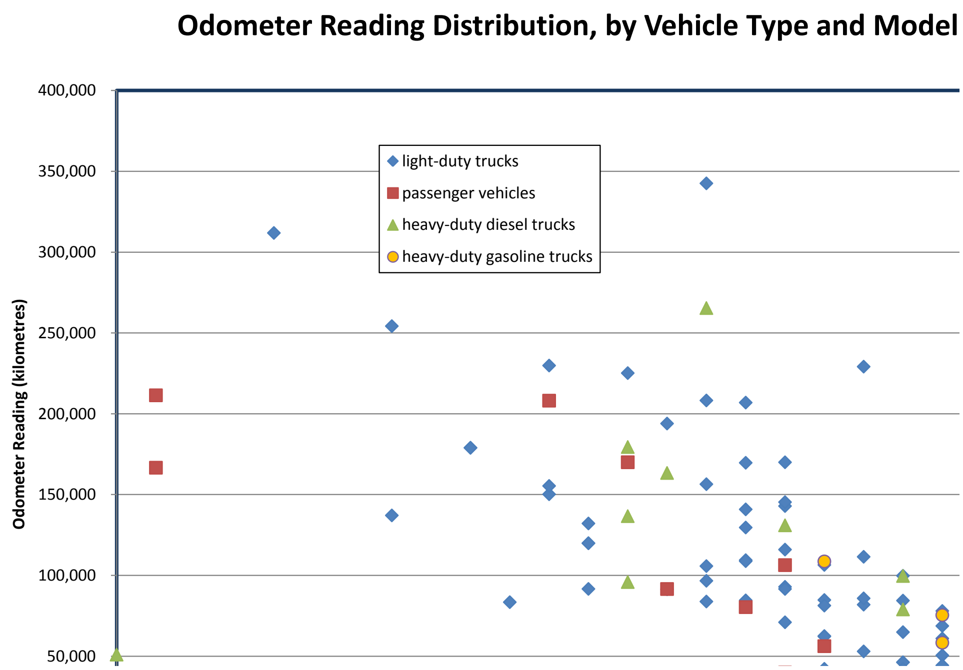
There is no real relationship engine size and model year, but the data is plotted below. It simply shows that cars do tend to have smaller engines than trucks, and that the biggest engines are typically in heavy-duty diesel trucks.



Odometer Readings

Passenger	mean= 114,793 km,	(range from 17,273 to 211,431)
Light gasoline truck	mean= 103,097 km,	(range from 1,981 to 342,581)
Heavy gasoline truck	mean= 57,526 km,	(range from 10,157 to 108,665)
Heavy diesel truck	mean= 122,165 km,	(range from 5,000 to 265,426)

Of all the charts plotted in this report, the following shows the clearest dependency on vehicle model year. It suggests that annual mileage averages about 20,000 km/year over the first 10 years of life, with no discernable difference between trucks and cars. This is a higher annual mileage than observed in the Vancouver region.



OBD-II vehicles

In Canada all 1998 and newer model year light-duty vehicles are required to have second generation On-Board Diagnostics (OBD II). OBD is a system wherein the vehicle's engine control module continually monitors a number of systems that are essential for controlling emissions. When the system detects a fault, it stores a Diagnostic Trouble Code (DTC) and, for some faults, it immediately lights the Malfunction Indicator Lamp (MIL) on the dash to alert the driver to the need for attention. For other faults the MIL is not illuminated until the fault has been confirmed by being detected a second time. OBD can help ensure that emission-related malfunctions are repaired promptly (rather than later or never) and, provide the repair mechanic with useful diagnostic information that can help pinpoint the problem.

Almost all of the vehicles presented for testing were of model years 1998 or newer. However, OBD-II is not mandated for heavy duty trucks and the information available from them is often not available.

Results

Tire Pressures

Of the 101 vehicles tested, there were only 5 light gasoline trucks, and the single motorcycle (6%) that had any tire with a pressure more than 5psi different to its proper specification.

The reference for tire pressure was the manufacturer's recommended cold inflation pressure for the size of tire fitted as shown on the label affixed to the vehicle. Occasionally, vehicle owners install different tires or have a specific preference for a higher inflation pressure. It is necessary to apply some judgment as to whether or not to adjust the tire pressures, either up or down. It should also be remembered that, given that vehicles participating in the clinic have been driven recently, their tires could be expected to show a 2-3 psi increase over the cold inflation pressure.
Overall, the incidence of incorrect tire pressures was significantly lower than observed in previous clinics elsewhere. The results suggest that motorists in Grande Prairie are already aware of the need to regularly

check tire inflation pressures. It is also a reflection of the age profile of the participant vehicles – about half were of 2008 model year or newer, and all these vehicles have Tire Pressure Monitoring Systems (TPMS) which alert the driver to any loss of pressure.

Generally, higher inflation pressures correspond to lower rolling resistance and better fuel economy. Manufacturers' tire pressure recommendations are based on a nominal load of passengers and cargo and strike a balance between ride quality, traction and tire life. Running tires at inflation pressures well above the recommended values causes them to wear in the centre and can compromise traction for braking and accelerating. The natural temperature increase that occurs when driving can push an over-inflated tire beyond the manufacturer's recommended maximum inflation pressure, which could be dangerous. As a rule, tire pressures above 30 psi are desirable. Inflation pressures greater than 35 psi are generally only recommended for truck tires where load capacity is higher.

Two-Speed Idle Test

Failure rate

The two-mode tailpipe emission test was conducted on all the gasoline-powered vehicles tested. None of the cars or trucks had readings that were high enough to fail the standards set for the 2500rpm high-idle test. Three light-trucks and two passenger vehicles failed the curb-idle HC standard, and two light-trucks failed the curb-idle CO standard.

Vtype	Make	Model	Year	Engine (L)	Odom (km)	VIN	curb_HC _Max	curb_HC _read	curb_HC _res	curb_CO _Max	curb_CO _read	curb_CO _res
Light Truck	GMC	SIERRA	1994	5.7	311,890	1GTEK19K8RE563985	218	640	Fail	1.67	0.50	Pass
Light Truck	GMC	SIERRA	1998	7.4	298,927	1GTGK29J8WE536254	129	276	Fail	0.60	0.15	Pass
Light Truck	CHEVY	TAHOE	1999	5.7	178,963	1GNEK13R6XJ458556	71	17	Pass	0.38	2.00	Fail
Light Truck	GMC	SAFARI	2005	4.3	342,581	GKDM19X25B508675	152	171	Fail	0.88	0.49	Pass
Light Truck	HYUNDAI	SANTA FE	2008	3.3	84,791	5NMSG73E38H210771	160	2	Pass	0.98	1.00	Fail
Passenger	CADILLAC	FLEETWOOD	1991	4.9	211,431	1C6CB53B6M4316988	82	171	Fail	0.50	0.16	Pass
Passenger	NISSAN	SKYLINE	1991	2.0	166,632	HCR32259830	110	250	Fail	0.86	0.48	Pass

The single motorcycle tested had HC and CO curb-idle readings of 208ppm HC and 3.00% CO. However motorcycles are certified to different emission standards than cars and trucks, and these readings may be normal for this model year 2007 motorcycle. It did however, have an aftermarket exhaust system installed and it was originally equipped with a catalytic converter which was no longer present.

Tailpipe Readings

The following plots show the distributions of HC and CO readings by model year.

For most vehicles tested there appears to be no relationship between the vehicle age, or vehicle type, and its emission readings. This is what one should expect from vehicles up to about ten years old and having about the same level of emission control technology. The readings plotted basically indicate the emission levels that should come from vehicles that are running the way they were intended to run, and the variation shown is all well within natural variation for normal vehicles.

Seven vehicles stand out as having higher readings:

- A 1991 Cadillac Fleetwood had curb-idle HC of 171ppm
- A 1991Nissan Skyline right-hand-drive grey-market import had curb-idle HC of 250ppm. It also had both CO readings around 0.5% which is a normal engine-out concentration and therefore usually indicates that there is either no catalytic converter on the vehicle, or that it is completely ineffective.

- A 1994 GMC Sierra had very high curb-idle HC of 640ppm (too high to appear on the graph) so it has a definite misfire. Its CO readings were both around 0.5% and, like the Nissan Skyline, there was either no catalyst present or it was completely ineffective.

- A 1998 GMC Sierra had curb-idle HC of 276ppm, but the peak value observed was 1400ppm.

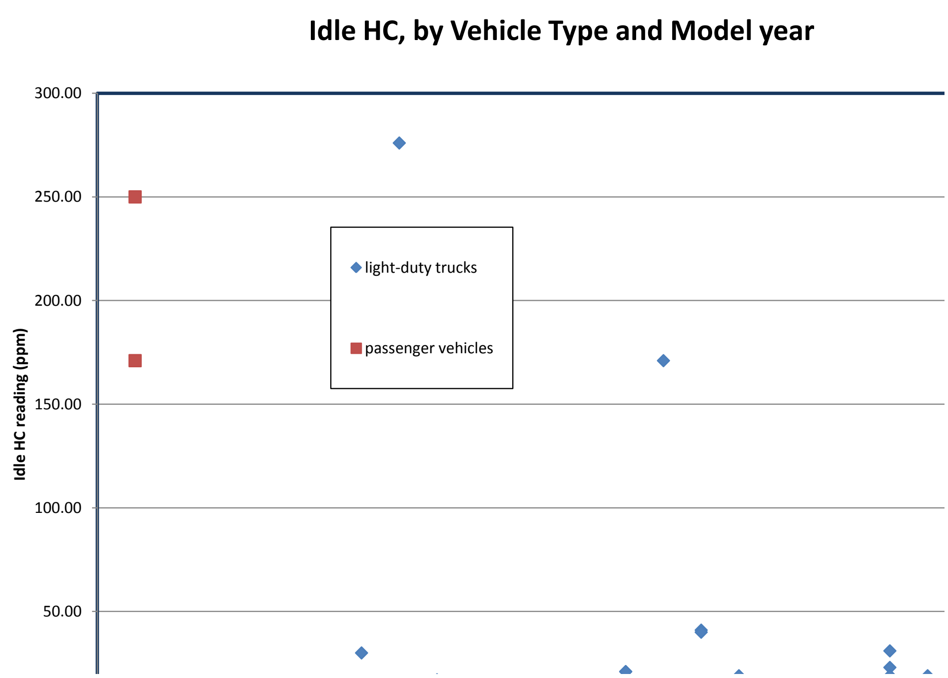
- A 1999 Chevrolet Tahoe had curb-idle CO of 2.0% which is too high to appear on the graph and is very much higher than normal. However its high-idle reading was 0.08% which does indicate good catalyst efficiency.

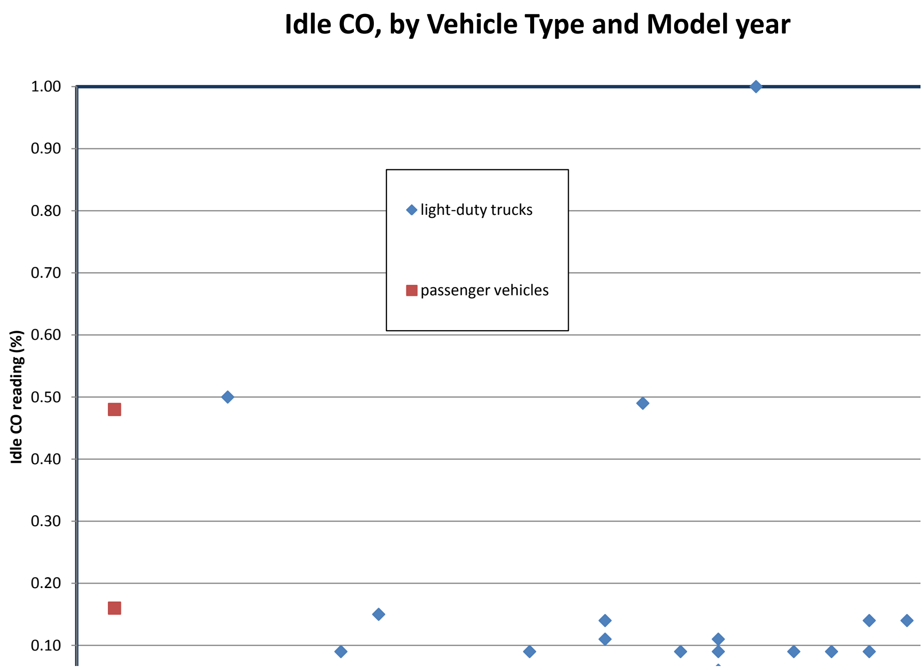
- A 2005 GMC Safari had curb-idle HC of 171ppm. Its CO readings were 0.49% and 0.67% This vehicle had a small aftermarket catalyst installed and the CO readings indicate it to be completely ineffective.. It also had its MIL illuminated and four DTCs for 'System too lean', 'Catalyst efficiency' and 'Evaporative emissions'

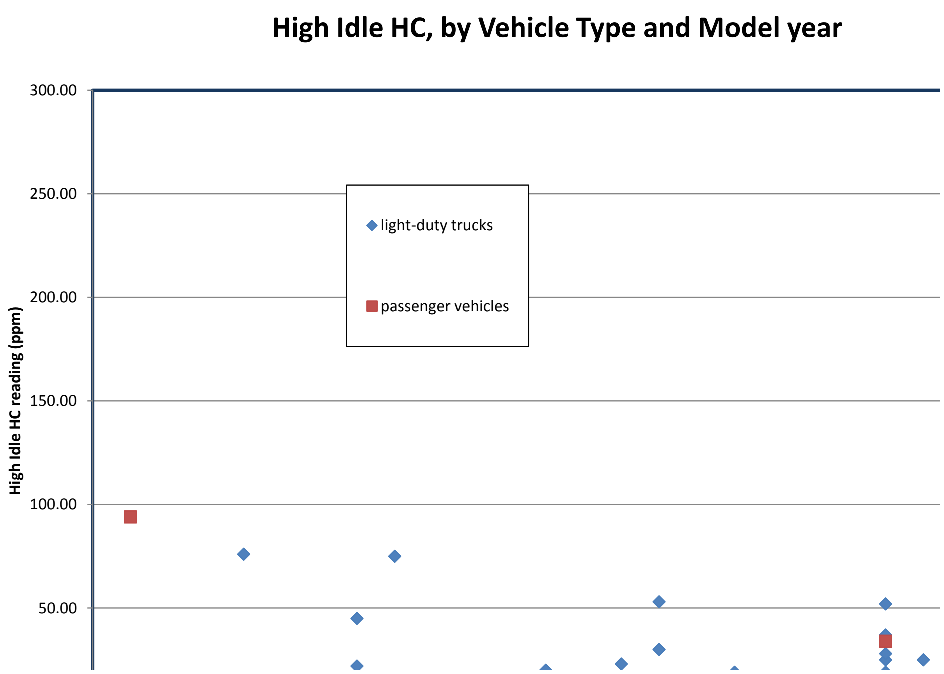
- A 2008 Hyundai Santa Fe had curb-idle CO of 1.0%, which is much higher than normal. However its high-idle reading was 0.03% which does indicate good catalyst efficiency. This vehicle had its MIL illuminated and DTCs for 'Evaporative emissions'.

In summary,

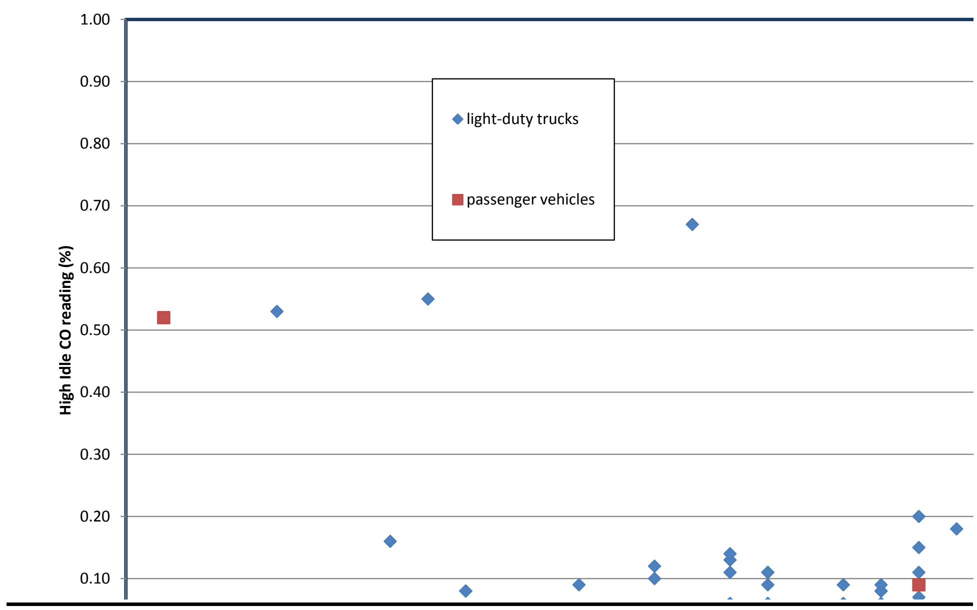
- Three vehicles appear to be in need of new catalytic converters
- Two vehicles have idle mixture problems
- Five vehicles have curb-idle HC problems.




Idle CO, by Vehicle Type and Model year
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
Idle CO reading (%)
light-duty trucks
passenger vehicles


High Idle HC, by Vehicle Type and Model year
300.00
250.00
200.00
150.00
100.00
50.00
High Idle HC reading (ppm)
light-duty trucks
passenger vehicles

High Idle CO, by Vehicle Type and Model year



Gas Cap and ECS Inspection

There were only five gasoline vehicle of an age where gas cap testing would have been appropriate. However, because no other vehicles were receiving such tests, the test was overlooked for four of these vehicles. One OBD vehicle that had a 'large leak' evaporative DTC did have a badly leaking gas cap. The customer had attempted to have the vehicle repaired on several occasions but they indicated the light was cleared with a scan tool without identifying or correcting the actual defect.

Diesels have vented filler caps.

Newer vehicles use the OBD system to check the gas cap as part of the evaporative emissions control system, so a separate gas cap pressure test is not necessary.

For the five vehicles where ECS inspection was appropriate we did not identify any problems.

OBD-II Inspection

Almost all of the vehicles were OBD-II tested. The monitors that were interrogated were:

- COMP Comprehensive Component Monitors (includes anything not covered by other specific monitors)
- FUEL Fuel System
- MISF Misfire
- CAT Catalytic Converter Efficiency
- EGR Exhaust Gas Recirculation System
- EVAP Evaporative Emissions Control System
- OXY Oxygen Sensors
- HOXY Oxygen Sensor Heaters

- PCV Positive Crankcase Ventilation
- SAIR Secondary Air Injection
- THER Thermostat
- HCAT Heated Catalyst
- ACSYS Air Conditioning System

The first three monitors (COMP, FUEL and MISF) are known as Continuous Monitors and are present on all OBD-II vehicles (except vehicles with more than 8 cylinder engines which do not require the misfire monitor, and light-duty diesels which may not have the fuel system monitor). All gasoline vehicles also have CAT, EVAP, OXY, and HOXY, monitors, and will have EGR and SAIR monitors if those systems are fitted. PCV and THER monitors were not common until model year 2000. Diesel vehicles have the three continuous monitors plus the EGR monitor, if EGR is fitted. The HCAT and ACSYS monitors are not required by any existing production vehicles.

When monitors run and find a problem they respond by setting a Diagnostic Trouble Code (DTC) and by turning on the Malfunction Indicator Lamp (MIL) which is also known as the 'Check Engine' light. The DTC indicates what problem was identified.

It is worth noting that there are generally three possible reasons why a monitor may be 'not-ready':

- One possible reason is that someone has recently cleared the codes and all the other OBD information, either using a scantool or by disconnecting the battery. This could be in order to extinguish the MIL, or could simply be because the battery has been changed or disconnected to prevent it draining. This type of situation is usually indicated by most or all of the non-continuous monitors being 'not ready'. The situation is usually resolved by waiting until a few more days of driving has allowed the monitors to run.
- A second possibility is that the conditions necessary for certain monitors to complete simply haven't been encountered since the OBD information was last cleared. The monitor most often affected this way is the EVAP monitor. Unless the vehicle is exposed to the required variations in ambient temperature and the vehicle has the required amounts of gasoline in the fuel tank, the EVAP monitor will not run. Another monitor that can sometimes take a while to complete is the CAT monitor. Each manufacturer strategically programs their catalyst monitor in different ways; some require just a certain amount of highway driving, but others require driving at certain speeds for specific periods. If a vehicle is not operated in the way required for its own catalyst monitor to run, it will simply remain 'not-ready'. Resolving this type of situation may require some research into exactly what operating cycle is required for the specific vehicle to run the monitor.
- The third possibility is that there is some underlying problem that prevents the monitor completing. All monitors have their own list of pre-conditions, which include certain operating conditions as described above, but also require that certain components are working correctly. A simple example is the catalyst monitor, which relies on upstream and downstream oxygen sensor signals to derive its assessment of catalyst efficiency. If a problem is detected with the oxygen sensors the catalyst monitor simply does not run. This type of problem might be suspected if a monitor still hasn't completed after a long period, or when one is sure that its required operating conditions have been provided. Its resolution requires some actual troubleshooting and diagnosis to find out what the underlying fault is.

In fact the readiness data, as recorded during the clinic, is not completely reliable, because there are many cases shown as 'not ready' that should actually be 'not supported'. This was because of a basic misunderstanding of the data input options. So it would be just a bit to speculative to read too much into the readiness data. The readiness data that does stand out is for three gasoline trucks that show all monitors as 'not supported'. These are a 2002 Ford, a 2005 GMC and a 2010 GMC. One possible explanation of this result for these vehicles would be that they have aftermarket replacement computers.

There were no OBD issues identified in any of the heavy-duty diesel or gasoline trucks.

We performed OBD tests on 72 light trucks and 8 passenger cars, and found problems on 16 trucks and one car. The three trucks that did not appear to support any of the normal monitors have already been mentioned. Of the remaining vehicles there were 13 that had the MIL commanded 'ON' (with supporting DTCs), and one truck where the MIL did not work. All these vehicles failed the inspection. Their failure rate can be compared to the current OBD failure rate for vehicles subject to the British Columbia AirCare inspection and maintenance program. AirCare does OBD inspections on vehicles from model years 1998 to 2005, and the current failure rate is about 5%. The clinic tested 20 light trucks and 3 passenger cars in this model year range, and 10 of them failed inspection – this is a rate of 43%.

All the vehicles where the MIL was ON had supporting DTCs. The single passenger car failure was a Hyundai Tiburon with four trouble codes, all for the vehicle speed sensor.

The most common codes were for the evaporative control system. There were a total of 13 EVAP codes from 7 trucks, and covering the full range of what can go wrong with these systems. Most vehicles had two DTCs, but three only had one DTC, one had three DTCs, and one had four DTCs.

Two trucks each had two codes indicating lean operation.

There were three codes (two trucks) indicating EGR problems.

There were two trucks with coolant temperature sensor problems.

There was one truck each with a DTC for idle air control, the oxygen sensor heater, and for catalytic converter efficiency.

This pattern of codes is similar to what are seen as the most common codes in the BC AirCare program. However, their overall rate of occurrence is significantly higher, which is presumably because vehicles subject to AirCare have typically had 3 or more inspections already since OBD inspection was introduced in 2007, and each time, whatever problems were identified would have had to be repaired. In contrast, an illuminated MIL on a Grande Prairie vehicle may initially be a concern, but it quickly becomes just an annoyance. Whatever is the actual explanation, the fact remains that problems identified by OBD, and illuminated MILs, are not being diagnosed or repaired. A number of drivers commented that there seemed to be a lack of OBD diagnostic expertise in the local repair industry.

Diesel Smoke Opacity

Diesel smoke opacity was measured using the Wager Opacimeter, basically according to the SAE J1667 procedure. The vehicles tested were seven pick-up trucks, one SUV and two fire-trucks.

Two of the pick-ups had smoke opacity results around 30%, which is significant and objectionable, and for this age of truck is often caused by an aftermarket engine control computer or other modifications.

The Excursion SUV made a lot of white smoke, which is unburned fuel, but does not cause a high opacity reading.

The other pick-ups had normal (low) readings.

One of the fire-trucks was model year 1990 and did make a small amount of smoke (5% opacity) but was operating very well for a truck of this vintage without any real emission controls. The other fire-truck was model year 2011, with all the latest emission control systems, and did not make the slightest trace of smoke.

Motorcycle

The one motorcycle tested was a 2007 Suzuki GSXR 600. Its tire pressures were low, and its emission readings were high. The tire pressures were corrected, but it is likely that the emission readings are simply normal, because motorcycles are certified to different standards than cars or trucks.

Conclusions and Recommendations

Tire Pressures

- Tire pressure awareness is much more important in a location with a wide range of winter-to-summer temperatures than in other, more moderate, climates. The temperature range can easily add or subtract 8 or 10 psi to/from a tire that was set correctly some months previously. However, motorists in Grande Prairie appear to be keeping their inflation pressures within reasonable values. It is also relevant that tire pressure monitoring has been mandatory on all light-duty vehicles since 2008, and this covers half of the vehicles checked in the clinic.

Tailpipe Emissions

- Although emissions-specific issues are not normally part of regular vehicle maintenance in Grande Prairie, we did not find a high incidence of high-emitting vehicles. The overall picture was 7 problem vehicles out of 101. However, this is probably just a reflection of the age profile of the vehicles tested rather than generally indicative of the in-use fleet in the area.

OBD Results

- There were a total of 17 vehicles with OBD problems, which is a remarkably high number when one considers that about half of those tested were only five years old or less. A comparison with the OBD failure rate in the BC AirCare program is even more extreme, giving a Grande Prairie OBD failure rate of 43% for the same model year range OBD tested by AirCare at a failure rate of about 5%. The explanation is partly that the advertising for the event specifically targeted vehicles with illuminated MILs, but it was also the case that in most cases, before attending this clinic, the MILs had commonly been ignored.

Tampering

- This clinic saw little evidence of intentional tampering with emission control components. In general, there is little to be gained from removing or tampering with such devices in modern vehicles. In fact, engine performance and fuel economy are likely to be adversely affected by such actions. With computerized engine controls, tampering will be detected by the on-board computer and could affect warranty coverage. Although tampering of gasoline vehicles is now relatively rare, it is an increasing problem with diesel vehicles, and this was mentioned by a number of participants as being fairly common practice.

Diesel Smoke

- The range of opacities observed from diesel vehicles was much as expected for the vehicles tested. Electronic engine controls and increasingly effective emission treatment systems have greatly reduced smoke output.

Organisation

- The operation of the clinic was a great success but the number of vehicles that were tested was lower than had been hoped for. Similar two-day clinics in Whitehorse averaged 171 vehicles tested, and three-day clinics in Prince George averaged 326 vehicles tested. One factor that may have reduced the numbers of vehicles was the continuous rain.

- It would be very worthwhile to obtain data about the total in-use fleet in Grande Prairie in order to compare with the profile of the vehicles tested.

- Establishing some regular pattern to dates and frequency of the clinics could be of great value, both in terms of being able to identify trends, and also for public education and awareness of vehicle emissions as an important issue.

Acknowledgements

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Their contributions to the success of the clinic were invaluable.