Transport Canada Transports Canada

atvp pvtp Advanced Technology Vehicles Program
Programme de véhicules à technologies de pointe

Advanced Technology Vehicles Program 2001 – 2002 Annual Report

Road Safety and Motor Vehicle Regulation Transport Canada

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Canada

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EXECUTIVE SUMMARY

Transport Canada Road Safety and Motor Vehicle Regulation Directorate has managed the Advanced Technology Vehicles Program (ATVP) since its inception in June 2001. This report encapsulates the major activities of the program to March 31, 2002.

The ATVP is a component of the Motor Vehicle Fuel Efficiency Initiative, one of five transportation measures identified under the Government of Canada's Action Plan 2000 on Climate Change (AP2000).

The goal of the ATVP is to support Transport Canada's efforts to reduce greenhouse gas emissions from transportation sources and achieve a transportation system for Canada that is sustainable. The program is aimed at reducing greenhouse gas emissions from on-road vehicles by:

- evaluating the fuel efficiency, emissions and safety performance of advanced technology vehicles;
- identifying opportunities and market potential for the introduction and use of advanced technology vehicles;
- identifying barriers to the introduction and use of advanced technology vehicles and recommending remedies;
- raising public awareness of advanced technology vehicles; and
- supporting Transport Canada's environmental programs.

The ATVP is helping Transport Canada match the pace of technological change in the automotive industry with programs that facilitate the introduction and use of clean, safe and efficient advanced technology vehicles.

As of March 31, 2002, the ATVP fleet comprised of 63 vehicles. The fuel efficiency, emissions and safety performance of these vehicles are being assessed through a comprehensive program of on-road evaluation, instrumented track tests and formal laboratory tests. In addition, a program of special events has been undertaken to showcase advanced technology vehicles and to raise the awareness of the public towards advanced technology vehicles and the role these vehicles can play in a sustainable future. 1.7 million Canadians have been reached through these events.

In addition, special studies and partnerships, aimed at evaluating the safety of vehicles, have been initiated with such organizations as the National Research Council of Canada, Health Canada, Environment Canada and the United Nations Economic Commission for Europe.

Although the ATVP has been in operation for only a short period of time, the following has been learned:

- low sulphur gasoline and diesel fuels and low-carbon alternative fuels are virtually unavailable in Canada;
- disharmony of global vehicle technical regulations is among the largest barriers to the availability of ATVs in Canada;
- technology exists today to improve fuel efficiency by 25% to 40%;
- diesels are an available technology that can cut fuel consumption by 40%. However, there are no diesel engines currently available in light-duty trucks in Canada. This is a large market segment with typically high fuel consumption;
- the transition to advanced vehicles and technologies will be largely seamless and transparent to consumers;
- there are concerns over particulate emissions from gasoline direct injection engines; and
- public reaction to small urban vehicles is positive but there is concern over their perceived lack of safety.

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1. INTRODUCTION

On October 6, 2000, the Government of Canada announced its Action Plan 2000 on Climate Change (AP2000). AP2000 outlined a comprehensive package of 37 measures to reduce greenhouse gas emissions (GHG) in all sectors of the Canadian economy. The plan was designed to put Canada firmly on the path to meeting the GHG emission reduction targets contained in the Kyoto Protocol.

Action Plan 2000 captures many of the best ideas coming out of Canada's national consultations on climate change. Federal, provincial and territorial Ministers of Transportation sponsored these consultations. The consultation process brought together the full spectrum of transportation stakeholders to recommend ways to reduce GHG emissions from transportation. More than 450 experts from industry, academia, non-government organizations and municipalities participated. Few other countries have adopted such an open, inclusive and comprehensive process.

Action Plan 2000 included five measures for the transportation sector. One of those measures was the Motor Vehicle Fuel Efficiency Initiative. This measure called for the significant improvement of the fuel efficiency of on-road motor vehicles by the year 2010.

The Advanced Technology Vehicles Program (ATVP) is part of the Motor Vehicle Fuel Efficiency Initiative. Under the ATVP, available and soon to be available advanced vehicles and technologies are being evaluated to determine their impact on fuel efficiency, safety and the environment. The sustainability of Canada's transportation system relies on the reduction of air emissions from transportation sources and the development of cleaner transportation systems, practices and technologies.

Transport Canada’s Road Safety and Motor Vehicle Directorate developed the Advanced Technology Vehicles Program (ATVP) and has been managing the ATVP since its official launch in June 2001. This report encapsulates all the activities of the program from its official launch to March 31, 2002. The program is primarily meant to support Transport Canada’s efforts to reduce greenhouse gas emissions from transportation sources and achieve a transportation system for Canada that is sustainable. The program contributes to the GHG reduction objectives of Action Plan 2000 and the Department’s Sustainable Transportation Strategy.

There are just over 18 million road motor vehicles registered in Canada. Emission standards for road vehicles in Canada are harmonized with those of the United States and are among the most stringent national emission standards in the world. Emissions of regulated pollutants (hydrocarbons, carbon monoxide, oxides of nitrogen, and particulate matter) have been reduced by up to 98% from pre-control days. Parallel programs on fuel efficiency administered by the Directorate have more than doubled the fuel efficiency of light-duty motor vehicles since the early 1970s.

Despite these substantial improvements in emission performance and fuel efficiency, road vehicles remain the single largest contributor to domestic air pollution and the single largest consumer of fossil fuels in Canada. Road vehicles account for about 1/3 of the air pollution problem and 1/4 of the greenhouse gas emissions in this country, and there is no comfort in recent trends. The use of on-road diesel fuel and on-road gasoline have grown by 74% and 44% respectively between 1990 and 2000 due to increases in the size and use of the vehicle fleet. Without some intervention, fuel demand will continue to increase in the future. This situation is not environmentally sustainable nor is it consistent with the expectations of the public for environmental protection.

The opportunities to meet the environmental challenges through incremental, evolutionary change, as in the past, are rapidly diminishing. We are on the threshold of a technological revolution that will introduce the advanced vehicle technologies needed to meet our environmental challenges head on. New classes of small, light vehicles, battery electric, hybrids, fuel cell and alternative low carbon fuel vehicles are poised for introduction over the next decade. The ATVP will enable Transport Canada to be ready to match the pace of technological change with programs that facilitate the introduction and use of advanced technology vehicles that are fuel efficient, clean and safe.

2. ADVANCED TECHNOLOGY VEHICLES

2.1 Near Term, Not Long Term

Action Plan 2000 is a five-year plan. This is a short period of time in the context of the automotive industry. For this reason, the Advanced Technology Vehicles Program has focused on vehicles that can be available in the near term. This would include technologies that are near market-ready, or that are already in the market in other parts of the world.

Despite this narrow scope, there is no shortage of near-term technological opportunities. Examples include:

New powertrains and engine developments
- Gasoline direct injection and advanced diesel engines
- Sequential spark ignition and other advanced combustion processes
- Variable valve timing and lift
- Cylinder deactivation
- Variable displacement
- Variable compression ratios
- Idle stop
- Hybrid, electric, and hydrogen fuel cell drives
- Advanced transmission systems
- Supercharging/turbocharging
- 42v electrical architecture
- Low rolling resistance tires
- Regenerative braking

New construction materials and methods
- Improved aerodynamics
- Use of lightweight and recyclable materials
- Small size/dimensions

Advanced or low carbon fuels
- Clean gasoline and diesel
- Biodiesel
- Ethanol
- Liquefied petroleum gas (LPG)
- Compressed natural gas (CNG)
- Hydrogen
- Electricity

2.2 New Powertrains and Engine Developments

2.2.1 Gasoline Direct Injection

As the name implies, fuel in a gasoline direct injection (GDI) engine is injected directly into the combustion chamber. The main advantage of this technology is that it enables lean operation of the engine, reducing fuel consumption by up to 15% compared to a conventional engine.

2.2.2 Advanced Diesel Engines

Modern diesel vehicles equipped with advanced engines incorporating turbocharging, direct injection and common rail or unit injector technology offer improvements in fuel efficiency of up to 40% over their gasoline counterparts. Additionally, road performance and driveability of diesel vehicles now parallels or surpasses that of gasoline vehicles making them attractive alternatives for the consumer.

2.2.3 Sequential Spark Ignition

Sequential spark ignition engines offer yet another option for controlling the combustion process. With this technology, each cylinder incorporates 2 ignition plugs in a diagonal layout; one near the intake valve, and the other near the exhaust valve. The spark plugs ignite the high swirl gas/air mixture at different places, optimizing the combustion. The ignition timing between these plugs also varies depending on the driving conditions. Due to this rapid, high pressure, and more complete combustion, an increase in torque can be realized as well as a decrease in hydrocarbon emissions. A 10% to 15% increase in fuel efficiency is possible with this technology.

2.2.4 Variable Valve Timing and Lift

This technology utilizes advanced electronic, hydraulic, pneumatic and mechanical means to vary the intake and exhaust valve timing and lift of an engine. This enables the volumetric efficiency of the engine to be optimized while meeting the torque and horsepower demands of the driver. This can often be accomplished with a smaller engine. Most recent developments of this technology have permitted the elimination of the traditional intake throttle on gasoline engines. Fuel consumption improvements of 6% to 8% are possible.

2.2.5 Cylinder Deactivation

Although not a new idea, the advent of more advanced computers and engine management systems and controls has made cylinder deactivation a more attractive option for both diesel and gasoline engines. The deactivation is accomplished by closing the intake and exhaust valves of the target cylinders using electronically controlled hydraulic, pneumatic or electric actuators.

This means that an eight-cylinder engine could be operated on six or four cylinders at times of light power demand. The transition from 8 to 6 or 4 cylinders and back would be seamless to the driver. Fuel consumption could be reduced by 7% to 10%.

2.2.6 Variable Displacement

Variable displacement differs a little from cylinder deactivation. This process involves changing the swept volume of the engine without changing the number of operational cylinders. This can be achieved by modifying the stroke of each cylinder through the use of a pivoted lever arm attached at the crankshaft. This produces an elliptical path for the connecting rod big end and modifies the stroke compared to a conventional engine. Manufacturers of these engines have claimed a 40% cut in fuel consumption; however, no commercial models are yet available for passenger vehicle applications.

2.2.7 Variable Compression Ratios

Variable compression ratio engines are able to modify the compression ratio, as a function of the vehicle performance needs. The variable compression ratio engines are optimized for the full range of driving conditions, such as acceleration, speed, and load. At low power levels, these engines operate at high compression to deliver fuel efficiency benefits, while at high power levels; the compression ratio is lowered to prevent knocking. Near-future engines are being designed with compression ratios ranging from 9.6:1 to 21:1. Improvements in fuel consumption of up to 30% are claimed.

2.2.8 Idle Stop

Idle Stop technology shuts off the engine during periods of idle when it is not necessary to have the engine running and restarts the engine when there is a power demand. This feature is particularly useful in city traffic where lots of stop-and-go driving is typical. The idle stop feature can reduce overall fuel consumption by 6% to 8%. This technology is most effective with large capacity starter/generators as found on today's hybrid vehicles but also works with conventional starter motors.

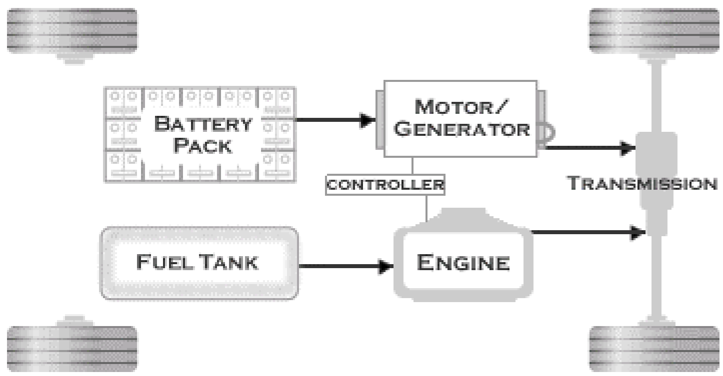
2.2.9 Hybrid Electric Vehicles

Hybrid electric vehicles (HEV) typically incorporate an internal combustion engine, an electric motor, a generator, and a battery pack. The nature, arrangement and integration of these components can be varied to maximize performance and efficiency, and reduce emissions levels.

For internal combustion engines, hybrid systems may use diesels or lean burn gasoline engines. Different types of batteries, fuel cells, ultra-capacitors, flywheels and other means of storing energy can be used as the "battery pack". Engines and battery packs can be arranged to operate in parallel, in series, or a combination of the two.

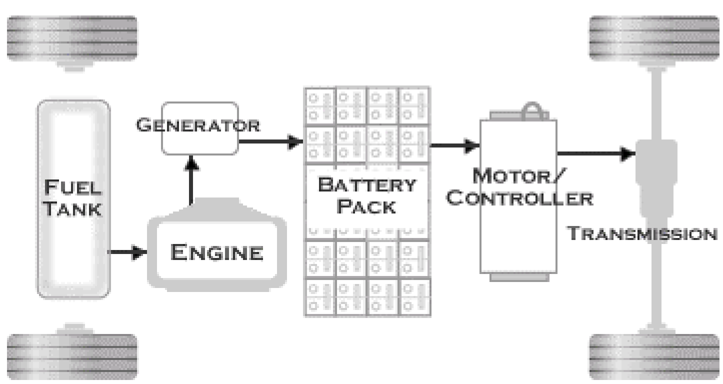
A parallel hybrid powertrain configuration, as shown in Figure 1, has a direct mechanical connection between the internal combustion engine and the wheels, as in a conventional vehicle, but also has an electric motor capable of driving the wheels directly. The internal combustion engine alone, the electric motor on its own, or, a combination of the two can then power the vehicle.

Figure 1
Hybrid Electric Vehicle Parallel Configuration



In a series hybrid (Figure 2), the internal combustion engine runs a generator, which charges the battery pack to power an electric motor that drives the wheels. The main advantage in this system is that the vehicle can be operated largely as an electric vehicle without the combustion engine running in urban areas, thereby reducing vehicle emissions.

Figure 2
Hybrid Electric Vehicle Series Configuration



Combining a series and parallel hybrid system, sometimes called a combined or a series/parallel design, allows the internal combustion engine to directly drive the wheels but also has the ability to charge the battery pack through a generator.

The ability of the control system of a hybrid vehicle to manage how much power flows to or from each component means that the vehicle designer has considerable flexibility in how components are combined and used. Components can be integrated with a control strategy to achieve the optimal design for a given set of design constraints.

Hybrid drivetrains, with varying degrees of electrification, offer very substantial fuel consumption improvements. Hybrid vehicles can offer 20% to 30% improvements.

2.2.10 Battery Electric Vehicles (Energy Storage and Battery Technology)

Research continues to improve the batteries, range, overall performance, efficiency, and recharging time of battery electric vehicles (BEV). These vehicles have zero tail-pipe emissions and for this reason have come to be known as "zero emission vehicles". However, the electricity needed to charge the vehicle batteries is usually supplied from the power grid. Depending on the method of power generation, various environmental impacts can be involved. Even electricity generated using water, wind, or nuclear methods is not without environmental impacts despite the fact that these sources of power have no direct air emissions.

Energy storage devices are key to the optimal performance of BEVs and HEVs. These vehicles each require different battery power to energy ratios and use battery power differently. Alternatives to traditional lead acid batteries include; lithium polymer batteries, nickel metal hydride batteries, flywheels and ultra-capacitors.

Batteries:
Chemical batteries are used to power electric vehicles. Batteries vary in the amount of driving range they allow a vehicle to travel based on their energy and power densities and their charging/discharging efficiencies. Most electric vehicles in the past century have used lead-acid batteries, but researchers are developing advanced batteries such as nickel-iron, nickel-cadmium, sodium-sulfur, zinc-air, and lithium batteries, among others.

Flywheels:
Kinetic energy is stored and released in a flywheel system by the increase and decrease of the rotational speed of the flywheel. Advanced materials with high strength-to-weight ratios are under consideration as are configurations in which the flywheel is integrated into the motor/generator. Like other secondary power sources, cost, reliability, efficiency, and safety need to be assessed fully.

Ultracapacitors:
Ultracapacitors are devices for storing electricity like a battery. Unlike a battery, however, they are designed to release their energy in a quick burst (ideal for starting or accelerating a car) and they store energy quickly (ideal for capturing the energy available when a car is braking). Current work is concentrated on improving performance and reducing costs.

Hydropneumatics:
This is a mechanical type of energy storage. Hydropneumatic systems store energy by using a high-pressure liquid to compress a gas. These systems have high power densities allowing a quick burst of energy, ideal for vehicle acceleration. However, they have low energy densities and can only store a small amount of energy.

A report from the Electric Vehicle Association of Canada (EVAC) shows that the use of BEVs in Canada can provide significant advantages to local air quality and global greenhouse gas reductions. The study indicates that every province in Canada would experience CO_2 reductions through the replacement of gasoline-fuelled vehicles with battery electric vehicles. On average, a BEV operating in Canada will reduce CO_2 emissions by 75% compared to a comparably sized conventional vehicle. Nevertheless, range, charging times, battery life and consumer acceptance remain challenges.

2.2.11 Fuel Cell Vehicles

This power source has excellent fuel efficiency, high power density, quiet operation and no harmful tailpipe emissions. Fuel cells convert a hydrogen rich gas and oxygen into electricity, which then powers electric motors to drive the vehicle. In an ideal system, one that is operated with pure hydrogen, the only by-product of the fuel cell is water vapour. There is no direct air pollution. However, there can be emissions in producing the hydrogen fuel.

Hydrogen could be derived from:

- Electrolysis of water to form hydrogen and oxygen. Clean sources of electricity (wind, solar, geothermal and possibly nuclear) would be preferred.
- Reforming of a hydrogen-rich feedstock such as ethanol, methanol, natural gas or even gasoline. Biomass could be used for ethanol production. CO_2 emissions are a byproduct of reforming natural gas and gasoline.
- Gasification of coal.

The hydrogen used by fuel cells can be stored as a compressed gas or a liquid in a cylinder directly on-board the vehicle, or can be manufactured on-board the vehicle through a process of reforming using a mini refinery.

The more promising fuel cell technologies should offer powerplants that are twice as efficient with half the greenhouse gas emissions of a conventional spark ignition gasoline vehicle.

2.2.12 Advanced Transmissions

The most common transmission types in Canada for light vehicles are the four-speed automatic and the five-speed manual transmission. For the 2002 model year, about 67% of passenger cars were equipped with 4-speed automatics and 25% with 5-speed manuals. For light trucks the statistics were 80% with 4-speed automatics and 6% with 5-speed manuals.

Adding more gears to either of these transmission types improves fuel consumption performance. Adding an infinite number of gears, as is done with a continuously variable transmission (CVT), is another approach.

CVTs can reduce vehicle emissions and fuel consumption by better matching vehicle operational demands with engine output. In many cases, engines can be downsized without degrading vehicle performance.

A new twist on the traditional manual transmission has been to take clutch operation duties away from the driver and turn them over to the vehicle on-board computers and electro-hydraulic systems. The driver then has the option of manually selecting gears or choosing an "automatic mode" and letting the vehicle handle all of the shifting chores. Called electrically shifted manual transmissions, or ESMATs, these transmissions give the convenience of an automatic transmission and the fuel efficiency of a manual.

These advanced transmissions can add significantly to better fuel efficiency. Compared to 4-speed automatic transmissions, the alternatives can add the following improvements in fuel consumption:

4-speed automatic	baseline
5-speed automatic	2% to 3%
5-speed manual	5% to 7%
5-speed manual with ESMAT	6% to 8%
6-speed manual	6% to 8%
CVT	4% to 5%

2.2.13 Supercharging and Turbocharging

The output of an internal combustion engine is proportional to the amount of fuel it can burn. To completely burn fuel, the engine requires 14.7 parts air to 1 part fuel. Since fuel can easily be pressurized and forced into the combustion chamber, an engine's output is extremely dependent on its ability to flow large quantities of air in a short amount of time. In conventional engines, the piston's movement to the bottom of the cylinder creates a vacuum, drawing in air.

Superchargers and turbochargers are forced induction systems that incorporate compressors to force more air into an engine. More air means that more fuel can be burned producing more power. Superchargers are typically driven off an engine's crankshaft and produce boost in direct relation to engine speed. Turbochargers are driven by waste heat and pressure in the exhaust gas exiting the combustion chamber.

By using superchargers and turbochargers, engines can be downsized without loss of output. This can yield fuel savings of 10%. Aggressive driving will significantly reduce the savings or eliminate them altogether.

2.2.14 42V Electrical Architecture

42-volt electrical systems will enable the introduction of various electrically operated accessories such as integrated starter/generators, electric power steering, air conditioner compressors and water pumps. This combination can yield a 7% reduction in fuel consumption and be applicable to virtually the entire car and light truck fleet.

2.2.15 Low Rolling Resistance Tires

Most tire manufacturers are developing high-efficiency tires that minimize rolling resistance while maintaining safety and performance. These tires can offer 20% less rolling resistance when compared to high performance radial tires. In city driving conditions, this can represent a fuel saving of some 3%, and 5% for highway usage.

2.2.16 Regenerative Braking

One way to reduce the amount of energy it takes to drive a vehicle is to recapture, store and reuse the kinetic energy usually dissipated as waste heat during vehicle braking. Most electric and hybrid electric vehicles on the road today accomplish this by operating the electric motor as a generator. This provides braking torque to the wheels and simultaneously recharges the batteries. The energy captured by regenerative braking can then be used for propulsion or to power vehicle accessories. The use of regenerative braking systems can also save on mechanical brake wear and maintenance. Regenerative braking can increase overall energy efficiency by as much as 30%

2.2.17 Summary of Fuel Consumption Improvements for Different Advanced Technologies

The fuel consumption improvements for advanced powertrains are summarized in Table 1. These improvements are not additive in all cases but are intended to give a flavour of the magnitude of the impact of individual technologies. It is felt that improvements of fuel consumption of the new car and light-duty truck fleet of 25% to 40% are possible in the next decade.

Table 1
Summary of Fuel Consumption Improvements for Different Advanced Technologies

Gasoline Direct Injection	15%	Hybrid Electric Vehicles	20% to 30%
Advanced Diesel Engines	40%	Battery Electric Vehicles	75%
Sequential Spark Ignition	10% to 15%	Fuel Cell Vehicles	*50% to 80%
Variable Valve Timing and Lift	6% to 8%	Advanced Transmissions	2% to 8%
Cylinder Deactivation	7% to 10%.	Supercharging and Turbocharging	10%
Variable Displacement	40%	42V Electrical Architecture	7%
Variable Compression Ratios	30%	Low Rolling Resistance Tires	3% to 5%
Idle Stop	6% to 8%	Regenerative Braking	*30%
* Energy Efficiency Improvements			

2.3 New Construction Methods and Materials

2.3.1 Aerodynamics

In the past, cars created a great deal of resistance (aerodynamic drag) when they moved through the air. This was largely due to their large frontal area and high drag. Typical coefficients of drag (C_D) ranged from 0.5 to 0.7. Modern vehicles are much more streamlined allowing air to flow over them with much less resistance ($0.28<C_D<0.38$) thus decreasing fuel consumption. With a further 20% to 25% reduction in C_D, reducing fuel consumption a further 2% to 2.5% from today's average should be possible.

2.3.2 Lightweight and Recyclable Materials

Lightweight materials include high strength steel, aluminum, magnesium, titanium, plastics, carbon fibre, and other composite materials. By using lightweight materials, manufacturers can build more fuel-efficient vehicles without sacrificing safety, durability and comfort. For every 10% of the weight eliminated from a vehicle, fuel consumption can be improved by 5% to 7%.

Current aluminum technology can cut half the weight out of a conventional body structure. Many manufacturers are already using aluminum extensively for complete body structures or selected panels such as hoods, trunk lids, doors and fenders. Aluminum can also be used in castings that replace cast iron for the engine block, cylinder heads, transmission housing and intake manifold. Aluminum forgings can be used to replace steel in the suspension, steering, axles, driveshafts and wheels.

About 75% of the weight of today's mostly metal vehicles is recycled at the end of vehicle life through a network of vehicle salvage and shredder facilities. This leaves about 25% of the weight of the vehicle, made up largely of plastics, glass and textiles, that are sent to land fills at a cost to manufacturers and ultimately to consumer and the environment. New recycling technologies for the plastic content of vehicles show promise at upping the recyclable total for a vehicle to 95% of its weight. Higher recycling rates will mean lower vehicle costs and less damage to the environment.

2.3.3 Small Urban Vehicles

In Europe and Asia, small, 2 and 4 passenger vehicles that weigh between 400kg and 900kg and are shorter than 3.4 meters are commonplace. Because of their compact dimensions, they reduce urban congestion. Because of their lightweight, fuel consumption in the 3 to 5 litres per 100-kilometer range is achieved.

2.4 Alternative Low Carbon Fuels

Although alternative fuels have been available for many years, they can play an important role in years to come in greenhouse gas reduction strategies. Of particular interest are alternative fuels that are low in carbon content. Vehicles operating on low-carbon alternative fuels such as compressed natural gas, ethanol, propane and hydrogen are presently being manufactured and developed by the automotive industry. It is also important to note that renewable, domestic resources such as wood, corn stalks, straw and switchgrass can be used to produce alternative fuels.

2.4.1 Clean Gasoline (C_4 to C_{12}) and Diesel (C_3 to C_{25})

Sulphur occurs naturally in petroleum products and causes increased emissions of sulphur dioxide and sulphate particles, both of which contribute to air pollution. Sulphur also decreases the efficiency of emission control systems in vehicles (e.g. catalysts, oxygen sensors), resulting in higher emissions of other pollutants such as carbon monoxide, oxides of nitrogen and volatile organic compounds.

Diesel fuel sulphur contributes significantly to fine particulate matter (PM) emissions through the formation of sulphates both in the exhaust stream and later in the atmosphere. Sulphur can also lead to corrosion and wear of engine systems. Furthermore, the efficiency of some exhaust after-treatment systems are reduced as fuel sulphur content increases, while others are rendered permanently ineffective through sulphur poisoning.

Car manufacturers see high sulphur levels in fuels as an impediment to the introduction of low emission vehicles and the next generation of fuel-efficient engines.

The Government of Canada has recently passed regulations to reduce sulphur content in on-road fuels. Starting in June 2006, diesel sulphur content will be reduced from the current limit of 500 parts per million (ppm) to a maximum of 15 ppm.

In 2001, the average level of sulphur in Canadian gasoline was 290 ppm. Effective July 2002, an average sulphur limit of 150 ppm came into effect for gasoline. This average limit may be met over a 2 ½ year interim period. This means that the sulphur limit of individual batches of gasoline may exceed 150 ppm as long as the required average is met over this 2 ½ year period. In January 2005, the interim period ends and a final 30 ppm annual average (80 ppm ceiling) sulphur limit comes into effect.

These reductions in the sulphur content of on-road gasoline and diesel fuel will help the introduction of advanced combustion engines in Canada, which in turn will help reduce fuel consumption and GHG emissions.

2.4.2 Biodiesel (C_{14} to C_{24})

Biodiesel is an alternative fuel that can be made from any fat or vegetable oil. The fuel can be used in any diesel engine with few or no modifications. Although biodiesel does not contain petroleum and can be used in its pure form, it can be blended with conventional diesel fuel in any proportion. This is typically done to enhance the cold weather performance of biodiesel. Biodiesels perform well, showing fuel consumption, horsepower, torque and haulage rates similar to conventional diesel fuels.

Compared to conventional diesel fuels, a 100% biodiesel fuel can reduce unburned hydrocarbons by 60%, carbon monoxide by 40%, and particulate matter by 40%, but can increase nitrous oxide emissions by 5%.

For plant derived biodiesel, the closed carbon cycle shows that the CO_2 released into the atmosphere when the biodiesel is burned can be recaptured at a rate of 70% to 80% by growing plants that produce the fuel. Well-to-Wheels CO_2 savings by using plant-derived biodiesel in place of conventional diesel in an internal combustion engine are about 50%. Savings approaching 90% are possible with biodiesels produced from animal fats.

2.4.3 Ethanol (C_2H_5OH)/Methanol (CH_3OH)

Low-level ethanol/gasoline blends have been used in Canada and the United States for many years. Ethanol can be produced domestically from corn or other crops, as well as from cellulosic biomass such as wood or paper wastes and grasses. With current technology ethanol is more expensive than gasoline to produce. New technologies offer the hope of significantly reduced costs for ethanol production.

Pure ethanol contains 35% oxygen. Adding oxygen to a fuel can result in more complete combustion that in turn reduces harmful tailpipe emissions. Emissions of criteria pollutants (HC, CO, NOx and PM) are typically the same or lower with ethanol fuels than conventional gasoline. Because of the renewable sources for ethanol fuels, some studies show that the use of a blend of 10% ethanol in gasoline could reduce greenhouse gas emissions by 2% to 4% compared with conventional gasoline. Biomass ethanol would provide a greater reduction than grain-based ethanol as would increasing the ethanol content of an ethanol/gasoline blend. GHG reductions of an E85 blend could reach 70% over conventional gasoline.

Methanol, like ethanol, is a high-performance liquid fuel. It can be produced at prices comparable to gasoline from natural gas. It can also be produced from any other renewable resource containing carbon such as seaweed, coal, waste wood and garbage. All major auto manufacturers have produced cars that run on "M85", a blend of 85 percent methanol and 15 percent gasoline. Cars that burn pure methanol (M100) offer a greater air quality and efficiency advantage than M85, however, there is a safety concern in that M100 burns with an invisible flame. There are also environmental concerns regarding groundwater contamination.

Although methanol has a lower energy content than gasoline, it burns more cleanly and efficiently. Compared to gasoline, the emissions of carbon monoxide, hydrocarbons, nitrogen oxides and particulate matter are lower from methanol-dedicated vehicles. Formaldehyde emissions, known carcinogens, can be higher. GHG emissions from renewable methanol production and use are considerably lower than for CNG-derived methanol. Well-to-Wheels CO_2 reductions for renewable M85 are about 78% relative to conventional gasoline.

2.4.4 Liquefied Petroleum Gas (LPG, C_3H_8)

Propane, or liquefied petroleum gas, is a by-product of petroleum refining and natural gas production. Propane-fueled vehicles are already common in many parts of the world.

Driving range with LPG vehicles is somewhat less than that of comparable gasoline-powered vehicles. Power, acceleration, payload, and cruise speed are as good or better.

Propane-fueled vehicles emit significantly lower levels of carbon monoxide, hydrocarbons, and particulate matter than gasoline-fueled vehicles. Well-to-Wheels GHG performance for propane is about 22% better than gasoline and 4.5% better than diesel when used in internal combustion engines.

2.4.5 Compressed Natural Gas (CNG, CH_4)

CNG is one of the cleanest burning fossil fuels. Compared to gasoline, its use could bring significant reductions in tailpipe emissions of all criteria pollutants.

Natural gas requires about four times the fuel tank volume to provide a driving range comparable to gasoline vehicles.

Well-to-Wheels GHG reductions for petroleum-derived CNG used in a spark ignition engine are about 28% compared to conventional gasoline. The reductions approach 99% for renewable CNG from biomass sources.

2.4.6 Hydrogen (H_2)

Hydrogen is a fundamental element in nature and is found in many common materials, including water. Its abundance and clean emission performance when used in a vehicle make hydrogen attractive as a major energy resource for the 21st century.

Hydrogen can be burned in a combustion engine or it can be used to produce electricity in a fuel cell to power an electric vehicle. Hydrogen combustion produces NO_x emissions. Its use in a fuel cell produces no direct harmful emissions and is preferred.

The greenhouse gas reduction benefits of hydrogen use depend largely on how the hydrogen is produced and used. Hydrogen is best used in a fuel cell application. The GHG reduction benefits are greatest when the hydrogen comes from renewable sources such as herbaceous ethanol and electrolysis of water using wind, solar or geothermal electricity. Well-to-Wheels GHG savings of 80% to 100% are possible.

2.4.7 Electricity

Canada is in the enviable position of producing 79.7% of its electrical power from sources with zero air emissions and having excess generation capacity, particularly at off-peak hours. According to data from Natural Resources Canada for 1995, 62.4% of our electrical power comes from hydro generation and an additional 17.3% from nuclear power. The remaining 20.3% comes from burning coal (14.8%), oil (2.2%), natural gas (2.5%), and other sources (0.8%).

For Canada this means that battery electric vehicles charged at off-peak hours would provide environmental benefits over conventional vehicles. Electrolysis of water to produce hydrogen for fuel cells is also attractive.

GHG savings for battery electric vehicles over conventional gasoline vehicles are about 66%.

2.4.8 CO_2 Reductions from Alternative Fuels and their Various Pathways

Choosing the fuel with the best Well-to-Wheels greenhouse gas emission performance is complicated. "Best" can depend on many factors. A fuel can often be derived from petroleum or biomass feedstocks and be used in many different ways. Fuels can be burned in a combustion engine, used in a hybrid/electric combination or be transformed into hydrogen or a different fuel using a fuel processor. All of these possibilities have different GHG impacts. The viability of any of these options is a function of local or domestic conditions governing the availability of feedstocks, fuel infrastructure and other similar considerations.

Table 2 lists data available from Natural Resources Canada GENIUS Model. The data highlights some of the fuel/technology options for Canadian light-duty vehicles and illustrates the diversity of options and their GHG impacts.

Table 2
Percent Reduction in CO_2 Equivalent Emissions
For Different Powertrain/Fuel Combinations/Fuel Production Methods vs. Conventional Gasoline

Power Plant	Fuel and Pathway	% CO_2 Reduction
Internal Combustion Engine	CNG from Wood via Biomass Power	99.1
Fuel Cell	CH_2 from Nuclear Energy via Thermocracking	89.6
Fuel Cell	E100 from Perennial Grasses via Biomass Power	82.3
Fuel Cell	CH_2 from Ethanol via Perennial Grasses	78.2
Internal Combustion Engine	M85 from Wood via Biomass Power	78.0
Battery Electric Vehicle	51% Nuclear, 30% Hydro, 18% Coal,2% Natural Gas	66.3
Fuel Cell	E100 from Corn via Natural Gas Power	61.4
Fuel Cell	CH_2 from Corn Ethanol	55.6
Fuel Cell	CH_2 from Electricity	53.4
Fuel Cell	CH_2 from Natural Gas	48.0
Diesel ICE Hybrid	Diesel from Crude Oil	41.8
Fuel Cell	CH_2 from Methanol	41.4
Fuel Cell	M100 from Natural Gas	40.7
Internal Combustion Engine	CNG from Natural Gas	28.1
Fuel Cell	CH_2 from LPG	26.9
Gasoline ICE Hybrid	Reformulated Gasoline from Crude Oil	26.2
Internal Combustion Engine	LPG from Natural Gas Liquids	21.8
Diesel ICE	Conventional Diesel from Crude Oil	17.4
Internal Combustion Engine	M85 from Natural Gas	7.9
Internal Combustion Engine	E10 from Perennial Grasses via Biomass Power	4.2
Internal Combustion Engine	E10 from Corn via Natural Gas Power	2.1

Source: NRCan GENIUS Model Projections for 2010

CH_2	Compressed Hydrogen
CNG	Compressed Natural Gas
E10	Blend of 10% Ethanol and 90% Conventional Gasoline
E100	Neat Ethanol
ICE	Internal Combustion Engine
LPG	Liquefied Petroleum Gas, Propane
M85	Blend of 85% Methanol and 15% Conventional Gasoline
M100	Neat Methanol

3. PROGRAM DESCRIPTION

Under the Advanced Technology Vehicles Program (ATVP), available and soon to be available advanced vehicles and technologies are being assessed to determine their impact on safety, energy efficiency and the environment.

Vehicles with advanced powertrains, materials, chassis designs, emission controls, fuels, controls and displays and other technologies are poised for introduction over the next decade.

The ATVP will ensure that Transport Canada is ready to match the pace of technological change with programs that facilitate the introduction and use of clean, safe and efficient advanced technology vehicles.

3.1 Program Goals

The goal of the ATVP is to support Transport Canada's efforts to reduce greenhouse gas emissions from transportation sources and achieve a transportation system for Canada that is sustainable. The program is aimed at reducing greenhouse gas emissions from on-road vehicles by:

- Evaluating the fuel efficiency, emissions and safety performance of advanced technology vehicles;
- Identifying opportunities and market potential for the introduction and use of advanced technology vehicles;
- Identifying barriers to the introduction and use of advanced technology vehicles and recommending remedies;
- Raising public awareness of advanced technology vehicles; and
- Supporting Transport Canada's environmental programs.

3.2 Program Activities

A program of acquisition, inspection, evaluation, testing and showcasing of advanced technology vehicles has been designed and implemented to meet the program goals. A description of the activities undertaken follows.

3.3 Vehicle Acquisition

As outlined in paragraph 2.1, the Advanced Technology Vehicles Program is targeting near-term advanced technology vehicles. The design, development and production of advanced vehicles and technologies from around the world are being monitored by the Directorate to identify and acquire suitable candidates for the program fleet.

The program fleet numbers 63 advanced vehicles. Twenty-seven were acquired during the 2001/2002 fiscal year. The current fleet includes:

- Battery electric vehicles;
- Gasoline/electric hybrid vehicles;
- Alternative fuelled vehicles (CNG, E85);
- Vehicles with advanced gasoline direct injection engines;
- Vehicles with advanced turbo direct injection diesel engines;
- Urban vehicles;
- Vehicles with advanced light-weight materials; and
- Other vehicles chosen specifically to challenge established regulations.

A complete list of vehicles in the program with specifications is contained in Annex 1.

3.4 Vehicle Evaluation

3.4.1 Vehicle Inspections

There are 827 separate requirements of the Canada Motor Vehicle Safety Standards and Regulations under the Motor Vehicle Safety Act to which compliance of a passenger vehicle can be determined by visual inspection. All vehicles in the ATVP fleet are being inspected to ascertain their state of compliance with the noted requirements. A copy of the inspection form used for this purpose is contained in Annex 2.

The results of these inspections can help identify regulatory barriers to the introduction of advanced technology vehicles in Canada. Similarly, the inspections can highlight opportunities to streamline, modernize and modify our regulations to facilitate the introduction of advanced technology vehicles in ways that do not compromise the environment or safety.

3.4.2 On-Road Evaluation

Most vehicles in the ATV fleet undergo an on-road evaluation. The vehicles are driven on public roads through all seasons and driving conditions. This permits an assessment of the vehicle in real-life conditions and a determination of how well the vehicle fits in with other vehicles and traffic on Canadian roads. Evaluations of a broad range of vehicle characteristics and performance parameters are made. A sample of the evaluation questionnaire, which is completed by each evaluator, is contained in Annex 3.

3.4.3 Instrumented Track Testing

Program engineers and technicians put the advanced vehicles through their paces at Transport Canada's Motor Vehicle Test Centre. This is a comprehensive test facility located on a 1200 acre site in Blainville, QC, which has available the laboratory and track facilities needed to properly test these vehicles under controlled conditions.

On the vehicle dynamics area, brake test area, brake hill, 7.2-kilometer long high speed oval and other road types at the test centre, vehicles are tested using the most modern and sophisticated test instrumentation for:

- Acceleration;
- Braking;
- Top speed;
- Handling on the skid pad, through a slalom and in an emergency lane change manoeuvre;
- Aerodynamic drag and rolling resistance; and
- Turning circle.

3.4.4 Laboratory Testing

On-road and instrumented track tests are complemented by a series of formal laboratory tests. Chassis dynamometers at Environment Canada are used to measure emissions and fuel consumption. Safety labs at the Transport Canada Test Centre are used to test:

- Occupant protection in front, rear and side crash tests;
- Roof strength;
- Side door strength;
- Seat belt anchorage;
- Defroster performance;
- Anti-lock brake performance on ice;
- Brakes (service and parking);
- Bumpers; and
- Noise.

3.5 Special Studies

In addition to the vehicle evaluations and tests described, a number of special studies are being performed. These studies include:

- Vehicle safety vs. vehicle size/weight;
- Comparison study of international safety regulations (Japanese, ECE, US, Australian, Canadian);
- Comparison of international rear barrier crash test requirements; and
- Motorcycle fuel system integrity.

These studies are just getting underway. Initial results and findings will be reported as they become available.

3.6 Partnerships

Partnerships with other federal government departments, the vehicle industry and non-government organizations have been struck. These will serve the partners in a number of ways including the sharing of information, research, costs, usage of testing facilities, participation in events and promotion of mutual objectives. The following partnerships have been established to date.

3.6.1 National Research Council of Canada and Nissan (Study of Particulate Emissions from Gasoline Direct Injection Engines)

The National Research Council of Canada (NRC) is Canada's premier science and technology research organization. The NRC is a leader in scientific and technical research, the diffusion of technology and the dissemination of scientific and technical information. NRC's institutes cover a wide range of research fields.

The ATVP and Nissan Canada are participating in research being conducted by the Institute for Chemical Process and Environmental Technology (ICPET)/Combustion Group of the National Research Council of Canada (NRC). The Council is developing a Laser-Induced Incandescence (LII) instrument as a practical tool for measuring exhaust particulates. The NRC is using a Nissan Gloria equipped with an advanced gasoline direct injection engine from the ATVP fleet as a test vehicle. Nissan Canada Inc. loaned this vehicle to Transport Canada. LII is a technique for measuring spatially and temporally resolved particulate concentration and size. LII is orders of magnitude more sensitive than the standard gravimetric measurement technique and thus offers the promise of real-time measurements and adds the increasingly desirable size and morphology information.

Currently, the NRC is also working on projects to measure particulate concentration and/or size from diesel engines, direct injection spark ignition engines, gas turbines, carbon black furnaces, and research flames. Other applications of the LII technology include evaluating fuel composition and additive effects and measuring/monitoring stack emissions from industrial furnaces, power generation plants and incinerators.

3.6.2 Health Canada (Characterization of Hazardous Airborne Chemicals in Emissions From Diesel Ether Fuels)

The objective of this project is to characterize chemicals in the emissions of high cetane ether blended diesel fuels under engine combustion conditions. Such characterization is critical to ensure that health concerns are addressed in the development of high cetane ethers and high quality diesel fuels. The project also reflects the federal government's objective to ensure that all energy projects are consistent with its commitment to sustainable development. The project measures both the regulated pollutants (NOx, CO, total hydrocarbons (THC) and particulate matter (PM)), and non-regulated pollutants (CO_2, VOCs, oxygenated combustion products, carbonyls, PAH/nitro-PAH) in diesel engine emissions. The tests will provide the full spectrum of vehicle exhaust composition, as well as identify potentially hazardous chemicals resulting from the addition of oxygenates in the fuel. As well, the potential mutagenicity of vehicle exhaust from various oxygenated fuels will be studied to assist in the selection of fuel additives.

This project has required close collaboration between a number of parties. Transport Canada has provided test vehicles. Environment Canada has carried out tests in their emissions lab. NRCan has helped select test fuel additives. Shell Canada has supplied diesel fuels as base fuels for the tests and, 'Université de Laval' has synthesized chemical additives that are not commercially available.

The project addresses some of the health issues surrounding the use of diesel ethers. The data from this study characterizing emissions can be used together with the results from other research to develop high cetane ethers. These can be blended with diesel fuel to make high cetane fuels that are clean and safe.

3.6.3 Environment Canada (Fuel Quality and Test Cycle Effects)

Environment Canada's Environmental Technology Centre, Emissions Research and Measurement Division, has donated the test facilities and personnel to perform the emission and fuel consumption tests on the vehicles in the ATVP. Transport Canada and Environment Canada are sharing the test results from this program.

In addition to this testing, the two departments are cooperating on two research projects.

The first is to investigate the effect of fuel sulphur on the emissions from vehicles equipped with gasoline direct injection (GDI) engines.

The second will compare the emissions and fuel consumption performance of a number of different vehicles on the U.S. EPA, the ECE and the Japanese test cycles.

3.6.4 University Researchers (Advanced Engine Research)

Over 30 universities in Canada offer engineering courses. They often conduct research in very advanced and specialized fields to prepare their students for the future. For the 1999 Society of Automotive Engineers Super-Mileage Student Competition, three Canadian universities finished in the top ten (2 being in the top three) of schools competing from across North America. This is a commendable accomplishment and demonstrates the innovative thinking and importance that Canadian students place on energy/fuel consumption and environmental issues. Teaming up with educational facilities for research, testing, and technology showcasing events is being considered.

3.7 United Nations Economic Commission for Europe, Working Party 29, Working Party on Pollution and Energy (UNECE/WP.29/GRPE)

WP.29 is a working party under the United Nations Economic Commission for Europe's Inland Transport Committee. The Working Party administers a number of agreements including the 1998 Global Agreement on the Harmonization of Vehicle Technical Regulations. The 1998 Global Agreement, to which Canada is a signatory, is a forum for countries to participate in an effective way in the development of harmonized global technical regulations for on and off road vehicles.

The Directorate is participating in the Working Party on Pollution and Energy (GRPE). This is a subsidiary working party under WP.29 where regulations concerning pollution of the environment, noise disturbances, new powertrain technologies and conservation of energy (fuel consumption) are developed. The Directorate also participates on a number of other safety related working groups.

Harmonization of global technical regulations for vehicles is critical for the introduction and use of advanced technology vehicles. The work of the Road Safety Directorate with the various working parties of the UNECE/WP.29 is meant to advance this objective.

3.8 Technology Showcasing Events

Public events are a fundamental part of the Advanced Technology Vehicles Program. The events are meant to raise the awareness of the general public to the existence and benefits of advanced technology vehicles.

A number of different approaches are used to reach the public. These include:

- Articles about the program and advanced technology vehicles in newspapers, magazines and books;
- Television programs and interviews;
- Live internet interviews; and
- Vehicle displays at conferences and various public events.

Feedback from the public is used to determine the general level of acceptance, knowledge, and interest in the advanced vehicles and in the goals and objectives of the program.

3.9 Website

The purpose of the ATVP website will be to increase public awareness of the ATV Program and of advanced technology vehicles and their impact on safety, energy efficiency and the environment.

The following information is planned for the site;

- Description of the program;
- Description of the vehicles in the advanced technology vehicle fleet;
- Test results;
- Vehicle evaluation reports;
- Vehicle test reports;
- Events calendar; and
- Program annual reports.

A business case may also be developed to support the use of video so that short action clips of the various vehicles may be made available to the public via the website.

3.10 Monitoring Penetration of ATVs in Canada

Preliminary monitoring of the Canadian market penetration of advanced technologies and vehicles is being done through the Vehicle Fuel Economy Information System (VFEIS).

The VFEIS system is designed to capture fuel consumption and drivetrain information for light-duty passenger cars and trucks sold in Canada. This information is collected as part of the government's Voluntary Fuel Consumption Program and is published in National Resources Canada's annual Fuel Consumption Guide.

There are a limited number of ATVs currently available to the general public. As market penetration increases, this multi-year database system will be able to track the trends.

Currently VFEIS can track:

- New powertrains and engine developments
  - Advanced transmission systems
  - Variable valve timing and lift
  - Hybrid and battery electric drives
  - Supercharging/turbocharging
- Advanced or low carbon fuels
  - Ethanol
  - Liquefied petroleum gas (LPG)
  - Compressed natural gas (CNG)
  - Electricity

Changes to VFEIS will be needed to better track the penetration and sales of advanced technologies and vehicles.

4. PROGRAM RESULTS

4.1 Vehicle Acquisitions

As of March 31, 2002, the ATVP fleet was comprised of a total of 63 advanced vehicles. Twenty-seven of these vehicles were purchased during the 2001-2002 fiscal year.

The advanced technologies encompassed by the fleet included:

- Battery electric vehicles;
- Hybrid gasoline/electric vehicles;
- Urban vehicles;
- Advanced scooters, motorcycles and power assisted bicycles;
- Advanced gasoline and diesel engines with:
    - Direct injection,
    - Variable valve timing and lift,
    - Turbocharging,
    - Idle stop, and
    - Integrated starter/generators
- Advanced transmissions:
    - 5 speed automatics,
    - Continuously variable transmissions,
    - Electronically shifted manual transmissions, and
    - Sequential shifters
- Alternative low carbon fuels (CNG, E85)
- Vehicles with:
    - Advanced aerodynamics,
    - Lightweight materials for bodies and chassis,
    - Electric power assisted steering and braking,
    - Regenerative braking,
    - Throttle by wire, and
    - Advanced restraint systems.

A complete list of the advanced vehicles in the fleet with a summary of their specifications and a photo are contained in Annex 1.

4.2 Vehicle Evaluation

Vehicles were evaluated through inspection, subjective on-road assessments, instrumented tests on the test track, and formal testing in the laboratory. Reports for vehicles evaluated in each of these areas have been produced. Summary reports that incorporate the results of all testing completed have also been produced as follows.

4.2.1 Vehicle Inspections

For the 2001/2002 fiscal year, five vehicles have been inspected against the requirements of the Canada Motor Vehicle Safety Standards (CMVSS) that can be determined by visual inspection. The vehicles inspected are the Volkswagen Lupo 3L (TC00-003), the Mercedes-Benz A170 (TC00-004), the MCC Smart (TC00-005), the Corbin Sparrow (TC01-026) and the Suzuki Swift (TC01-027).

4.2.2 On-Road Evaluation

261 evaluations by different drivers covering over 300,000 kilometers of driving of 19 vehicles in the ATV fleet have been completed. All evaluations for a particular vehicle are reviewed and a summary report produced. A summary of the factors rated for each vehicle is presented in Table 3.

Table 3
Sample On-Road Evaluation Summary

VEHICLE CHARACTERISTICS	
Ease of Operation	Visibility
Handling	Night Visibility
Manoeuvrability	Cargo Space
Ergonomics	Front Seat Comfort
Vehicle Size	Braking performance
Engine Power	Occupant Restraint Comfort
Drivability	Head Restraint Placement
Fuel Efficiency	Mirror Functionality/Adjustability
Transmission Control and Operation	Performance in Adverse Weather/ Poor Roads
Driving Range	Practicality of the Vehicle
Instrument Panel and Displays	Market Potential
Climate Control System	Feeling of Safety While Driving
Noise	

During the on-road evaluations, fuel consumption of the evaluation vehicles was being tracked. Table 4 below summarizes the on-road fuel consumption by season and compares it to the results from the laboratory dynamometer tests. The laboratory results tabulated are for the combined fuel consumption. This is the sum of 55% of the city and 45% of the highway fuel consumption results from the laboratory tests. The combined fuel consumption test result from the laboratory is most comparable to the on-road fuel consumption achieved during summer driving.

By comparison, the combined city and highway fuel consumption for new passenger cars sold in Canada ranges from 3.6 to 15.1 l/100km. The average for all new cars is 7.7 l/100km.

Table 4
Summary of On-Road Fuel Consumption

ON-ROAD FUEL CONSUMPTION		*ENGINE*		*SPRING*		*SUMMER*		*FALL*		*WINTER*		*OVERALL* ALL SEASONS COMBINED		*COMBINED* CITY/HIGHWAY
		SIZE (LITRES/ VOLTS)	*FUEL TYPE*	*KM*	*AVG F.C. (L/100KM)*	*KM*	*AVG F.C. (L/100KM)*	*KM*	*AVG F.C. (L/100KM)*	*KM*	*AVG F.C. (L/100KM)*	*KM*	*AVG F.C. (L/100KM)*	*LAB RESULT (L/100KM)*
99-003	Chevrolet Metro	1.0	G	2095	6.196	3906	5.903	1483	6.402	1355	7.450	8839	6.49	N/A
99-004	Chevrolet Metro	1.0	G	2030	4.514	2410	4.457	1021	6.461	3491	7.131	8952	5.64	N/A
99-010	Ford F-250 CNG	5.8	CNG	2928	21.146	3884	18.310	1764	19.400	2552	20.299	11128	19.79	14.9
99-013	Honda Civic GX CNG	1.6	CNG	1829	7.804	3121	8.237	1825	9.776	2473	9.470	9248	8.82	6.8
00-001	Honda Insight	1.0/144	G/E	3042	4.882	6518	3.701	3740	5.087	6073	5.113	19373	4.70	3.5
00-002	Renault Mégane	2.0	G/E	663	9.351	3179	9.556	2245	11.113	1347	10.164	7434	10.05	6.6
00-003	Volkswagen Lupo 3L	1.2	D	4783	4.002	4518	4.391	2514	4.300	2787	4.408	14602	4.28	3.4
00-004	MB A-170 CDI	1.7	D	6178	5.837	5160	5.915	6253	5.812	3183	5.973	20774	5.88	4.5
00-005	MCC Smart CDI	0.8	D	6365	4.702	5777	4.890	5725	4.895	4029	4.615	21896	4.78	3.1
00-006	Mitsubishi Dion	2.0	G											
00-007	Nissan Gloria	3.0	G											
00-008	Nissan Sentra CA	1.8	G	990	8.186	740	10.606	4277	9.254	2278	8.776	8285	9.21	6.5
00-009	Yamaha Razz	0.049	G											3.4
00-010	MCC Smart Cabrio	0.6	G									1718	4.61	4.4
01-002	Suzuki Alto LX	0.660	G							2277	6.946	2716	6.95	4.6
01-003	Suzuki Wagon R	0.660	G					3534	6.162			3534	6.16	N/A
01-004	Honda Acty Dump Truck	0.660	G					2293	8.112	1495	9.365	3788	8.74	7.2
01-005	BMW C1	0.125	G					441	3.751			441	3.75	2.6
01-006	Toyota Prius	1.5/274	G/E	609	6.470					2751	6.390	3360	6.43	3.8
01-007	Honda Turbo Z	0.660	G	857	10.117			1828	8.935	1570	10.682	4255	9.91	N/A
01-010	VW Beetle GLS TDI	1.9	D	2129	5.143	1927	3.902	3308	5.676			7364	4.91	4.5
01-011	Audi A2 1.4L	1.4	D	1735	4.126	3553	5.087	2416	5.608	2628	5.110	10332	4.98	4.1
01-014	Honda Vamos L	0.660	G	1258	8.545					4035	7.989	5293	8.27	N/A
01-022	Nissan Sentra GXE	1.8	G			2600	8.139	1105	8.666			3705	8.40	6.6
01-024	Toyota Echo	1.5	G	3456	5.718							3456	5.72	5.2
01-025	Chrysler PT Cruiser	2.2	G	3825	9.797	2409	9.959	1796	11.031	6526	10.771	14556	10.39	8.5
01-027	Suzuki Swift GL	1.3	G	1434	6.060	2301	6.387					3735	6.22	5.2
02-005	Chevrolet Silverado	6.6	D	3372	14.858							3372	14.86	13.9
02-006	Ford Focus ZX5	2.0	G	917	7.928							917	7.93	N/A
02-015	MCC Smart Cabrio Pulse (45kW)	0.6	G	1349	5.552							1349	5.55	N/A
02-019	Audi A6 TDI	2.5	D	2936	7.861							2936	7.86	6.2
02-031	VW Jetta GLS	1.9	D	908	6.597							908	6.60	N/A

G -Gasoline
G/E -Gas/Electric Hybrid
D -Diesel
CNG -Compressed Natural Gas

4.2.3 Instrumented Track Testing

17 vehicles have completed track testing. The results are summarized in Table 5 below.

<u>Table 5</u>
Summary of Track Test Results

VEHICLE TEST RESULTS		*ENGINE*		*ACCELERATION / SPEED*			*BRAKING*	*ROAD HANDLING*		
		DISPLACEMENT (LITRES/VOLTS)	*FUEL TYPE*	*0-100KPH (SEC)*	*1/4 MILE (SEC~KPH)*	*TOP SPEED (KPH)*	*100-0 KPH (M~SEC)*	*LATERAL ACCELERATION (G)*	*SLALOM (KPH)*	*EMERGENCY LANE CHANGE (KPH)*
98-007	Solectria	156V/180V	E	*Norm N/A *Max N/A	27.53~78.3 24.57~86.0	97.2	24.0~2.39[2]	0.64	78.0	81.0
98-022	Ford Ranger EV	312V	E	21.47	21.59~100.2	118.9	50.9~3.60	0.76	88.0	89.0
99-004	Chevrolet Metro	1.0	G	18.17	20.53~102.5	148.0	46.5~3.38	0.72	88.0	85.0
00-001	Honda Insight	1.0/144V	G/E	12.63	18.72~118.7	146.0	44.5~3.18	0.80	94.0	97.0
00-002	Renault Megane	2.0	G	8.74	16.33~140.6	206.0	40.3~2.83	0.94	88.0	93.0
00-003	VW Lupo 3L	1.2	D	**A 14.30 **M 15.70	19.90~113.1 20.00~112.0	166.0	42.3~3.06	0.82	80.0	88.0
00-004	MB A-170	1.7	D	12.5	19.20~119.7	175.0	40.8~2.93	0.88	89.0	86.0
00-005	MCC Smart CDI	0.8	D	**A 18.20 **M 19.30	21.40~105.1 21.60~104.9	128.5	44.2~3.12	0.76	78.0	97.0
00-006	Mitsubishi Dion	2.0	G							
00-010	MCC Smart Cabrio	0.6	G	**A 14.61 **M 14.44	19.78~116.0 19.58~116.4	137.0	43.8~3.11	0.76	77.0	96.0
01-005	BMW C1	0.125	G	N/A	22.37~92.9	105.0	44.6~3.05	N/A	79.0	N/A
01-009	Nissan Hypermini	115V	E	N/A	22.73~93.5	103.6				
01-010	VW Beetle GLS TDI	1.9	D	12.06	18.39~122.7	164.0	42.7~3.02	0.88	92.0	86.0
01-011	Audi A2 1.4L	1.4	D	14.86	19.57~114.0	165.0	43.7~3.11	0.87	92.0	93.0
01-025	Chrysler PT Cruiser	2.2	G	11.79	18.25~124.9	176.0	41.1~2.92	0.83	92.0	93.0
01-026	Corbin Sparrow	156V	E	N/A	31.26~65.8	114.0	54.7~3.81	0.76	82.0	84.0
01-027	Suzuki Swift GL	1.3	G	11.83	18.19~118.7	164.0	51.0~3.66	0.82	90.0	86.0

G -Gasoline
EA -Electric Assist
D -Diesel
E -Battery Electric
G/E -Gas/Electric Hybrid
* -Range setting on transmission
** -Automatic or manual setting on transmission

[1]90-0kph [2]70-0 kph

4.2.4 Laboratory Testing

25 vehicles have been tested in the laboratory. Table 6 below summarizes the results of the various tests completed.

<u>Table 6</u>

Summary of Laboratory Test Results

LABORATORY TEST RESULTS		*ENGINE*			*FUEL CONSUMPTION (L / 100 km)*		*CRASH TESTS*					*OTHER TESTS (Destructive and Non)*			
		DISPLACEMENT (LITRES/VOLTS)	*FUEL TYPE*	*EMISSIONS*	*CITY*	*HIGHWAY*	*FRONT*	*SIDE*	*REAR*	*BUMPER*	*ROOF CRUSH*	*DEFROSTER/ DEFOGGER*	*BRAKES*	*NOISE*	*SEAT BELT ANCHORAGE*
99-003	Chevrolet Metro	1.0	G	A		4.2				R		A			
99-004	Chevrolet Metro	1.0	G	A		4.4				R		A			
99-010	Ford F-250 CNG	5.4	CNG	A	15.6	11.5									
99-013	Honda Civic CNG	1.6	CNG	A	7.9	5.4									
00-001	Honda Insight	1.0/144V	G/E	A	4.0	2.9				A		A	A		A
00-002	Renault Megane	2.0	G	A	7.6	5.3						A			
00-003	Volkswagen Lupo 3L	1.2	D	NI	3.8	3.0	A			NI		A			
00-004	Mercedes-Benz A-170	1.7	D	NI	5.2	3.8	A			NI		A			
00-005	MCC Smart CDI	0.6	D	A	3.3	2.8	A			NI		NI			
00-006	Mitsubishi Dion	2.0	G												
00-007	Nissan Gloria	3.0	G												
00-008	Nissan Sentra CA	1.8	G												
00-009	Yamaha Razz	0.049	G	NI	3.4								A	A	
00-010	MCC Smart Cabrio	0.6	G	A	4.9	3.8						NI			
01-002	Suzuki Alto	0.660	G	A	5.0	4.0									
01-004	Honda Acty Dump Truck	0.660	G	NI	7.2	7.1									
01-005	BMW C1	0.125	G										A	NI	
01-006	Toyota Prius	1.5/274V	G/E	A	4.0	3.5				A					A
01-010	VW Beetle GLS TDI	1.9	D	A	5.2	3.8	A		A	A		A			A
01-011	Audi A2 1.4L	1.4	D	A	4.8	3.2						A			
01-014	Honda Vamos	0.660	G	NI	7.4							NI			
01-022	Nissan Sentra GXE	1.8	G	A	7.7	5.3				A		A			A
01-024	Toyota Echo	1.5	G	A	5.9	4.9		A	A				A		
01-025	Chrysler PT Cruiser	2.2	G	A	11.7	8.3	A			A					A
01-027	Suzuki Swift GL	1.3	G	A	6.0	4.2			R						

G/E	-Gasoline/Electric Hybrid	A	–Acceptable
G	-Gasoline	NI	–Needs Improvement
D	-Diesel	R	–Research
E	-Battery Electric		
EA	-Electric Assist		
CNG	-Compressed Natural Gas		

4.3 Special Studies

4.3.1 Vehicle Safety vs Vehicle Size/Weight

Frontal barrier crash tests have been performed on several small vehicles from the ATVP fleet, namely the MCC Smart, Volkswagen Lupo, Mercedes Benz A170 and Geo Metro. Results from these tests show that these vehicles would pass the Canadian regulated requirements. More testing has been scheduled. The test results and their implications for the safety of small cars will be presented in the next steps of the program.

4.3.2 Comparison Study of International Safety Regulations (Japanese, ECE, US, Australian, Canadian)

The regulations and standards from the ECE, the USA, Canada, Australia and Japan that apply to road motor vehicles are summarized by number and presented in Annex 4.

This table highlights the need for common global standards and regulations to reduce the development and certification burden. Global standards would result in greater product availability at a lower cost for all consumers.

4.3.3 Motorcycle Fuel System Integrity

Transport Canada is developing regulations for the fuel system integrity of motorcycles and three wheeled vehicles. There are currently no such standards in Canada or the US. There are however standards in Europe and recommended practices in the US issued by the Society of Automotive Engineers (SAE).

The Department is conducting research on the European and SAE requirements to determine whether adopting both requirements as alternatives is appropriate. This would be the least restrictive approach for the entry of advanced versions of these vehicles into Canada.

The department tested one motorcycle to the SAE recommended practice, J1241, in order to evaluate the validity of the tests and the associated costs of compliance. Although no actual testing was conducted to the European requirement, both requirements were deemed to provide an acceptable level of occupant safety for the Canadian proposed regulation.

The Department subjected a three-wheeled vehicle to SAE recommended practice J288, “Snowmobile Fuel Tanks”, in order to evaluate the validity of the tests and the associated costs. The SAE practice was found to provide a minimum acceptable level of safety for the vehicle occupants, and was proposed for the new Canadian regulation. No vehicle was tested to the European requirement, and this has not yet been offered as an alternative to the SAE recommended practice.

4.4 Partnerships

4.4.1 National Research Council of Canada and Nissan (Study of Particulate Emissions from Gasoline Direct Injection Engines)

The LII technique being developed for measuring spatially and temporally resolved particulate concentration and size has shown good results.

Primary particle sizes of particulate matter (PM) have been measured over the range of 0.010 to 0.100 (10 to 100 nm), with a precision of ±10 %. Research on aggregate sizing with a combined LII/inelastic scattering technique will provide size distributions over the range PM 0.001 to PM 1.

4.4.2 Health Canada (Characterization of Hazardous Airborne Chemicals in Emissions From Diesel Ether Fuels)

The objective of this project is to characterize chemicals in the emissions of high cetane ether blended diesel fuels under engine combustion conditions. So far, several tri-ether and di-ethers as potential fuel additives have been tested. These tests will continue and their results will be presented in future ATVP Annual Reports.

4.4.3 Environment Canada (Fuel Quality and Test Cycle Effects)

The effect of fuel sulphur on the emissions from vehicles equipped with gasoline direct injection (GDI) engines is being evaluated. Vehicles have been tested with gasoline containing 0ppm sulphur and are currently undergoing mileage accumulation on gasoline with 15ppm sulphur. More testing will be done with sulphur contents of 30ppm, 150ppm, 300ppm and finally 0ppm again. Results will be presented as they become available.

Comparing the emissions and fuel consumption performance of vehicles on the U.S. EPA, the ECE and the Japanese test cycles is also underway. Test results will be reported when available.

Characteristics of the 3 cycles being compared are summarized in Table 7.

Table 7
Summary of US EPA, ECE and Japanese Test Cycles

	US EPA		ECE		JAPANESE
	City	Highway	City	Highway	City Highway Combined
Time (seconds)	1369	765	780	400	660
Length (km)	12	16	4.052	6.955	4.16
Top Speed (kph)	91.3	96.5	50	120	70
Average Speed (kph)	32	77	18.7	62.6	22.7
Number of Stops	18	0	16	0	7

Although the tests cycles from the three jurisdictions are very different, the vehicles being produced to meet emission standards pursuant to the various cycles are very similar. Perhaps there is opportunity for global harmony of emission standards. This would be a major step forward towards a global market.

4.4.4 University Researchers (Advanced Engine Research)

No results to report.

4.5 UNECE/WP.29/Working Party on Pollution and Energy

The WP.29 –Working Party on Pollution and Energy (GRPE) is presently researching health risks and test procedures for ultra fine particles. A working group chaired by the United Kingdom has been struck to investigate the instrumentation required to measure ultra-fine particulates. Transport Canada is actively participating on this working group. The NRC results from the partnership project noted in paragraph 4.4.1 have been shared with the GRPE members to help advance the search for suitable instrumentation. The results from this project will enable the development of standards that will protect human health from ultra-fine vehicular particulate emissions.

Another working group the GRPE has established is responsible for the development of safety standards related to liquid and gaseous hydrogen storage tanks. The Canadian Transportation Fuel Cell Alliance (CTFCA) is presently responsible for developing these standards in Canada. A technical expert from the CTFCA has been appointed to this GRPE working group. The establishment of safe hydrogen storage regulations is key to early adoption of fuel cell vehicles. These regulations are being developed as ECE regulations. It would be preferable to develop them as Global Technical Regulations (GTRs) to avoid a potential barrier to the introduction of fuel cell vehicles in Canada.

The Directorate participates on other safety related working groups. Work is underway to develop GTRs related to controls and displays, motorcycle brakes, location of exterior lighting, and common definitions for vehicle categories, masses and dimensions.

4.6 Technology Showcasing Events

It is estimated that by the end of the 2001/2002 fiscal year, 1.7 million Canadians were made aware of the Advanced Technology Vehicles Program and advanced technology vehicles through a comprehensive program of events. The events focused on the print media (newspapers, magazines and books), television, radio, live Internet and major events such as auto shows, conferences and other public functions. As of March 31, 2002, thirty-five events have been held with thirteen occurring from April 1 2001 to March 31, 2002.

Table 8 summarizes all the events held to the end of March 2002 and the estimated number of Canadians reached by each event.

Table 8
Summary of Events

EVENT AND LOCATION	DATE	ATTENDANCE
Honda on the Hill Parliament Hill, Ottawa, Ontario	March 31, 2000	500
Autorama Annual Exhibition Lansdowne Park, Ottawa, Ontario	March 31 to April 2, 2000	10,000
ATVP Vehicle Display Transport Canada, Tower C, Ottawa, Ontario	April 27, 2000	375
Ford on the Hill Parliament Hill, Ottawa, Ontario	May 4, 2000	2,500
Nortel Transportation Fair Kanata, Ontario	May 5, 2000	1,500
Road Safety Motor Vehcile Safety Standards and Research Branch (ASFB) General Staff Meeting Transport Canada, Brock Building, Ottawa, Ontario	May 16, 2000	40
Presentation to NRCan Transport Canada, Brock Building, Ottawa, Ontario	May 25, 2000	15
SAE Ottawa Transport Canada, Brock Building, Ottawa, Ontario	May 25, 2000	40
Canada Post Environment Week Ottawa, Ontario	May 31, 2000	150
Electric Vehicle Council of Ottawa (EVCO) Electrathon Capital City Raceway, Ottawa, Ontario	June 3, 2000	62
Windsor Workshop Windsor, Ontario	June 5 to 7, 2000	750
Journée de l'air pur Montreal, Quebec	June 7, 2000	500
CEVEQ Vehicle Display St.-Jerome, Quebec	June 8, 2000	30
Millennium Transportation Conference Toronto, Ontario	June 11 to 12, 2000	350
Road Safety Directorate and Collision Investigation Teams meeting Motor Vehicle Test Centre, Blainville, Quebec	June 12 to 16, 2000	45

Le Guide de l'Auto (TV Show) Motor Vehicle Test Centre, Blainville, Quebec	June 12 to 13, 2000	150,000
Le Droit (VW Lupo Article) Transport Canada, Brock Building, Ottawa, Ontario	August 19, 2000	40,000
CGRC Radio Interview (re.: Le Droit article) Hull, Quebec	August 23, 2000	5,000
Ottawa Citizen (Wheels Section) Transport Canada, Brock Building, Ottawa, Ontario	September 4, 2000	400,000
Office of Energy Efficiency Conference Ottawa, Ontario	October 10 to 12, 2000	700
Transport Canada Senior Management Conference Aylmer, Quebec	November 1, 2000	250
Le Guide de l'auto – Book Release Montreal, Quebec	November 1, 2000	150
Colloque 2001 - Forum énergie Estrie Sherbrook, Quebec	May 1 to 2, 2001	200
ASFB Branch Meeting Transport Canada, Brock Building, Ottawa, Ontario	May 23, 2001	30
AIAMC Advanced Technology Showcase Hull, Quebec	May 30, 2001	300
Transport Canada Environment Week Transport Canada, Tower C, Ottawa, Ontario	June 6, 2001	327
Windsor Workshop Windsor, Ontario	June 4 to 6, 2001	750
EVCO Monthly Meeting Transport Canada, Brock Building, Ottawa, Ontario	July 30, 2001	45
Cruise Night at Orleans Mall Orleans, Ontario	August 15, 2001	2,300
Kemptville College Visit Transport Canada, Brock Building, Ottawa, Ontario	November 19, 2001	35
Montreal Auto Show Montreal, Quebec	January 23 to February 4, 2002	210,000
Ottawa Citizen Transport Canada, Brock Building, Ottawa, Ontario	January 25, 2002	420,000
Toronto Auto Show Toronto, Ontario	February 15 to 24, 2002	413,000
Kemptville College Open House Kemptville, Ontario	March 16, 2002	2000
Transport Canada Transportation Management Committee Meeting Aylmer, Quebec	March 26, 2002	290
TOTALS	35 Events	1,662,234

For use in the noted events, two specialized displays have been developed to illustrate the technical details of hybrid vehicles. The first display consists of the powertrain from a Toyota Prius that includes the nickel-metal hydride battery pack. The second display is a cutaway version of a Honda Insight, which demonstrates the advanced lightweight aluminum construction and hybrid drivetrain.

Also for use during events, several in-house produced videos are available. The videos demonstrate the different technologies being evaluated and highlight the full spectrum of testing being undertaken.

4.7 Website

Web traffic will be monitored to determine the interest and level of usage of the website by the public. There are no results to report as the website is not yet online.

4.8 Monitoring Penetration of ATVs in Canada

Monitoring the penetration of ATVs in Canada can be accomplished in part through the VFEIS data system. The following data items cannot be collected through VFEIS and will have to be acquired through other means.

- New powertrains and engine developments
  - 42v electrical architecture
  - Low voltage lighting
  - Low rolling resistance tires
  - Regenerative braking
- New body construction and innovations
  - Improved aerodynamics
  - Use of lightweight and/or recyclable materials
  - Small size/dimensions
- New chassis strategies
  - High strength steel
  - Lightweight metals
  - Composite materials

Preliminary results on the penetration of ATVs in Canada available to date are summarized in Tables 9 and 10.

Table 9
Summary of ATV penetration in Canada
Advanced or low carbon fuels

	1999		2000		2001		2002	
Fuel Type	% Fleet	Volume[a]	% Fleet	Volume[a]	% Fleet	Volume[a]	% Fleet	Volume[a]
Diesel								
- Cars	0.88	6,115	1.49	12,498	1.85	14,186	1.69	11,771
- Trucks	0.02	-	-	-	-	-	-	-
Ethanol								
- Cars	-	-	-	-	-	-	-	-
- Trucks	0.19	1,117	0.20	1,259	0.13	811	1.25	7,318
CNG								
- Cars	-	-	-	-	-	-	0.01	-
- Trucks	-	-	-	-	0.00	23	0.01	97
Hybrid								
- Cars	-	-	-	-	0.13	779	0.08	510
- Trucks	-	-	-	-	-	-	-	-
[a] Estimated number of vehicles								

Table 10
Summary of ATV penetration in Canada
Advanced transmission systems

	1999		2000		2001		2002	
Transmission	% Fleet	Volume[a]	% Fleet	Volume[a]	% Fleet	Volume[a]	% Fleet	Volume[a]
A3								
- Cars	4.36	30,299	4.97	41,558	2.30	17,824	-	-
- Trucks	0.29	1,681	0.37	2,346	0.29	1,741	0.10	586
A4								
- Cars	2.66	18,498	0.86	7,210	0.71	5,532	3.50	24,406
- Trucks	0.77	4,370	0.65	4,080	0.75	4,494	1.61	9,402
A5								
- Cars	-	-	-	-	-	-	-	-
- Trucks	-	-	-	-	-	-	0.32	1,900
E4								
- Cars	67.31	467,235	67.79	567,371	67.42	522,519	63.19	441,207
- Trucks	87.38	492,383	89.91	556,877	83.00	495,147	78.79	458,833
E5								
- Cars	2.57	17,862	2.35	19,662	3.73	29,914	3.64	5,414
- Trucks	4.77	26,926	3.47	21,501	9.88	58,972	12.45	72,513
E6								
- Cars	-	-	-	-	-	-	0.08	582
- Trucks	-	-	-	-	-	-	-	-
M5								
- Cars	20.45	141,966	20.40	170,733	22.23	172,285	25.09	175,210
- Trucks	6.63	37,363	5.48	33,979	6.35	37,938	5.65	32,926
M6								
- Cars	0.29	2,047	0.60	5,054	0.60	4,672	0.89	6,238
- Trucks	-	-	-	-	0.01	78	-	-

S4								
- Cars	2.26	15,704	2.16	18,108	1.67	12,917	1.20	8,351
- Trucks	0.13	771	0.08	550	0.24	1,435	0.47	2,788
S5								
- Cars	0.07	507	0.86	7,186	1.24	9,604	2.26	15,803
- Trucks	-	-	-	-	0.21	1,281	0.23	1,375
S6								
- Cars	0.01	-	0.00	-	0.01	-	0.02	-
- Trucks	-	-	-	-	-	-	-	-
Variable								
- Cars	-	-	-	-	0.09	-	0.13	933
- Trucks	-	-	-	-	-	-	0.33	-

[a] Estimated number of vehicles

A3:	3-Speed Automatic Transmission	M5:	5-Speed Manual Transmission
A4:	4-Speed Automatic Transmission	M6:	6-Speed Manual Transmission
A5:	5-Speed Automatic Transmission	S4:	4-Speed Automatic Transmission with Manual Mode
E4:	4-Speed Electronic Transmission	S5:	5-Speed Automatic Transmission with Manual Mode
E5:	5-Speed Electronic Transmission	S6:	6-Speed Automatic Transmission with Manual Mode
E6:	6-Speed Electronic Transmission	Variable:	Continuously Variable Transmission

5. OBSERVATIONS

The Advanced Technology Vehicles Program has officially been operating for less than one year (June 2001 to March 2002). Although considerable work has been done, findings at this stage are preliminary.

5.1 Availability of Low Sulphur and Alternative Fuels is a Problem

Other than conventional gasoline, and to a lesser degree, conventional diesel fuel, availability of alternative fuels to consumers at retail outlets is extremely limited or nonexistent. This applies to clean gasoline, clean diesel, compressed natural gas, propane, ethanol, methanol, hydrogen and electricity (at commercial recharging stations). This is highlighted in Table 11, which gives the number of retail outlets in Canada where a consumer can refuel/recharge a vehicle.

Table 11
Availability of Clean/Alternative Fuels at Retail Outlets Across Canada

FUEL TYPE	NUMBER OF RETAIL OUTLETS
Conventional gasoline	13,922
Conventional diesel	5,871
Low sulphur gasoline (<30ppm sulphur)	Unknown
Low sulphur diesel (<15ppm sulphur)	Unknown
Compressed natural gas	139
Automotive propane	1,964
Hydrogen	0
E10	929
E85	1
M85	12
Electricity (commercial recharging stations)	0

As can be seen from Table 11, conventional gasoline and diesel are the fuels of choice for road transportation vehicles in Canada. New regulations under the Canadian Environmental Protection Act will limit sulphur levels in gasoline to a maximum of 30ppm in 2005 and to 15ppm for on-road diesel fuel in 2006. These are positive changes that will enable the introduction of clean and fuel-efficient advanced gasoline and diesel technologies. Some clean gasoline and diesel may be sold in Canada now but in the absence of pump labeling, the consumer would be unaware of his/her purchase.

Compressed natural gas (CNG) is a good motor fuel but not readily available to consumers. A CNG fuel-dispensing pump costs about 10 times as much to install as a gasoline pump ($250,000 vs. $25,000). Retailers are not in a rush to make the investment. At today's prices for natural gas, there is little or no saving for drivers in their annual fuel bill. As a further disincentive, vehicle range is significantly reduced compared to a conventional vehicle and cargo space is traded for CNG tanks.

Automotive grade propane has much better availability than CNG. In the heyday for propane in the 1980s, there were 170,000 propane vehicles on Canadian roads and propane was available at as many retail outlets as diesel fuel (about 5,000). Fuel availability is still acceptable today. However, there are no light-duty propane vehicles available from original equipment (OE) manufacturers.

There are currently no commercial outlets for hydrogen motor fuels in Canada. There are also no hydrogen-powered vehicles for consumers to buy. So, the lack of fuel availability is not a problem for now. However, vehicles that burn hydrogen as a fuel directly or use it in fuel cells will be available in the marketplace this decade. It will be important to have in place the fuel and infrastructure needed to support these developments.

The Government of Canada has invested $23 million in the Canadian Transportation Fuel Cell Alliance (CTFCA) program. The Program focuses its efforts on showcasing refueling demonstration projects, evaluating different fuelling routes for light-, medium- and heavy-duty fuel-cell vehicles, monitoring the resulting greenhouse gas emission reductions, and developing the necessary supporting framework for the fuelling infrastructure, including technical codes and standards, training, certification and safety.

Most modern vehicles are compatible with gasoline containing up to 10% ethanol (E10). Low-level blends of ethanol in gasoline are typically available across Canada and are a good way of increasing the use of ethanol as a motor fuel. The virtual lack of retail E85 refueling stations makes operating these vehicles on ethanol difficult. For the most part, E85 compatible vehicles are not realizing the significant GHG reduction potential of ethanol.

Action Plan 2000 includes a program to help increase the supply and use of ethanol produced from biomass such as plant fibre, corn and other grains. This new program will encourage the expansion of ethanol production capacity from the current 175 million litres per year to approximately 750 million litres per year of grain and cellulose-derived ethanol.

The future for methanol looks less bright than for ethanol. There are virtually no commercial fuel stations and no OE vehicles.

Although almost everyone has electricity at home, there are few places, other than homes and possibly the workplace, where an electric vehicle can be recharged.

5.2 Greater Harmony in Global Vehicle Technical Regulations Needed

The advanced technology vehicles in the current fleet fall into two categories - those that are certified to Canadian safety and emission requirements and those that are certified to the standards of another country. The former vehicles are fully compliant; the latter comply to varying degrees.

From the limited evaluation that has been done to date, vehicles not designed and certified to Canadian requirements comply, or are capable of complying with the major emissions and safety requirements. Shortfalls are greatest for lighting (not including headlights), mirrors and labeling.

Greater global harmony on vehicle technical safety and emissions regulations would facilitate the introduction of ATVs in Canada.

5.3 The Transition to Advanced Vehicles and Technologies will be Seamless and Transparent to Consumers

The Transport Canada fleet of advanced technology vehicles includes a broad cross section of advanced technologies. Most technologies outlined in Chapter 2 are represented in the fleet. With most of these technologies, it would not be apparent to consumers that they were driving anything but an ordinary, everyday vehicle.

The advanced electro-hydro-mechanical mechanisms that bring us variable valve timing, lift and other engine developments perform their work unbeknownst to the driver, all the while delivering better performance, driveability and efficiency without compromising their expectations for safety, comfort, convenience, performance and reliability. The diesels are quiet, smokeless and odourless. From the cabin, they're indistinguishable from a regular gasoline engine. The CVT and ESMAT transmissions do their shifting as conveniently as any automatic transmission - only more efficiently. The Idle Stop features cut idle emissions and fuel consumption. The operation of this feature is indiscernible to the driver. Electric vehicles have a starting and operating procedure that mimics that of a regular gasoline powered vehicle. The only giveaway that you are driving anything different is the silence, the high torque from rest and the regenerative braking deceleration.

5.4 Diesels are an Available Technology that can cut Fuel Consumption by 40%

While diesel passenger vehicles in Canada account for less than 2% of the current fleet, diesels in Europe make up about 30% of new passenger car sales. The European Automobile Manufacturers Association (ACEA) expects this market share to grow further. For some major companies, diesel sales already exceed 50% of their new passenger car sales.

The magnitude of the diesel share of the market in Europe is due largely to their fuel efficiency, the high price of gasoline ($1.60/L to $2.00/L) and the decision of several European governments to price diesel fuel significantly below gasoline. On average, European diesel fuel prices are about 23% lower than gasoline with the difference being as high as 40%.

The role of diesel technology in light-duty vehicles in Canada will depend on their ability to meet future emission standards, the availability of low sulphur fuel and the fuel price differential of diesel fuel with gasoline. Given the relatively low price of gasoline in Canada compared to Europe, Canadian new car buyers are not typically attracted by the fuel efficiency of diesel vehicles. The exception is high mileage drivers.

Diesel powered passenger car sales have more than doubled in Canada since 1999. However, there are no diesel powered light-duty trucks (GVWR<8,500 pounds) available in Canada. This is a high consumption market segment that could benefit greatly from the fuel efficiency of diesels.

5.5 Technology Exists Today To Vastly Improve Fuel Efficiency

As summarized in Table 1, the technology exists today to improve fuel consumption of light-duty vehicles by 20% to 40%. The technology however comes at a cost. It is estimated, for example, that the hybrid gasoline/electric technology used in today's passenger cars adds about $5,000 to the price of the car.

Consumers are willing to pay for technology that reduces fuel consumption as long as that technology pays for itself by way of fuel savings. Therein lies the dilemma for consumers and vehicle manufacturers alike. At today's fuel prices, a short-term payback is unlikely for anyone but high mileage drivers. Incentives may be needed to make fuel-efficient vehicles more attractive to consumers. Barring this, technology that could otherwise improve fuel efficiency will be applied to enhance vehicle attributes consumers will pay for (more power or performance). This is evident in new vehicle trends in the last decade.

5.6 Potential Concerns over Particulate Emissions from GDI Engines

Vehicles equipped with gasoline direct injection (GDI) engines seem to play an important role in the Japanese and European strategy to improve fuel efficiency. One of the characteristics of these engines is that they produce a large number of ultra-fine particles (smaller than 2.5 micrometres). Research is ongoing on the health effects of these ultra-fine particulates. If the research produces strongly negative results, there is a potential need for new emission requirements, which could impact on the fuel efficiency of direct-injected engines.

5.7 Positive Public Reactions to Small Urban Vehicles, but Concern with their Safety

The vehicles in the Transport Canada fleet of advanced vehicles have been shown to more than 1.6 million Canadians. The reactions to the vehicles are many and varied. With respect to the small urban vehicles like the MCC Smart, VW Lupo and Japanese Kei class vehicles, the reactions generally fall into two categories - those that are attracted to the cars and want to know where they can buy one, and those who like the cars but wonder if they are safe in the land of the Sport Utility Vehicle (SUV).

Preliminary frontal crash test results on these small cars suggest that they meet the applicable occupant protection standard under the Motor Vehicle Safety Act. Future testing will focus on the overall safety of small cars if integrated into the mix of vehicles including large SUVs and pick-ups on Canadian roads.

5.8 Technology comes at a Price, but there is Hope

Most of the vehicles being evaluated by the Directorate are more expensive than conventional ones. This is mainly because their market penetration is relatively small and the vehicles are produced in small numbers. Another factor influencing their cost is the amount of technology some of these vehicles incorporate. It is estimated, for example, that the hybrid gasoline/electric technology adds about $5,000 to the price of the car. However, their fuel consumption reduction capabilities have been proven and the auto industry has stepped up its efforts in building such vehicles. Motivated by increasing consumer demand, ever-tightening vehicle emission regulations, and concerns over greenhouse gas emissions, the auto industry will offer more of these vehicles in the future which should in turn reduce their cost, as economies of scale take effect.

However expensive the initial offerings of these advanced technology vehicles are, there are some vehicles under evaluation that are more comparable in price to conventional passenger cars than others. Small urban vehicles, for example, may not offer the storage capacity of a Sport Utility Vehicle, but are nonetheless practical for commuting and can be obtained for a cost of $10,000 to $20,000. Add to this their offered fuel savings and their cost seems much less expensive. The same goes for vehicles equipped with diesel engines, however, depending on the size and output of the engine, their prices may add some $3,000 to the price of the vehicle.

6. ANNEXES

Annex 1 List of Vehicles

Annex 2 CMVSS Inspection Form

Annex 3 On-Road Vehicle Evaluation Questionnaire

Annex 4 Summary of International Vehicle Safety Standards and Regulations

ANNEX 1

List of Vehicles

1998

TC# 98-007

Solectria Force

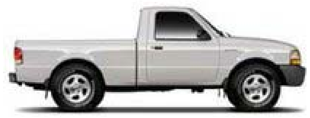
38 kW @ 156V; 42 kW @ 180V
AC Induction Drive with Direct-Drive and Regenerative Braking.

Empty Weight: 1115 kg

Electric Vehicle equipped with Lead-Acid Batteries.
Charger: 220V, 120Amp with 110V adapter

TC# 98-022

Ford Ranger EV



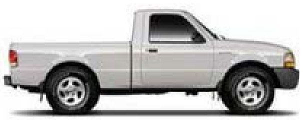
312 V (39 batteries @ 8 V)
Single-speed direct coupled trans-axle.

Empty Weight: 2198 kg

Electric Vehicle equipped with Lead-Acid Batteries
Charger: 220 - 240 volt, 30 Amp.

TC# 98-023

Ford Ranger EV



312 V (39 batteries @ 8 V)
Single-speed direct coupled trans-axle.

Empty Weight: 2198 kg

Electric Vehicle equipped with Lead-Acid Batteries
Charger: 220 - 240 volt, 30 Amp

1999

TC# 99-003

Chevrolet Metro

1.0L 3 Cylinder Gasoline Engine.
5-Speed Manual Transmission

Empty Weight: 807 kg

Conventional Technology vehicle with excellent fuel economy values.

City:	6.0	l/100km*
Highway:	4.2	l/100km**

TC# 99-004

Chevrolet Metro

1.0L 3 Cylinder Gasoline Engine.
5-Speed Manual Transmission

Empty Weight: 807 kg

Conventional Technology vehicle with excellent fuel economy values.

City:	6.0	l/100km*
Highway:	4.4	l/100km**

TC# 99-010

Ford F-250 CNG

5.4 L 8 Cylinder CNG Engine.
4-Speed Auto. Transmission

Empty Weight: 2243 kg

Compressed Natural Gas powered vehicle emitting significantly less pollution.

City:	15.9	l/100km**
Highway:	11.5	l/100km**

TC# 99-013

Honda Civic GX

1.6L 4 Cylinder CNG Engine.
4-Speed Auto. Transmission

Empty Weight: 1173 kg

Compressed Natural Gas powered vehicle emitting significantly less pollution.

City:	7.9	l/100km**
Highway:	5.4	l/100km**

2000

Honda Insight

TC# 00-001

1.0L 3 Cylinder Gasoline Engine with Electric Motor Assist.
5-Speed Manual Transmission

Empty Weight: 856 kg

Hybrid Powertrain, Aluminum body and Aerodynamic design. 144 V (120 batteries @ 1.2 V)

City:	4.0	l/100km**
Highway:	2.9	l/100km**

Renault Mégane

TC# 00-002

2.0L 4 Cylinder Gasoline Engine.
5-Speed Manual Transmission

Empty Weight: 1135 kg

Vehicle equipped with Direct Injection (DI) gasoline engine reducing fuel consumption.

City:	7.6	l/100km**
Highway:	5.3	l/100km**

VW Lupo 3L

TC# 00-003

1.2L TDI 3 Cyl. Diesel Engine.
5-Speed Electronically Shifted Manual Transmission.

Empty Weight: 830 kg

Aluminum doors, engine cover, wheels, magnesium parts, auto-stop feature.

City:	3.8	l/100km**
Highway:	3.0	l/100km**

Mercedes-Benz A170

TC# 00-004

1.7L Turbo 4 Cylinder Diesel Engine.
5-Speed Manual Transmission

Empty Weight: 1095 kg

The manual transmission is equipped with an automatic clutch.

City:	5.2	l/100km**
Highway:	3.8	l/100km**

MCC Smart CDI

TC# 00-005

800cc 3 Cylinder Turbo Diesel Engine (30kW).
6-Speed Electronically Shifted Manual Transmission.

Empty Weight: 730 kg

2 seater, short wheelbase vehicle.

City:	3.3	l/100km**
Highway:	2.8	l/100km**

Mitsubishi Dion

TC# 00-006

2.0L 4 Cylinder Gasoline Engine.
4-Speed Auto. Transmission

Vehicle equipped with Direct Injection (DI) gasoline engine reducing fuel consumption.

Nissan Gloria

TC# 00-007

3.0L 6 Cylinder Gasoline Engine.
4-Speed Auto. Transmission

Vehicle equipped with Direct Injection (DI) gasoline engine reducing fuel consumption.

Nissan Sentra CA

TC# 00-008

1.8L 4 Cylinder Gasoline Engine.
4-Speed Auto. Transmission

Empty Weight: 1164 kg

Vehicle equipped with Direct Injection (DI) gasoline engine reducing fuel consumption and meeting California SULEV requirements.

Yamaha Razz

TC# 00-009

50cc, 1 Cyl. 2 stroke Gasoline Engine
CV Transmission

Empty Weight: 53 kg

1 seat, 2 wheeled scooter.

Fuel Economy:
City: 3.4 l/100km**

MCC Smart Cabrio

TC# 00-010

600cc 3 Cylinder Turbo Gasoline Engine (40kW)
6-Speed Electronically Shifted Manual Transmission.

Empty Weight: 730 kg

2 seater, short wheelbase vehicle.

City: 4.9 l/100km**
Highway: 3.8 l/100km**

2001

Toyota Prius

TC# 01-001

1.5L 4 Cylinder Gasoline Engine with Electric Motor.
CV Transmission

Empty Weight: 1254 kg

Hybrid Powertrain, Conventional body and NiMH Batteries. 273.6 V (228 batteries @ 1.2 V)
City: 4.5 l/100km*
Highway: 4.6 l/100km*

Suzuki Alto

TC# 01-002

660cc 3 Cylinder Gasoline Engine.
5-Speed Manual Transmission

Empty Weight: **730 kg**
(Weight is with 1L engine)

Vehicle designed specifically for the Japanese market.
City: 5.0 l/100km**
Highway: 4.0 l/100km**

Suzuki Wagon R

TC# 01-003

660cc 3 Cylinder Gasoline Engine.
5-Speed Manual Transmission

Empty Weight: **975 kg**
(Weight is with 1.3L engine)

Vehicle designed specifically for the Japanese market.

City/Highway: 4.5 l/100km*

Honda Acty SDX

TC# 01-004

660cc 3 Cylinder Gasoline Engine.
5-Speed Manual Transmission

Empty Weight: 860 kg

Vehicle designed specifically for the Japanese market. AWD equipped.

City: 7.2 l/100km**
Highway: 7.1 l/100km**

BMW C1 125

TC# 01-005

125cc, 1 Cylinder Gasoline Engine
CV Transmission

Empty Weight: 185 kg

1 seat, 2 wheeled, commuter vehicle equipped with 3 way catalytic converter and O_2 sensor.

City: 6.3 l/100km*
Highway: 4.4 l/100km*

Toyota Prius

TC# 01-006

1.5L 4 Cylinder Gasoline Engine with Electric Motor.
CV Transmission

Empty Weight: 1254 kg

Hybrid Powertrain, Conventional body and NiMH Batteries. 273.6 V (228 batteries @ 1.2 V)
City: 4.0 l/100km**
Highway: 3.5 l/100km**

Honda Z

TC# 01-007

660cc 3 Cylinder Gasoline Engine.
4-Speed Automatic Transmission

Empty Weight: 970 kg

Vehicle designed specifically for the Japanese market. AWD Turbo equipped.

Combined: 6.4 l/100km*

Zem

TC# 01-008

2 Battery = 24V

Empty Weight: **83 kg**
(Without electric motor)

Electric Power-on-Demand Restricted Use Motorcycle.

Continuous power: 600W

Nissan Hypermini

TC# 01-009

115V
Neodymium Magnet AC Synchronous Motor.

Empty Weight: 840 kg

Electric Vehicle equipped with Lithium Ion Batteries

VW Beetle TDI

TC# 01-010

1.9L TDI V4 Diesel Engine.
5-Speed Manual Transmission

Empty Weight: 1320 kg

Natural Resources Canada has named this vehicle the most fuel-efficient subcompact diesel car sold in Canada.

City: 5.2 l/100km**
Highway: 3.8 l/100km**

Audi A2

TC# 01-011

1.4L TDI 3 Cyl. Diesel Engine.
5-Speed Manual Transmission

Empty Weight: 1020 kg

Aluminum frame, body, wheels, and brakes.

City: 4.8 l/100km**
Highway: 3.2 l/100km**

Honda Vamos L

TC# 01-014

660cc 3 Cylinder Gasoline Engine.
5-Speed Manual Transmission

Empty Weight: 1000 kg

Vehicle designed specifically for the Japanese market. AWD equipped.

City: 7.4 l/100km**

EV Global Motors

TC# 01-015

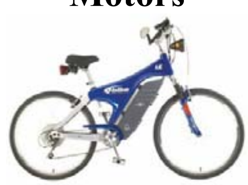
1 NiMH Battery = 36V
Range: 24km to 30km

Empty Weight: 40 kg

Electric Power-on-Demand Bicycle with Police Package.

Continuous power: 500W

EV Global Motors



TC# 01-016

1 NiMH Battery = 36V
Range: 24km to 30km

Empty Weight: 40 kg

Electric Power-on-Demand Bicycle.

Continuous power: 500W

Nissan Sentra GXE

TC# 01-022

1.8L 4 Cylinder Gasoline Engine.
4-Speed Automatic Transmission

Empty Weight: 1193 kg

Conventional Vehicle used for Comparison Study with TC#00-008.

City:	7.7	l/100km**
Highway:	5.3	l/100km**

Toyota Echo

TC# 01-024

1.5L 4 Cylinder Gasoline Engine with Variable Valve Timing.
5-Speed Manual Transmission

Empty Weight: 924 kg

Conventional Vehicle with Good Fuel Economy and advanced gasoline engine.

City:	5.9	l/100km**
Highway:	4.9	l/100km**

Chrysler PT Cruiser

TC# 01-025

2.4L 4 Cylinder Gasoline Engine.
5-Speed Manual Transmission

Empty Weight: 1415 kg

Conventional Vehicle used for Comparison Study with European Diesel Version (To Be Purchased).

City:	11.7	l/100km**
Highway:	8.3	l/100km**

Corbin Sparrow

TC# 01-026

13 x 12V Lead Acid Batteries = 156V
Range: 65 to 100 km

Empty Weight: 612 kg

1 seat, 3 wheeled, electric commuter vehicle charges with 110V 20A supply.

Continuous power:	25hp
Peak power:	40hp

Suzuki Swift

TC# 01-027

1.3L 4 Cylinder Gasoline Engine.
5-Speed Manual Transmission

Empty Weight: 862kg

Conventional Vehicle with excellent Fuel Economy.

City:	6.0	l/100km**
Highway:	4.2	l/100km**

2002

GMC Sonoma FFV

TC# 02-001

2.2L 4 Cylinder Flex Fuel Engine.
Will Run on E0 to E85.
4-Speed Automatic Transmission

Empty Weight: 862kg

Alternative Fuel Vehicle.

City (Ethanol):	17.7	l/100km*
City (Gasoline):	12.6	l/100km*
Highway(Ethanol):	12.2	l/100km*
Highway(Gasoline):	8.5	l/100km*

BMW 320d

TC# 02-002

2.0L 4 Cylinder Turbo Diesel Engine.
4-Speed Automatic Transmission

Empty Weight: 1450 kg

Conventional vehicle equipped with an advanced diesel engine.

City:	7.6	l/100km*
Highway:	4.4	l/100km*

BMW 318i

TC# 02-003

2.0L 4 Cylinder Turbo Gasoline Engine/
4-Speed Automatic Transmission

Empty Weight: 1395 kg

Vehicle equipped with advanced variable valve timing and lift eliminating intake throttle and reducing engine pumping losses.

City:	10.2	l/100km*
Highway:	5.5	l/100km*

BMW C1 200

TC# 02-004

176cc, 1 Cylinder Gas Engine
CV Transmission

Empty Weight: 185 kg

1 seat, 2 wheeled, commuter vehicle equipped with 3 way catalytic converter and O_2 sensor.

Combined:	3.2	l/100km*

Chevrolet Silverado

TC# 02-005

6.6L 8 Cyl. Turbo Diesel Engine.
5-Speed Automatic Transmission

Empty Weight: 1520 kg

Vehicle equipped with an advanced diesel engine and transmission.

City:	16.4	l/100km**
Highway:	10.7	l/100km**

Ford Focus ZX5

TC# 02-006

2.0L 4 Cylinder Gasoline Engine.
5-Speed Manual Transmission

Empty Weight: 1179 kg

Conventional Vehicle used for Comparison Study with European Diesel Version (To Be Purchased).

City:	9.3	l/100km*
Highway:	6.4	l/100km*

Honda Insight CVT

TC# 02-007

1.0L 3 Cylinder Gasoline Engine with Electric Motor Assist.
Continuously Variable Transmission

Empty Weight: 893 kg

Hybrid Powertrain, Aluminum body and Aerodynamic design. 144 V (120 batteries @ 1.2 V)

City:	4.1	l/100km*
Highway:	4.2	l/100km*

Dodge Caravan FFV

TC# 02-009

3.3L 6 Cylinder Flex Fuel Engine.
Will Run on E0 to E85.
4-Speed Automatic Transmission

Empty Weight: 2336 kg

Alternative Fuel Vehicle.

City (Ethanol):	18.3	l/100km*
City (Gasoline):	13.4	l/100km*
Highway (Ethanol):	12.1	l/100km*
Highway (Gasoline):	9.0	l/100km*

Honda Silverwing

TC# 02-010

600cc, 2 Cylinder Gas Engine
CV Transmission

Empty Weight: 216 kg

Scooter equipped with continuously variable transmission.

Combined:	N/A	l/100km*

Honda Insight CVT

TC# 02-011

1.0L 3 Cylinder Gasoline Engine with Electric Motor.
Continuously Variable Transmission

Empty Weight: 893 kg

Hybrid Powertrain, Aluminum body and Aerodynamic design. 144 V (120 batteries @ 1.2 V)

City:	4.1	l/100km*
Highway:	4.2	l/100km*

Toyota Prius

TC# 02-012

1.5L 4 Cylinder Gasoline Engine with Electric Motor.
CV Transmission

Empty Weight: 1254 kg

Hybrid Powertrain, Conventional body and NiMH Batteries. 273.6 V (228 batteries @ 1.2 V)

City:	4.5	l/100km*
Highway:	4.6	l/100km*

Toyota Prius

TC# 02-013

1.5L 4 Cylinder Gasoline Engine with Electric Motor.
CV Transmission

Empty Weight: 1254 kg

Hybrid Powertrain, Conventional body and NiMH Batteries. 273.6 V (228 batteries @ 1.2 V)

City:	4.5	l/100km*
Highway:	4.6	l/100km*

Smart Cabrio Pulse

TC# 02-015

600cc 3 Cylinder Turbo Gasoline Engine (45kW)
6-Speed Electronically Shifted Manual Transmission.

Empty Weight: 730 kg

2 seater, short wheelbase vehicle.

City:	6.3	l/100km*
Highway:	4.4	l/100km*

Smart Coupé Pure

TC# 02-016

800cc 3 Cylinder Turbo Diesel Engine (30kW).
6-Speed Electronically Shifted Manual Transmission.

Empty Weight: 730 kg

2 seater, short wheelbase vehicle.

City:	3.6	l/100km*
Highway:	3.2	l/100km*

Smart Cabrio Passion

TC# 02-017

800cc 3 Cylinder Turbo Diesel Engine (30kW).
6-Speed Electronically Shifted Manual Transmission.

Empty Weight: 730 kg

2 seater, short wheelbase vehicle.

City:	3.6	l/100km*
Highway:	3.2	l/100km*

Smart Coupé Passion

TC# 02-018

600cc 3 Cylinder Turbo Gasoline Engine (40kW)
6-Speed Electronically Shifted Manual Transmission.

Empty Weight: 730 kg

2 seater, short wheelbase vehicle.

City:	6.3	l/100km*
Highway:	4.4	l/100km*

Audi A6

TC# 02-019

2.5L 6 Cylinder Diesel Engine.
Continuously Variable Transmission

Empty Weight: 1590 kg

Vehicle equipped with advanced transmission and diesel engine.

City:	9.3	l/100km*
Highway:	5.7	l/100km*

Toyota Nadia

TC# 02-023

2.0L 4 Cylinder Gasoline Direct Injection Engine.
4-Speed Automatic Transmission

Empty Weight: 1320 kg

Japanese market vehicle equipped with advanced gasoline engine.

Combined:	7.0	l/100km*

Toyota Estima

TC# 02-024

2.4L 4 Cylinder Gasoline Engine with Electric All Wheel Drive. Continuously Variable Transmission

Empty Weight: 1850 kg

Japanese Market Hybrid Vehicle with AWD, Advanced Transmission and NiMH Battery Pack.

Combined:	5.6	l/100km*

Audi A2

TC# 02-025

1.2L TDI 3 Cyl. Diesel Engine. 5-Speed Electronically Shifted Manual Transmission.

Empty Weight: 855 kg

Aluminum frame, body, wheels, and brakes.

City:	3.7	l/100km
Highway:	2.7	l/100km

VW Lupo FSI

TC# 02-026

1.4L FSI 3 Cyl. Gasoline Engine. 5-Speed Electronically Shifted Manual Transmission

Empty Weight: 950 kg

Aluminum doors, engine cover, wheels, magnesium parts, auto-stop feature and direct gasoline injection.

Combined:	4.9	l/100km*

VW Lupo 3L

TC# 02-027

1.2L TDI 3 Cyl. Diesel Engine. 5-Speed Electronically Shifted Manual Transmission.

Empty Weight: 830 kg

Aluminum doors, engine cover, wheels, magnesium parts, auto-stop feature.

City:	3.4	l/100km*
Highway:	2.7	l/100km*

MB Vaneo

TC# 02-028

1.7L 3 Cylinder Diesel Engine. 5-Speed Automatic Transmission

Empty Weight: 1425 kg

European Designed Vehicle Equipped with Advanced Diesel and Transmission.

City:	8.4	l/100km*
Highway:	5.6	l/100km*

Chevrolet Tahoe FFV

TC# 02-029

5.3L 8 Cylinder Flex Fuel Engine. Will Run on E0 to E85. 4-Speed Automatic Transmission

Empty Weight: 2382 kg

Alternative Fuel Vehicle.

City (Ethanol):	23.1	l/100km*
City (Gasoline):	16.8	l/100km*
Highway (Ethanol):	15.9	l/100km*
Highway (Gasoline):	11.8	l/100km*

VW Jetta

TC# 02-031

1.9L 4 Cylinder Turbo Diesel Engine. 4-Speed Automatic Transmission

Empty Weight: 1365 kg

Conventional vehicle equipped with a diesel engine and achieving excellent fuel economy.

City:	6.9	l/100km*
Highway:	4.9	l/100km*

Honda Civic

TC# 02-032

1.7L 4 Cylinder Gasoline Engine. 4-Speed Automatic Transmission

Empty Weight: 1135 kg

Conventional Vehicle used for Comparison Study with Civic Hybrid (To Be Purchased).

City:	8.2	l/100km*
Highway:	6.1	l/100km*

Honda VFR 800 	TC# 02-033 800cc, 4 Cylinder Gasoline Engine with variable valve timing. 6-Speed Transmission Empty Weight: 210 kg Conventional motorcycle used for Comparison Study with California model equipped with catalytic converter (To Be Purchased). Combined: N/A l/100km*	
* OEM Fuel Consumption Figures ** TC Fuel Consumption Test Results		

ANNEX 2

CMVSS Inspection Form

Foreword

The following table is the list of standards compiled from the Canadian Motor Vehicle Safety Standard (CMVSS) inspection form. These standards incorporate some 827 components that are verifiable by visual inspection or non-destructive testing. For a more detailed description of the requirements, please refer to the Canada Motor Vehicle Safety Act and Regulations.

CMVSS
101 - Location And Identification Of Controls And Displays
102 - Transmission Shift Control Sequence
103 - Windshield Defrosting And Defogging
104 - Windshield Wiping And Washing System
105 - Hydraulic And Electric Brake Systems
106 - Brake Hoses
108 - Lighting System And Retroreflective Devices
108.1- Alternative Requirements For Headlamps
110 - Tire Selection And Rims
111 - Rearview Mirrors
112 - Headlamp Concealment Devices
113 - Hood Latch System
114 - Locking System
115 - Vehicle Identification Number
116 - Hydraulic Brake Fluid
118 - Power Operated Windows
124 - Accelerator Control Systems
135 - Passenger Car Brake System
201 - Occupant Protection
202 - Head Restraints
203 - Driver Impact Protection
205 - Glazing Material
206 - Door Latches, Hinges And Locks
207 - Anchorage Of Seats
208 -Seat Belt Installations
209 - Seat Belt Assemblies
210 - Seat Belt Anchorages
210.1 - User-Ready Tether Anchorages For Restraint Systems
213.4- Built-In Child Restraint Systems And Built-In Booster Cushions

ANNEX 3

On-Road Vehicle Evaluation Questionnaire

Thank you for taking the time to complete this evaluation. Your time and effort are very important and are greatly appreciated.

VEHICLE

Year, Make and Model: ______________________ TC # ____________

Dates (From / To): ______________________

Kilometers Driven: ____________ km

EVALUATOR

Name: ______________________

What is your area of expertise? ☐ TC - Road Safety Programs ☐ Other Specify: ____________

What vehicle do you normally drive? (Year, Make and Model) ______________________

NOTES FOR EVALUATOR

1. Please use the back of pages if extra space is needed for comments.
2. If the vehicle you are evaluating has right hand drive, please do not comment on this aspect of the vehicle or the impact it has on vehicle operation.
3. Please fill the vehicle with fuel at the end of your evaluation and calculate your fuel consumption in L/100km.

Advanced Technology Vehicles Program
Programme de véhicules à technologies de pointe

CONDITIONS OF USE

The on-road evaluation of the vehicle identified on this form is an approved element of the Advanced Technology Vehicles Program. The approval is subject to the following Terms and Conditions.

Terms and Conditions

1. By signing this form, the evaluator signifies that:
    - the evaluator has read and understood these Terms and Conditions;
    - vehicle features, or the lack of vehicle features, that could affect the safe operation of the vehicle have been explained to the evaluator;
    - the evaluator has a valid driver's license for the class of vehicle being evaluated and that license is not currently under suspension;
    - the evaluator is a full time employee of Transport Canada, Road Safety, unless otherwise authorized; and
    - the evaluator accepts these Terms and Conditions.
2. These Terms and Conditions are in addition to the Conditions and Notes contained in the Vehicle Authorization and Log Record, all of which also apply.
3. Authorized Use is use for the expressed purpose of completing this Evaluation Questionnaire. Even though use may be authorized, taxable benefits may apply.
4. Operation by evaluators while on annual leave status is not authorized.
5. The self-insurance policy of the Government does not apply to unauthorized use, in which case operators have no protection.
6. The vehicle is to be driven only by the evaluator. Occupants may include immediate family members and Government of Canada employees.
7. It is the responsibility of the evaluator to arrange and pay for parking during the evaluation period.
8. Driving is restricted to the National Capital Region unless otherwise authorized.
9. The vehicle being evaluated is likely to be highly visible. This is an opportunity for the evaluator to answer the inevitable questions from the public about the vehicle and the ATV Program. Please familiarize yourself with the vehicle specifications and program description on the sheet provided.
10. The vehicle being evaluated is likely to be highly visible. Please refrain from vehicle use that will be embarrassing to you or the Department.
11. The vehicle may be used by the Advanced Technology Vehicles Program in exhibits and public displays. Your efforts to keep the vehicle in good condition and not expose it to potential damage such as that in tight or unsupervised parking areas is appreciated.
12. Each vehicle has a logbook that contains an accident report form, an insurance card and a credit card for use when purchasing vehicle supplies such as fuel, oil, washer fluid etc. or emergency repairs. When making purchases, the details should be entered on the Vehicle Authorization and Log Record and the vehicle's TC number and odometer reading should be written on the bill. The TC number is located on a yellow label affixed to the windshield in front of the driver, and is also on the cover of the logbook.
13. In the event of a collision, collect the necessary information to complete the accident report form. Report the incident to John Thorpe (998-2560) at your earliest opportunity. In the event of a serious collision, immediately call Brian Monk of the Collision Investigation Division at 993-3667 during normal working hours or 786-8711 outside of normal working hours. Mr. Monk will investigate the collision on behalf of the Road Safety Directorate.
14. If you require towing, call Ottawa Metro Towing at 731-1936 and have the vehicle returned to the Brock Building, 2780 Sheffield Road, Ottawa.
15. Any problems or deficiencies with the vehicle should be noted on the Vehicle Authorization and Log Record.
16. The vehicle shall be returned to the Brock Building on Friday afternoon by 4:00pm. The vehicle should be returned clean (inside and out), full of fuel, and with the Evaluation Questionnaire and Vehicle Authorization and Log Record completed. You are welcome to use the car cleaning facilities at the Brock Building if needed.

____
Signature of Evaluator

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Please rate the following characteristics of the vehicle. Circle the number that applies best.
1 = deficient; **2** = poor; **3** = average; **4** = good; **5** = excellent

EASE OF OPERATION

1 2 3 4 5 (OVERALL EASE OF OPERATION RATING)

Did you have difficulty operating the vehicle? If so, what was the reason?

POWER

1 2 3 4 5 (OVERALL POWER RATING)

Was the power adequate for:

-keeping up with urban traffic?	**1 2 3 4 5**
-merging with traffic on highways?	**1 2 3 4 5**
-cruising on divided highways?	**1 2 3 4 5**
-overtaking other traffic at highways speeds?	**1 2 3 4 5**

DRIVEABILITY

1 2 3 4 5 (OVERALL DRIVEABILITY RATING)

Did the engine start easily and quickly without long cranking time when the engine was: -cold?	1 2 3 4 5	
-hot?	1 2 3 4 5	
Did the engine idle smoothly and at a steady, proper speed?	1 2 3 4 5	
Did the vehicle accelerate without stalls, hesitations, sags, or flat spots?	1 2 3 4 5	
Did vehicle cruise at steady speed without hunting up and down?	1 2 3 4 5	
Did the engine stall while driving?	1 2 3 4 5	
Did the engine run-on or keep running after the ignition was turned off?	1 2 3 4 5	

HANDLING

1 2 3 4 5 (OVERALL HANDLING RATING)

Is the vehicle sensitive to cross winds and the wakes of large vehicles?	1 2 3 4 5	
Does the vehicle track straight on the road, or wander due to crown in the road or other road surface irregularities?	1 2 3 4 5	
Does the steering have good feel, response, and sensitivity?	1 2 3 4 5	
Is the steering effort comfortable?	1 2 3 4 5	
Do the shock absorbers adequately control vehicle motions?	1 2 3 4 5	
Is body roll (lean) excessive in cornering?	1 2 3 4 5	
Does the vehicle understeer, oversteer, or is it neutral in cornering?	1 2 3 4 5	
How would you judge the rollover propensity?	1 2 3 4 5	

RIDE QUALITY

1 2 3 4 5 (OVERALL RIDE QUALITY RATING)

How would you rate the ride quality on:

- smooth pavement? 1 2 3 4 5

-undulating pavement? 1 2 3 4 5

-rough roads (pot holes, rail road tracks, frost heaves)? 1 2 3 4 5

BRAKING PERFORMANCE

1 2 3 4 5 (OVERALL BRAKING PERFORMANCE)

Do the brakes feel powerful? 1 2 3 4 5

Is it easy to modulate braking force? 1 2 3 4 5

Are stops straight and controllable? 1 2 3 4 5

Are you satisfied with ABS operation? 1 2 3 4 5

Is brake fade evident under normal driving conditions? 1 2 3 4 5

Does the parking brake hold adequately on a hill? 1 2 3 4 5

Is the effort to engage and disengage the parking brake comfortable? 1 2 3 4 5

NOISE/VIBRATION/HARSHNESS

1 2 3 4 5 (OVERALL N / V / H RATING)

Rate the noise level from:

-engine 1 2 3 4 5

-wind 1 2 3 4 5

-road 1 2 3 4 5

-other sources (specify) 1 2 3 4 5

Are there any unpleasant vibrations (engine, tires, other)? 1 2 3 4 5

FUEL EFFICIENCY

1 2 3 4 5 (OVERALL FUEL EFFICIENCY RATING)

What was your fuel consumption?

_______________________L/100km

_______________________distance driven (km)

How would you rate the fuel consumption you achieved?

DRIVING RANGE

1 2 3 4 5 (OVERALL DRIVING RANGE RATING)

What is your estimate of the driving range?

_______________________ km

How would you rate this driving range?

VEHICLE SIZE

1 2 3 4 5 (OVERALL SIZE RATING)

Is the vehicle too big, too small, or just right for your needs? **1 2 3 4 5**

Is the space the vehicle occupies used efficiently without waste? **1 2 3 4 5**

MANEUVERABILITY

1 2 3 4 5 (OVERALL MANEUVERABILITY RATING)

Can you see all four corners of the vehicle?	**1 2 3 4 5**	
Is it easy to park?	**1 2 3 4 5**	
How do you find the turning circle?	**1 2 3 4 5**	

VISIBILITY (BLIND SPOTS)

1 2 3 4 5 (OVERALL VISIBILITY RATING)

Rate the direct vision in all directions.	**1 2 3 4 5**	
Are there any blind spots or obstructions to direct vision?	**1 2 3 4 5**	
Are there any reflections in the windows that affect direct vision?	**1 2 3 4 5**	
Can you see the front and rear corners of the vehicle?	**1 2 3 4 5**	
Are there any vehicle components that obstruct direct vision?	**1 2 3 4 5**	
Are the sun visors effective?	**1 2 3 4 5**	

NIGHT VISIBILITY

1 2 3 4 5 (OVERALL NIGHT VISIBILITY RATING)

Do the headlights give good forward illumination on both beams?	**1 2 3 4 5**	
Are there reflections in the windows that affect vision?	**1 2 3 4 5**	
Are the remaining lights adequate for conspicuity and signaling purposes?	**1 2 3 4 5**	

<u>MIRROR-FUNCTION/ADJUSTMENT</u>

1 2 3 4 5 (OVERAL MIRROR RATING)

Do the mirrors give and adequate field of view? 1 2 3 4 5

Do the mirrors adjust easily and maintain adjustment? 1 2 3 4 5

What is your opinion on the suitability of a convex driver's side exterior mirror, if so fitted? 1 2 3 4 5

<u>INSTRUMENT PANEL AND DISPLAYS</u>

1 2 3 4 5 (OVERAL I/P AND DISPLAYS RATING)

Are the instruments, displays, and tell-tales easy to see, read, and interpret (day & night)? 1 2 3 4 5

Are there any reflections or obstructions that affect seeing the instruments, displays, or tell-tales? 1 2 3 4 5

<u>HAND CONTROLS</u>

1 2 3 4 5 (OVERALL HAND CONTROLS RATING)

Are the hand controls:

-logically located? 1 2 3 4 5

-adequately identified (day & night)? 1 2 3 4 5

-natural and easy to operate? 1 2 3 4 5

Can the controls be operated with winter gloves? 1 2 3 4 5

FOOT CONTROLS

1 2 3 4 5 (OVERALL FOOT CONTROLS RATING)

Are the foot controls easy to:

-reach?	1 2 3 4 5
-operate?	1 2 3 4 5
-operate with large winter footwear?	1 2 3 4 5

CLIMATE CONTROL SYSTEM

1 2 3 4 5 (OVERALL CLIMATE CONTROL SYSTEM RATING)

Are the controls:

-adequately identified (day & night)?	1 2 3 4 5
-easy to: -see?	1 2 3 4 5
-read?	1 2 3 4 5
-operate?	1 2 3 4 5
Are ventilation, heat, and air conditioning sufficient for all conditions?	1 2 3 4 5
Does the engine warm up quickly?	1 2 3 4 5
How effective is: -windshield defroster?	1 2 3 4 5
-rear window defroster?	1 2 3 4 5

TRANSMISSION CONTROL AND OPERATION

1 2 3 4 5 (OVERALL TRANSMISSION RATING)

How would you rate shifter:	
-precision?	1 2 3 4 5
-effort?	1 2 3 4 5
Was it easy to know what transmission position you were in?	1 2 3 4 5
Were you comfortable with the way the transmission operated?	1 2 3 4 5
Did you find shift indicators useful?	1 2 3 4 5
Were driver selectable modes (performance vs economy, manual vs automatic, torque converter locked or unlocked) useful?	1 2 3 4 5

FRONT SEAT COMFORT

1 2 3 4 5 (OVERALL FRONT SEAT COMFORT RATING)

Is the seat comfortable for you?	1 2 3 4 5
Is it easy to adjust the seat position?	1 2 3 4 5
Is there adequate head, hip, and leg-room?	1 2 3 4 5
Is there adequate room in the front for two adults wearing winter clothing?	1 2 3 4 5
Can the seat be adjusted to properly reach all hand and foot controls, and to see all instruments, displays and telltales?	1 2 3 4 5

REAR SEAT COMFORT

1 2 3 4 5 (OVERALL REAR SEAT COMFORT RATING)

Is the seat comfortable for you?	1 2 3 4 5	
Is it easy to adjust, fold, or remove the seat?	1 2 3 4 5	
Is there adequate head, hip, and leg-room?	1 2 3 4 5	
Is there adequate room in the rear for two adults wearing winter clothing?	1 2 3 4 5	

OCCUPANT RESTRAINTS (FRONT)

1 2 3 4 5 (OVERALL FRONT OCCUPANT RESTRAINT RATING)

Is it easy to find the tongue and buckle and fasten the belt?	1 2 3 4 5	
How is the force required to release the belt?	1 2 3 4 5	
Is the belt comfortable to wear?	1 2 3 4 5	
Does the belt fit properly on the pelvis and upper torso?	1 2 3 4 5	
Does the lap portion ride up on the stomach?	1 2 3 4 5	
Does the upper torso belt fall off the shoulder or rub on the neck?	1 2 3 4 5	

OCCUPANT RESTRAINTS (REAR)

1 2 3 4 5 (OVERALL FRONT OCCUPANT RESTRAINT RATING)

Is it easy to find the tongue and buckle and fasten the belt?	1 2 3 4 5	
Is the belt comfortable to wear?	1 2 3 4 5	
How is the force required to release the belt?	1 2 3 4 5	
Does the belt fit properly on the pelvis and upper torso?	1 2 3 4 5	
Does the lap portion ride up on the stomach?	1 2 3 4 5	
Does the upper torso belt fall off the shoulder or rub on the neck?	1 2 3 4 5	

HEAD RESTRAINTS

1 2 3 4 5 (OVERALL HEAD RESTRAINT RATING)

Is the head restraint the right height for you?	1 2 3 4 5	
Is it easy to adjust and does it maintain adjustment?	1 2 3 4 5	
Do you think it would provide adequate protection?	1 2 3 4 5	
Does the head restraint needlessly affect vision?	1 2 3 4 5	

CARGO SPACE

1 2 3 4 5 (OVERALL CARGO SPACE RATING)

Is there adequate cargo space for you?	1 2 3 4 5	
Is the cargo space a usable shape?	1 2 3 4 5	
Is it easy to load & unload heavy objects into the cargo area?	1 2 3 4 5	
Is the cargo adequately separated from the passenger compartment?	1 2 3 4 5	

IN-VEHICLE DEVICES

1 2 3 4 5 (OVERALL IN-VEHICLE DEVICES RATING)

Did this vehicle have any in-vehicle devices (communications, navigation, entertainment, hybrid power flow displays, etc.)? If so, please specify the device and its purpose.

Comment on:

-its ease of use 1 2 3 4 5

-utility 1 2 3 4 5

-potential for driver distraction 1 2 3 4 5

OVERALL VEHICLE RATING 1 2 3 4 5

Did weather, road conditions, vehicle loading (passengers & cargo), or other factors adversely affect the operation or performance of the vehicle?

Is this a practical vehicle? Why or why not?

If price were not a factor, would you buy this vehicle? Yes or No? Why or why not?

What do you think the market potential of such a vehicle would be in Canada? How could it be improved?

Do you feel driving this vehicle is safe? Why or why not?

Do you have any other general comments or concerns on this vehicle?

Do you have any suggestions on how to improve this Evaluation Questionnaire?

ANNEX 4

Summary of International Vehicle Safety Standards and Regulations

	MOTOR VEHICLE STANDARDS AND REGULATIONS					
	EEC[1]	ECE[2]	USA	CAN	AUS	JAPAN
	Directives	Regulations	FMVSS*	CMVSS**	ADR***	SRRV****
ACTIVE SAFETY						
Brake Systems	71/320	13, 13-H, 78	105, 135	105, 135	31	12, 13, 61
Brake Fluid			116	116	31	
Brake Hoses			106	106	7	6, 11
Brake Lining		90				
Tire/Rims	92/23	30, 64, 75, 88, 106, 108, 109	109, 110, 129	MVTSR, 109, 110	20, 23, 24, 71	9
Steering	70/311	79				11
Accelerator Cont.			124	124		8
Coupling Device (Hitches)	94/20	55, 102			62	19
Towing System	77/389					
Pressure Tank	87/404					
Controls						
Instrumentation		39			18	46
Controls and Displays	78/316	60	101	101		10
Pedals		35				10
Transmission			102	102	42	
Glare reduction in field of view					12	
Power Windows			118	118		
Theft Protection	74/61	18, 97, 62	114	114	25	11-2
Reverse Gear Speedometer	75/443					
Visibility Conditions						
Direct View	77/649					
Indirect View/Rearview Mirrors	71/127	46, 81	111	111	14	44, 64-2
Glazing mat.	92/22	43	205	205	8	29
Windshield mounting			212	212		
Windshield zone intrusion			219	219		
Defrost/Defog	78/317		103	103	15	45
Wipe/Wash	78/318	21	104	104	16	45
Light Signalling Devices	76/756	48	108	108	13	32 - 42

	EEC[1]	ECE[2]	USA	CAN	AUS	JAPAN
	Directives	Regulations	FMVSS*	CMVSS**	ADR***	SRRV****
Headlamps	76/761	1, 5, 8, 20, 31, 50, 56, 57, 72, 76, 82, 98, 99	108	108	46	32, 62
Front Fog Lamps	76/762	19	108	108	50	33
Direction Indicator Lamps	76/759	6	108	108	6	41
Tail/Stop Lamps	76/758	7	108	108	49	37, 39, 39-2
Centre High Mounted Stop Lamp	95/458	7	108	108	60	39
License Plate Lamps	76/760	4	108	108	48	36
Rear Fog Lamps	77/538	38	108	108	52	37-2
Reverse Lamps	77/539	23	108	108	1	40
Reflex Refloctors	76/757	3, 104	108	108	47	35, 38, 42, 63
Daytime Running Lights		87	108	108	49	
Parking Lamps	77/540	77	108	108	49	37-3
Bulbs		37	108 Part 564	108	51	42
Other light and light signalling		7, 53, 65, 74, 86, 91	108	108	45	34, 35-2, 49
Warning Devices (Triangles, etc.)	76/756	27, 28, 69, 70	125			43-4
Audible Warning Devices	70/388	28			43	43
Radio Interference Suppression	72/245, 89/336	10				17-2
Reflecting Labelling		104				
Climate Control						
Climate Control	78/548					
PASSIVE SAFETY						
Outside						
External Dimensions	74/483, 92/114	26, 61				18
Front Underride protection		93				18-2
Bumper		42	Part 581	215		
Hood Latch System			113	113		
Side Protection	89/297	73				
Splash Protection	91/226					
Inside						
Energy Absorption Front	96/79	33, 42, 94	208	208	69, 73	18

	EEC[1]	ECE[2]	USA	CAN	AUS	JAPAN
	Directives	Regulations	FMVSS*	CMVSS**	ADR***	SRRV****
Energy Absorption Rear		32, 42, 58		Part of 301		
Energy Absorption Side	96/27	73, 95	214	214	29, 72	18, 18-2
Energy Absorption Roof			216	216		
Fuel System Integrity – CNG, LPG, Gasoline and Diesel		34, 49, 67, 110	303, 304	301.1, 301.2		15, 16, 17
Interior Flammability			302	302		20
Interior Fittings	74/60	12, 29	201	201	21	20
Steering Control Protection / Rearward displacement	74/297	12	203, 204	204, 204	10/01	11
Restraint Systems, Occupant Crash Protection		94	208	208	69, 73	18, 22-3
Restraint Systems, Seat Belt Assemblies	77/541	16	209	209	4/03	22-3
Restraint Systems, Seat Belt Anchorage	76/115	14	210	210	5/04	22-3
Seating Systems	74/408	17, 80	207	207	3/02	20, 22
Head Restraintes	78/932	25	202	202	22	22-4
Door Latches/Hinges	70/387	11	206, 401	206	2	25
Child Restraints		44	213, 225	213, 213.4, 210.1	5/04, 34/01	22-5
Environment						
Emissions	70/220	15, 40, 47, 83, 101	CFR Part 86	CEPA Part 7	37, 79/01	31
Diesel Engine Exhaust Smoke	72/306, 88/77	24, 49, 96	CFR Part 86	CEPA Part 7	30	31
LPG		49, 67	CFR Part 86	CEPA Part 7		
Noise	70/157	41, 51, 63, 92	CFR Part 205	1106	28	30, 65
Dangerous Substances	76/769	105				50-2, 51, 52
Fuel Consumption	80/1268	84, 101	FR Part 600	MVFCA	81	1
Exhaust System					42	
Catalyst		103				
General Vehicle Requirements						
Maximum Speed		68				

	EEC[1]	ECE[2]	USA	CAN	AUS	JAPAN
	Directives	Regulations	FMVSS*	CMVSS**	ADR***	SRRV****
VIN	76/114		CFR Parts 565, 567	115	61	
Consumer Information			CFR Part 575			
Registration of Parts			CFR Parts 541, 542, 543			
Masses and Dimensions	92/21, 86/364					2
Dimensions		26				2, 18, 35-4
Type Approval	70/156					
Technical Monitoring	77/143					
Product Liability	92/59					
Engine Power	80/1269	85				
Mounting of Rear License Plate	70/222				62	
Electric Vehicles		100	305	305		
Vehicle Classification			CFR Part 523			

1 European Union
2 United Nations (1958 Global Agreement)
* Federal Motor Vehicle Safety Standard
** Canadian Motor Vehicle Safety Standard
*** Australian Design Rule
**** Safety Regulations for Road Vehicles