High-Tech Inspection and Maintenance Tests

(Procedures and Equipment)

High- Tech Tests for High-Tech Vehicles

Modern vehicles are equipped with sophisticated emission control systems capable of minimizing pollution from exhaust and from evaporating fuel. Inspection and Maintenance (I/M) programs have been established in many parts of the country to ensure these systems are working properly so vehicles retain their low pollution profiles in actual use. The 1990 Clean Air Act requires improved I/M programs and more comprehensive testing in certain areas.

The U.S. Environmental Protection Agency (EPA) has developed three new short tests for use in these I/M programs. The new tests are specifically designed to measure emissions from today's high-tech vehicles.

The "high-tech" tests provide a very thorough check of vehicle emission control systems. The sophistication of these tests enables them to determine a car's true emissions and do a better job than current I/M tests of identifying vehicles needing emission repair. The accuracy of the high-tech tests also ensures that malfunctioning vehicles will be repaired to truly acceptable emission levels.

The high-tech test includes three distinct elements:

- Transient, mass emission tailpipe test ("IM240")
- Purge flow test of the evaporative canister
- Pressure test of the evaporative system

The IM240 differs from traditional I/M tests in that the emissions are measured while the vehicle is driven on a treadmill-like device called a dynamometer. Most I/M tests today are conducted while the vehicle is idling. A few states test vehicles on a dynamometer, but only operate the vehicle at one speed.

In the IM240, the vehicle is operated over a driving cycle that has many different speeds. The cycle is designed to resemble typical city driving and includes driving modes such as acceleration and deceleration. Vehicle acceleration and deceleration can be significant sources of emissions from malfunctioning vehicles.

Hydrocarbon (HC), carbon monoxide (CO), and oxides of nitrogen (NOx) emissions are all measured during the IM240, while only HC and CO emissions are measured in traditional I/M tests. HC and NOx emissions combine in the atmosphere to form ground-level ozone, the primary component of smog.

Another important difference between the IM240 and traditional I/M tests is the way emissions are measured. The IM240 captures the entire exhaust stream during the test and measures the total mass of emissions from the vehicle (grams of pollutant per mile driven). Traditional tests measure the concentration of pollutants in exhaust (percent or ppm). Mass emissions are a more accurate way of measuring the emission performance of large and small engines and are more directly related to the contribution that each car makes to air pollution. The IM240 also can measure fuel economy.

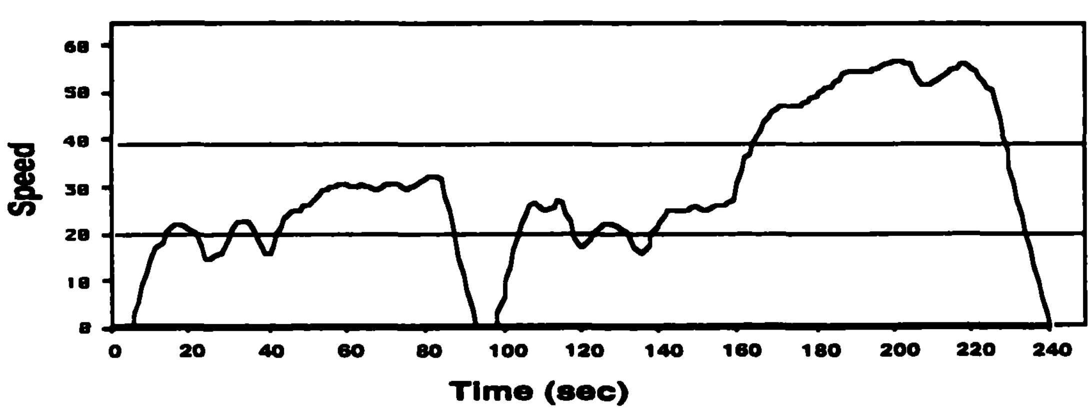
The purge and pressure tests check for proper functioning of a vehicle's evaporative emission system. This control system prevents fuel vapors from escaping into the atmosphere. Evaporative emissions can be a much greater source of HC pollution than exhaust emissions, especially in hot weather when smog levels are highest. Traditional I/M tests cannot measure evaporatative emissions.

The evaporative emission system uses engine vacuum to draw fuel vapors in the fuel tank and vapors temporarily stored in the evaporative canister into the engine for combustion. The purge test determines whether this system is functioning properly by measuring the flow of vapors into the engine during the IM240. The pressure test checks the evaporative emission system for leaks.

IM240 Test Procedure

The IM240 begins by driving the vehicle onto the dynamometer, activating vehicle restraints, properly placing the exhaust collection device, and positioning the auxiliary engine cooling fan. An inspector then "drives" the vehicle according to a prescribed cycle displayed on a video screen. The inspector follows the driving cycle by using the accelerator pedal and the brake to speed up or slow down just as if the vehicle were being driven on a city street. A cursor on the video screen indicates vehicle speed. The inspector adjusts the speed to keep the cursor on the trace. This technique is easily and quickly learned by anyone who can drive a car.

IM240 Driving Trace



The length of the IM240 test varies depending on the vehicle's emissions. To determine emission levels, second-by-second instantaneous emission measurements are taken and integrated by a computer. Failure levels for vehicles undergoing I/M tests are generally two to three times higher than manufacturer certification standards for new cars. The computer continually monitors and assesses the emission levels during each phase of the test and uses pass/fail algorithms to identify exceptionally clean or dirty vehicles. As soon as the emission rates indicate that a vehicle is exceptionally clean or dirty, the computer automatically notifies the inspector to stop testing. For vehicles that are close to maximum allowable emission levels, the test may continue for a full 240 seconds. Thus, while the complete driving cycle is 240 seconds long, the average test time will be only two to three minutes.

IM240 Test Equipment

The equipment needed to perform the IM240 is different from the equipment used for either the idle-type I/M test or the single-speed dynamometer tests used in some states (e.g., Arizona and Florida). These differences include dynamometer capabilities, video driver trace monitors, special sampling systems, and emission analyzers. In addition, the high-tech test system will use computer controls with integrated quality assurance functions, and will be completely automated.

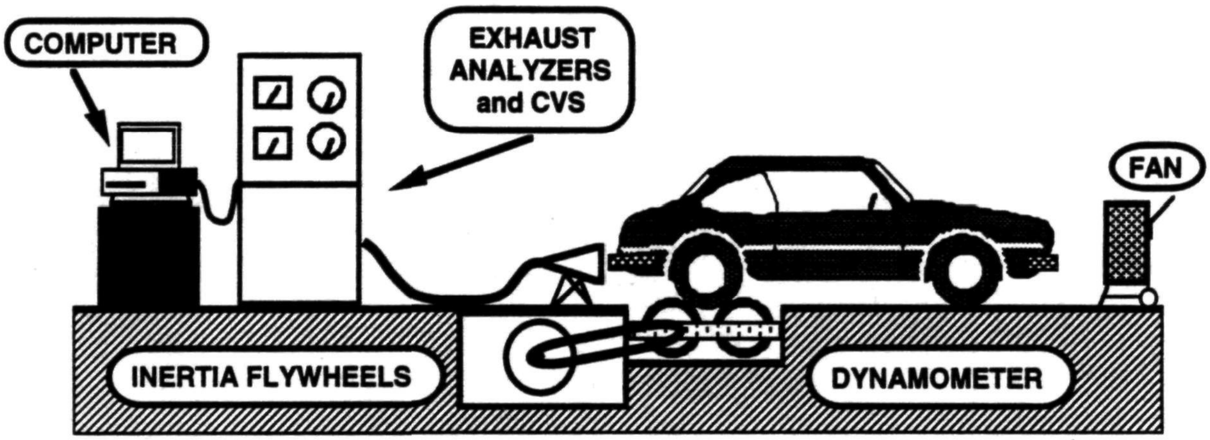
The primary difference between the dynamometer used for the IM240 and those used for single speed I/M tests is the addition of inertia flywheels. The inertia flywheels used are based on the weight of the car being tested. They allow the inspection test to simulate vehicle acceleration and deceleration by putting a load on the engine. This in turn allows the measurement of emissions under these normal driving conditions. This type of dynamometer is widely available and is similar to the ones used by EPA and car manufacturers for new car certification.

The selection of the inertia weight and test horsepower for an individual vehicle will be automatically determined by computer so that the I/M inspector is only required to drive the vehicle onto the dynamometer. Even the system used to hold the vehicle on the dynamometer will be automatic in order to minimize test set-up time and improve testing efficiency.

The vehicle's mass emissions are determined by collecting the entire exhaust flow from the tailpipe with a device known as a Constant Volume Sampler (CVS). The CVS dilutes the exhaust with fresh air and measures the flow rate of the mixture. Mass emissions (for each second) are calculated by multiplying this flow rate by the measured concentration of pollutants in the mixture. To arrive at the official test value in grams per mile, the mass emissions for each second are added together; this sum is then divided by the distance (number of miles) traveled over the 240-second test cycle.

The fresh air dilution is vital because it preserves the integrity of the sample and because it protects the emission analyzers from high concentrations of water vapor produced by the vehicle. The dilution process also allows the measurement system to accommodate the differences in exhaust flow between small engines and large engines while measuring the true amount of emissions from each type of engine.

The dilute sample, however, lowers the concentration of pollutants to be measured, and hence requires more sensitive emission analyzers than those used by traditional I/M programs. In addition, the method for measuring HC emission uses a different and more accurate technique than traditional programs. HC emissions are measured with a Flame Ionization Detector (FID), while CO and carbon dioxide emissions are measured using non-dispersive infra-red analyzers. NOx emissions are measured with a chemiluminescense analyzer.



Evaporative System Purge Test

Since 1971, fuel tanks on cars have been designed as a closed system in which vapors that evaporate from the gasoline in the tank are not released into the atmosphere. The system is sealed and under pressure so that excess vapors are shunted to a container filled with charcoal known as the evaporative canister.

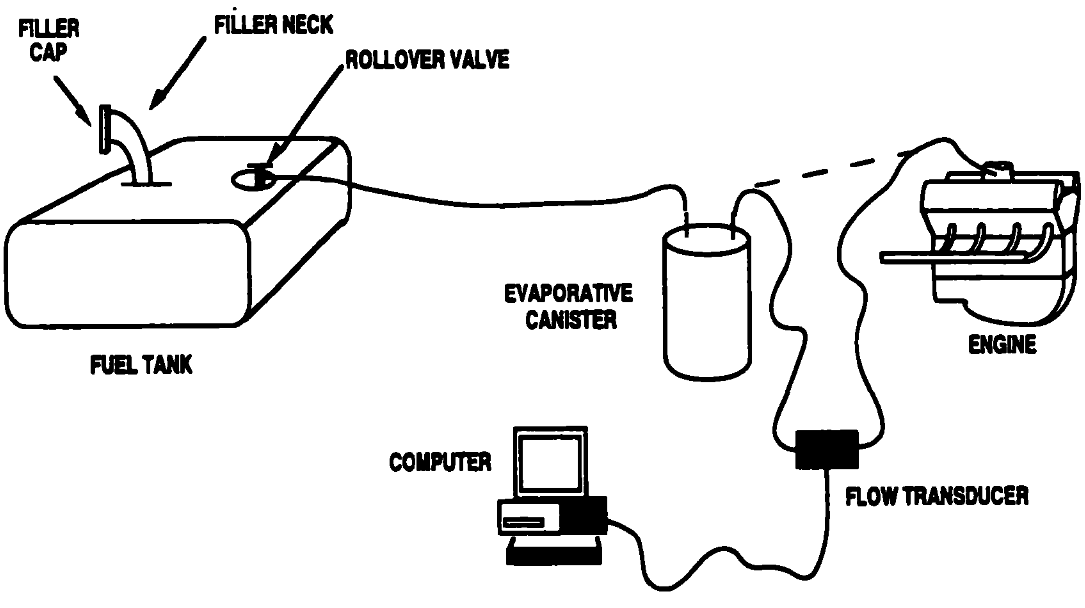
The evaporative system purge test is used to determine whether fuel vapor stored in the evaporative canister and present in the fuel tank is being properly drawn into the engine for combustion. If the purge system is not working properly, the evaporative canister can become saturated and start to vent hydrocarbons into the atmosphere. In addition to causing HC emissions, failure of the purge system wastes gasoline.

The purge test is conducted while the vehicle is undergoing the IM240 on the dynamometer. Purge flow is measured by simply inserting a flow meter at one end of the hose that runs between the evaporative canister and the engine.

Determination of an acceptable purge rate is based on the total volume of gas that flows through the system during the IM240, not by instantaneous flow rates. The vehicle must have a minimum of 1 liter of volume in order to pass. Most cars in proper working order will accumulate as much as 25 liters during the IM240 cycle. As soon as a vehicle exceeds 1 liter of volume, the purge test is complete. The entire IM240 driving cycle ends as soon as final results are determined for the emission test.

The purge test requires a flow meter that can measure the total volume of flow over the transient cycle. Additionally, hoses and universal fittings are required to hook up the flow meter as indicated below. Finally, a computer is needed to control the test process, collect and record the data, and determine the pass/fail status.

Purge Test Schematic

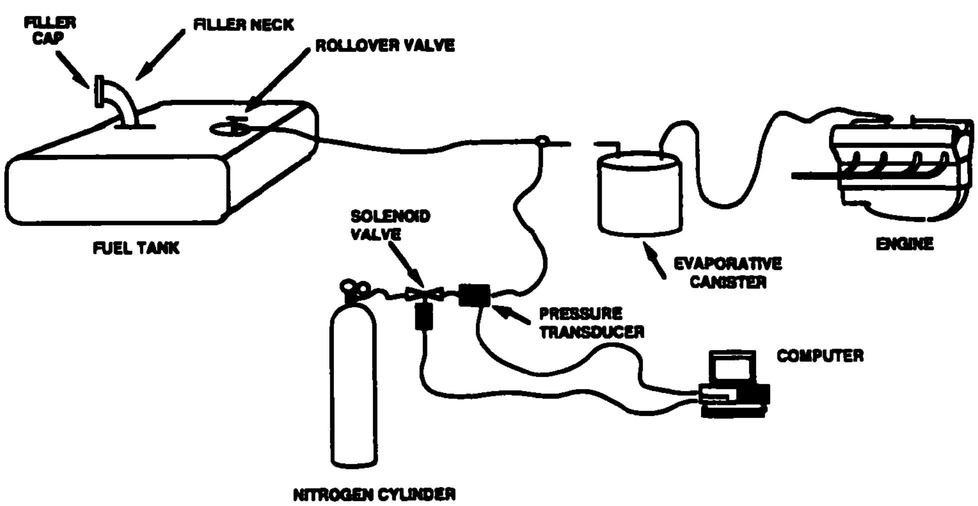


Evaporative System Pressure Test

The pressure test checks the system for leaks that would allow fuel vapors to escape into the atmosphere. A "pressure decay" method is used to monitor for pressure losses in the system. In this method, the vapor lines to the fuel tank and the fuel tank itself are filled with nitrogen to a pressure of 14 inches of water (about 0.5 psi). To pressurize these components, the inspector must locate the evaporative canister, remove the vapor line from the fuel tank, and hook up the pressure test equipment to the vapor line. After the system is filled, the pressure supply system is closed off and the loss in pressure is observed. If pressure in the system remains above eight inches of water after two minutes, the vehicle passes the test.

A source of nitrogen, a pressure gauge, a valve, and associated hoses and fittings are needed to perform the pressure test. In addition, a computer is used to automatically meter the nitrogen, monitor the pressure, and collect and process the results. Algorithms will be developed to optimize the test so that a pass/fail decision can be made in less than two minutes on most vehicles.

Pressure Test Schematic



For Further Information

The EPA National Vehicle and Fuel Emissions Laboratory is the national center for research and policy related to automotive pollution. Contact the Emission Planning and Strategies Division at 2565 Plymouth Road, Ann Arbor, MI 48105; or call 313/668-4456.