Figure 82-1 The underhood decal showing that this Lexus RX-330 meets both national (Tier 2, BIN 5) and California LEV-II (ULEV) regulation standards.

Chart 82-1 EPA Tier 2—120,000-Mile Tailpipe Emission Limits. NMOG stands for non-methane organic gases which is a measure of all gases except those often created naturally by wildlife. After January 2007, the highest allowable Bin is 7. Source: Data compiled from the Environmental Protection Agency (EPA). NOTE: The bin number is determined by the type and weight of the vehicle.
Figure 82-2 This label on a Toyota Camry hybrid shows the relative smog-producing emissions, but this does not include carbon dioxide (CO₂), which may increase global warming.

CHART 82–3 Air Pollution Score Source: Courtesy of the Environmental Protection Agency (EPA).
Figure 82-3  Photo of a sign taken at an emissions test facility.

Figure 82-4  A vehicle being tested during an enhanced emission test.

Figure 82-5  Trace showing the Inspection/Maintenance 240 test. The test duplicates an urban test loop around Los Angeles, California. The first "hump" in the curve represents the vehicle being accelerated to about 20 mph, then driving up a small hill to about 30 mph and coming to a stop at 94 seconds. Then, the vehicle accelerates while climbing a hill and speeding up to about 50 mph during the second phase of the test.
FREQUENTLY ASKED QUESTION

What Does NMHC Mean?
NMHC means non-methane hydrocarbon and it is the standard by which exhaust emission testing for hydrocarbons is evaluated. Methane is natural gas and can come from animals, animal waste, and other natural sources. By not measuring methane gas, all background sources are eliminated, giving better results as to the true amount of unburned hydrocarbons that are present in the exhaust stream.

FREQUENTLY ASKED QUESTION

How Can My Worn-Out, Old, High-Mileage Vehicle Pass an Exhaust Emission Test?
Age and mileage of a vehicle are generally not factors when it comes to passing an exhaust emission test. Regular maintenance is the most important factor for passing an enhanced Inspection and Maintenance (I/M) exhaust analysis test. Failure of the vehicle owner to replace broken accessory drive belts, leaking air pump tubes, defective spark plug wires, or a cracked exhaust manifold can lead to failure of other components such as the catalytic converter. Tests have shown that if the vehicle is properly cared for, even an engine that has 300,000 miles (483,000 km) can pass an exhaust emission test.
Exhaust emissions are very complex. When the air-fuel mixture becomes richer, some exhaust emissions are reduced, while others increase.

**TECH TIP: CO Equals O₂**

If the exhaust is rich, CO emissions will be higher than normal. If the exhaust is lean, O₂ emissions will be higher than normal. Therefore, if the CO reading is the same as the O₂ reading, then the engine is operating correctly. For example, if both CO and O₂ are 0.5% and the engine develops a vacuum leak, the O₂ will rise. If a fuel-pressure regulator were to malfunction, the resulting richer air-fuel mixture would increase CO emissions. Therefore, if both the rich indicator (CO) and the lean indicator (O₂) are equal, the engine is operating correctly.

A hole in the exhaust system can cause outside air (containing oxygen) to be drawn into the exhaust system. This extra oxygen can be confusing to a service technician because the extra oxygen can cause increased CO readings.
TECH TIP: How to Find a Leak in the Exhaust System

A hole in the exhaust system can dilute the exhaust gases with additional oxygen (O₂). See Figure 82–8. This additional O₂ in the exhaust can lead the service technician to believe that the air-fuel mixture is too lean. To help identify an exhaust leak, perform an exhaust analysis at idle and at 2500 RPM (fast idle) and compare with the following:

- If the O₂ is high at idle and at 2500 RPM, the mixture is lean at both idle and at 2500 RPM.
- If the O₂ is low at idle and high at 2500 RPM, this usually means that the vehicle is equipped with a working AIR pump.
- If the O₂ is high at idle, but okay at 2500 RPM, a hole in the exhaust or a small vacuum leak that is “closed up” at higher speed is indicated.

TECH TIP: Your Nose Knows

Using the nose, a technician can often identify a major problem without having to connect the vehicle to an exhaust analyzer. For example:

- The strong smell of exhaust is due to excessive unburned hydrocarbon (HC) emissions. Look for an ignition system fault that could prevent the proper burning of the fuel. A vacuum leak could also cause a lean misfire and cause excessive HC exhaust emissions.
- If your eyes start to burn or water, suspect excessive oxides of nitrogen (NOX) emissions. The oxides of nitrogen combine with the moisture in the eyes to form a mild solution of nitric acid. The acid formation causes the eyes to burn and water. Excessive NOX exhaust emissions can be caused by:
  - A vacuum leak causing higher-than-normal combustion chamber temperatures
  - Overadvanced ignition timing causing higher-than-normal combustion chamber temperatures
  - Lack of proper amount of exhaust gas recirculation (EGR) (This is usually noticed above idle on most vehicles.)
- A dizzy feeling or headache. This is commonly caused by excessive carbon monoxide (CO) exhaust emissions. Get into fresh air as soon as possible. A probable cause of high levels of CO is an excessively rich air-fuel mixture.

TECH TIP: Check for Dog Food?

A commonly experienced problem in many parts of the country involves squirrels or other animals placing dog food into the air intake ducts of vehicles. Dog food is often found packed tight in the ducts against the air filter. An air intake restriction reduces engine power and vehicle performance.
REAL WORLD FIX

The Case of the Retarded Exhaust Camshaft

A Toyota equipped with a double overhead camshaft (DOHC) inline six-cylinder engine failed the state-mandated enhanced exhaust emission test for NOx. The engine can perfectly without spark knocking (ping), which is usually a major reason for excessive NOx emissions.

The technician checked the following:

- The ignition timing, which was found to be set to specifications (if too far advanced, can cause excessive NOx).
- The cylinders, which were decarbonized using top engine cleaner.
- The EGR valve, which was inspected and the EGR passages cleaned.

After all the items were completed, the vehicle was returned to the inspection station where the vehicle again failed for excessive NOx emissions (better, but still over the maximum allowable limit).

After additional hours of troubleshooting, the technician decided to go back to basics and start over again. A check of the vehicle history with the owner indicated that the only previous work performed on the engine was a replacement timing belt over a year before.

The technician discovered that the exhaust cam timing was retarded two teeth, resulting in late closing of the exhaust valve. The proper exhaust valve timing resulted in a slight amount of exhaust being retained in the cylinder. The extra exhaust was added to the amount supplied by the EGR valve and helped reduce NOx emissions. After repositioning the timing belt, the vehicle passed the emissions test well within the limits.

REAL WORLD FIX

O2S Shows Rich, but Pulse Width Is Low

A service technician was attempting to solve a driveability problem. The computer did not indicate any driveability trouble codes. A check of the oxygen sensor voltage indicated a higher-than-normal reading almost all the time. The pulse width to the port injectors was lower than normal. The lower-than-normal pulse width indicates that the computer is attempting to reduce fuel flow by decreasing the amount of fuel for all the injectors.

What could cause a rich mixture if the injectors were being commanded to deliver a lean mixture? Finally, the technician shut off the engine and took a careful look at the entire fuel-injection system. Although the vacuum hose was removed from the fuel-pressure regulator, fuel was found dripping from the vacuum hose. The problem was a defective fuel-pressure regulator that allowed an uncontrolled amount of fuel to be drawn by the intake manifold vacuum into the cylinders. While the computer tried to reduce fuel by reducing the pulse width signal to the injectors, the extra fuel being drawn directly from the fuel rail caused the engine to operate with too rich an air-fuel mixture.