Most catalytic converters are located as close to the exhaust manifold as possible, as seen in this display of a Chevrolet Corvette.

A typical catalytic converter with a monolithic substrate.
Figure 86-3 The three-way catalytic converter first separates the NOx into nitrogen and oxygen. The three-way converter then converts the NOx and CO into harmless water (H2O) and carbon dioxide (CO2). The nitrogen (N2) passes through the converter and exits the tailpipe and enters the atmosphere which is about 78% nitrogen.

Figure 86-4 The small oxidation section of the converter helps build heat for the reduction section to reduce NOx emissions in the rear bricks on most newer vehicles.

Figure 86-5 The OBD-II catalytic converter monitor compares the signals of upstream and downstream oxygen sensors to determine converter efficiency.
Figure 86-6: The waveform of a downstream O2S sensor from a properly functioning converter shows little, if any, activity.

Figure 86-7: The highest catalytic converter efficiency occurs when the air-fuel mixture is about 14.7:1.

Figure 86-8: A catalytic converter that rattles when tapped was removed, and the substrate, or what was left of it, fell out. This converter has to be replaced and the root cause of why it failed needs to be determined.
FREQUENTLY ASKED QUESTION

Can a Catalytic Converter Be Defective without Being Clogged?
Yes. Catalytic converters can fail by being chemically damaged or poisoned without being mechanically clogged. Therefore, the catalytic converter should be tested not only for physical damage (clogging) by performing a back pressure or vacuum test and a rattle test but also for temperature rise, usually with a pyrometer or propane test, to check the efficiency of the converter.

Figure 86-9 A back pressure test can be made by using an oxygen sensor housing and epoxy or braze to hold the tube to the housing.

Figure 86-10 This partially melted catalytic converter tested okay at idle but had excessive back pressure at higher engine speeds.
The temperature of the outlet should be at least 10% hotter than the temperature of the inlet. If a converter is not working, the inlet temperature will be hotter than the outlet temperature.

**TECH TIP: Aftermarket Catalytic Converters**

Some replacement aftermarket (nonfactory) catalytic converters do not contain the same amount of cerium as the original part. Cerium is the element that is used in catalytic converters to store oxygen. As a result of the lack of cerium, the correlation between the oxygen storage and the conversion efficiency may be affected enough to set a false diagnostic trouble code (P0422).

NOTE: If an aftermarket converter is being installed, be sure that the distance between the rear of the catalyst block is the same distance from the rear oxygen sensor as the factory converter to be ensured of proper operation. Always follow the instructions that come with the replacement converter. SEE FIGURE 86-12.

Whenever replacing a catalytic converter with a universal unit, first measure the distance between the rear brick and the center of the rear oxygen sensor. Be sure that the replacement unit is installed to the same dimension.
**TECH TIP: Catalytic Converters Are Murdered**

Catalytic converters start a chemical reaction but do not enter into the chemical reaction. Therefore, catalytic converters neither wear out nor die of old age. If a catalytic converter is found to be defective (nonfunctioning or plugged), look for the root cause. Remember this: *Catalytic converters do not commit suicide—they are murdered.*

Items that should be checked when a defective catalytic converter is discovered include all components of the ignition and fuel systems. Excessive unburned fuel can cause the catalytic converter to overheat and fail. The oxygen sensor must be working and fluctuating from 0.1 to 0.9 V (volts per second) to provide the necessary air-fuel ratio variations for maximum catalytic converter efficiency.

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**CATALYTIC CONVERTER OPERATION 1**

Carbon monoxide leaves the engine through the exhaust valve on the exhaust stroke.

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**CATALYTIC CONVERTER OPERATION 2**

The CO molecule is starting to enter the converter.
A CO molecule is ready to enter a cell. The number of cells ranges from 300 to 900 per sq. in. The substrate is cordierite (Mg, Al, Si) or foil-backed metal with a 0.002- to 0.006-inch (0.05- to 0.15-mm)-thick wall.

The CO molecule enters a cell. The substrate is coated with porous aluminum (Al$_2$O$_3$), called the washcoat. The catalytic material is sprayed onto the washcoat.

The CO molecule enters a micropore, which has been created in the porous washcoat.
CATALYTIC CONVERTER OPERATION 6. The CO molecule enters a smaller micropore.

CATALYTIC CONVERTER OPERATION 7. The CO molecule is absorbed onto a catalyst site. Only a few grams of catalyst material are applied to the washcoat.

CATALYTIC CONVERTER OPERATION 8. The CO molecule is converted to a CO$_2$ molecule.
CATALYTIC CONVERTER OPERATION 9  The CO₂ molecule is exiting the small micropore.

CATALYTIC CONVERTER OPERATION 10  The CO₂ molecule is exiting the larger micropore.

CATALYTIC CONVERTER OPERATION 11  The CO₂ molecule is exiting the converter.
A poisoned converter.