WALKER®

CATALYTIC
CONVERTERS

Understanding the Catalytic Converter

- What is a Catalytic Converter
- Evolution of the Catalytic Converter
- Why a Catalytic Converter Fails
- Catalytic Converter Diagnostics
- Walker® Features and Benefits

What is a Catalytic Converter?

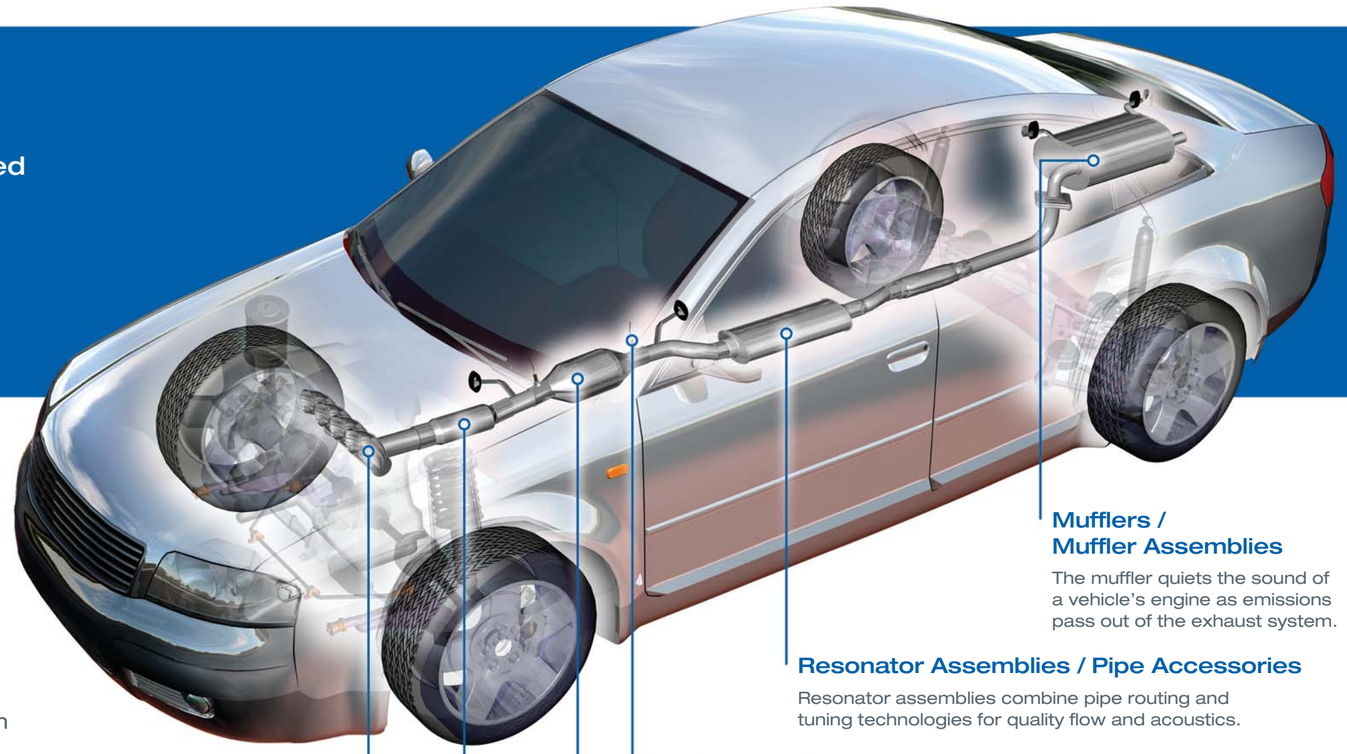
A catalytic converter is a vital part of a vehicle emissions control system

The catalytic converter is designed to convert harmful emissions, produced by an internal combustion engine, to less-harmful elements: H_2O (Water), CO_2 (Carbon Dioxide) and N_2 (Nitrogen).

To perform this conversion, the catalytic converter works with a vehicle's PCM (Powertrain Control Module) and other emissions control devices.

OBDII (On-Board Diagnostics Version 2) monitors the emissions control devices and provides feedback on their operating condition.

As the EPA (Environmental Protection Agency) updates emissions standards, the OBDII system becomes more sensitive to fluctuations in emissions performance.



Mufflers / Muffler Assemblies

The muffler quiets the sound of a vehicle's engine as emissions pass out of the exhaust system.

Resonator Assemblies / Pipe Accessories

Resonator assemblies combine pipe routing and tuning technologies for quality flow and acoustics.

O_2 (Oxygen) Sensors

Detect the level of O_2 in the exhaust stream. This information is utilized by the PCM for fuel control, and to monitor converter efficiency.

Catalytic Converters

Converts harmful engine emissions to less-harmful emissions.

Pre-Catalyst

Heats up quickly due to its close proximity to the engine, reducing cold-engine emissions.

Manifold / Headers

Typically made of cast iron or fabricated tubing, the headers - which are connected to the engine at the exhaust ports, with flange connectors - are designed to collect exhaust gases from each cylinder. These gases are then funneled into a common outlet.

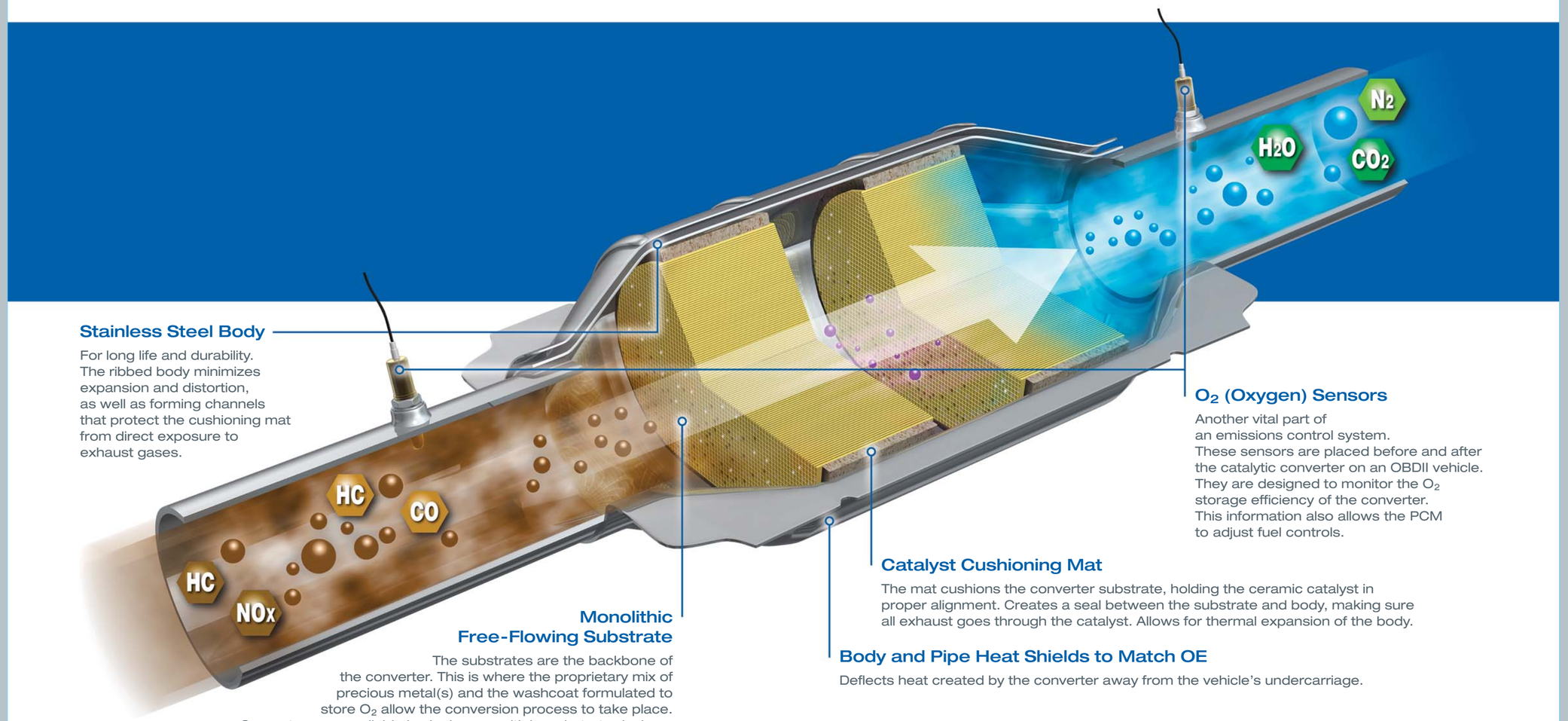
The Anatomy of a Catalytic Converter

A catalytic converter has no moving parts. It is designed to last the normal operating life of a vehicle.

Element Legend

Harmful Emissions (Product of Incomplete Combustion)		
HC	Hydrocarbon	Unburnt fuel
CO	Carbon Monoxide	Partially burnt fuel or oil
NO_X	Oxides of Nitrogen	Extreme combustion temperature

Less-Harmful Emissions (By-product of Complete Combustion)	
H_2O	Water
CO_2	Carbon Dioxide
N_2	Nitrogen



Stainless Steel Body

For long life and durability. The ribbed body minimizes expansion and distortion, as well as forming channels that protect the cushioning mat from direct exposure to exhaust gases.

O_2 (Oxygen) Sensors

Another vital part of an emissions control system. These sensors are placed before and after the catalytic converter on an OBDII vehicle. They are designed to monitor the O_2 storage efficiency of the converter. This information also allows the PCM to adjust fuel controls.

Monolithic Free-Flowing Substrate

The substrates are the backbone of the converter. This is where the proprietary mix of precious metal(s) and the washcoat formulated to store O_2 allow the conversion process to take place. Converters are available in single- or multiple-substrate designs.

Catalyst Cushioning Mat

The mat cushions the converter substrate, holding the ceramic catalyst in proper alignment. Creates a seal between the substrate and body, making sure all exhaust goes through the catalyst. Allows for thermal expansion of the body.

Body and Pipe Heat Shields to Match OE

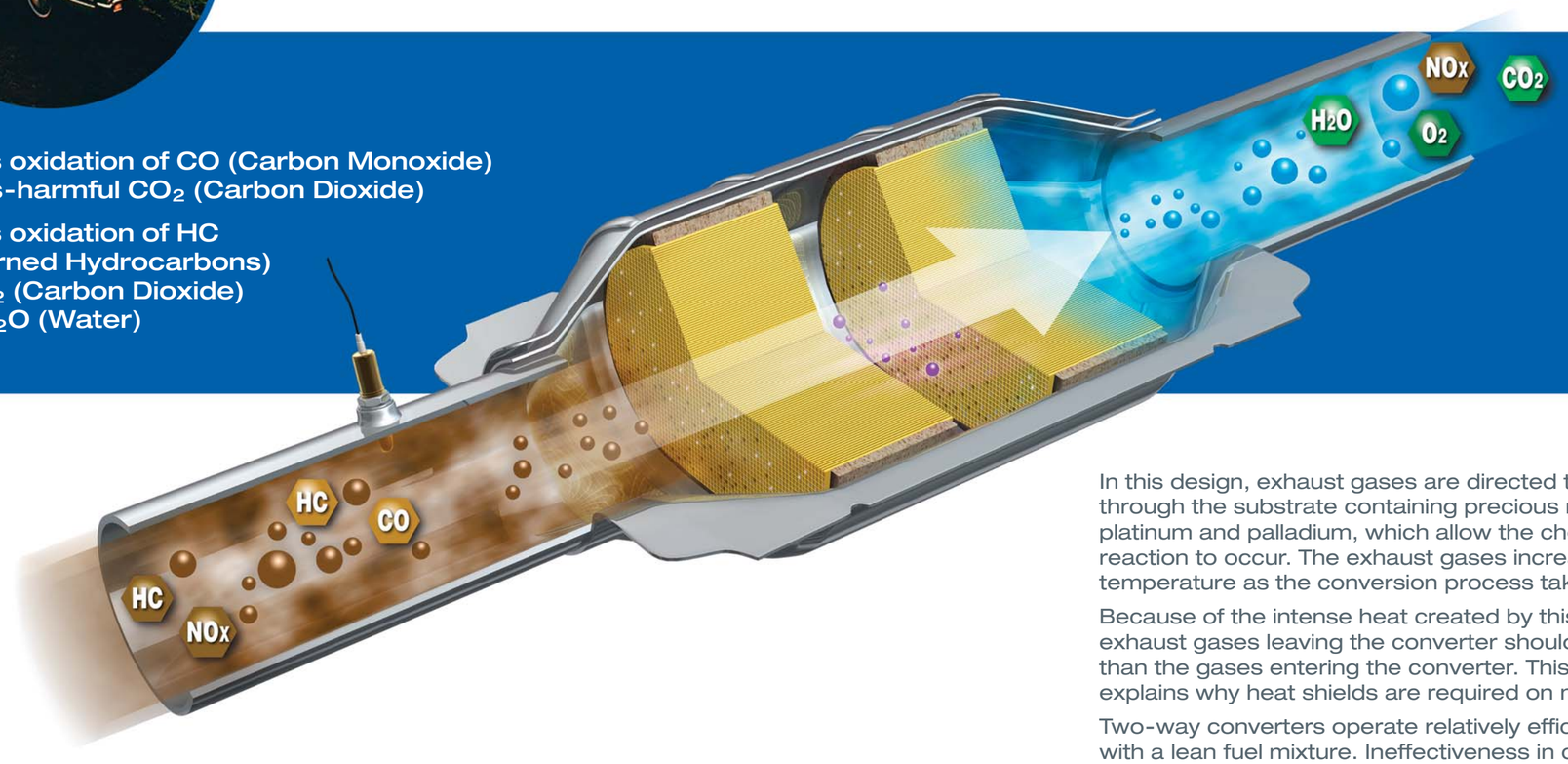
Deflects heat created by the converter away from the vehicle's undercarriage.

Evolution of the Catalytic Converter

Two-Way Catalytic Converters

The Evolution of the Catalytic Converter

1) Allows oxidation of CO (Carbon Monoxide) to less-harmful CO_2 (Carbon Dioxide)
2) Allows oxidation of HC (Unburned Hydrocarbons) to CO_2 (Carbon Dioxide) and H_2O (Water)



In this design, exhaust gases are directed to flow through the substrate containing precious metals platinum and palladium, which allow the chemical reaction to occur. The exhaust gases increase in temperature as the conversion process takes place.

Because of the intense heat created by this process, exhaust gases leaving the converter should be hotter than the gases entering the converter. This also explains why heat shields are required on most units.

Two-way converters operate relatively efficiently with a lean fuel mixture. Ineffectiveness in controlling NO_X led to the introduction of three-way converters.

Element Legend

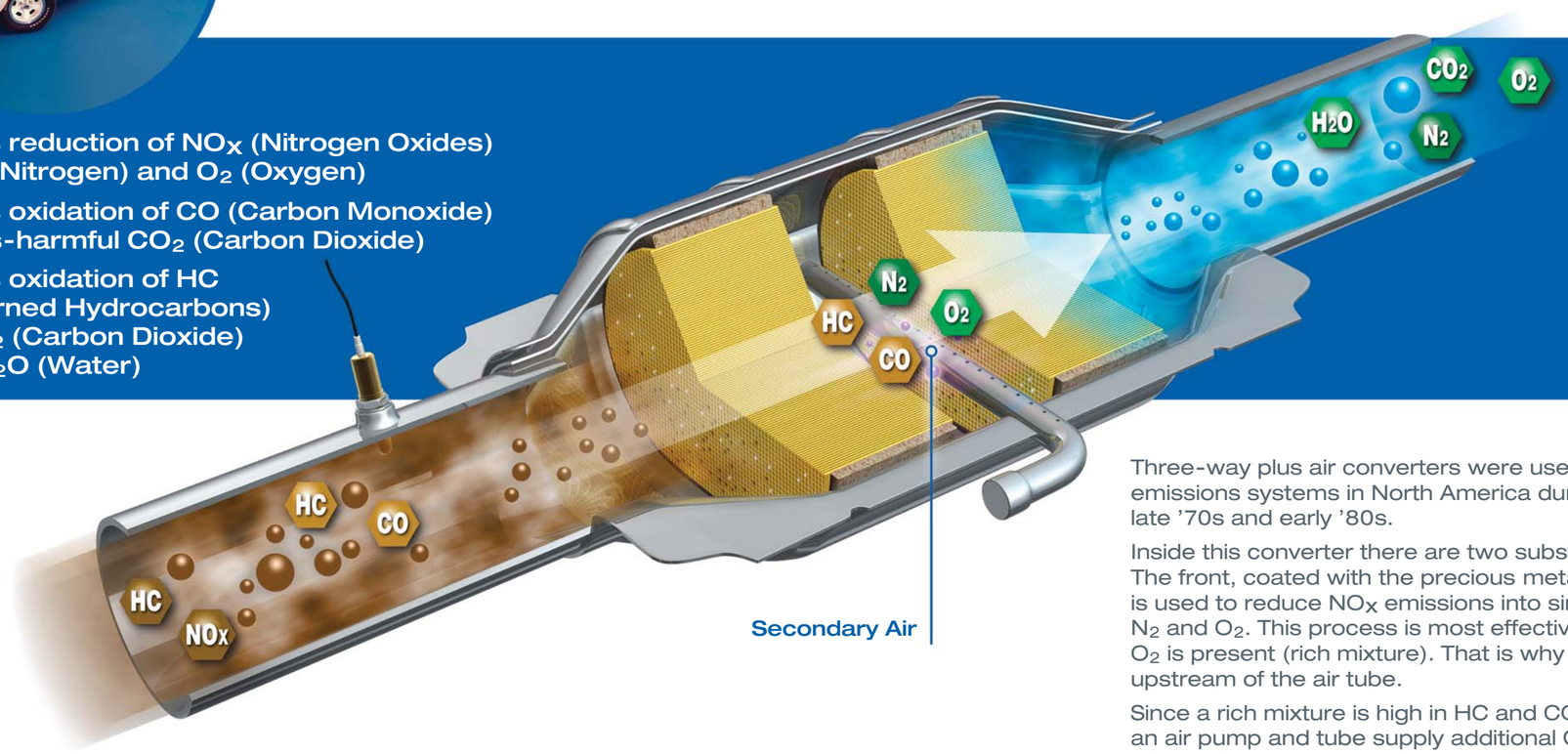
Harmful Emissions (Product of Incomplete Combustion)		
HC	Hydrocarbon	Unburnt fuel
CO	Carbon Monoxide	Partially burnt fuel or oil
NO_X	Oxides of Nitrogen	Extreme combustion temperature

Less-Harmful Emissions (By-product of Complete Combustion)	
H_2O	Water
CO_2	Carbon Dioxide
N_2	Nitrogen

Three-Way Plus Air Catalytic Converters

The Evolution of the Catalytic Converter

1) Allows reduction of NO_X (Nitrogen Oxides) to N_2 (Nitrogen) and O_2 (Oxygen)
2) Allows oxidation of CO (Carbon Monoxide) to less-harmful CO_2 (Carbon Dioxide)
3) Allows oxidation of HC (Unburned Hydrocarbons) to CO_2 (Carbon Dioxide) and H_2O (Water)



Element Legend

Harmful Emissions (Product of Incomplete Combustion)		
HC	Hydrocarbon	Unburnt fuel
CO	Carbon Monoxide	Partially burnt fuel or oil
NO_X	Oxides of Nitrogen	Extreme combustion temperature

Less-Harmful Emissions (By-product of Complete Combustion)	
H_2O	Water
CO_2	Carbon Dioxide
N_2	Nitrogen

Three-way plus air converters were used in vehicle emissions systems in North America during the late ’70s and early ’80s.

Inside this converter there are two substrates. The front, coated with the precious metal rhodium, is used to reduce NO_X emissions into simple N_2 and O_2. This process is most effective when little O_2 is present (rich mixture). That is why it is located upstream of the air tube.

Since a rich mixture is high in HC and CO, an air pump and tube supply additional O_2 to this mixture before it enters the second substrate.

The second substrate, coated with the precious metals palladium and platinum, allows oxidation of HC and CO to less harmful emissions CO_2 and H_2O.

This system was not very efficient and was phased out in the early ’80s, when the current three-way converter was introduced.

Three-Way Catalytic Converters

The Evolution of the Catalytic Converter

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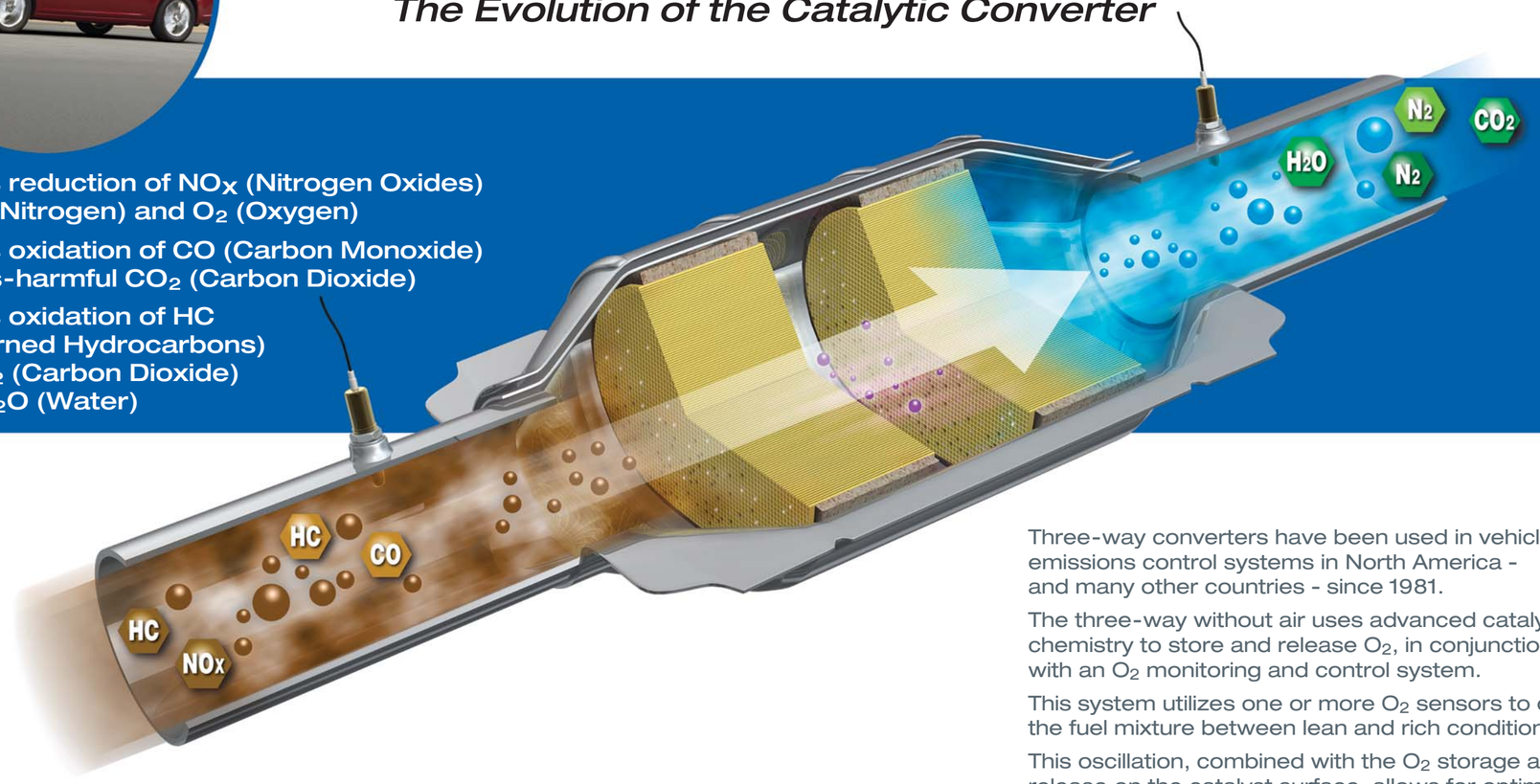

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Less-Harmful Emissions (By-product of Complete Combustion)	
H_2O	Water
CO_2	Carbon Dioxide
N_2	Nitrogen

Three-way converters have been used in vehicle emissions control systems in North America - and many other countries - since 1981.

The three-way without air uses advanced catalyst chemistry to store and release O_2, in conjunction with an O_2 monitoring and control system.

This system utilizes one or more O_2 sensors to oscillate the fuel mixture between lean and rich conditions.

This oscillation, combined with the O_2 storage and release on the catalyst surface, allows for optimum reduction of all three emissions.

Three-way converters are used in conjunction with OBDII diagnostic systems on today's vehicles. This system alerts the driver when the converter is not working at peak efficiency.

High NO_X, Exhaust Emissions

Why a Catalytic Converter Fails

High NO_X can be formed by various system malfunctions or component failures - anything that allows combustion chamber temperatures to exceed 2,300° F.

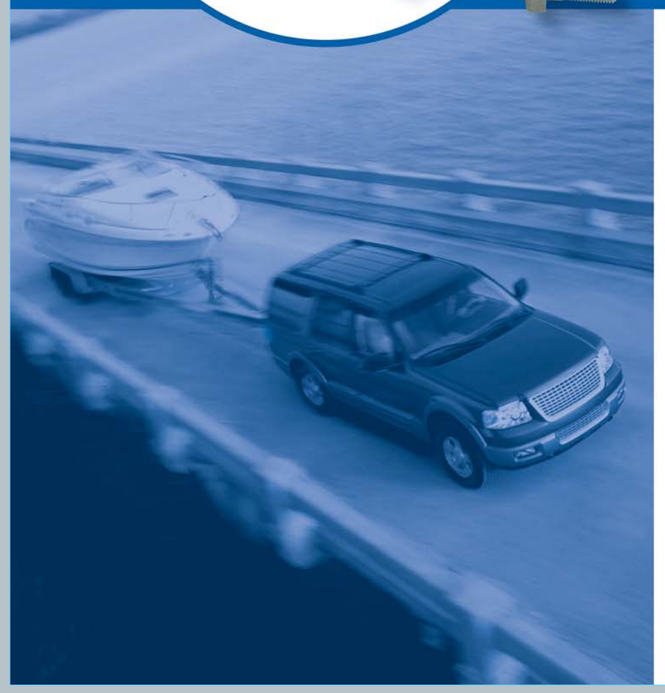
Potential causes for high NO_X readings include:

- Incorrectly adjusted or malfunctioning EGR valve
- O_2 Sensor failure
- Upstream leak in exhaust tubing
- Excessive carbon deposits in combustion chamber (hot spots) increase compression ratio
- Malfunctioning spark advance
- Obstructed coolant passage
- Lean AFR (Air / Fuel Ratio)
- Compromised engine sensor

Overheated, Melted or Broken Converters

Why a Catalytic Converter Fails

Any malfunction causing an unusually high level of unburned HC (Hydrocarbons – raw or partially-burned fuel) to enter the converter will dramatically elevate its temperature.



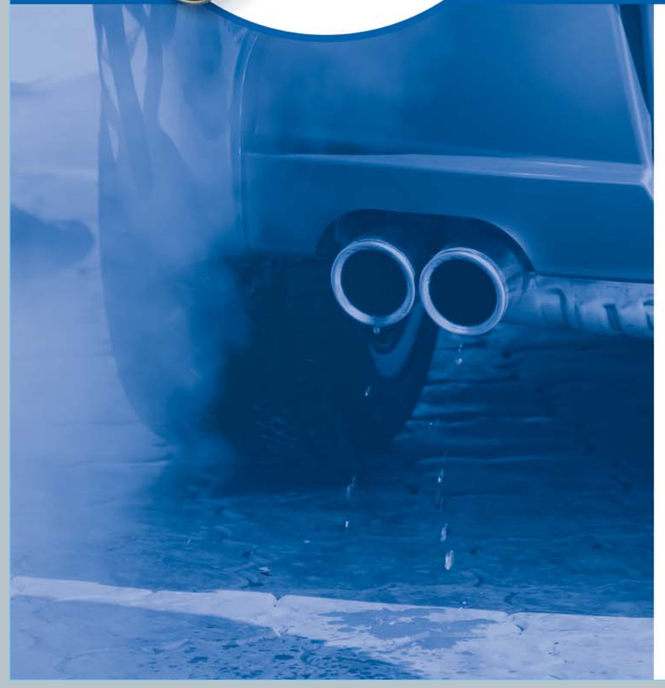
Potential causes for high HC readings may include:

- Fuel delivery system or fuel quality
- Sluggish (worn out) O_2 Sensors
- Restricted air cleaner
- Excessive backpressure
- Low compression
- Poor spark, or weak ignition
- Excessive engine or vehicle load
- Temperatures in excess of 1600° F may damage catalyst, without visible signs of melting

Coated / Oil-Fouled Substrate

Why a Catalytic Converter Fails

Catalyst poisoning occurs when the converter is exposed to emissions containing substances that coat the working surfaces, enveloping the catalyst to the point it cannot contact - and treat - the exhaust.



Potential causes for coated or fouled substrate may include:

- Excessive carbon build-up in exhaust
- Internal coolant leaks (head / intake gasket)
- Use of non-converter-safe gasket sealants
- Excessive oil consumption (burning oil)
- Improper fuels or additives (E85, diesel)

Structural Damage

Why a Catalytic Converter Fails

The primary cause of structural damage is road debris striking the converter. Normally, some evidence of impact is visible on the converter shield.

Other conditions that may cause structural damage:

- Corrosion
- Thermal shock
- Metal fatigue
- Stress fractures
- Stripped O_2 Sensor threads
- Flex pipe failure
- Air-gap pipe failure

Converter Efficiency Diagnostic

The function of any catalytic converter is to reduce harmful emissions generated by a ***properly-tuned engine***

Catalytic converters can only function efficiently if the engine is operating properly, and the exhaust system is leak-free. Both too-rich and too-lean fuel mixtures may lead to converter efficiency issues, and possible failure.

The precious metal catalyst is incorporated within a ceramic substrate. The converter honeycomb has hundreds of channels, allowing exhaust gases to flow against a maximum substrate surface area, where the catalyst reaction occurs. The catalyst and emissions must make direct contact for the reaction to take place.

If the converter substrate gets clogged or fouled with carbon, lead or oil, the unit's efficiency is compromised.

The type of converter required for a specific vehicle varies with model year, engine size and vehicle weight. For some vehicles, multiple converters have been installed to meet emissions reduction standards.

Use the proper converter for the vehicle being serviced, as specified in the manufacturers' application guide.

Typical Gas Analyzer Readings (Good Converter) 2000 rpms

CO	CO_2	HC	O_2	A / F
< .2%	> 13.5%	< 15 ppm	< .2%	14.6 - 14.8%

Typically, a Converter is Defective, or not Lighting Off, if:

HC	+	CO	+	O_2
125 - 380 ppm		> .3%		> .4%

Converter Efficiency Diagnostic

1) Obtain Vehicle History

Customer feedback is an invaluable tool. Driveability, performance and service history can help guide you through the diagnostic process.

- Has the catalytic converter ever been replaced?
- What service has been performed in the last six to twelve months?
- Does the vehicle require coolant or oil to be added regularly?
- Has the fuel economy decreased recently?
- Is the engine hard to start, either hot or cold?
- Does the engine run smooth?
- Have you noticed any engine misfires?
- Has the vehicle run out of fuel?
- Did the wrong fuel get added?
- Do you use fuel additives?
- What is the condition of the coolant?
- Does the heater work properly?
- Have aftermarket parts been added?
  - Performance PCM programmer (Chip)
  - Performance exhaust
  - Remote starter
- How is the vehicle used, and driven?
  - Towing with transmission in low gear
  - Parking brake engaged, putting extra load on engine
  - Locked in 4WD low for extended periods of time

Converter Efficiency Diagnostic

2) Correct Other Engine Codes

Any condition that increases emissions or affects sensor readings could cause a converter to fail diagnostics even if the converter is good.

- Many OBDII trouble codes will affect converter performance. Correct all other codes prior to correcting converter codes.
- The following codes are related to the catalytic converter:
  - P0420 Catalyst system efficiency below threshold (Bank 1)
  - P0421 Warm-up catalyst efficiency below threshold (Bank 1)
  - P0422 Main catalyst efficiency below threshold (Bank 1)
  - P0423 Heated catalyst efficiency below threshold (Bank 1)
  - P0424 Heated catalyst temperature below threshold (Bank 1)
  - P0430 Catalyst system efficiency below threshold (Bank 2)
  - P0431 Warm-up catalyst efficiency below threshold (Bank 2)
  - P0432 Main catalyst efficiency below threshold (Bank 2)
  - P0433 Heated catalyst efficiency below threshold (Bank 2)
  - P0434 Heated catalyst temperature below threshold (Bank 2)

3) Correct Exhaust System Leaks

Leaks in the exhaust system can affect O_2 (Oxygen) storage in the converter and lead to improper O_2 (Oxygen) Sensor readings, affecting the AFR (Air / Fuel Ratio) balance.

- Check all weld areas for cracks, especially O_2 sensor ports.
- Check all pipe connections for improper alignment or burnt gaskets.
- Check all clamp connections for leaks.
- Pay close attention to any flex-pipe in the system.

Converter Efficiency Diagnostic

4) Check Converter Temperature

Using an infrared thermometer, check the temperature of the converter's front and rear weld rings, to ensure the converter has "lit off." Depending on their sizes, most converters begin to light off around 350° F, and are fully lit around 500° F.

Under normal conditions, the rear weld ring may reach temperatures which are as much as 150° F higher than the front weld ring. If the rear weld ring reaches temperatures in excess of 150° F higher than the front weld ring, the engine may have an emissions problem.

- Keep in mind that the converter's rear weld ring temperature is directly related to the amount of work the converter is performing. Therefore, elevated temperatures may indicate an emissions issue.
- If the rear weld ring is significantly cooler than the front, the converter may not be lighting off. This may indicate the converter has failed, or that the exhaust mixture is not correct - the symptom of an underlying emissions issue.
- Typically, converter temperatures will not exceed 1200° F on a properly running engine. Periodic operation above 1600° F can negatively affect the precious metals coating on the substrate, reducing its efficiency. Excessive temperatures can reduce the converter's durability, or - if high enough - destroy the converter's matting or substrate.
- Damaged matting and melted substrates typically occur at temperatures exceeding 1700° F. It is possible to test for a cracked substrate or damaged matting by tapping on the converter housing. Using a rubber mallet, "thump" the shell, listening for loose components.
- A bronze / blue rainbow discoloration of the shell typically indicates elevated temperatures. If the converter is removed, look through the substrate to observe whether the small passageways are melted or collapsed. The substrate may actually appear normal at either end, since the substrate melts internally.

Converter Efficiency Diagnostic

5) Backpressure

Although backpressure varies with application, typically the pressure should be less than 5 psi.

On some applications, however, backpressure as low as 3 psi may indicate a problem.

- Using the O_2 Sensor ports, check for excessive backpressure ahead of - and behind - the converter.
- High backpressure behind the converter indicates a restricted muffler or resonator.
- High backpressure ahead of the converter indicates a restricted converter.
- High backpressure at the exhaust manifold indicates a blocked Y-connection.
- Excessive back pressure will adversely affect AFR, leading to excessive emissions.

6) Check O_2 (Oxygen) Sensor

O_2 (Oxygen) Sensors are critical to fuel control and to the PCM's converter diagnostics.

- The front sensor should be very active, and typically oscillate rapidly from approximately 0 to less than 1 volt. If the front sensor shows low or no voltage, the sensor could be defective; or, there might be an exhaust leak before or immediately behind the sensor.
- Typically, the rear sensor should emit a fairly steady signal. If the signal is below 250m V, check for activity by rapid accelerator kickdown, or by raising the engine speed to approximately 2000 rpm. Some movement should be noted.
- Many diagnostic tools exist to accurately test O_2 Sensors. Verify operation before replacing any sensors.

Converter Efficiency Diagnostic

7) Cooling System

Internal cooling system leaks can destroy a catalytic converter.

- An internal leak in the cooling system would allow coolant to enter the exhaust system and poison the catalytic converter.
- Perform a leak-down test to make sure the cooling system holds system pressure (check pressure cap for exact pressure) for 15 minutes.
- If the cooling system is not maintained properly, it may build up sludge, which may reduce heat transfer from the combustion chambers, increasing NO_X emissions.

8) Fuel System

There are many things in the fuel system that can damage a catalytic converter or increase HC (Hydrocarbon) emissions.

- Use a fuel pressure gauge to perform a fuel pressure and leak-down test. Fuel pressure should be within the manufacturer's specifications and hold steady after the pump is shut off.
- A rapid drop in pressure may indicate that fuel injectors are leaking, or that a problem exists with the fuel pressure regulator, or the supply check valve.
- Fuel pressure which is slightly shy of the normal working range can result in significant emissions issues, and can also result in excessive cranking time when cold. Both conditions can cause rapid converter failure.
- The fuel filter should be replaced per the manufacturer's recommended maintenance schedule. Finally, check for water contamination in the fuel tank, and air trapped in the fuel rails, which can cause cylinder misfires.

Converter Efficiency Diagnostic

9) Fuel Trim – AFR (Air / Fuel Ratio)

Adjusted by the vehicle's PCM, with data received from the oxygen sensors, in an attempt to maintain a 14.7 : 1 AFR (Air / Fuel Ratio).

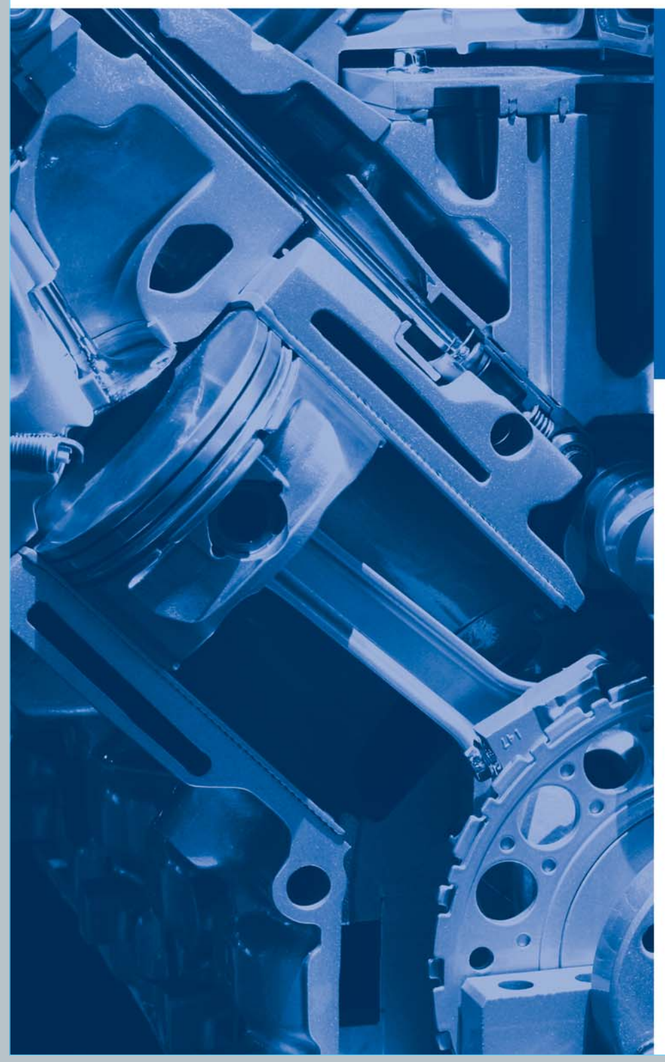
- Short-term fuel trim is based on readings from the current engine run cycle. Long-term fuel trim averages several of the short-term readings, to affect the fuel base mapping.
- Any fuel trim readings greater than 3% indicate a problem that requires checking cylinder balance, and / or checking with a five-gas analyzer.
- Remember, fuel trim is just one of several systems that affect emissions. The fuel trim may be correct, yet the engine may still be producing excessive emissions.

10) Check Emissions Gas Analyzer

One of the most effective ways to resolve emissions issues is by sampling the exhaust gases.

- High HC emissions indicate unburned fuel.
- High CO levels indicate partially burnt fuel, or oil.
- High NO_X levels are normally caused by high combustion temperatures and pressures, lean AFR, and high ignition timing.
- Tailpipe emissions readings low in HC and CO levels with high NO_X emissions are typically **NOT** caused by a defective converter. The low HC and CO readings indicate that the converter is functioning. The root cause of the problem is an engine which is emitting excessively high NO_X emissions. These high NO_X emissions may reduce the durability and efficiency of the converter.

Converter Efficiency Diagnostic



11) Cylinder Balance

Any cylinder that is not working as hard as the others is the most likely cause of emissions issues.

- Most professional scan tools can accurately perform a cylinder balance test by dropping one cylinder at a time.
- With an infrared thermometer, look for cylinders that are running hotter or colder than others. This can indicate a lean - or rich - condition. Likewise, it can indicate high - or low - cylinder compression.
- Rear cylinders which are running progressively hotter than the front indicate cooling system deposits (rust or sludge) restricting flow to the rear of the engine block. This can result in high NO_X emissions due to increased combustion temperatures, even though the average coolant temperature reads normal.

12) Mechanical Condition

High-mileage engines can have many mechanical problems that contribute to high emissions.

- If the vehicle is so equipped, the EGR valve and passages should be inspected for proper operation, and cleaned, if necessary.
- Perform a compression check to identify the condition of the piston rings, valve train and combustion chambers.
- Check the camshaft lobes and the timing belt or chain for wear. Verify cam and ignition timing.

13) PCM Re-flash

Re-flashing is the process of updating the PCM (Powertrain Control Module) with the latest program available from the vehicle's manufacturer.

- In some cases, manufacturers have released Technical Service Bulletins indicating that a re-flash of the PCM will help resolve emissions problems.
- When a vehicle is new, there may be "unseen variations" that occur with the aging of the engine components.
- PCM updates are usually very specific to the vehicle build dates and options.

Features and Benefits

No matter what type of vehicle you drive – Pre-OBDII, OBDII or California Emissions – our catalytic converters are application-engineered with the right combination of precious metals and washcoat technology to help solve emissions problems

Universal Fit:
The clear choice for installers with custom jobs that require fabrication and welding.

Universal converters, while appropriate for many vehicles on the road today, do usually require some specific cutting and welding for exhaust system installation.

Direct-Fit:
For installers and repair shops that require quick turnaround in the service bay.

Designed with OE-style mounting hardware, flex couplings and air-gap pipe where required, our direct-fit converters work in concert with existing factory exhaust systems. No welding, cutting or bending required.

Features
and Benefits

WALKER STANDARD CATALYTIC CONVERTERS

WALKER Ultra CATALYTIC CONVERTERS

WALKER CalCat CATALYTIC CONVERTERS

Universal and Direct-Fit for
Pre-OBDII Vehicles
(1995 and Older)
Designed for aftermarket requirements in 49 states and Canada

Universal and Direct-Fit for
OBDII Vehicles
(1996 and Newer)
Designed for aftermarket requirements in 49 states and Canada

Universal and Direct-Fit for
California Vehicles
California Air Resources Board (CARB)-compliant

With a higher loading of precious metals, CalCat Converters comply with specific pre-OBDII and OBDII aftermarket requirements in the state of California

WALKER EXHAUST SYSTEMS

WALKER® STANDARD CATALYTIC CONVERTERS

WALKER® Ultra® CATALYTIC CONVERTERS

WALKER® CalCat® CATALYTIC CONVERTERS

Walker® Standard Converters	
Emissions Warranty	
25,000 miles	40,000 kilometers
Structural Warranty	
5 years / 50,000 miles	5 years / 80,000 kilometers

Walker® Ultra® Converters	
Emissions Warranty	
25,000 miles	40,000 kilometers
Structural Warranty	
5 years / 50,000 miles	5 years / 80,000 kilometers

Walker® CalCat® Converters	
Emissions Warranty	
50,000 miles	80,000 kilometers
Structural Warranty	
5 years / 50,000 miles	5 years / 80,000 kilometers

Remember, continuing to replace converters under warranty costs everyone.
Find the cause of converter failure before installing a new one.

The Right Support

Walker's in-depth educational programs help installers identify and diagnose underlying emissions issues.

Training Clinics

Walker provides ongoing professional training for technicians nationwide, helping installers educate consumers about exhaust maintenance.

Collateral Material

Informative reference material identifying symptoms of converter failure and corrective diagnostics.

Informative Product Catalogs

Maximize sales with accurate, industry-leading publications, convenient e-catalog and ERIS CD catalog.

Technical Assistance:

49 States and Canada: **1 (734) 384-7839** M - F, 8:30 am - 5:30 pm EST
California only: **1 (734) 384-7824** M - F, 8:30 am - 5:30 pm EST

Walker's ASE-certified Technical Support Team will help you with answers to the most frequently-asked application, installation and emissions questions. They can also provide invaluable catalytic converter training information. If you are looking for answers, Walker's Technical Assistance Team is just a phone call away.

www.walkerexhaust.com

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