

# Automotive Fuel and Emissions Control Systems 4/E


## Chapter 28 Catalytic Converters

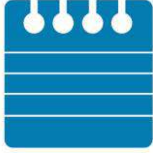





### Opening Your Class







KEY ELEMENT	EXAMPLES
Introduce Content	This course or class covers operation and service of <b>Automotive Fuel and Emissions Control Systems</b> . It correlates material to task lists specified by ASE and NATEF.
Motivate Learners	Explain how the knowledge of how something works translates into the ability to use that knowledge to figure why the engine does not work correctly and how this saves diagnosis time, which translates into more money.
State the learning objectives for the chapter or course you are about to cover and explain this is what they should be able to do as a result of attending session or class.	Explain the chapter learning objectives to the students. <ol style="list-style-type: none"><li>1. Explain the purpose, function, construction, operation, and performance of catalytic converters.</li><li>2. Describe how to diagnose and replace catalytic converters.</li></ol>
Establish the Mood or Climate	Provide a <i>WELCOME</i> , Avoid put downs and bad jokes.
Complete Essentials	Restrooms, breaks, registration, tests, etc.
Clarify and Establish Knowledge Base	Do a round robin of the class by going around the room and having each student give their backgrounds, years of experience, family, hobbies, career goals, or anything they want to share.

**NOTE: This lesson plan is based on Fuel & Emission Control 4<sup>th</sup> Edition Chapter Images found on Jim's web site @ [www.jameshalderman.com](http://www.jameshalderman.com)**

**LINK CHP 28: [Chapter Images](#)**

ICONS	Ch28 Catalytic Converters
	<p><b>1. SLIDE 1 CH28 Catalytic Converters</b></p> <p>Check for <b>ADDITIONAL VIDEOS &amp; ANIMATIONS</b>  @ <a href="http://www.jameshalderman.com/">http://www.jameshalderman.com/</a>  <b>WEB SITE REGULARLY UPDATED</b></p> <p><b><u>VIDEOS</u></b></p> <p>At the beginning of this class, you can download the crossword puzzle &amp; Word Search from the links below to familiarize your class with the terms in this chapter &amp; then discuss them</p> <p><b>Crossword Puzzle (<a href="#">Microsoft Word</a>) (PDF)</b>  <b>Word Search Puzzle (<a href="#">Microsoft Word</a>) (PDF)</b></p> <p><b><u>CATALYTIC CONVERTER OPERATION</u></b>  <b><u>(VIEW) (DOWNLOAD)</u></b></p> <p><b>2. SLIDE 2 EXPLAIN</b> Catalytic Converters &amp; <b>EXPLAIN</b> Figure 28-1 Most catalytic converters are located as close to the exhaust manifold as possible, as seen in this display of a Chevrolet Corvette</p> <p><b>3. SLIDE 3 EXPLAIN</b> Figure 28-2 typical catalytic converter with a monolithic substrate.</p> <p><b>4. SLIDE 4 EXPLAIN</b> Figure 28-3 three-way catalytic converter first separates the NO<sub>x</sub> into nitrogen and oxygen and then converts the HC and CO into harmless water (H<sub>2</sub>O) and carbon dioxide (CO<sub>2</sub>). The nitrogen (N) passes through the converter and exits the tailpipe and enters the atmosphere which is about 78% nitrogen</p> <p><b><u>DEMONSTRATION: WITH A VEHICLE ON LIFT,</u></b>  <b>SHOW INSTALLED CATALYTIC CONVERTERS &amp;</b>  <b>THEIR LOCATIONS. POINT OUT THE REDUCTION</b>  <b>CATALYST &amp; OXIDIZING CATALYST.</b></p>

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	<p>BECAUSE PRICES OF PRECIOUS METALS USED IN CATALYTIC CONVERTERS HAVE RISEN STEEPLY IN THE PAST FEW YEARS, THESE COMPONENTS HAVE BECOME POPULAR AMONG THIEVES. OWNERS OF TRUCKS &amp; 4WD VEHICLES HAVE RETURNED TO THEIR PARKED VEHICLES TO FIND THAT THIEVES HAVE STOLEN THEIR CATALYTIC CONVERTERS WITH BATTERY-POWERED RECIPROCATING SAW. REPLACEMENTS CAN RUN AS HIGH AS \$2,500.</p>
	<ol style="list-style-type: none"> <li>5. <b>SLIDE 5 EXPLAIN FIGURE 28–4</b> The small oxidation section of the converter helps build heat for the reduction section to reduce NOx emissions in the rear brick on most newer vehicles.</li> <li>6. <b>SLIDE 6 EXPLAIN OBD-II CATALYTIC CONVERTER PERFORMANCE &amp; FIGURE 28-5</b> OBD-II catalytic converter monitor compares signals of upstream and downstream oxygen sensors to determine converter efficiency.</li> <li>7. <b>SLIDE 7 EXPLAIN FIGURE 28–6</b> The waveform of a downstream O2S sensor from a properly functioning converter shows little, if any, activity.</li> </ol>
	<p><b><u>DEMONSTRATION:</u> AFTER SHOWING STUDENTS A WAVEFORM OF UPSTREAM OXYGEN SENSOR, CONNECT DSO TO <u>DOWNSTREAM OXYGEN SENSOR</u> TO SHOW DIFFERENCE BETWEEN SENSORS. OBD-II USES DOWNSTREAM SENSOR TO CHECK EFFICIENCY OF CATALYTIC CONVERTER</b></p>
	<p><b><u>DISCUSSION:</u> HAVE THE STUDENTS DISCUSS HOW OFTEN A <u>PCM TESTS A CATALYTIC CONVERTER</u>. HOW IS CATALYTIC CONVERTER MONITOR CLASSIFIED? WHEN WILL THE MONITOR CHECK THE EFFICIENCY OF CONVERTER? WHAT WILL HAPPEN IF THE TEST FAILS?</b></p>
	<p><b><u>DEMONSTRATION:</u> TALK ABOUT DIAGNOSING CATALYTIC CONVERTERS. <u>HOW ARE CATALYTIC CONVERTERS TESTED?</u></b></p>
	<p><b><u>DEMONSTRATION:</u> CONNECT A <u>DIGITAL STORAGE OSCILLOSCOPE (DSO)</u> TO AN <u>UPSTREAM OXYGEN SENSOR</u> &amp; OPERATE ENGINE AT NORMAL OPERATING TEMPERATURE.</b></p>

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	<p><b>SHOW <u>WAVEFORM</u> OF AN <u>UPSTREAM</u> OXYGEN SENSOR IN OPERATION.</b></p>
	<p><b>8. SLIDE 8 EXPLAIN OBD-II CATALYTIC CONVERTER PERFORMANCE &amp; FIGURE 28-7</b>  The highest catalytic converter efficiency occurs when the air-fuel mixture is <b>about 14.7:1</b>.</p> <p><b>DISCUSS FREQUENTLY ASKED QUESTION</b></p>
	<p><b><u>DEMONSTRATION:</u> SIMULATE A PLUGGED OR MELTED CONVERTER BY INSTALLING AN <u>EXPANDABLE PLUG</u> INTO A VEHICLE EXHAUST PIPE. OPERATE VEHICLE ON DYNAMOMETER OR ON A TEST DRIVE WITH VACUUM GAUGE TAPED TO WINDSHIELD. SHOW STUDENTS HOW VACUUM DROPS AS EXHAUST BACK PRESSURE INCREASES, CAUSING A SUBSTANTIAL DROP IN ENGINE PERFORMANCE. REMOVE PLUG AND OPERATE VEHICLE NORMALLY TO SHOW PROPER VACUUM READINGS.</b></p>
	<p><b>9. SLIDE 9 EXPLAIN FIGURE 28-8</b> 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 &amp; root cause of why it failed found and corrected.</p> <p><b>10. SLIDE 10 EXPLAIN Figure 28-9</b> back pressure tool can be made by using an oxygen sensor housing and epoxy or braze to hold the tube to the housing</p>
	<p><b><u>DEMONSTRATION:</u> INSTALL <u>EXHAUST BACK PRESSURE GAUGE</u> IN PLACE OF AN OXYGEN SENSOR <u>FIGURE 28-9</u>. LEAVE OXYGEN SENSOR CONNECTED WHILE IT IS REMOVED AND OPERATE ENGINE, SHOWING STUDENTS NORMAL BACK PRESSURE. INSTALL EXPANDABLE PLUG IN TAILPIPE TO SIMULATE A PLUGGED CONVERTER AND HAVE STUDENTS WATCH BACK PRESSURE INCREASE.</b></p>
	<p><b><u>ON-VEHICLE NATEF TASK:</u> PERFORM EXHAUST SYSTEM <u>BACK-PRESSURE TEST</u>; DETERMINE NECESSARY ACTION.</b></p>

## ICONS

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11. **SLIDE 11 EXPLAIN FIGURE 28-10** This partially melted catalytic converter tested okay at idle but had excessive back pressure at idle speeds.
12. **SLIDE 12 EXPLAIN FIGURE 28-11** temperature of outlet should be at least 10% hotter than temperature of the inlet. If a converter is not working, the inlet temperature will be hotter than the outlet temperature

### **EXPLAIN TECH-TIP**

13. **SLIDE 13 EXPLAIN FIGURE 28-12** 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











### **CATALYTIC CONVERTER (2004+) (VIEW) (DOWNLOAD)**

**DISCUSSION: HAVE THE STUDENTS TALK ABOUT CATALYTIC CONVERTER EFFICIENCY TESTS. HOW ARE RESULTS OF AN OXYGEN LEVEL TEST INTERPRETED?**

**HANDS-ON TASK: HAVE STUDENTS OPERATE AN ENGINE AT 2,500 RPM UNTIL NORMAL OPERATING TEMPERATURE IS ACHIEVED, THEN MEASURE INLET & OUTLET TEMPERATURES OF CATALYTIC CONVERTER WITH AN INFRARED THERMOMETER. FIGURE 28-5**

**ON-VEHICLE NATEF TASK: INSPECT AND TEST CATALYTIC CONVERTER EFFICIENCY.**

**DISCUSSION: DISCUSS WITH THE STUDENTS THAT AN OVERLY RICH MIXTURE OR ANY MALFUNCTION SUCH AS MISFIRE CAN ALLOW UNBURNED HYDROCARBONS TO ENTER CATALYTIC CONVERTER. HOW DOES THIS AFFECT THE CATALYTIC CONVERTER? (POINT OUT THAT THIS CAN CAUSE THE CONVERTER TO MELT INTERNALLY AND CAN EVEN SET ON FIRE)**

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 	<p><b><u>DEMONSTRATION:</u> WITH VEHICLE ON A LIFT, CREATE A MISFIRE; FOR EXAMPLE, CLOSE ELECTRODES ON A SPARK PLUG. OPERATE AT 2,500 RPM UNTIL THE CONVERTER BEGINS TO OVERHEAT AND STUDENTS OBSERVE THE SMELL OF ROTTEN EGGS. CONTINUE OPERATING VEHICLE FOR A FEW MORE MINUTES, CHECK CONVERTER TEMPERATURE WITH INFRARED THERMOMETER TO SHOW STUDENTS EXTREME OVERHEAT CONDITION.</b></p>
	<p><b>BECAUSE HEAT IS SO CRITICAL FOR CONVERTER OPERATION, AND UNDERHOOD SPACE IS LIMITED, MANY OEMS LOCATE CATALYST IN EXHAUST MANIFOLD.</b></p>
	<p><b>EXPLAIN TECH-TIP</b></p>
	<p><b><u>HANDS-ON TASK:</u> HAVE THE STUDENTS LOOK UP <u>CATALYST EFFICIENCY DTCS</u> FOR THEIR OWN VEHICLES. STUDENTS SHOULD BE ABLE TO FIND CONDITIONS THAT MUST BE MET FOR <u>DTC</u> TO SET AND FIND OEM TROUBLESHOOTING PROCEDURE TO DIAGNOSE <u>DTC</u>.</b></p>
 	<p><b><u>DEMONSTRATION:</u> DEMONSTRATE CATALYTIC CONVERTER OPERATION BY TESTING EXHAUST EMISSIONS WITH <u>5-GAS ANALYZER</u> BEFORE AND AFTER CONVERTER RUNS. REMOVE THE UPSTREAM OXYGEN SENSOR AFTER THE ENGINE HAS WARMED UP, THEN OPERATE ENGINE WITH SENSOR CONNECTED AND INSERT ANALYZER PROBE INTO SENSOR BOSS WHILE SAMPLING.</b></p>
	<p><b><u>DEMONSTRATION:</u> PERFORM <u>CONVERTER SNAP-THROTTLE TEST</u> WHILE SAMPLING EXHAUST EMISSIONS. PAY ATTENTION TO O2 READINGS TO DETERMINE EFFICIENCY.</b></p>
 	<p><b><u>ON-VEHICLE NATEF TASK:</u> CATALYTIC CONVERTER RATTLE TEST</b></p>

## ICONS



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### ON-VEHICLE NATEF TASK: CATALYTIC CONVERTER PERFORMANCE TEST

**14. SLIDES 14-25 EXPLAIN Catalytic Converter SLIDE SHOW**