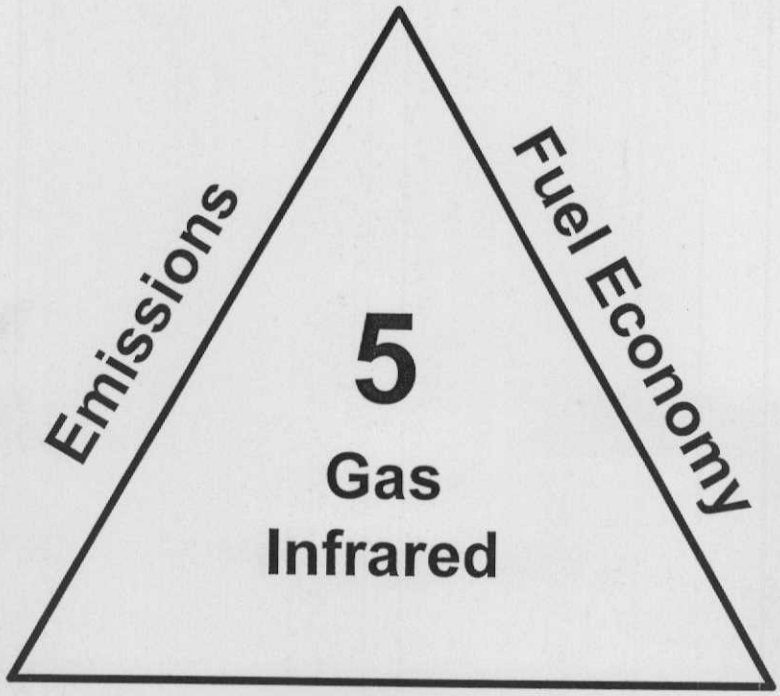
Engine Performance Testing



OHIO AUTOMOTIVE TECHNOLOGY

William A. Fulton

5 GAS INFRARED DIAGNOSTICS

WARRANTY

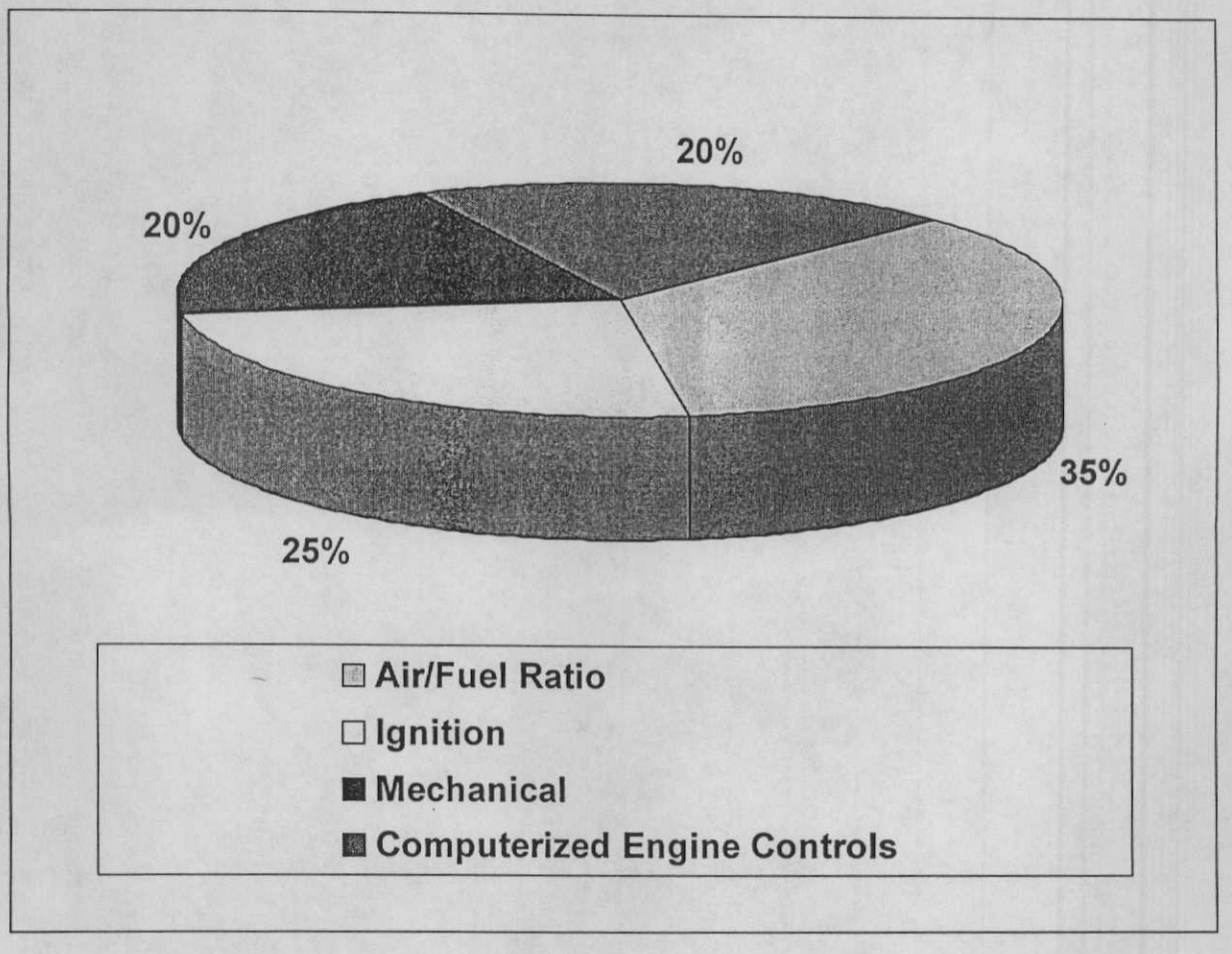
Disclaimer of Warranties: Although test procedures and test information in this manual were obtained by an ASE certified Master Technician with known good test equipment on real Domestic and Import vehicles, individual tests may vary due to equipment and technicians. No warranty can be made to personal testing procedures for accuracy or completeness obtained from the ideas of this manual; nor, does its author, or anyone connected with him, assume any responsibility. The acceptance of this manual is conditional on the acceptance of this disclaimer. If the terms of this disclaimer are not acceptable, please return the manual to the instructor immediately.

OHIO AUTOMOTIVE TECHNOLOGY

Engine Performance Problem vs. Emission Failure

OHIO AUTOMOTIVE TECHNOLOGY

80 / 20 Rule



OHIO AUTOMOTIVE TECHNOLOGY

5 Gas Infrared Checks for Good Combustion Integrity and Catalyst Efficiency

OHIO AUTOMOTIVE TECHNOLOGY

3-Way Catalyst with Feedback Controls

Eliminates 98% H/C and C/O 88% of NOx

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Most engine performance problems have a direct effect on one or more gases.

Examples:

H/C = Poor Combustion Indicator

C/O = Rich Indicator

O2 = Lean Indicator

CO2 = Efficiency Indicator

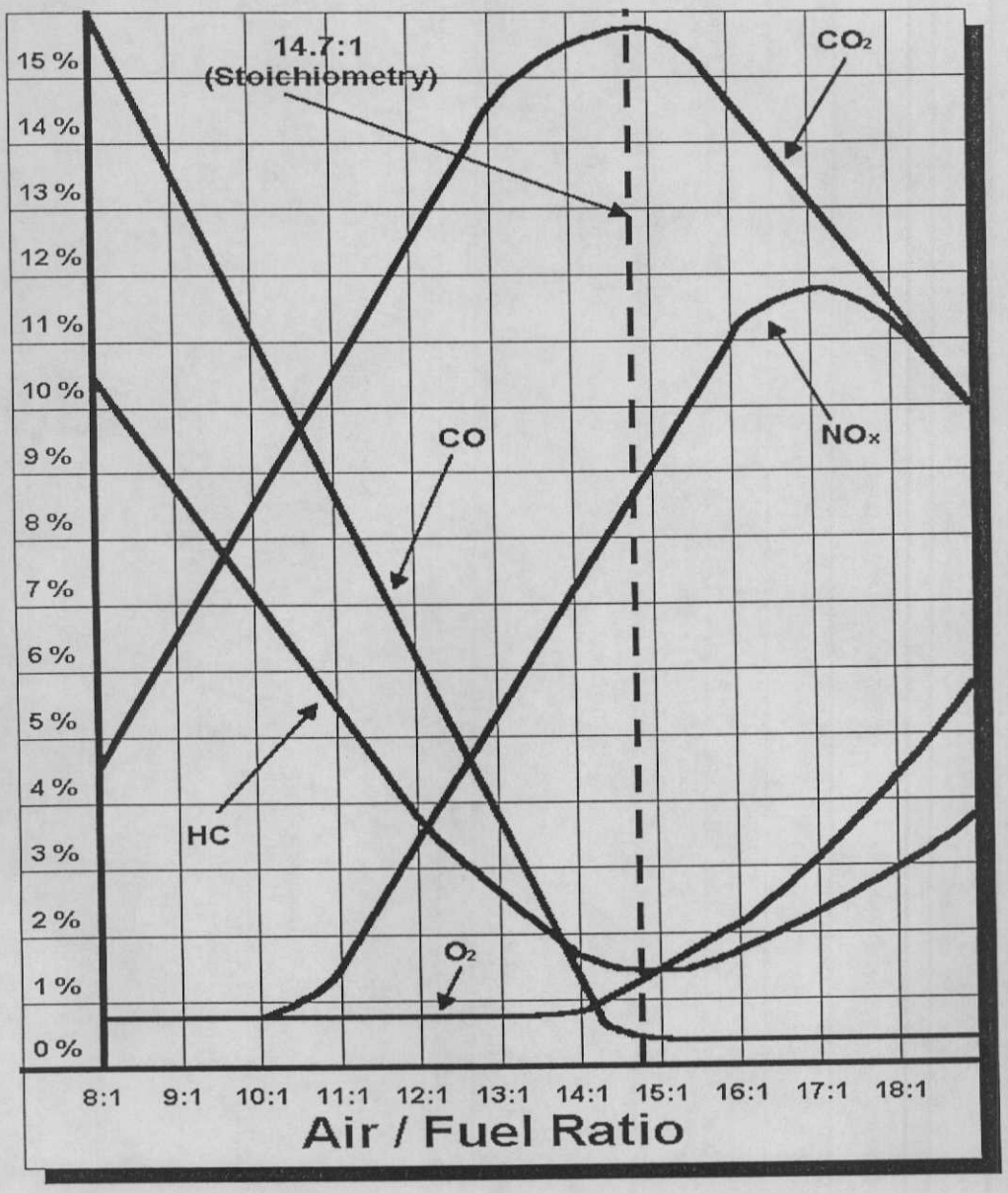
Stoichiometry

14.7 lbs. of Air to 1 lb. Of Fuel

Good Stoichiometric A/F ratio with a good working catalyst will control _____ of H/C and C/O and _____ of NOx.

OHIO AUTOMOTIVE TECHNOLOGY

5 GAS INFRARED DIAGNOSTICS



OHIO AUTOMOTIVE TECHNOLOGY

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Hydrocarbons H/C PPM (Unburned Fuel)

Quenching Effect

Excessive H/Cs are the result of _____ _____ _____. Any _____ regardless of the cause raises H/C.

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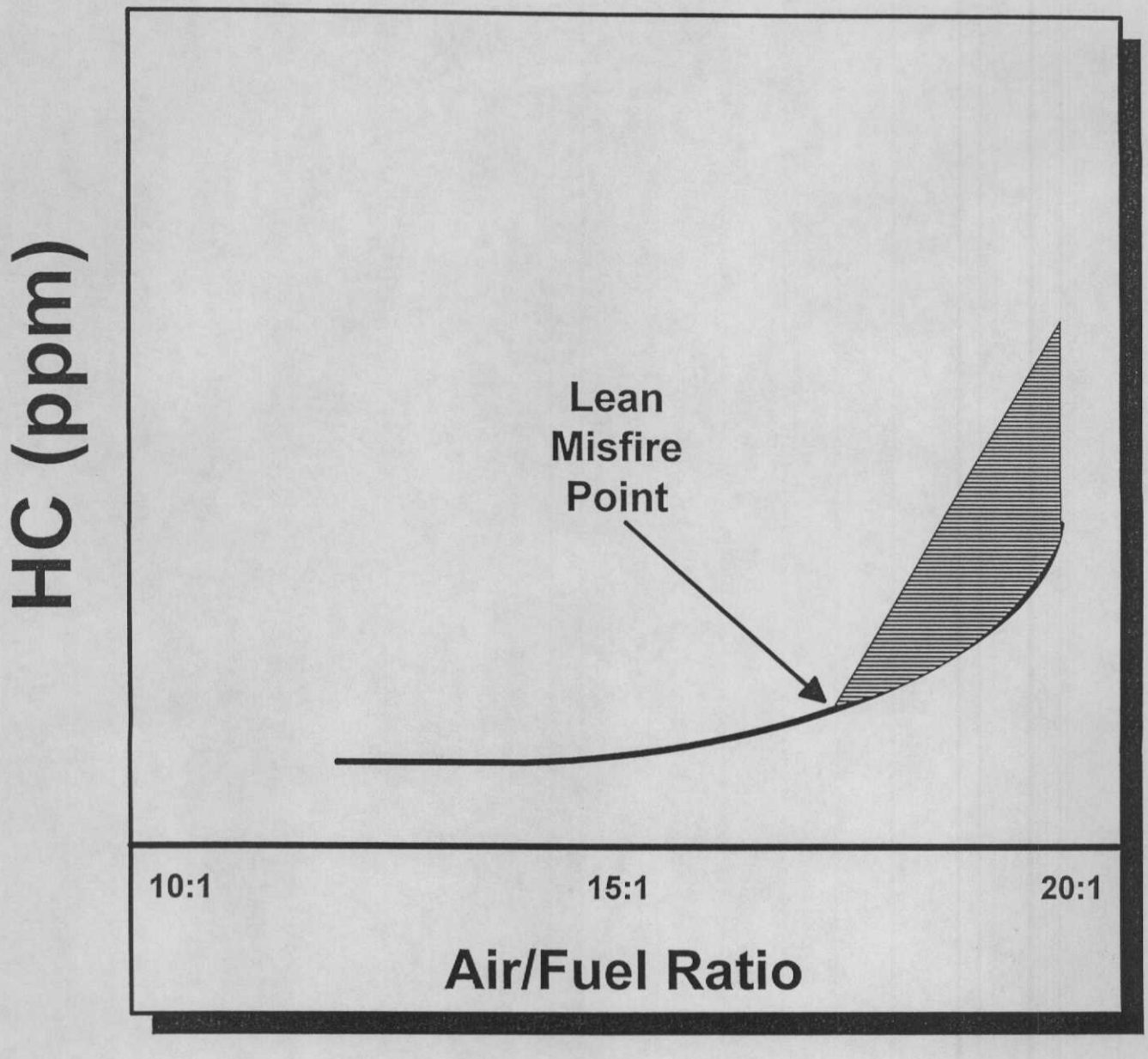
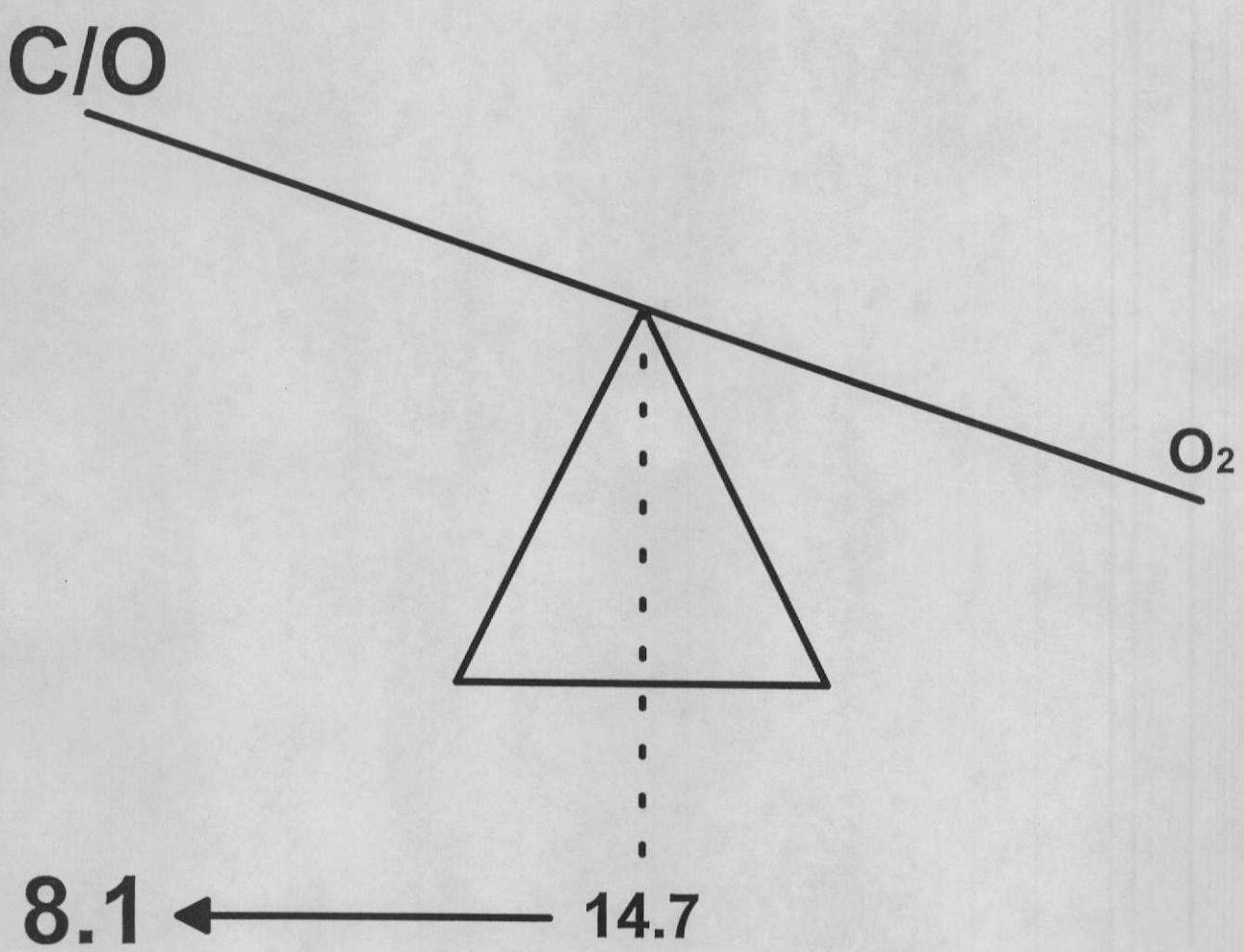
5 Gas Infrared



OHIO AUTOMOTIVE TECHNOLOGY

CO = Rich Indicator



C/O = Carbon Monoxide
(Consumed Oxygen)

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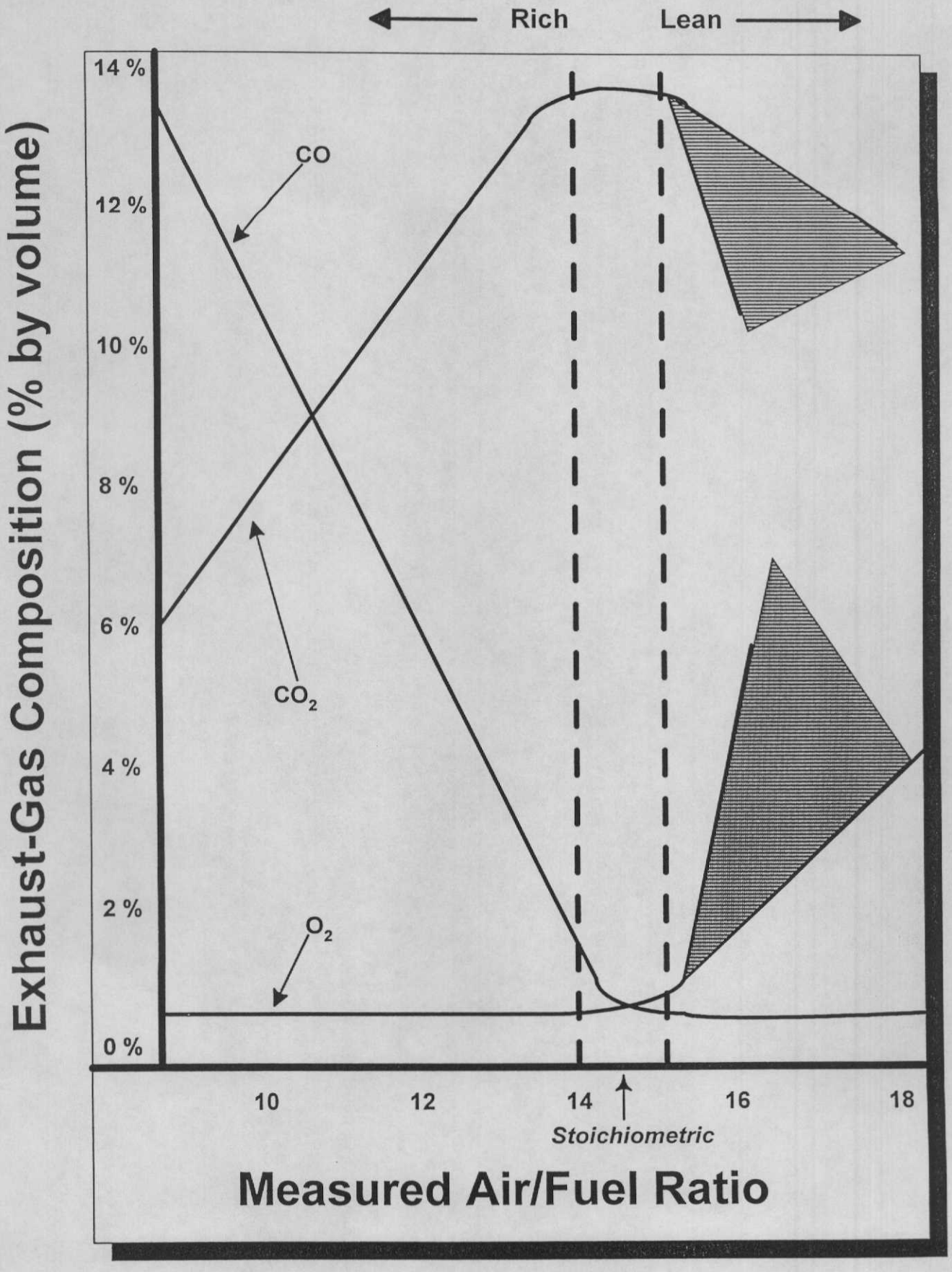
C/O % of Volume By-Product of Combustion

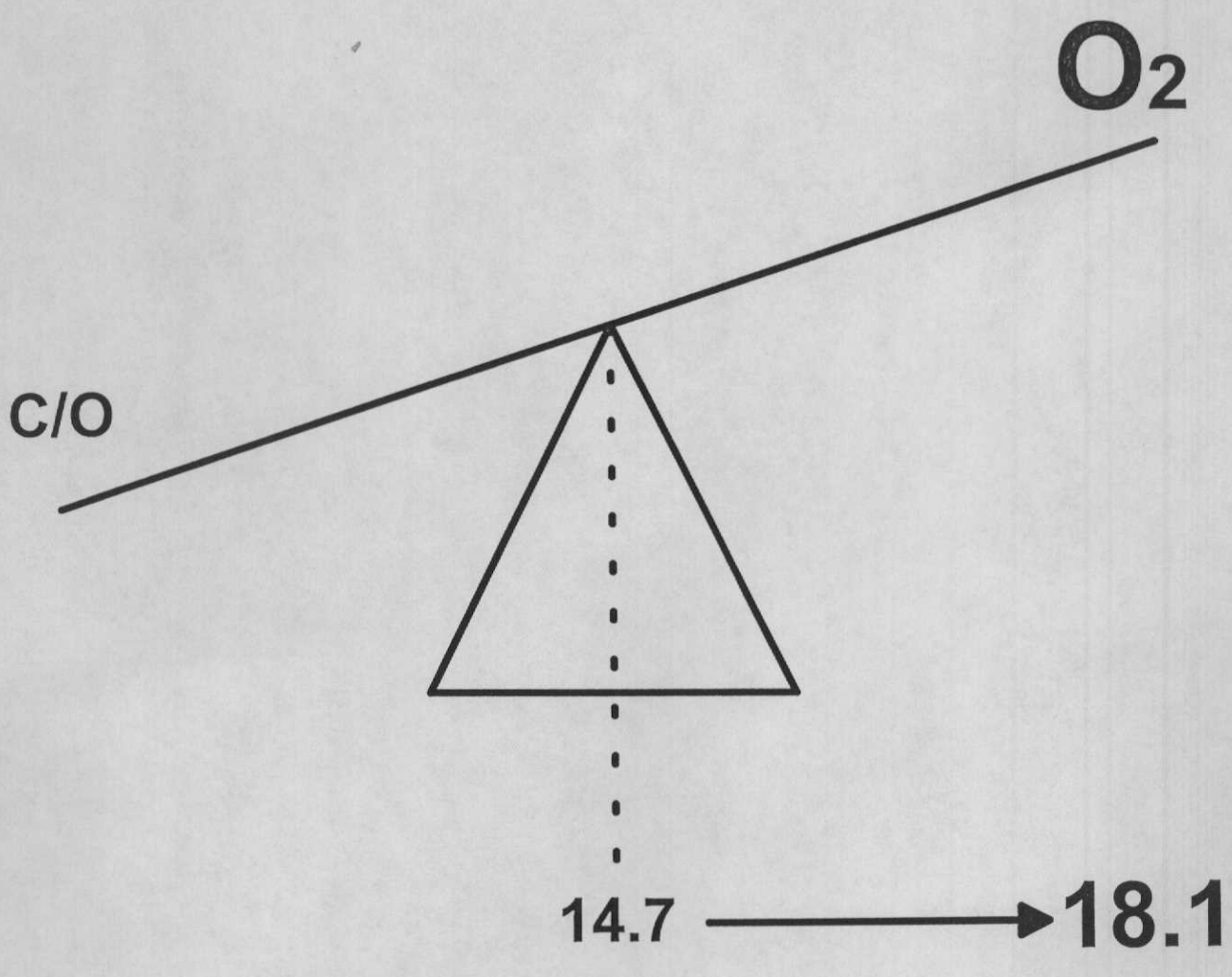
Carbon Monoxide is used as a _____ _____.

Technicians can also use high C/O readings as a _____ _____ indicator.

5 Gas Infrared



O_2 = Lean Indicator



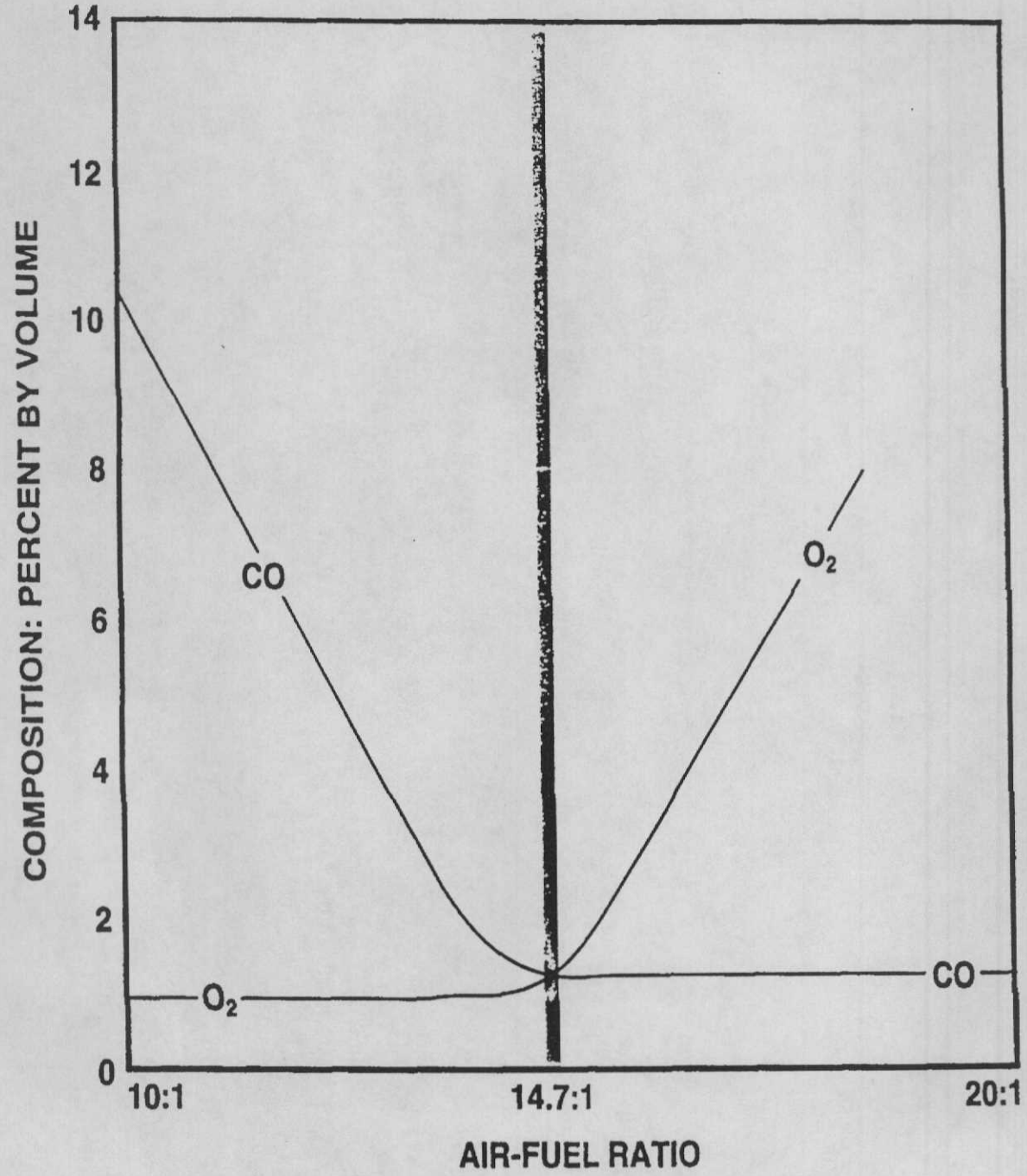
O_2 % of Volume Lean Indicator Catalyst Efficiency

O2 is known as a _____ indicator in respect to the A/F ratio.

O2 is also used as a good _____ indicator.

OHIO AUTOMOTIVE TECHNOLOGY

C/O and O_2 Relationship



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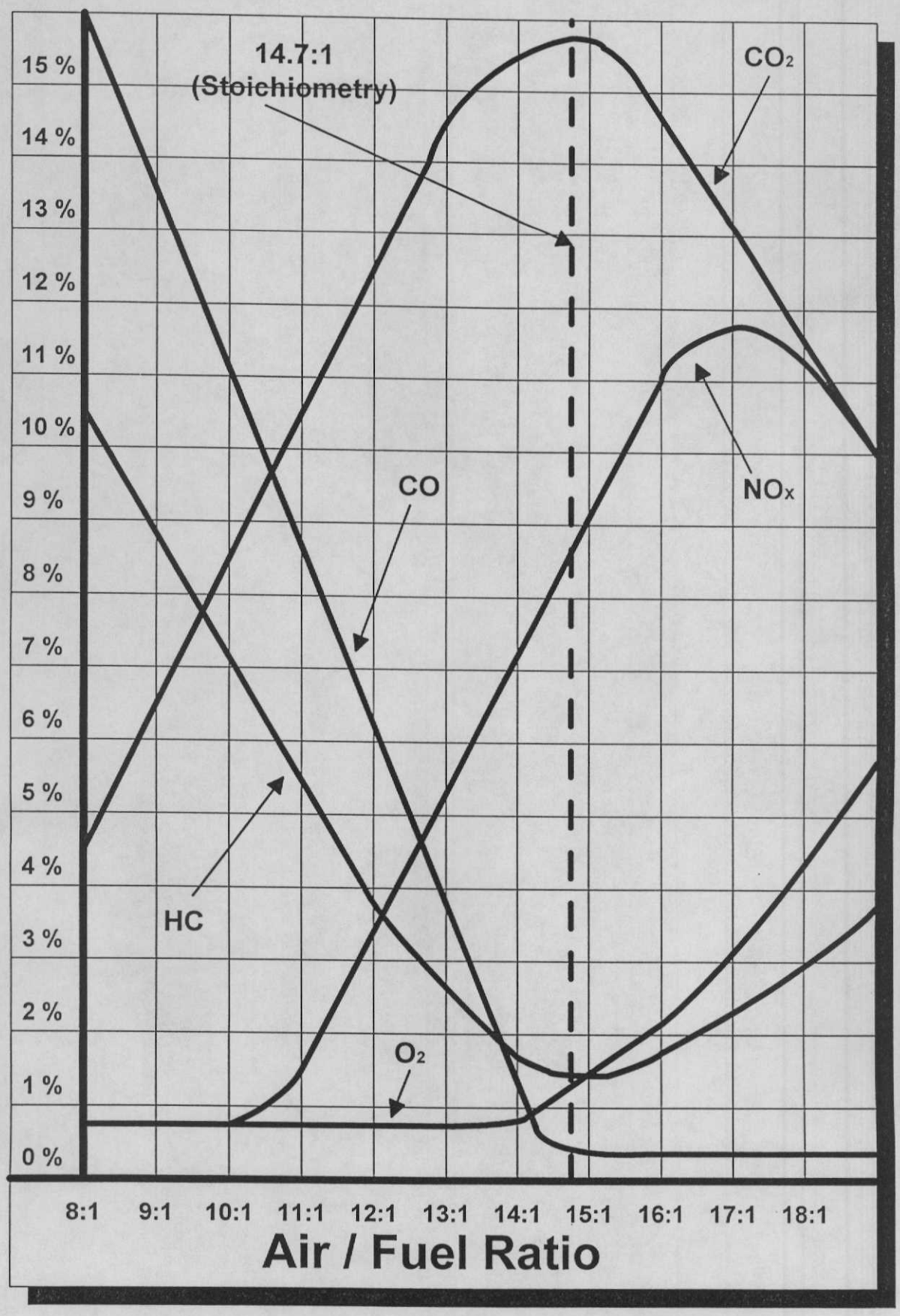
CO_2 % of Volume Efficiency Indicator

With 5 Gas diagnostics, the better the combustion the higher the _____.

Catalytic converters also have an effect on raising _____.

OHIO AUTOMOTIVE TECHNOLOGY

5 Gas Infrared



OHIO AUTOMOTIVE TECHNOLOGY

Spark Timing

- 3 ms Flame Front
- Blows out at 10 degrees ATDC

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NOx (PPM)

- 2500 Degrees or higher raises Nox
- Pre-Ignition
- Detonation

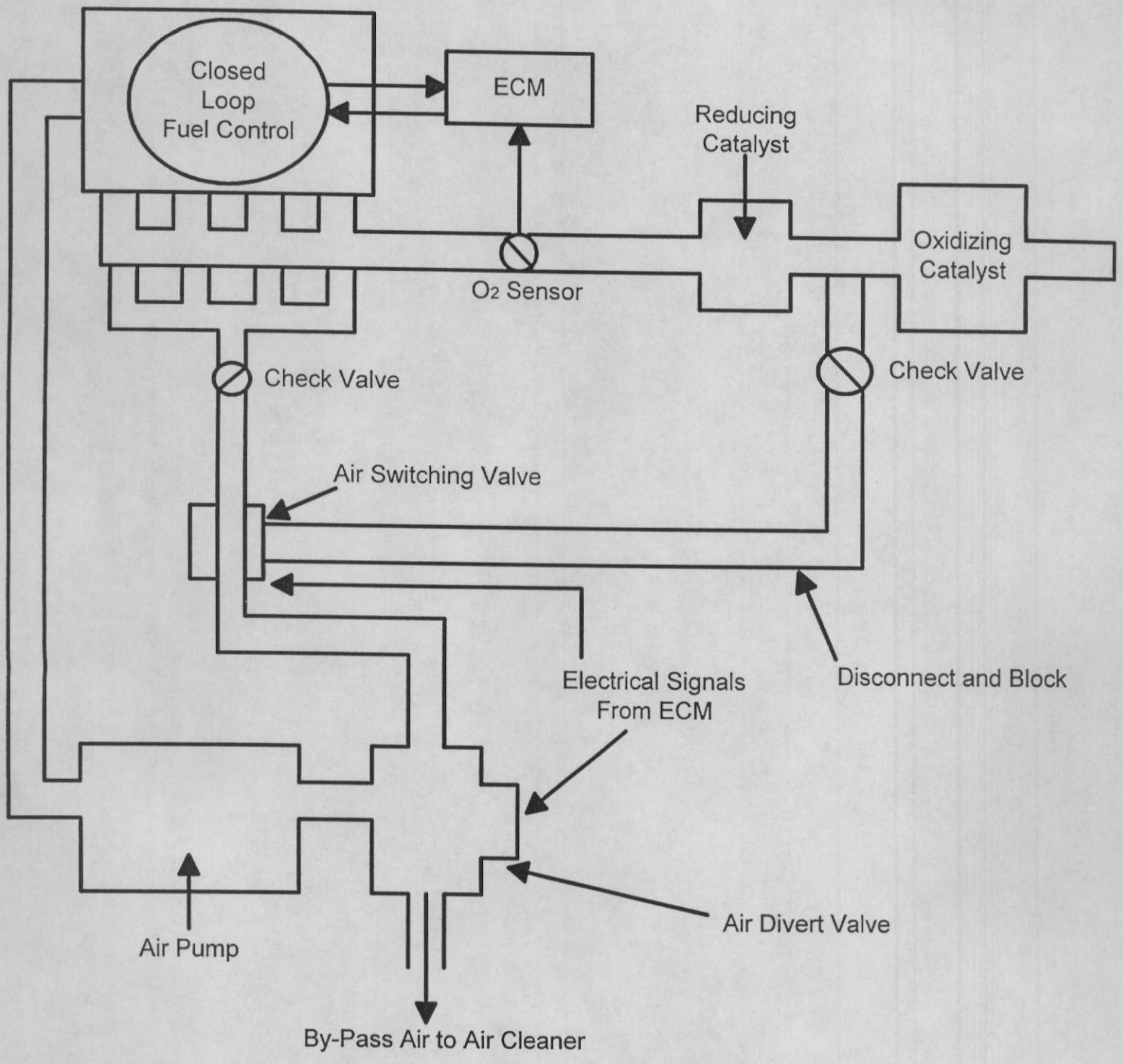
Excessive NOx can only be detected under _____ _____ _____.

OHIO AUTOMOTIVE TECHNOLOGY

Facts to Know About NOx

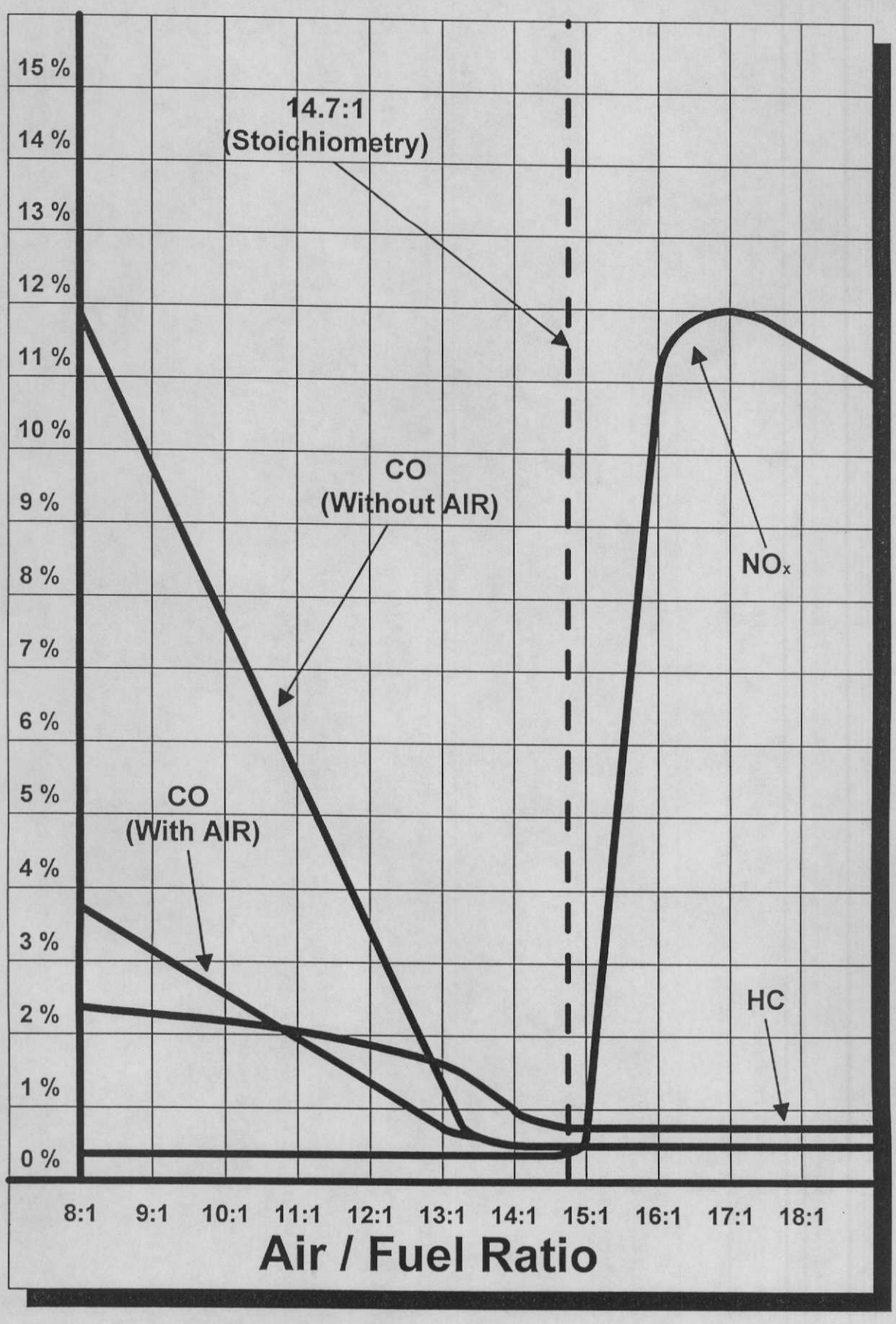
- 1994 and newer vehicles can drive NOx readings as low as 100 PPM under light load.
- An engine under load, with a cool catalytic converter, may produce as much as 3000 PPM of NOx.
- NOx is formed on cold engines as well as hot.
- When the converter lights off, as much as 1500 PPM of NOx can be reduced.
- Normal NOx readings under light and steady road load conditions will range from 100 to 500 PPM.
- The leading cause of NOx failure is inoperative EGR valves or clogged EGR passages.
- NOx must always be tested under road load conditions.
- NOx readings may increase, with initial accelerations, to as much as 800 PPM, but should return quickly to normal values.
- A.I.R. Diverter Valves tend to increase NOx levels when energized on deceleration.
- When combustion chamber temperatures reach 2500 degrees F, NOx levels cannot be controlled.
- Pre-ignition is a result of hot spots inside the combustion chamber which cause major increases in NOx.
- Detonation, unlike pre-ignition, is caused by excessive combustion chamber temperatures, which super-heat the A/F mixture, causing it to ignite too soon. Detonation drastically increases NOx.

A.I.R. System

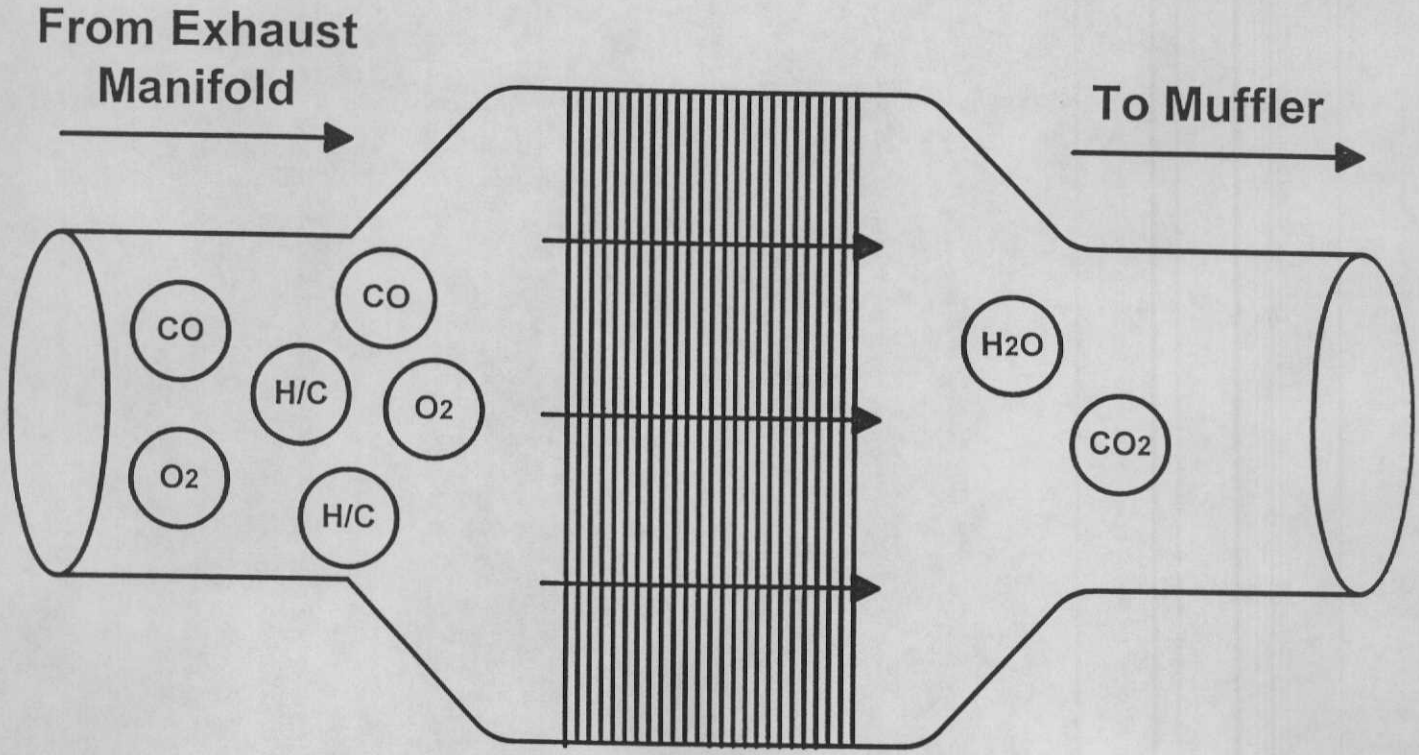


OHIO AUTOMOTIVE TECHNOLOGY

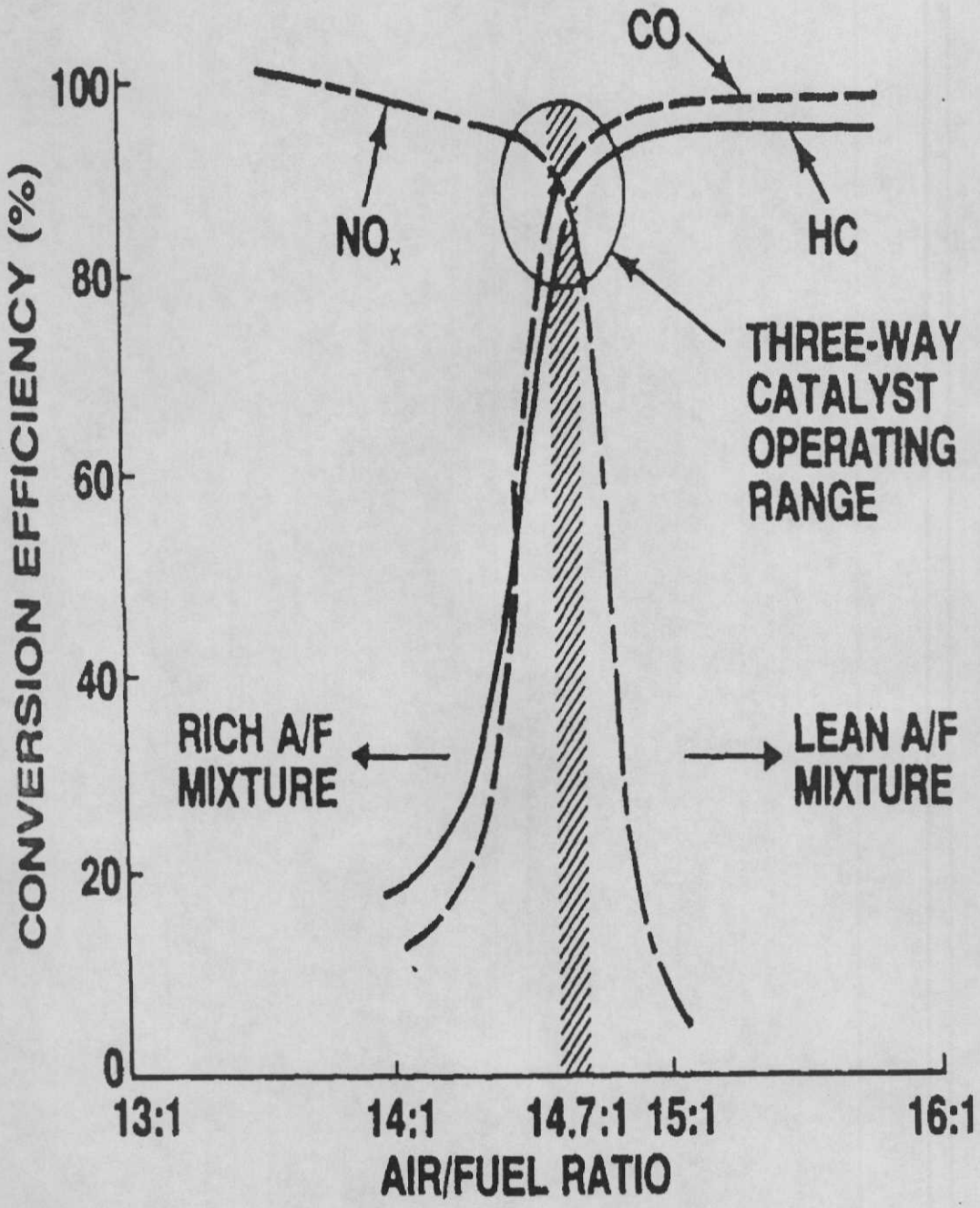
5 Gas Infrared



Catalytic Converter

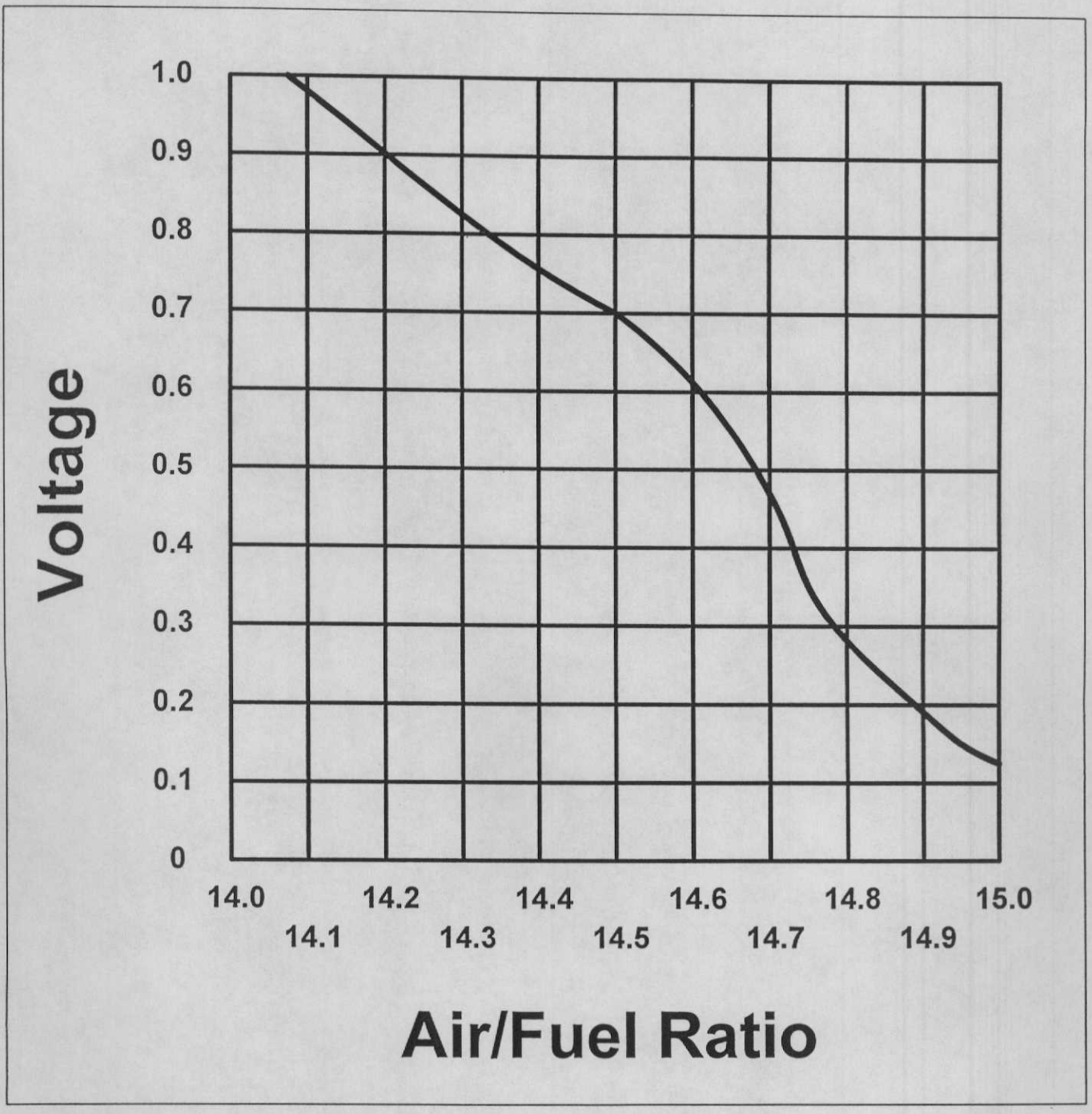


Catalyst Efficiency Window



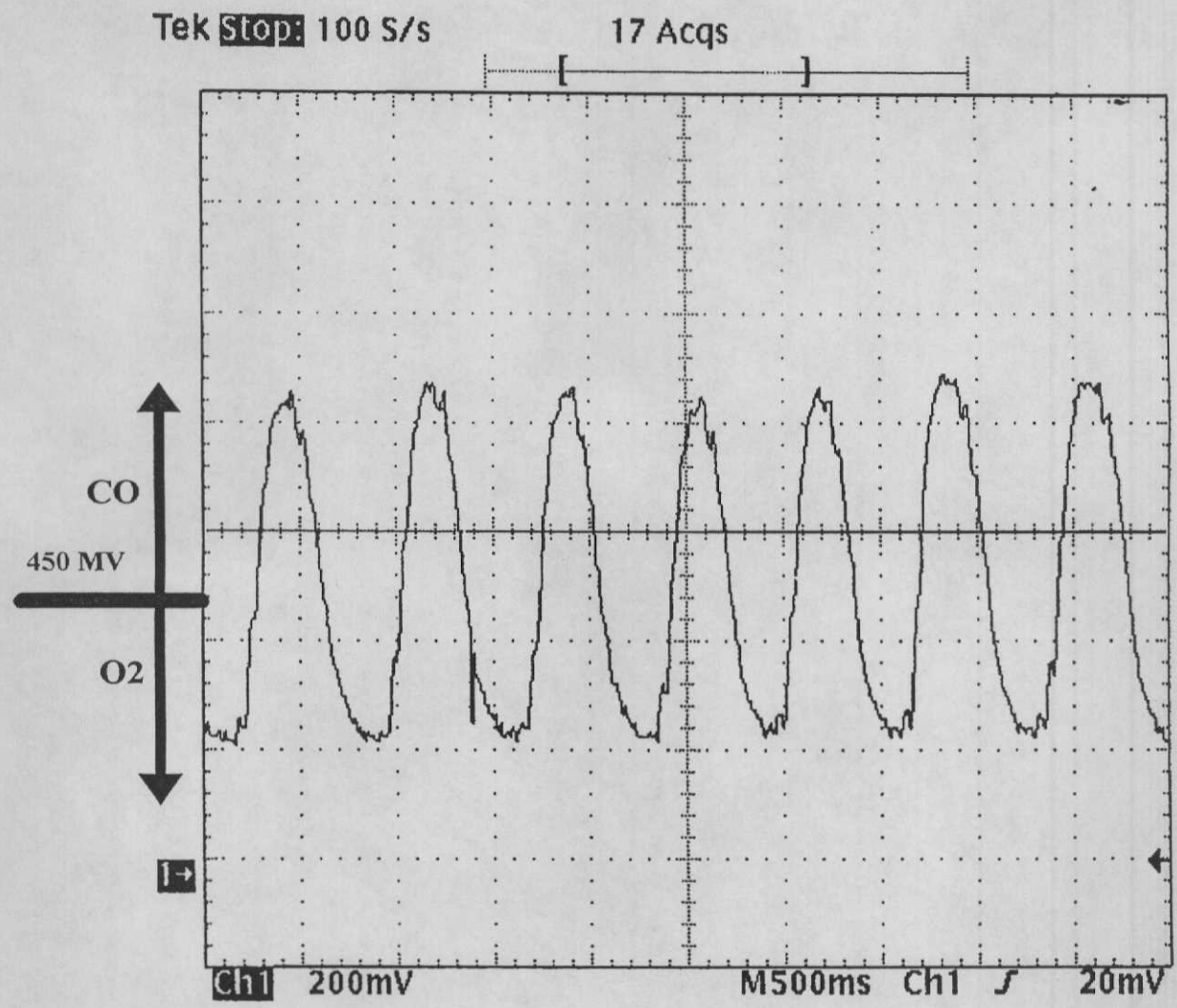
OHIO AUTOMOTIVE TECHNOLOGY

O_2 Voltage vs. Air/Fuel Ratio



OHIO AUTOMOTIVE TECHNOLOGY

O2 Sensor Waveform with Good Feedback Control



Test Results *Before* Converter

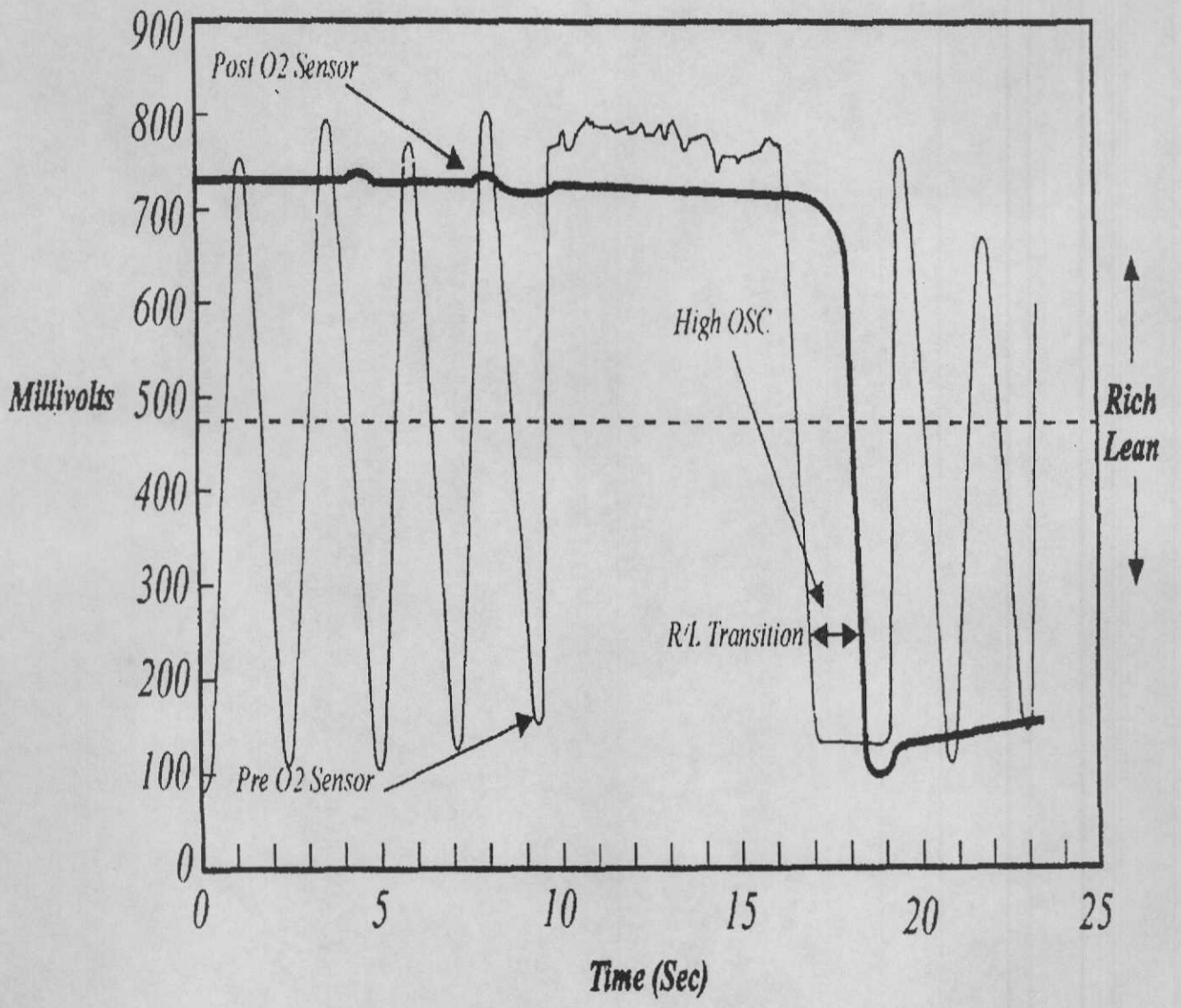
HC	332 PPM *
CO	0.62%
CO_2	13.2%
O_2	1.4% *
NO_x	215 PPM

Test Results *After* Converter

HC	74 PPM *
CO	0.55%
CO_2	13.7%
O_2	0.8% *
NO_x	120 PPM

OHIO AUTOMOTIVE TECHNOLOGY

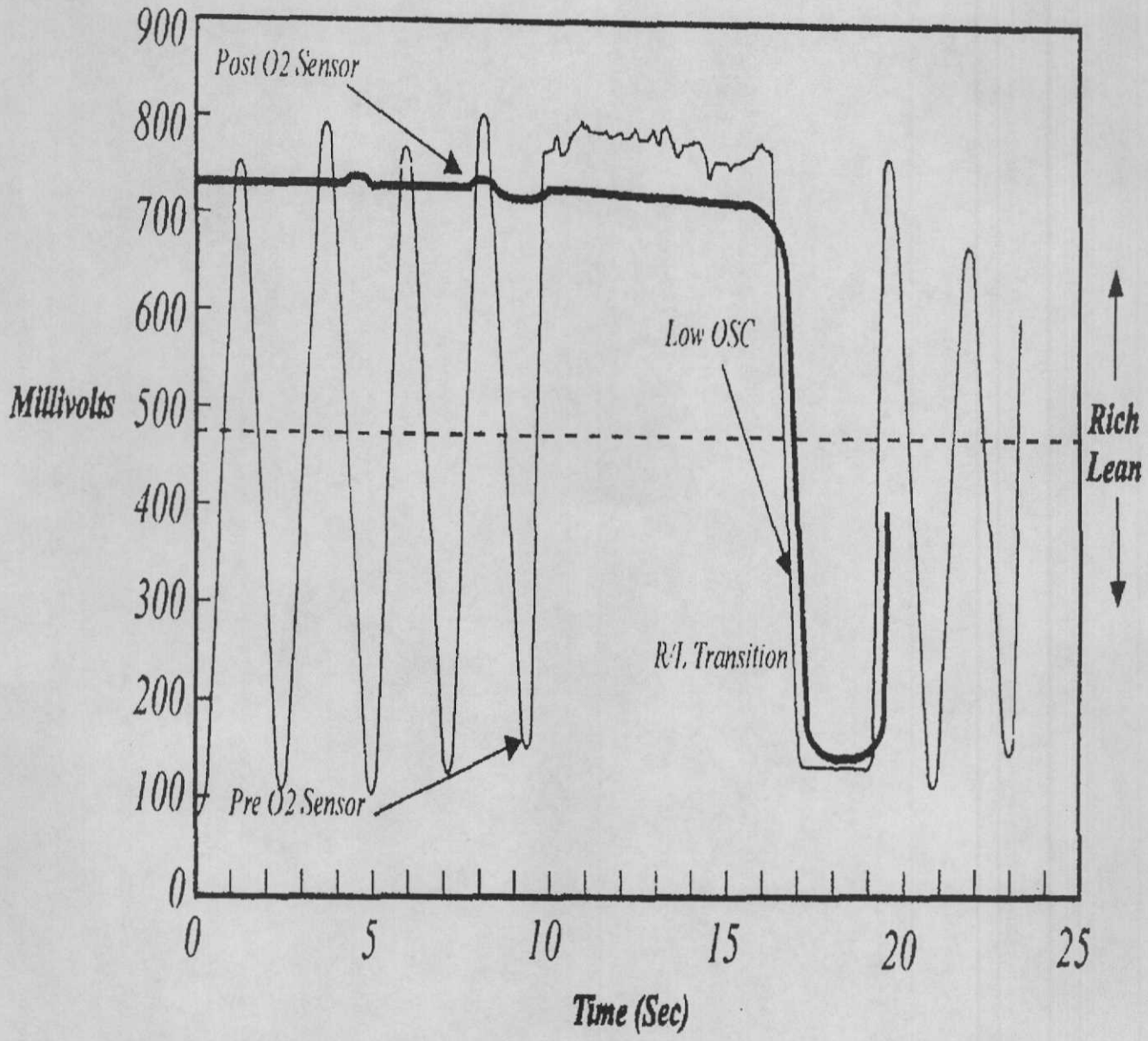
Idle Catalyst Monitor



Idle Catalyst Monitor (High Oxygen Storage)

OHIO AUTOMOTIVE TECHNOLOGY

Idle Catalyst Monitor



Idle Catalyst Monitor (Low Oxygen Storage)

OHIO AUTOMOTIVE TECHNOLOGY

Normal 5-Gas Readings

	CLOSED LOOP WARM ENGINE COOL CAT	CLOSED LOOP WARM ENGINE HOT CAT	CLOSED LOOP WARM ENGINE HOT CAT A.I.R ACTIVE
H/C	150 – 200 PPM	0-75 PPM	0-50 PPM
C/O	.5 % - .8 %	0 % - .3 %	0 % - .2 %
O_2	1.5 % - 2 %	0 % - .8 %	4 % - 8 % (Depends on A.I.R)
CO_2	12.8 % - 13.7 %	13 % - 15.8 %	9 % - 12 % (Depends on A.I.R)
NOx	1000 – 2000 PPM Before CAT Light Off, Under Road Load	100 – 500 PPM Depends on Engine Load	100 – 500 PPM Depends on Engine Load, High Loads Increase NOx

OHIO AUTOMOTIVE TECHNOLOGY

MERL Chart

	MECH.	ELECT.	RICH	LEAN
H/C PPM				
C/O %				
O_2 %				
CO_2 %				
NO_x PPM				

Engine Condition's Effect on 5-Gas Readings

ENGINE CONDITIONS	*EXHAUST EMMISSIONS*				
	H/C	CO	CO_2	O_2	NO_X
Ignition Misfire	Large Increase	Some Decrease	Some Decrease	Some-Large Increase	Some-Large Decrease
Compression Loss	Some-Large Increase	Some Decrease	Some Decrease	Some Increase	Some-Large Decrease
Rich Mixture	Some-Large Increase	Large Increase	Some Decrease	Some Decrease	Some-Large Decrease
Lean Mixture	Some Increase	Large Decrease	Some Decrease	Some Increase	Some-Large Decrease
Very Lean Mixture	Large Increase	Large Decrease	Some Decrease	Large Increase	Some Increase
Slightly Retarded Timing	Some Increase	No Change Or Some Increase	Slight Change	Slight Change	Large Decrease
Very Retarded Timing	Some Increase	No Change	Some-Large Decrease	Slight Increase	Some Increase
Advanced Timing	Some Increase	No Change Or Some Decrease	Slight Decrease	Slight Increase	Large Increase
EGR Operating	No Change	No Change	Some Decrease	No Change	Large Decrease
EGR Leaking	Some Increase	No Change	No Change Or Some Decrease	No Change	Some Decrease or No Change
Air Injection Operating	Large Decrease	Large Decrease	Some-Large Decrease	Large Increase	No Change
Catalytic Converter Functional	Some Decrease	Some Decrease	Some Increase	Some Decrease	Some Decrease W/ TWC
Exhaust Leak	Some Decrease	Some Decrease	Some Decrease	Some Increase	No Change
Worn Engine	Some Increase	Some Increase	Some Decrease	Some Decrease	No Change
Flat Camshaft	No Change Or Some Decrease	Some Decrease	Some Decrease	No Change Or Some Decrease	No Change Or Some Decrease

5 Gas Infrared

Vehicle: 1993 Isuzu Amigo
2.6 L Engine
A.I.R. System
73,000 Miles

Conditions: Warm Engine
Hot CAT
With A.I.R

Symptom: Poor Fuel Economy

H/C	C/O	O_2	CO_2	NOx
49 PPM	.08%	6.3%	10.3%	16 PPM

Hot CAT

Condition: A.I.R Disabled

H/C	C/O	O_2	CO_2	NOx
86 PPM	3.9%	.01%	8.3%	18 PPM

Hot CAT

⇒ This vehicle was running extremely rich. Note the effect AIR system can have on covering up C/O.

OHIO AUTOMOTIVE TECHNOLOGY

5 Gas Infrared

Vehicle: 1993 Chevy Lumina
3.1 L Vin T Engine
No A.I.R. System
71,000 Miles

Conditions: Idle
No Load

H/C	C/O	O_2	CO_2	NO_x
32 PPM	.01%	.05%	13.8%	68 PPM

Hot CAT

Condition: Steady Loaded Cruise

H/C	C/O	O_2	CO_2	NO_x
110 PPM	.08%	.18%	13.9%	1780 PPM

Hot CAT

⇒ Under a steady cruise condition. Note the high amount of NO_x due to clogged EGR passages.

OHIO AUTOMOTIVE TECHNOLOGY

5 Gas Infrared

Vehicle: 1995 Cavalier
2.2 L PFI System
No A.I.R. System
82,000 Miles

Conditions: Warm Engine at Idle
Hot CAT
Lean Condition
Rough Idle/No Misfire
No Propane

H/C	C/O	O_2	CO_2	NOx
48 PPM	.04%	6.78%	10.23%	32 PPM

Hot CAT

Conditions: Light Load in Drive
Hot CAT
No VSS
Lean Misfire
No Propane

H/C	C/O	O_2	CO_2	NOx
58 PPM	.01%	2.89%	13.7%	129 PPM

Hot CAT

⇒ H/C levels are still relatively low due to hot CAT. Note though that O_2 levels are still too high.

OHIO AUTOMOTIVE TECHNOLOGY

5 Gas Infrared

Vehicle: 1990 Toyota Corolla
1.6 L PFI System
No A.I.R. System
73,000 Miles

Conditions: Warm Engine at Idle
Normal Readings

H/C	C/O	O_2	CO_2	NOx
162 PPM	.86%	1.34%	13.4%	62 PPM

Cool CAT

- Note O_2 and CO_2 Levels

Condition: Warm Engine at Idle

H/C	C/O	O_2	CO_2	NOx
12 PPM	.01%	.28%	14.8%	62 PPM

Hot CAT

- Note O_2 and CO_2 Levels, H/C Level

$\Rightarrow$ The converter has a major effect on O_2 and CO_2 levels.

OHIO AUTOMOTIVE TECHNOLOGY

5 Gas Infrared

Vehicle: 1993 Mazda 929
3.0 L MPFI SFI Engine
No A.I.R. System
73,000 Miles

Conditions: Lean Condition at Idle
No Load

H/C	C/O	O_2	CO_2	NO_x
210 PPM	.06%	3.9%	12.1%	18 PPM

Hot CAT

Condition: Steady Loaded Cruise

H/C	C/O	O_2	CO_2	NO_x
43 PPM	.03%	.7%	13.6%	48 PPM

Hot CAT

⇒ The above example is a very typical reading from a vehicle with a simple vacuum leak. Note how well the H/Cs clean up off idle.

OHIO AUTOMOTIVE TECHNOLOGY

5 Gas Infrared

Vehicle: 1993 Astro Van
4.3 L Vin W Engine
No A.I.R. System
168,000 Miles

Conditions: Warm Engine at Idle
Hot CAT

H/C	C/O	O_2	CO_2	NO_x
110 PPM	3.8%	.03%	9.18%	38 PPM

Hot CAT

Condition: Warm Engine
Steady Cruise
Hot CAT

H/C	C/O	O_2	CO_2	NO_x
38 PPM	.6%	1.04%	14.7%	680 PPM

Hot CAT

⇒ Off idle away from Minimum Air Rate. Note how well the gases begin to clean up.

OHIO AUTOMOTIVE TECHNOLOGY

Glossary

Acronym – A word formed from the initial letter or letters of each successive part (or major parts) of a compound term. Example: PCM (Powertrain Control Module)

Active Testing – Testing where the PCM controls the system (or a component in an explicit action) while monitoring takes place.

Additive – A substance added in small amounts to another substance (such as gasoline) to improve and/or strengthen its properties.

AIR – An abbreviation for Secondary Air Injection. A Secondary Air Injection system is an emissions system that is primarily found on large-engine vehicles. It reduces HC and CO emissions by pumping fresh air into the exhaust stream.

Air Density – The relationship, stated in percent, of the weight to a specified volume of air at a given temperature, pressure, and humidity.

Air Fuel Ratio – The ratio of air to fuel, by weight, contained in a combustible mixture entering the engine. The best ratio for exhaust emissions control (in conjunction with the catalytic converter) is 14.7 air parts to 1 part fuel. This ratio, also known as the Stoichiometric ratio, is often expressed as 14.7:1.

Alternating Current (AC) Voltage – Electrical current, within a circuit, that first flows in one direction then another.

Altitude – Elevation, a measured in relationship to the earth's surface at sea level.

Ambient Air Temperature – The temperature of the air pertaining to the surroundings of a certain object, such as a vehicle.

Amperage – The total amount of current flowing in a circuit (measured in amperes).

Ampere (AMP) – The standard unit of measurement in relationship to the flow of electrical current.

Analog Signal – An electrical where the voltage varies in exact proportion to a measured quantity. (e.g., speed, pressure, temperature, etc.)

Anti-Knock Index – A measure of the fuel's ability to resist engine knock, stated as a number, which relates to the octane quality of the fuel.

Atmospheric Pressure – The pressure exerted on all things based on the weight of the air above them. This is approximately 14.7 pounds-per-square-inch atmospheric (psia) at sea level.

Atomize – To separate or reduce into fine/minute particles.

Glossary (Continued)

Back Pressure – The exhaust system's resistance to flow. It is measured in pounds per square inch (psi) or Kilopascals (kPA).

Baffle – A plate or shield that is used to direct the flow of a gas or liquid.

Balance Shaft – A shaft in the engine that, as it rotates, is designed to reduce or cancel some of the vibration produced by the engine.

Barometric Pressure – The measure of atmospheric pressure that reflects altitude and weather conditions. It is measured in inches of mercury (Hg).

Battery – An electro-chemical device that converts chemical energy to electrical energy.

Baud Rate - The speed at which bits of computer information are transmitted/received on a serial data stream. Measured in bits per second (bps).

Bi-directional Communication – Computer communication that utilizes serial data as an input and an output.

Bit – 1. The smallest unit of measurement that is recognized by a computer. 2. The individual voltage signal on a serial data stream.

Blow-By Gases – Combustion gases that leak (past the piston rings) into the crankcase during the compression and combustion stroke of the engine.

Boost – An increase, measured in pounds per square inch, in air pressure above atmospheric.

Bottom Dead Center (BDC) – The lowest position in the cylinder that a piston can travel without reversing its direction. It is the baseline measurement for determining the cubic inch displacement of a cylinder.

British Thermal Unit (BTU) – The amount of heat that is required to raise 1 pound of water 1° F at sea level.

Buffer – A circuit or component used to reduce the amount of interaction between two electronic circuits.

Byte – Eight bits of computer information that are processed as a unit and transmitted in sequence on a serial data stream.

Calpac (Also Calpak) – A device, inside the ECM, that is used (with fuel injection) to allow fuel delivery in the event of an ECM or PROM malfunction.

Glossary (Continued)

Carbon Dioxide (CO2) – A colorless, odorless, non-flammable gas that is produced during the combustion process. The degree of CO2 that is present in the exhaust can be used to assess the efficiency of an engine's combustion.

Carbon Monoxide (CO) – An odorless, colorless and highly poisonous gas that is formed by the incomplete combustion of gasoline.

Catalytic Converter – A stainless-steel canister in the vehicle's exhaust system that converts exhaust emissions into less harmful gases. It includes a layer of catalytic material spread over a large area of inert supports. A three-way converter refers to the conversion of the following three emissions: Carbon Monoxide, oxides of nitrogen, and hydrocarbons.

Class 2 – A type of digital data stream used in the majority of GM OBD II diagnostic systems. Class 2 utilizes two-bit pulse widths and toggles between 0 volts (passive) and 7 volts (active).

CO – An acronym for Carbon Monoxide, an odorless, colorless and highly poisonous gas that is formed by the incomplete combustion of gasoline.

Combustion – The burning of the air and fuel mixture in the engine's cylinders.

Combustion Chamber – The space left within the cylinder once the piston is at the top of its travel. The top of the piston and a cavity in the cylinder head forms it. Since most of the combustion takes place in this space, its design and shape can adversely affect the power, fuel efficiency, and emissions of the engine.

Compression Ratio – The ratio of the volume in the engine cylinder with the piston at BDC (bottom dead center) to the volume at TDC (top dead center).

Computer – A device that can perform high speed logical or mathematical calculations and otherwise process data.

Coolant – The liquid mixture contained within the engine cooling system.

Current – The rate, measured in amperes, at which electrons flow in a single direction on an electrical circuit.

Data – Information used as a basis for electronic or mechanical computation.

Detonation – A violent explosion in the combustion chamber that often causes a loud, audible knock. It is created by uncontrolled burning of the air/fuel mixture.

Diagnostic – On-board tests performed by the Diagnostic Management System that check for malfunctions, breakdowns, or errors in vehicle systems/components.

Glossary (Continued)

Diagnostic Executive – The software on the Diagnostic Management System that stores/records test results and controls the activation of lamps.

Diagnostic Management System – The PCM system accountable for powertrain components/systems testing, test result recording, and TEST FAIL processing.

Diagnostic Trouble Code (DTC) – A numeric or alphanumeric sequence, which indicates a fault in the vehicle's operating system. Each sequence represents a specific malfunction. DTCs can be obtained by reading them with a scan tool.

DIC – An acronym for Driver Information Center. The DIC alerts the driver (via messages) of instructions, warnings, and malfunctions. It may show alerts related to the TYPE C DTCs.

Digital Signal – An electrical signal that is either "on" or "off" with no in-between.

Direct Current (DC) Voltage - Electrical current, within a circuit, that flows in one direction.

DLC – An acronym for Data Link Connector. This connector, a standard 16 cavity connector under OBD II, allows diagnostic scan tools to connect directly to the vehicle (under driver-side instrument panel).

Driveability – The general evaluation of the powertrain's operating qualities. This includes idle smoothness, throttle response, cold and hot starting, power delivery, and tolerance for altitude changes.

Driver – An electronic device (usually a power transistor) that operates like a switch by turning circuits on and off by providing ground.

Dual Overhead Camshaft (DOHC) – An engine designed with two camshafts above each cylinder line, one for exhaust and one for intake.

Duration – A rating system utilized for engine camshafts that determines the amount of time the valve will be open, relative to the crankshaft movement in degrees.

Dwell – The amount of time (recorded on a dwell meter in degrees) that voltage passes through a closed switch.

ECT – An acronym for Engine Coolant Temperature sensor.

Electrode – A solid conductor through which current enters or leaves a substance, such as a gas or liquid.

Glossary (Continued)

Electromagnetic Interference (EMI) – An undesirable electronic signal. EMI is caused by the building up and collapsing of a magnetic field, which creates unwanted electrical interference on a nearby circuit.

Emissions – Gases and particles remaining after the combustion of an engine, or from a fuel system. Hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen (NO_x) are the primary emissions of concern.

Enable Criteria – The precise conditions that are required for the performance of a diagnostic test.

Engine Control Module (ECM) - The on-board computer responsible for controlling the fuel, emissions, and diagnostics for the vehicle's engine management system.

Enleanment – The act of creating a leaner air/fuel mixture by reducing fuel delivery.

Enrichment – The act of creating a richer air/fuel mixture by increasing fuel delivery.

Environmental Protection Agency (EPA) - a federal government agency that establishes regulations and supervises the enforcement of law in relation to the environment. The content and amount of automotive emissions are in included in these regulations/laws.

Ethanol (Grain Alcohol) – A fuel oxygenate. It is primary used as an octane enhancer and is added to gasoline; however, pure ethanol can be used in specially designed vehicles.

Ethyl Tertiary Butyl Ether (ETBE) – An octane enhancer for gasoline. A fuel oxygenate that is created by reacting isobutylene with ethanol.

Evaporative Emissions (EVAP) – Utilized to prevent fuel vapors in the tank from entering the atmosphere as hydrocarbon emissions.

Exhaust Gas Re-circulation (EGR) - An emissions system that re-circulates some of the exhaust gas back to the intake manifold; therefore, reducing the NO_x (oxides of nitrogen) emissions.

Fail Record – A record that contains (stored) information regarding the operating conditions when a DTC was stored. Multiple Fail Records can be stored and updated.

Freeze Frame – The operating conditions that are stored (in PCM memory), the instant a DTC is set/stored and the MIL is activated. A Freeze Frame can only be overwritten under special conditions and is stored for only one DTC.

Frequency – The number of cycles within an electrical signal for a given period of time.

Glossary (Continued)

FTP – An acronym for Federal Test Procedure. The FTP is a strict series of tests that the EPA uses to gauge and certify the emissions output of US sold vehicles.

Fuel – A substance that is burned thereby producing heat and creating motion in an engine.

Fuel Injection – A system that meters fuel to the engine. It regulates flow and atomizes fuel through electronic or mechanical means by using a pump and injectors or nozzles.

Fuel Trim - An ECM function that adjusts fuel delivery, during closed loop operation, in attempts to optimize the air/fuel mix ratio (optimal ratio = 14.7:1).

Fulcrum – The support or point at which a lever pivots.

Generator – A device that creates electrical energy from mechanical energy.

Hall Effect – When a magnetic field is interjected perpendicular to a current flowing through a solid conductor, a measurable voltage is induced at right angle to the main current flow through the conductor.

HC – An acronym for Hydrocarbons. HCs are any number of carbon and hydrogen compounds used as fuel, such as gasoline.

HO2S – An abbreviation for Heated Oxygen Sensor.

Horsepower – A mechanical power measurement, or the rate at which work is done. One horsepower equals 33,000 pounds-feet of work per minute.

Hydraulic Lifter – A valve lifter that uses simple valving and oil pressure to slightly adjust its length, thereby maintaining zero clearance in the valvetrain.

Hydrocarbons - Any number of carbon and hydrogen compounds used as fuel, such as gasoline.

I/M – An abbreviation for Inspection and Maintenance. I/M usually refers to state emissions testing programs.

IAC – An acronym for Idle Air Control valve.

IAT – An acronym for Intake Air Temperature sensor.

Icing – The formation of ice on or around the throttle plate.

Ignition – The electrical system that provides the spark to ignite the air/fuel mixture during combustion.

Glossary (Continued)

Induction – The establishment of a magnetic field or electrical charge in a substance by the proximity of an electrified source, a magnet or magnetic field.

Intermittent – A repeatable condition/concern with specific criteria. The event must be active for diagnosis to occur. For example, temperature, speed, accessory, altitude, load, etc.

Intrusive Diagnostic Test – Any (on-board) test performed by the PCM which could have effects on the vehicle emissions or performance.

ISO 9141 – The International Standards Organization endorsed/recommended data communication network interface.

Isobutylene – A petrochemical that is reacted with methanol to form MTBE or ethanol to form ETBE.

Lash – The erratic movement of valvetrain components due to improper adjustment or lack of lubrication.

Leakdown, Hydraulic Lifter – The loss of oil pressure, during operation, from within a valve lifter.

Light Emitting Diode (LED) – A low voltage semiconductor that illuminates as current flows through it.

Lubricant – A substance or material, such as oil, that is placed between two moving parts to reduce friction.

Manifold Absolute Pressure (MAP) – The intake manifold pressure/vacuum.

Manifold Vacuum – A vacuum within the intake manifold developed from the cylinder intake strokes.

Mass Air Flow (MAF) – The volume of air passing into the engine.

Methanol (Wood Alcohol) – Usually manufactured from natural gas. Used, in combination with other co-solvent alcohols, as an octane enhancer.

Methyl Tertiary Butyl Ether (MTBE) - An octane enhancer for gasoline. A fuel oxygenate that is created by reacting isobutylene with methanol.

MIL – An acronym for Malfunction Indicator Lamp. Formerly known as, "Check Engine" or "Service Engine Soon" lamp.

Misfire - An incomplete or failed combustion in one or more cylinders. This is usually due to improper fuel, ignition, cylinder compression, or air.

Glossary (Continued)

Mode – A specific state of operation.

Non-Volatile Memory – Computer memory that is not lost when power is removed.

NO_x – An acronym for Oxides of Nitrogen. NOx is an emission produced when nitrogen and oxygen are combined, at high temperatures, in the combustion chamber.

OBD I – An acronym for On-Board Diagnostics Generation One. OBD I is a diagnostic system that is required by the California Air Resources Board since 1988. It monitors and controls various engine driveability functions by utilizing a microprocessor and sensors.

OBD II – An acronym for On-Board Diagnostics Generation Two. In addition to the OBD I functions, OBD II is expanded to include the monitoring of emissions system and sensor deterioration.

Octane – The measurement of a gasoline's ability to resist engine knock.

OHM – A measurement of electrical resistance.

Oxidation Catalysts – Platinum and palladium utilized in the catalytic converter to combine oxygen with hydrocarbons and carbon monoxide to create non-harmful emissions of water and carbon dioxide.

Oxides of Nitrogen (NOx) - An emission produced when nitrogen and oxygen are combined, at high temperatures, in the combustion chamber.

Oxygenate – An octane component that contains hydrogen, carbon, and oxygen in its molecular structure.

Passive Testing - Testing where the PCM monitors the system or component under normal operation.

PCM – An acronym for Powertrain Control Module. The PCM is an on-board control module that monitors engine and transaxle/transmission functions.

Pending Fault Code – A Type B DTC that has not matured.

Photocell – A semiconductor that controls, based on the presence of light, the current flow through a circuit.

Plenum – A chamber used to distribute the intake charge more evenly and efficiently. It is located between the throttle body and the runners of the intake manifold.

Polarity – The condition, in an electrical circuit or component, that determines the direction of current flow.

Glossary (Continued)

Ported Vacuum – A vacuum developed on the air cleaner side of the throttle plate as air moves past it.

Positive Crankcase Ventilation (PCV) – The system used to prevent blow-by gases from the crankcase from entering the atmosphere.

Post-Ignition - Occurs when the air/fuel mix self ignites during combustion, which results in a second flame front that collides with the first, causing an audible knock.

Potentiometer – A variable resistor that varies the voltage drop in a circuit.

Pounds Per Square Inch (PSI) – The unit of measure for the pressure of a gas or liquid.

Pounds-Feet (LB-FT) – The unit of measure for torque. One LB-FT torque equals the twisting force produced when one-pound force is applied to the end of a one-foot-long lever.

Powertrain – Combination of an engine and transmission.

Powertrain Control Module (PCM) – An on-board control module that monitors and controls engine and transaxle/transmission functions.

Pre-Ignition – The ignition of the air/fuel mixture prior to the timed ignition spark.

Pressure Regulator – A device that maintains/regulates a specified pressure within a system.

Programmable Read Only Memory (PROM) – A type of ROM (Read Only Memory) that can be programmed for different uses and applications.

Pulse Width Modulation (PWM) – The operation of device by a digital signal that is controlled by the time duration the device is turned ON and OFF.

Quad Driver – An integrated circuit that has the capability of four separate outputs.

Radio Frequency Interference Signal (RFI) – A high frequency type of EMI within the radio frequency band.

Random Access Memory (RAM) – A non-permanent type of memory that is used for information storage and retrieval. RAM is considered volatile as the memory is lost or "emptied" once power is removed.

Read Only Memory (ROM) – A permanent type of memory that is programmed by the computer manufacturer. It stores the parameters and operating instructions of the computer. ROM is considered non-volatile.

Glossary (Continued)

Refrigerant – The substance, utilized in A/C systems, that absorbs, carries, and releases heat.

Reid Vapor Pressure (RVP) – A method for determining the vapor pressures of gasoline and/or other petroleum based products.

Reserve Capacity – The amount of time (minutes) that a battery can deliver a 25-amp current while not dropping below 10.5 volts at 80 degrees F.

Resistance – The opposition to current flow in a circuit. (measured in ohms)

Revolutions Per Minute (RPM) – The measurement of how fast an object rotates around an axis.

Rheostat – *See Potentiometer.*

Scavenging – The process of drawing air/fuel into the cylinder, as a result of the movement of exhaust gases out.

Schrader Valve – A spring-loaded valve.

Society of Automotive Engineers (SAE) - An organization of automotive designers and engineers who establish standards and conduct tests on many automotive related functions.

Solenoid – An electrical device that, when energized, produces a mechanical motion.

Statistical Filtering – The process in which the PCM filters our information that could cause a false DTC to set. The PCM (over a period of time) internally creates charts based on the results of diagnostic testing, which in turn, are used to create a baseline for testing.

Stoichiometric Ratio – *See Air/Fuel Ratio.*

Stroke – The distance a piston travels from BDC (bottom dead center) to TDC (top dead center).

Supercharger – A compressor that forces air (under pressure) into the cylinders to increase volumetric efficiency.

Suspend – An action the PCM may take with certain DTCs that will cease the running of some monitors when a fault exists in one system that could affect another system.

Synthetic Oil – A man-made oil that has improved resistance to thermal breakdowns.

Glossary (Continued)

System Status (I/M Ready) - An emission testing signal which states that all of the on-board diagnostics have been performed. The System Status (I/M Ready) is only concerned with whether or not the test was ran and not if it passed or failed.

TCC – An acronym for Torque Converter Clutch. The TCC is a clutch device, found in automatic transmissions, that creates a fluid coupling between the final drive output and the engine.

Thermistor – A resistor that varies resistance based on temperature changes.

Thermostat – A device that controls the flow within a system based on temperature, such as in the engine cooling system.

Throttle Body – A housing that contains a valve to regulate the airflow through the intake manifold, usually located between the air cleaner and the intake plenum.

Top Dead Center (TDC) – The highest point, in the cylinder, that a piston can travel.

Torque – A turning/twisting force measured in pounds-feet.

Torque Converter – A special form of fluid coupling where torque is increased.

TP – An acronym for Throttle Position sensor.

TRIP – A key cycle (Key ON, RUN, Key OFF) where the diagnostic's enable criteria is met and the diagnostic test occurs.

Turbocharger – An exhaust powered supercharger.

Turbulence – (As in an engine) The rapid swirling motion of the air and fuel mix entering the cylinder. Turbulence provides better fuel vaporization and cylinder fill.

TWC – An acronym for Three-Way Converter.

UART - An acronym for Universal Asynchronous Receive and Transmit. The UART is the data stream type used on non-OBD II systems. It toggles between 5 volts (passive) and 0 volts (active).

Vacuum – Negative pressure (less than atmospheric pressure), measured in inches of mercury.

Valve Overlap – The amount of time, measured in degrees of crank rotation, the intake and exhaust valves are both open.

Valvetrain – The group or collection of parts that allow the valves to operate. This includes the camshaft(s), related drive components, valves, and associated parts.

Glossary (Continued)

Vapor Lock – Vaporized fuel that is usually found in the fuel line, which prevents the necessary fuel delivery (to the cylinders).

Vehicle Control Module (VCM) - An on-board computer that controls the transmission, engine management, and other systems such as ABS.

Vehicle Identification Number (VIN) – An alphanumeric number on each vehicle that identifies the vehicle type, assembly plant, powertrain, etc.

Volatile Memory – Computer memory that is only retained while power is supplied.

Volatility – The measurement of the tendency of a liquid to change to vapor.

Volt – A unit of measurement for the force of pushing electrical current through a circuit.

Voltage – The number of volts required to pass current, against resistance, through a conductor.

Voltage Drop – A reduction or drop in voltage across a resistance within a circuit.

Volumetric Efficiency – The ratio, expressed in percent, between the actual and ideal amount of air/fuel mix entering the cylinder.

Warm-Up Cycle - A Warm-Up Cycle is attained when the ECT rises at least 40° F (22° C) from startup and reaches a minimum temperature of 160° F (71° C). The PCM utilizes Warm-Up Cycles rather than Key Cycles to clear DTCs.

Word – The number of bits needed to represent the largest data element processed by a computer, or the number of bits needed to represent a computer instruction. *Also See Byte.*