

Emissions

1999 INSPECTION HANDBOOK

Includes an Overview of Emissions Inspection and Maintenance Programs (I/M) in the United States and Canada



Emissions



Published by the
American Association of Motor Vehicle Administrators

CCMTA • CCATM

In Partnership with the
Canadian Council of Motor Transport Administrators

Contents

Introduction.....3

Chapter 1—Regulating Emissions.....6

 A. What Emissions Are Regulated?6

 1. Hydrocarbons (HC)6

 2. Carbon Monoxide (CO)6

 3. Oxides of Nitrogen (NO_x)6

 4. Particulates (PM)6

 B. How Emissions Are Produced.....6

 1. Formation of Hydrocarbons (HC)7

 a. Evaporative Emissions7

 b. Crankcase Emissions7

 c. Engine Exhaust7

 2. Formation of Carbon Monoxide (CO)7

 3. Formation of Oxides of Nitrogen (NO_x)8

 C. How Emissions Are Controlled8

 1. Pre-catalytic Converter Technology (Prior to the Early 1970s)8

 2. Post-catalytic Converter, Pre-electronic Feedback Control
 Technology (Mid-1970s to Early 1980s)10

 3. Post-catalytic Converter, Post-electronic Feedback Control
 Technology (Early 1980s to Present)10

 a. Catalytic Converter10

 b. Air Injection Reaction (AIR)12

 c. Exhaust Gas Recirculation (EGR) System.....12

 D. How Emissions Relate to Air Pollution13

Chapter 2—Purpose of Inspection/Maintenance (I/M)15

 A. First I/M Tests15

 B. Enhanced I/M Requirements.....16

Chapter 3—I/M Tests & Procedures17

 A. Pre-inspection Safety Check17

 B. Emissions Component Inspection17

 C. Clean-Screen Testing17

 1. Remote Sensing Devices (RSD)18

 2. Computer Generated Low-emitting Vehicle Profiles18

 3. Vehicle Model Year Exemptions18

D. Basic I/M Tests	18
1. Idle Inspection Test.....	18
2. Two-speed Idle Test	18
E. Enhanced I/M Tests	19
1. IM 240 Test	19
a. IM 240 Test Procedure	19
b. IM 240 Emissions Measurements.....	20
2. BAR-31 Test	20
3. ASM Test	21
Chapter 4—Evaporative System Inspection	22
Chapter 5—On-Board Diagnostic System	23
Chapter 6—Diesel Smoke Emissions Inspection.....	24
A. Diesel Engine Technology.....	24
B. Federal Emissions Standards.....	24
C. Strategies To Improve Diesel Engine Emissions	24
1. Engine Modifications	24
2. Exhaust After-treatment	24
D. Heavy-duty Diesel Vehicle (HDDV) Opacity (Smoke) Tests.....	25
1. Snap Acceleration Test	25
2. Rolling Acceleration Test	25
Glossary.....	26
Acronyms.....	28

Introduction

The American Association of Motor Vehicle Administrators (AAMVA) in partnership with the Canadian Council of Motor Transport Administrators (CCMTA) is proud to offer this section of the new, expanded version of the *Vehicle Inspection Handbook Set*, with recommended inspection procedures and standards for all types of vehicles in the United States and Canada including:

- Motorcycles,
- Passenger Vehicles & Light Trucks,
- Salvage Vehicles,
- Trucks, Buses & Trailers, and
- Emissions.

Each handbook section contains information compiled from multiple sources and is based on actual working systems and programs in the United States and Canada.

To order additional handbook sections, please use the order form provided with this handbook or contact AAMVA (703-522-4200). In Canada, contact CCMTA (613-736-1003).

Emissions Inspections

The *Emissions Inspection Handbook* provides general background information on emissions Inspection and Maintenance (I/M) programs, with an overview of the emissions test strategies used by many jurisdictions. It also describes the emissions control equipment installed by vehicle manufacturers.

I/M was identified in the early 1970s as an effective way to reduce in-use motor vehicle emissions. By repairing their vehicles and performing routine maintenance, vehicle owners

can reduce emissions to the level expected for a properly maintained vehicle.

The agency responsible for the I/M program in each area may elect to employ one of the tests described herein or a variation of the test. These agencies also establish emissions test procedures and standards. For this reason, this handbook specifically excludes emissions pass/fail criteria. Specific questions about testing programs in any jurisdiction should be directed to the appropriate local agency.

Based on the Development of Emissions Programs in the U.S.

Information in this handbook is based primarily on the development of emissions inspection programs, related technology and legislation in the United States. Implementation of I/M programs is mandatory in those areas of the country that are not in compliance with the National Ambient Air Quality Standards (NAAQS), under provisions of the 1977 Clean Air Act. These areas are commonly referred to as “nonattainment areas.”

In the United States, the Environmental Protection Agency (EPA) is the federal agency responsible for regulating vehicle emissions, and the state of New Jersey was the first to use its regulatory authority to require that an I/M program be established. By 1983, I/M programs were established in 64 cities throughout the United States.

Canadian Programs

Unlike the United States, Canada does not have a national mandate for provinces to implement I/M programs. Instead, the Canadian Council of Ministers of the Environment (CCME) serves as an intergovernmental forum for discussion and joint action on environmental issues, and makes recommendations about where I/M programs should be implemented. The CCME also publishes federal guidelines for I/M programs that provide a standard format for the future development of I/M programs in Canada.

Currently, Canada has one active I/M program (AirCare) in lower mainland British Columbia, which began in 1992. In addition, Ontario plans to implement annual emissions testing for cars, trucks and buses in certain urban areas. Canada also has a voluntary nationwide emissions inspection clinic program designed to inform vehicle owners about the importance of proper vehicle maintenance and to capture emissions information on Canada's in-use light duty vehicle fleet.

U.S. and Canadian Differences in Emissions Standards for New Vehicles

In 1954, cloud chamber work by California researcher Dr. Hagan-Smit established the first connection between vehicle exhaust and smog. Since then, the United States and Canadian governments have set standards for vehicle emissions to bring down the levels of pollutants, and the automobile industry has responded by developing new emissions control technologies.

Beginning in 1971, new cars had to meet evaporative emissions standards established by the United States and Canada for the first time. It is important to note that Canadian and United States' emissions standards for new vehicles were similar, but not identical from

1971 to 1979. When the United States adopted stricter standards in 1980 and 1981, Canada did not. Canadian standards remained the same until September 1, 1987.

Because of different approaches to air pollution control, Canadian vehicles from the 1975 to 1988 period have different control equipment compared to their American counterparts. Among these differences are the later use of catalytic converters in Canadian vehicles. During the 1981-1987 period, certain manufacturers produced vehicles only to the United States EPA standards. However, many of the major manufacturers produced different versions of the same model vehicle—one that would comply with the 1981 United States standards and another version with less sophisticated emissions control systems that complied with Canadian standards. Often, popular models that were capable of meeting only Canadian emissions standards were sold without a catalytic converter or with a simpler oxidation catalyst. A similar vehicle made to meet United States standards would have been equipped with a three-way catalyst and possibly an air pump.

Reviewed by Experts

This handbook was developed by AAMVA's Handbook Working Group, which is part of AAMVA's Engineering and Vehicle Inspection Committee. Information was provided and/or reviewed by representatives from CCMTA, American Automobile Manufacturers Association, Association of International Automobile Manufacturers, Inc. and Specialty Equipment Market Association.

The source of statistics used in this handbook is the *1996 American Automobile Manufacturer's Association Facts and Figures*.

Handbook Set Reflects Experience and Cooperation

AAMVA has been involved in publishing vehicle inspection handbooks since the late 1980s, when AAMVA and the National Highway Traffic Safety Administration began working cooperatively to publish handbooks for passenger vehicles, trucks and buses with information provided primarily by the American Automobile Manufacturer's Association.

In 1995, AAMVA published the first edition of the *Vehicle Inspection Handbook* for passenger vehicles. A year later, AAMVA's Engineering and Vehicle Inspection Committee began devel-

oping this expanded edition of the handbook to provide inspection recommendations for all types of vehicles.

In 1997, CCMTA offered its manual, *Commercial Vehicle Inspections in Canada*, as the basis of the *Trucks, Buses & Trailers Inspection Handbook*, and AAMVA and CCMTA agreed to collaborate on the publication of the entire handbook set.

Because it includes recommendations for both the United States and Canada, the *Vehicle Inspection Handbook Set* is an important step toward the harmonization of standards throughout North America.

Regulating Emissions

A. What Emissions Are Regulated?

Internal combustion engines used in most of today's vehicles are a significant source of man-made air pollution. These engines produce four types of emissions that can be regulated through emissions inspection and maintenance (I/M) programs:

- Hydrocarbons (HC),
- Carbon Monoxide (CO),
- Oxides of Nitrogen (NO_x) and
- Particulates (PM).

1. HYDROCARBONS (HC)

Hydrocarbons are emitted either as unburned fuel in the exhaust or as fuel vapor from the engine or fuel system. This is known as evaporative emissions.

Automobiles, trucks, and motorcycles contribute approximately 27 percent of the man-made hydrocarbons emitted into the earth's atmosphere worldwide.

2. CARBON MONOXIDE (CO)

Carbon monoxide is a product of incomplete combustion caused by an overly rich air/fuel ratio. This may be caused by an excess of fuel or a shortage of air delivered to the engine cylinders. In the United States, approximately 80 percent of man-made carbon monoxide is from motor vehicles. In urban areas, vehicles may account for as much as 90 percent of the carbon monoxide.

3. OXIDES OF NITROGEN (NO_x)

Oxides of nitrogen are formed in the engine's combustion chamber when high temperature

and pressure causes oxygen and nitrogen to chemically bond. The greater the temperature/pressure during combustion, the more oxides of nitrogen will be formed. In the United States, approximately 32 percent of man-made oxides of nitrogen are produced by motor vehicles.

4. PARTICULATES (PM)

Man-made particulate emissions are microscopic solid particles that are small enough to remain suspended in the air. They are produced primarily by industrial processes and internal combustion engines. The United States Environmental Protection Agency (EPA) regulates particulate emissions at 2.5 and 10 microns.

B. How Emissions Are Produced

Once ignited in the cylinder of an internal combustion engine, the hydrogen and carbon contained in the fuel react with oxygen in the air as they burn. This reaction produces the energy that drives down the pistons in an internal combustion engine. It also creates chemical byproducts that are emitted in the exhaust.

Ideally, the combustion of fuel (HC) and air should produce only water (H₂O) and carbon dioxide (CO₂). The nitrogen component of air passes through the reaction unchanged in the form of N₂. However, fuel is not composed of pure hydrocarbons (HC), and internal combustion engines do not produce perfect combustion. As a result, in addition to carbon dioxide (CO₂) water (H₂O) and nitrogen (N₂), motor vehicle exhaust also contains carbon monoxide (CO), oxides of nitrogen (NO_x), hydrocarbons (HC), and particulates.

1. FORMATION OF HYDROCARBONS (HC)

Hydrocarbon emissions may be released through evaporative emissions (fuel evaporation), crankcase emissions and engine exhaust.

a. Evaporative Emissions

Evaporative emissions result from the release of fuel vapors from the fuel system simply due to leakage caused by the expansion of vapors. This type of emission causes the most concern in warm climates and during the summer months. As ambient temperatures rise, vapor pressure in a vehicle's fuel system increases because fuel in the fuel tank evaporates and expands. If uncontrolled, this higher vapor pressure is vented to the atmosphere causing the release of evaporative emissions.

In addition, fuel vapors are emitted when motor vehicles are refueled. Vapor recovery controls, referred to as Stage I and Stage II, are installed at most gasoline pumps in areas that do not meet United States air quality standards.

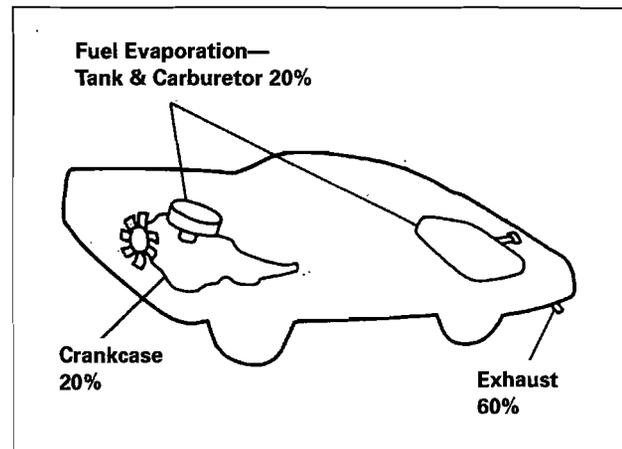
Evaporative emissions also may be produced when vehicle exhaust pipes, engines or other heat sources, warm the surface of the road.

b. Crankcase Emissions

The second source of hydrocarbon emissions is the engine crankcase. Exhaust gases from the combustion chamber leak past the piston rings into the crankcase. If uncontrolled, blow-by gases would be exhausted to the atmosphere. Over time, the volume of blow-by gas increases as piston rings and cylinder walls begin to wear, allowing more gas to leak into the crankcase during compression.

c. Engine Exhaust

The third source of hydrocarbon emissions is the engine exhaust. Due to incomplete combustion, not all of the hydrocarbon in motor vehicle fuel is burned during combustion.



Three Sources of Auto Emissions

2. FORMATION OF CARBON MONOXIDE (CO)

Carbon monoxide emissions are produced during the combustion process when the air/fuel ratio is too rich. An ideal (stoichiometric) air/fuel ratio for gasoline is 14.7 lbs. of dry air to 1 lb. of gasoline. When converted to gallons of air and gasoline, this equates to 9,000 gallons of air to one gallon of gasoline.

Anything that causes a rich air/fuel mixture such as a clogged air filter or air intake passage, fuel-contaminated oil, a leak in the air intake system, or a faulty fuel control system component, such as an oxygen sensor or mass air flow sensor, will cause tailpipe emissions of carbon monoxide to increase.

Carbon monoxide emissions also increase when an engine is under strong load, such as during heavy acceleration or while climbing a steep grade. Fuel enrichment under these conditions is necessary to protect the engine and catalyst from overheating.

3. FORMATION OF OXIDES OF NITROGEN (NO_x)

Oxides of nitrogen emissions result from incomplete combustion under very high temperature and pressure conditions. In fact, if the combustion reaction were allowed to continue for a longer period of time, the oxides of nitrogen (NO_x) formed during combustion would again reduce to nitrogen (N₂) and carbon dioxide (CO₂) and/or water (H₂O). However, rotation of the crankshaft automatically purges the exhaust gases from the cylinder, terminating the combustion reaction and fixing the oxides of nitrogen compounds in the exhaust.

It should be noted that there is a natural trade-off between reducing oxides of nitrogen emissions and reducing carbon monoxide, and to a lesser extent, hydrocarbon emissions. This trade-off occurs because the operating conditions that are conducive to the formation of oxides of nitrogen suppress carbon monoxide and hydrocarbon emissions, and those engine operating conditions that are conducive to carbon monoxide and hydrocarbon emissions suppress the formation of oxides of nitrogen. Engine calibration engineers must optimize this trade-off when designing the software that controls the air/fuel ratio under all operating conditions.

Finally, exhaust after-treatment methods are relied upon to lower levels of all three emissions. This is accomplished by catalyzing chemical reactions that transform some harmful gases into less harmful gases.

C. How Emissions Are Controlled

In the United States, the 1990 Clean Air Act gave the EPA broad authority to regulate motor vehicle emissions, as well as other industrial sources of pollutants. Vehicles built for sale in the United States must meet tailpipe and evaporative emissions standards for hydrocarbons, carbon monoxide, oxides of nitrogen and particulates, as determined by Congress. The EPA generally does not mandate the pollution con-

trol devices to be used, but instead sets performance standards. This allows vehicle manufacturers to choose the best available technology to meet their engineering needs and stimulates innovation.

The technology used to control vehicle emissions can be divided into three generations:

- Pre-catalytic Converter Technology
- Post-catalytic Converter, Pre-electronic Feedback Control Technology
- Post-catalytic Converter, Post-electronic Feedback Control Technology

The majority of the vehicles currently on the roads in the United States fall into the third generation.

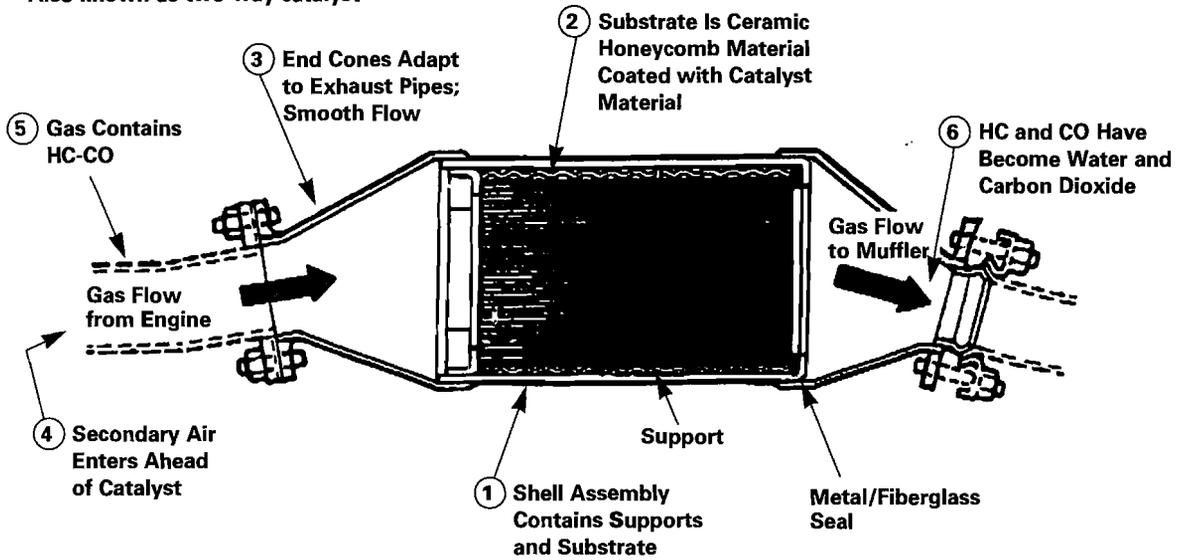
1. PRE-CATALYTIC CONVERTER TECHNOLOGY (PRIOR TO THE EARLY 1970s)

Emission reductions during the late 1960s and the early 1970s were obtained primarily through improved engine design. Carburetors were designed to deliver a leaner air/fuel mixture to the cylinders, ignition timing was retarded to extend the combustion reaction allowing for more complete burning of the fuel, and compression ratios were reduced to 8.5 to 1 or less. Thermostatically controlled air cleaner systems also were developed to improve cold start driveability, which was adversely affected by leaner air/fuel mixture.

In addition to base engine design changes, several emissions control systems were added to vehicles during this period. Carbon canister systems were added to vehicles in order to control evaporative emissions by storing excess vapor while the vehicle was at rest, and the vapor was redirected to the intake manifold when the vehicle was operating. Modified camshafts were installed along with exhaust gas recirculation systems to help reduce oxides of nitrogen emissions. Positive Crankcase Ventilation (PCV) systems, which vented the crankcase to the intake manifold rather than to the atmosphere, also were introduced.

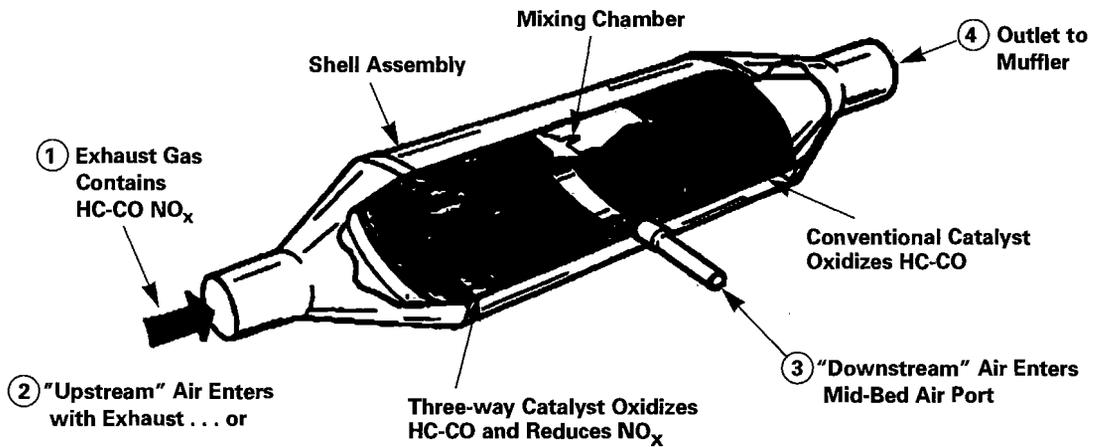
CONVENTIONAL OXIDATION CATALYST (COC)

- Controls HC and CO
- Also known as two-way catalyst



THREE-WAY CATALYST (TWC) CONVERTER

- Controls HC, CO and NO_x
- Contains a COC element and a three-way element
- Also called dual-bed converter



Diagrams of Early Control Systems

Courtesy of Ford Motor Company (1986)

2. POST-CATALYTIC CONVERTER, PRE-ELECTRONIC FEEDBACK CONTROL TECHNOLOGY (MID-1970s TO EARLY 1980s)

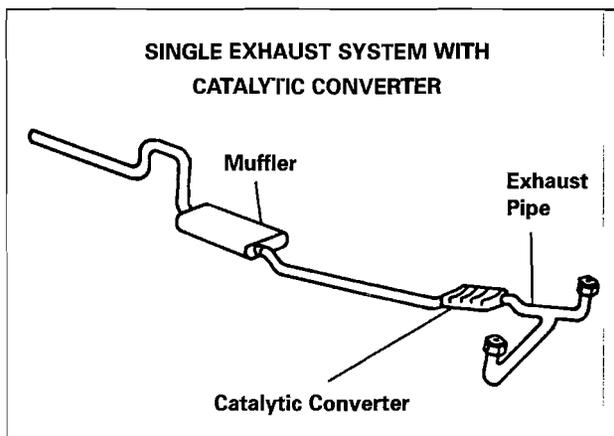
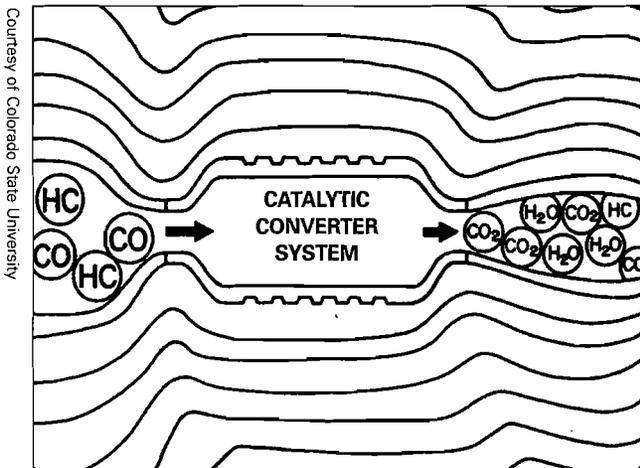
In the mid-1970s, EPA emissions standards were tightened significantly. The need for large reductions in hydrocarbon and carbon monoxide emissions prompted the introduction of oxidation catalytic converters. These catalytic converters chemically convert hydrocarbon (HC) and carbon monoxide (CO) exhausted from the engine into water (H₂O) and carbon dioxide (CO₂) before the exhaust gas leaves the tailpipe.

Prior to the introduction of catalytic converters, lead was widely used by fuel refiners to boost the octane of gasoline. But lead poi-

soned the catalytic converters by depositing on the catalytic surface, thereby preventing the oxidation reaction needed to convert hydrocarbon and carbon monoxide to carbon dioxide and water. This, in addition to the fact that there was increasing evidence that lead contamination from gasoline was having serious adverse health effects, especially for young children, hastened the mandatory introduction of unleaded gasoline and the phasing out of lead as a fuel additive.

Development of the catalytic converter also resulted in the development of air injection systems. To operate properly, a catalytic converter requires oxygen and heat. While the hot exhaust gases flowing through the catalyst naturally supply the heat, air injection systems had to be introduced to supply the requisite air.

Air injection systems were either pump- or pulse-based, depending on whether the air was supplied by a belt-driven pump, or by air ingestion through a valve body operating on the negative pressure pulse in the exhaust manifold caused by valve closing. Air was routed from the pump or valve body to the catalytic converter. Some systems also furnished air to the exhaust manifold near the exhaust valves in order to take advantage of the extremely high temperature in this region to extend the combustion process in the exhaust manifold.



Oxidation Catalytic Converter Operation

3. POST-CATALYTIC CONVERTER, POST-ELECTRONIC FEEDBACK CONTROL TECHNOLOGY (EARLY 1980s TO PRESENT)

Emissions standards were tightened again beginning with the 1981 model year. Not only were hydrocarbon and carbon monoxide standards stricter, but a drastic reduction in oxides of nitrogen was required as well. As a result, catalytic converter technology was further refined to control all three of the regulated emissions.

a. Catalytic Converter

The purpose of the automotive catalytic converter is to chemically convert emissions of

hydrocarbons, carbon monoxide and oxides of nitrogen into less harmful byproducts. This is accomplished by coating a substrate material that has a very large amount of surface area with catalytic metals (platinum, palladium, and rhodium are the most commonly used) in order to provide a sufficient number of catalytic sites for oxidation and reduction of the targeted emissions through catalyzation.

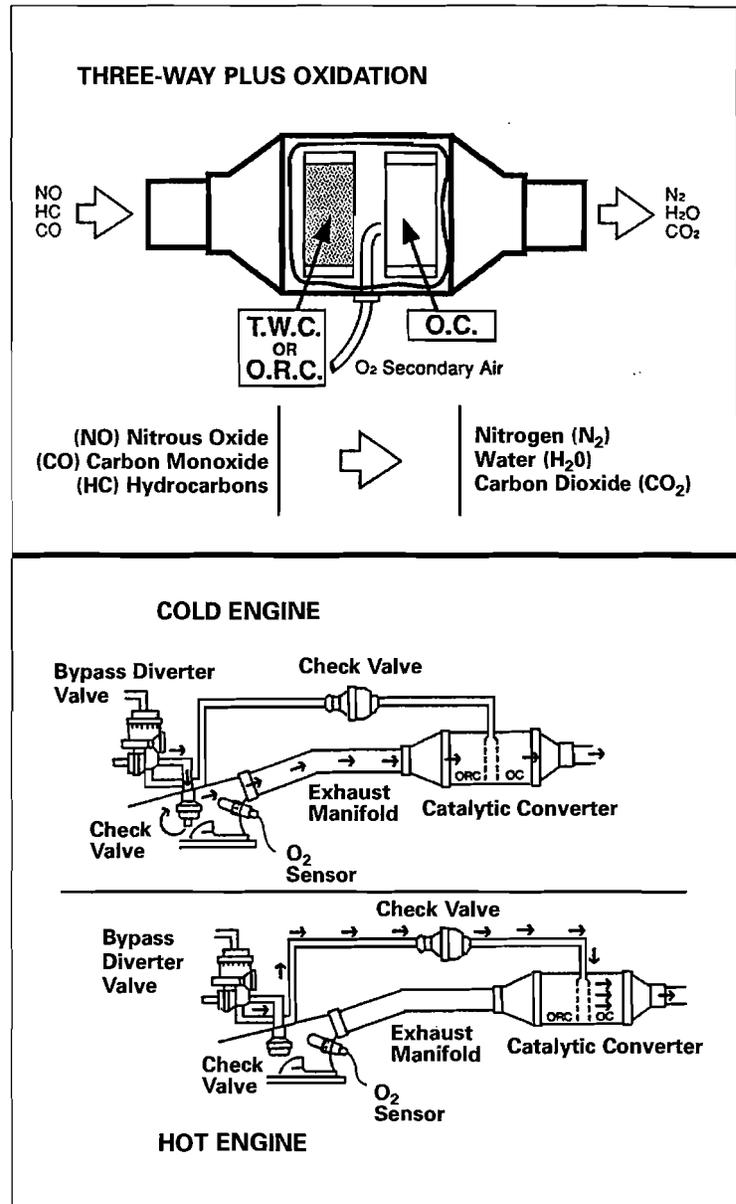
During the catalyzation process, hydrocarbon and carbon monoxide molecules are oxidized, and oxides of nitrogen are reduced. While oxidation of hydrocarbon and carbon monoxide requires oxygen, oxides of nitrogen are most efficiently reduced when there is an oxygen deficiency.

To catalyze emissions, the converter must be heated to approximately 250 degrees Celsius (482 degrees Fahrenheit). Beyond approximately 850 degrees Celsius (1562 degrees Fahrenheit), thermal degradation of the catalyst begins to become critical. Prolonged operation at such high temperatures will eventually destroy the catalytic activity.

Catalysts are manufactured in different sizes and use three different types of catalyst support materials or substrate:

- Ceramic pellet (bead type—not widely used)
- Ceramic monolith (honeycomb type)
- Metal monolith (honeycomb type)

Because a catalytic converter is inefficient until it reaches a temperature of approximately 250 degrees Celsius (482 degrees Fahrenheit),



Operation of Three-way Catalyst—Air/Fuel Ratio

several things are done to help get the converter up to this temperature quickly (also known as “light-off”) to reduce cold-start emissions. The idle speed may be raised; air may be injected into the exhaust manifold; a small “light-off” catalyst may be positioned close to the exhaust manifold; or the main catalyst itself may be located closer to the exhaust manifold.

In order for a three-way catalytic converter to effectively reduce all three pollutants, the engine must be operated at or near an air/fuel ratio of 14.7

to 1 (stoichiometric), and an electronically controlled fuel system is necessary. In addition to a control computer, called the powertrain control module (PCM), such a system requires various actuators that regulate idle air, purge, or Exhaust Gas Recirculation (EGR) flow, for example, and numerous sensors to monitor the state of the engine. The sensors may monitor conditions such as exhaust gas oxygen content, manifold absolute pressure, crankshaft angular position and speed, inlet air temperature, coolant temperature, and throttle position. These inputs are “fed back” (hence the term “feedback” control system) to the computer, which determines the appropriate amount of fuel, spark advance, EGR flow, purge, etc., to provide under given operating conditions.

b. Air Injection Reaction (AIR)

The AIR system is one of the earlier emissions control systems introduced by manufacturers. Because of the system’s relative cost-effectiveness, it is still in widespread use today.

AIR systems are designed to pump air into the exhaust manifold and to the downstream bed of a dual-bed catalytic converter. Under cold engine/catalyst operating temperatures, oxygen in the air allows unburned fuel in the exhaust to continue to burn in the exhaust manifold and outlet pipe. That, in turn, reduces the amount of unburned fuel that enters the catalyst before it has warmed up and increases the temperature of the exhaust gases entering the cold catalyst, which hastens light-off. After the engine and catalyst reach normal operating temperatures, air is diverted downstream to the catalyst oxidation bed, where the oxygen in the air again facilitates the conversion of hydrocarbons (HC) and carbon monoxide (CO) to water (H₂O) and carbon dioxide (CO₂).

There are three general types of AIR systems used by manufacturers—air pump-based systems, aspirated systems and pulse air feeder systems. AIR systems should be checked for proper condition and routing of vacuum and air delivery hoses. In most systems, switching valve function can be verified by

feeling for the air pulses in the outlet hoses from the valve. The proper operation of electronically controlled systems can be checked through the vehicle’s On-Board Diagnostic (OBD) system using an appropriate scan tool or key-activated code storage retrieval.

c. Exhaust Gas Recirculation (EGR) Systems

The purpose of an EGR system is to lower the temperature of combustion in order to suppress the formation of oxides of nitrogen emissions. This is accomplished by reintroducing inert exhaust gases to the combustion chamber during the power stroke. The inert gases mix with the reactive air fuel mixture, thereby diluting the charge, and in turn, lowering the peak temperature of combustion.

There are two types of EGR systems—vacuum-driven and electronic.

Vacuum-driven EGR systems typically consist of a pintle-type, diaphragm-actuated valve located on the exhaust manifold, that is controlled by a backpressure transducer coupled with an EGR solenoid. The backpressure transducer modulates EGR flow according to a ported vacuum signal.

Electronic EGR systems typically consist of one or more EGR solenoids acting on a pintle valve to allow more or less EGR flow to the intake manifold, depending upon engine operation conditions and loads. The solenoid(s) are controlled by the powertrain control module (PCM), which “maps” EGR and other engine control functions according to software protocols designed by the manufacturer. Electronic EGR can be more precisely controlled, and therefore is less likely to cause driveability problems, unless it is malfunctioning. Also, because electronic EGR operates independently of manifold or ported vacuum, EGR flow can occur over a greater range of operation regimes, thereby enhancing the system’s oxides of nitrogen reduction function.

The EGR system should be inspected for proper condition and routing of vacuum hoses. The condition of the valve and free operation of the pintle also should be veri-

fied. The proper functioning of electronic EGR systems can be verified through the OBD software using an appropriate scan tool or key-activated code storage retrieval.

D. How Emissions Relate to Air Pollution

Emissions play a significant role in creating the air pollution problem commonly referred to as smog, a term which was formed originally by combining the words smoke and fog. There are two types of smog—sulfurous smog and photochemical smog.

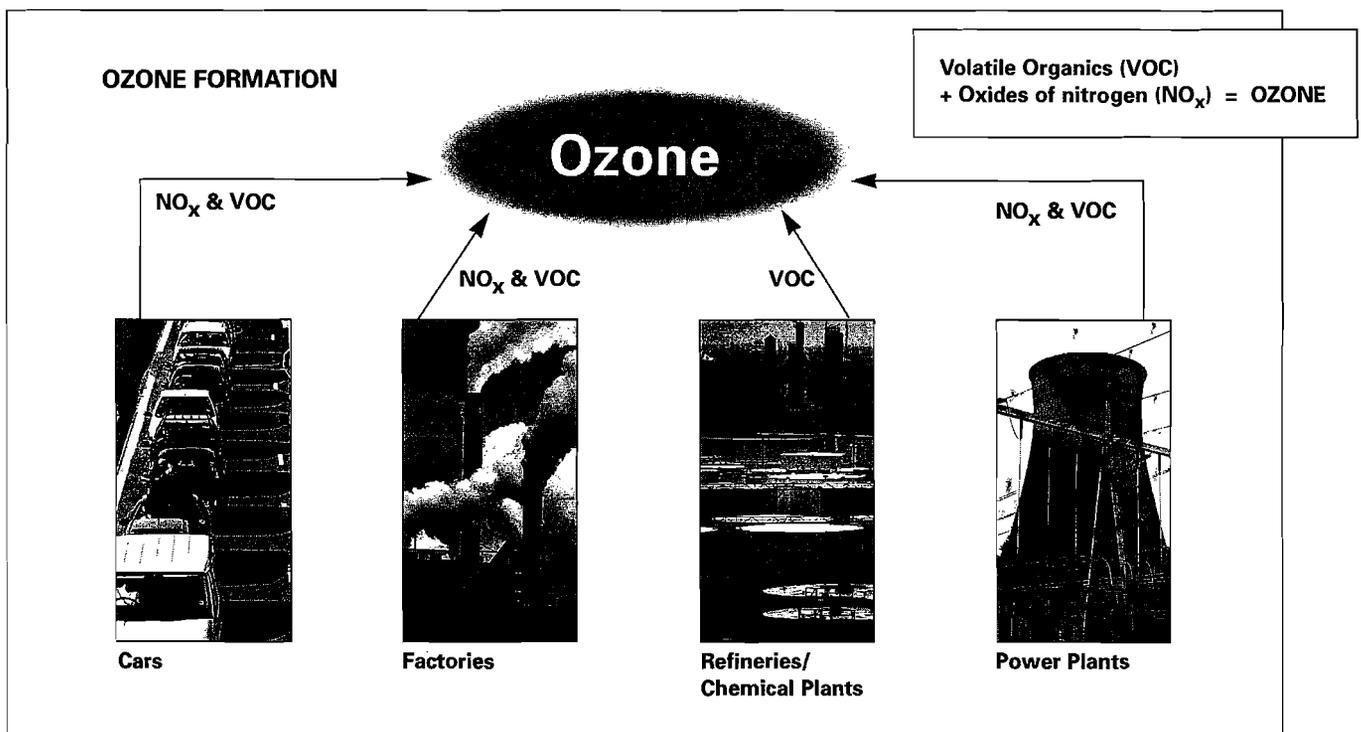
Sulfurous smog results from a combination of sulfur-bearing pollutants emitted by coal- and oil-burning stationary sources. Mobile sources, such as on-road vehicles, also contribute to sulfurous smog.

Photochemical smog is caused to a great extent by motor vehicles. Photochemical smog results from hydrocarbons and oxides of nitrogen reacting chemically in the presence of sunlight. One of the main sources of hydrocarbons and

oxides of nitrogen is the internal combustion engine found in motor vehicles.

The primary component of photochemical smog is ozone. Ozone is made up of three atoms of oxygen (O_3). Ozone occurs naturally in the upper atmosphere and serves to block out harmful ultraviolet rays from reaching the earth's surface. However, near the earth's surface, ozone formed from man-made pollutants has been shown to exacerbate certain lung conditions, such as asthma, and to accelerate the deterioration of rubber, as well as certain paints and coatings.

Ozone levels are generally highest during summer months and in warmer climates for two reasons. First, there are more hours of daylight during the summer. Second, summertime meteorological conditions produce stagnant masses of high pressure air over large parts of North America. These stagnant conditions allow hydrocarbons and oxides of nitrogen to mix for long periods of time, often several days, which results in elevated ozone levels and the possibility of multiple violations of national air pollution standards.



The effect of photochemical smog is multiplied when temperature inversions occur and where geographical barriers exist. An inversion is when the air temperature at higher elevations is warm relative to surface air temperature. The warmer air effectively traps the colder air, preventing dispersion. When a mountain range

exists around an inversion, the dispersion rate of the pollutants is slowed even more. This is why certain locations, such as the Los Angeles basin, have a very serious smog problem, while other locations with a similar number of people and automobiles, may not.

Purpose of Inspection/Maintenance (I/M)

The purpose of I/M programs is to identify through inspection, vehicles that are emitting significantly more pollutants than they were designed to emit, and to bring them back into compliance with applicable standards through maintenance and repair services.

I/M was identified in the early 1970s as an effective way to reduce in-use motor vehicle emissions. By repairing their vehicles and performing routine maintenance, vehicle owners can reduce emissions to the level expected for a properly maintained vehicle. The state of New Jersey was the first to use its regulatory authority to require that an I/M program be established.

In the United States, in 1977, the Clean Air Act was amended to require, among other measures, mandatory implementation of I/M programs in those areas of the country that were not in compliance with the National Ambient Air Quality Standards (NAAQS). These areas are commonly referred to as “nonattainment areas.” If states with responsibility for those areas did not implement I/M programs, they faced federal sanctions including the loss of highway funds and the ability to grant permits for new industrial sources.

A. First I/M Tests

Although the United States Environmental Protection Agency (EPA), the federal agency responsible for regulating vehicle emissions, eventually promulgated regulations covering five different “short tests,” two of which were loaded mode tests, the vast majority of jurisdictions implemented I/M programs based on a two-speed idle test in order to keep the I/M test simple and inexpensive, usually under \$20.

These I/M tests could be performed at either centralized or decentralized facilities. Centralized facilities are operated by either governments or contractors working for governments. Decentralized facilities are privately owned repair facilities, gas stations or franchised dealerships.

EPA auditing of I/M programs found that reductions in emissions were substantially less than expected. In addition, newer, computer-controlled cars and trucks required more sophisticated test procedures. The 1990 Clean Air Act sought to address these issues by creating a category of I/M called “enhanced I/M.” Enhanced I/M programs were required to be implemented in all nonattainment areas classified as serious, severe or extreme, based on the degree and duration of noncompliance with NAAQS.

B. Enhanced I/M Requirements

In 1992, EPA established requirements for enhanced I/M programs. The purpose of enhanced I/M tests is to produce greater reductions in hydrocarbon, carbon monoxide and oxides of nitrogen emissions than can be achieved with basic I/M tests. Strategies used to get these additional reductions include:

- Evaporative system tests,
- Road simulation tests for oxides of nitrogen tailpipe emissions,
- \$450 waiver repair requirements, and
- More stringent program enforcement.

In 1995, the United States Congress passed an amendment to the National Highway Systems Designation Act that allowed jurisdictions substantial flexibility in designing an I/M program that would still be considered “enhanced.” In response, jurisdictions have developed a variety of I/M programs based on different test protocols. The majority of these programs are decentralized. The following sections detail some of the different types of I/M test protocols that may be used. For program requirements that pertain to specific areas, check with the I/M operating agency in that jurisdiction.

I/M Tests & Procedures

A. Pre-inspection Safety Check

To prevent injury and/or damage to vehicles, it is important to conduct a safety inspection before performing a dynamometer-based I/M emissions test. Refer to appropriate sections of the *Passenger Vehicles & Light Trucks Inspection Handbook* for more information about inspection procedures. At a minimum, the following items should be checked before proceeding with the emissions inspection.

Tires. Reject the vehicle if a tire is excessively worn or a space-saver spare is used on a drive axle. The risk of a blowout should not be taken.

Brakes. If the vehicle cannot maintain the drive trace during the test due to poor braking performance, it will fail the test.

Exhaust System Leaks. A visual inspection of the entire exhaust system should be performed prior to an I/M test. Vehicles with leaking exhaust systems should be rejected.

Steering and Suspension. If steering or suspension components are significantly worn or damaged, or have been modified to the extent that normal function is affected, the vehicle should be rejected.

Fuel System. Vehicles that are leaking fuel should be rejected because they are a fire hazard.

Overheating/Fluid Leaks. A visual inspection of the instrument panel malfunction indicator lights or gauges, as well as a visual inspection of the cooling system and underbody of the

vehicle should be performed. Vehicles that appear to be overheated and those that are leaking coolant or oil should be rejected from testing.

B. Emissions Component Inspection

A visual inspection should be conducted for the presence and condition of the following components. If any emissions components are missing, the vehicle should be rejected.

Fuel Inlet Restrictor—To prevent the introduction of leaded fuel into a vehicle manufactured for unleaded fuel use.

Catalytic Converter—The presence of the catalytic converter is required to be verified as part of the anti-tampering inspection.

Under-the-hood Emissions Control Components—Some jurisdictions require visual inspection for the presence of the EGR system, air pump, PCV, etc.

C. Clean-Screen Testing

Because the majority of vehicles normally produce emissions well below I/M standards, the United States EPA allows I/M programs to exempt certain “clean” vehicles from complete I/M tests. Jurisdictions may use one of three different approaches for clean-screening: remote sensing devices (RSD), computer generated low-emitting vehicle profiles, or vehicle model year exemptions.

By using one of these clean-screen tests, jurisdictions will be able to reduce the number of vehicles going through either test-only or test-and-repair I/M systems. EPA and jurisdiction's I/M agencies will jointly determine the effectiveness of I/M programs with clean-screen components.

1. REMOTE SENSING DEVICES (RSD)

Remote sensing devices can be used for on-road inspections or at inspection stations to measure the emissions of vehicles in operation. If vehicles scheduled for I/M tests meet the jurisdiction's "clean-screen" standards, they may be exempted from the I/M test currently scheduled.

2. COMPUTER GENERATED LOW-EMITTING VEHICLE PROFILES

California has developed computer profiles of the vehicles that are statistically most probable to pass I/M tests. These computer profiles are based on previous I/M results, vehicle specific studies and remote sensing device data. By using these profiles, jurisdictions may issue I/M test exemptions for the current I/M tests.

3. VEHICLE MODEL YEAR EXEMPTIONS

EPA and state testing has shown that most of the vehicles currently being sold in the United States are able to meet I/M standards for up to four years, provided scheduled maintenance is performed. Therefore, jurisdictions may exempt new vehicles for up to four years from I/M tests.

D. Basic I/M Tests

Basic I/M test programs are used in areas with moderate air pollution problems. Basic tests use exhaust gas analyzers to check the exhaust concentration of two pollutants, hydrocarbon and carbon monoxide. The test may be conducted while the vehicle is at idle speed or at 2,500

rpm while the vehicle is in "PARK" or "NEUTRAL."

During the test, the exhaust gas analyzers use Non-Dispersive Infrared (NDIR) technology to measure the gases. Hydrocarbon is measured in parts per million (ppm) and carbon monoxide in percent (%).

Exhaust gas analyzers are usually built to specifications developed by the California Bureau of Automotive Repair (BAR). BAR specifications are labeled by the year they became effective. There are BAR-74, BAR-80, BAR-84, BAR-90, and BAR-97 specifications, which reflect changes due to more stringent standards that were imposed on motor vehicles over this time period, as well as the increased use of computer technology.

Jurisdictions set emissions standards based on the national emissions certification standards to which the vehicle was built to comply. Compared to older vehicles, newer cars have much stricter emissions standards.

1. IDLE INSPECTION TEST

The idle inspection test measures exhaust emissions with the vehicle in "NEUTRAL" (manual transmission) or "PARK" (automatic) and the engine at idle speed. When the vehicle is properly prepared for the test, and the exhaust gas analyzer is warmed up and calibrated, the test can be performed.

With the analyzer in the test mode, the inspector places a probe in the tailpipe and observes the emissions measurement reading, or waits for electronic "pass" or "fail" results. The exhaust emissions must fall below the applicable standard in order to pass the inspection.

2. TWO-SPEED IDLE TEST

During this test, emissions measurements are made at two speeds while the vehicle is in "PARK" or "NEUTRAL."

First, the vehicle emissions are measured at idle. Then, the engine is accelerated and held at approximately 2,500 rpm for a speci-

fied time period while the emissions are measured again. A third reading is taken when the engine is returned to idle speed.

The pass/fail determination may be based on the lowest of the two emissions readings taken at idle speed. Alternatively, depending on applicable jurisdictional regulations, all three readings may be required to be below the applicable emissions standards.

By allowing the second set of idle readings to be used for making the pass/fail determination, jurisdictions are recognizing the possibility that the vehicle may not have been properly preconditioned for the emissions test. Running the vehicle at 2500 rpm helps to ensure that the engine and catalytic converter are operating at a normal temperature. Catalytic converter cooling that can occur under prolonged idle conditions may otherwise cause a properly functioning vehicle to fail the test.

E. Enhanced I/M Tests

There are two types of enhanced I/M tests used to simulate on-the-road operating conditions: transient tests and steady-state tests.

Transient tests measure tailpipe exhaust at varying speeds. This is done by placing a vehicle on a dynamometer (essentially a treadmill) and running it through a drive cycle that represents normal operating conditions. Jurisdictions use different driving cycles for their transient enhanced I/M tests including the IM-240 and the BAR-31. All the exhaust coming out of the tailpipe is collected and measured in a testing device called a Constant Volume Sampling (CVS) system.

Steady-state tests measure the tailpipe exhaust at one, two or three constant speeds. This is done by placing a vehicle on a dynamometer, running it up to the target speed, and measuring the exhaust gas at only the target speed for a specified period of time. If more than one target speed is used, the vehicle is brought up to those speeds and exhaust gas is measured only at those speeds as well. This is

different than a transient I/M test where the exhaust gas is measured all the time. Because of the less demanding testing procedure, a CVS system does not have to be used with a steady-state test. Instead, an idle-test emissions analyzer with the addition of an oxides of nitrogen testing module may be used.

Jurisdictions use different test procedures for their steady-state enhanced I/M tests. The most common is the Acceleration Simulation Mode (ASM).

1. IM 240 TEST

IM 240 stands for Inspection/Maintenance, 240-second inertia-loaded dynamometer test. This enhanced test measures mass emissions in grams per mile through a tailpipe exhaust test while the vehicle is driven on a variable inertia-loaded dynamometer. The test includes vehicle speed transitions from 0 to 56 mph (0 to 90 kmh), and emissions are measured through a CVS system. The maximum test time is 240 seconds, unless preconditioning provisions allow for an extension.

The IM 240 test is derived from various parts of the Federal Test Procedures (FTP). The FTP is a much lengthier dynamometer-based emissions test protocol, which uses more sophisticated measurement equipment and exhaust gas analyzers to which new vehicles are certified by the United States EPA. New vehicles must meet applicable EPA or California Air Resources Board (CARB) emissions standards before they may be offered for sale in the United States.

a. IM 240 Test Procedure

After the safety pre-inspection, the vehicle's registration is compared to the vehicle identification number (VIN) plate and the VIN is entered into the test lane computer. The computer identifies and sets the appropriate dynamometer inertia load (flywheel weights that closely simulate the acceleration weight of the vehicle) and vehicle emissions standards, or cutpoints that determine pass or fail.

The vehicle is then safety-locked to the dynamometer rollers, and an inspector “drives” the vehicle on the dynamometer following a “drive trace” that is displayed on a monitor. The inspector must keep the vehicle speed within several mph of the drive trace displayed on the screen. If the speed goes out of the required range, the test will be aborted and must be restarted. (See the drive trace diagram below.)

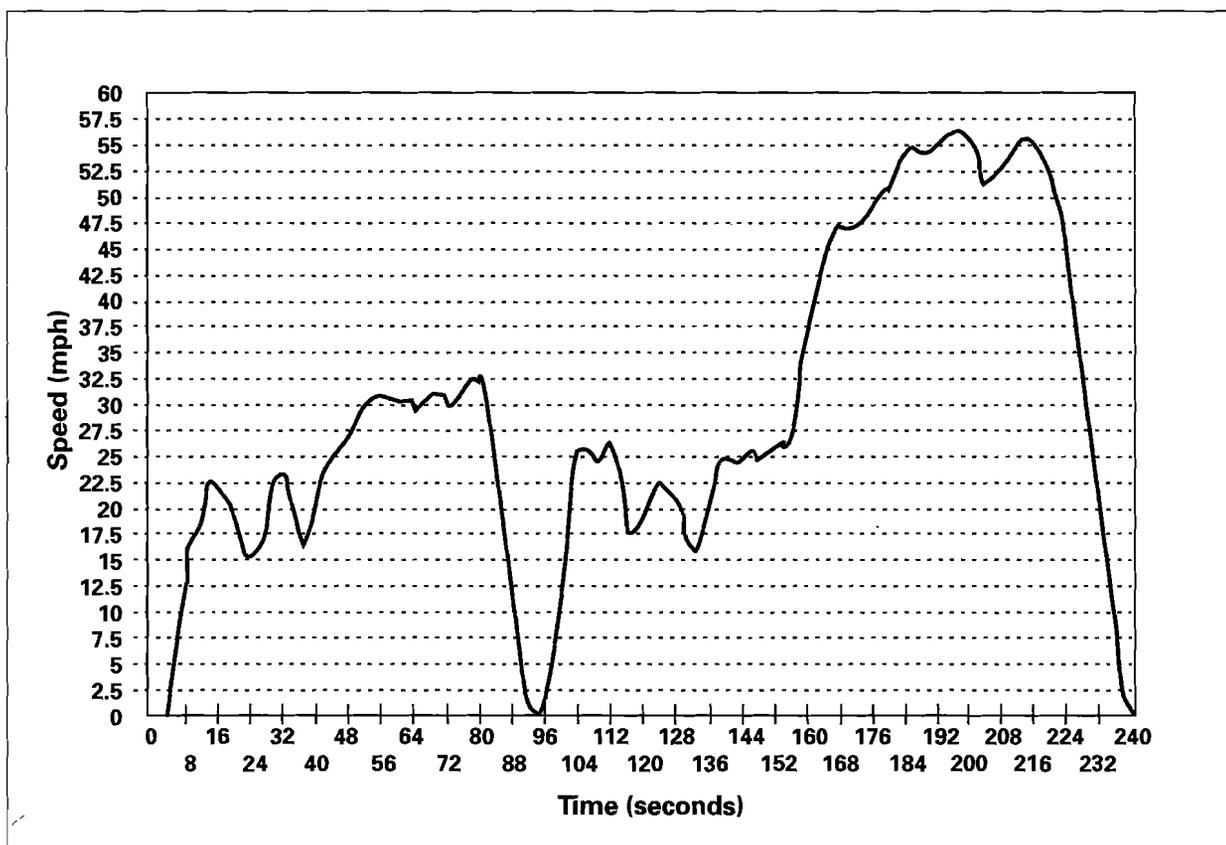
b. IM 240 Emission Measurements

A vehicle will fail the IM 240 test if it exceeds the grams per mile (gpm) standard by the end of the test, or it may fail if it does not meet the “fast pass” criteria established by the EPA. If a jurisdiction uses the “fast pass” criteria, the vehicle will pass the test if the mass emissions do not exceed a lower threshold than the actual standard within a prescribed period of time. Emissions standards for IM 240 tests are set by jurisdictions based on EPA guidelines.

Note: An important difference between the IM 240 and the basic I/M program is the way emissions are measured. IM 240 looks at the total mass of exhaust emissions from the vehicle (grams of pollutants per mile) by using a CVS system. Mass emissions tests provide a much clearer picture of the total amount each vehicle contributes to air pollution. In comparison, basic and ASM-based enhanced programs measure the concentration of pollutants in the exhaust (percent or parts per million).

2. BAR-31 TEST

The BAR-31 test is similar to the IM 240 test. The same test equipment is used and exhaust emissions are measured the same way. The BAR-31 test is faster than the IM 240 test. It can be conducted in 31 seconds, and because of the simpler driving trace, the BAR-31 test is easier to perform.



Enhanced I/M Driving Cycles—IM 240

Usually, at least three BAR-31 tests are conducted before a pass/fail decision is made. (See the BAR-31 diagram below.)

3. ASM TEST

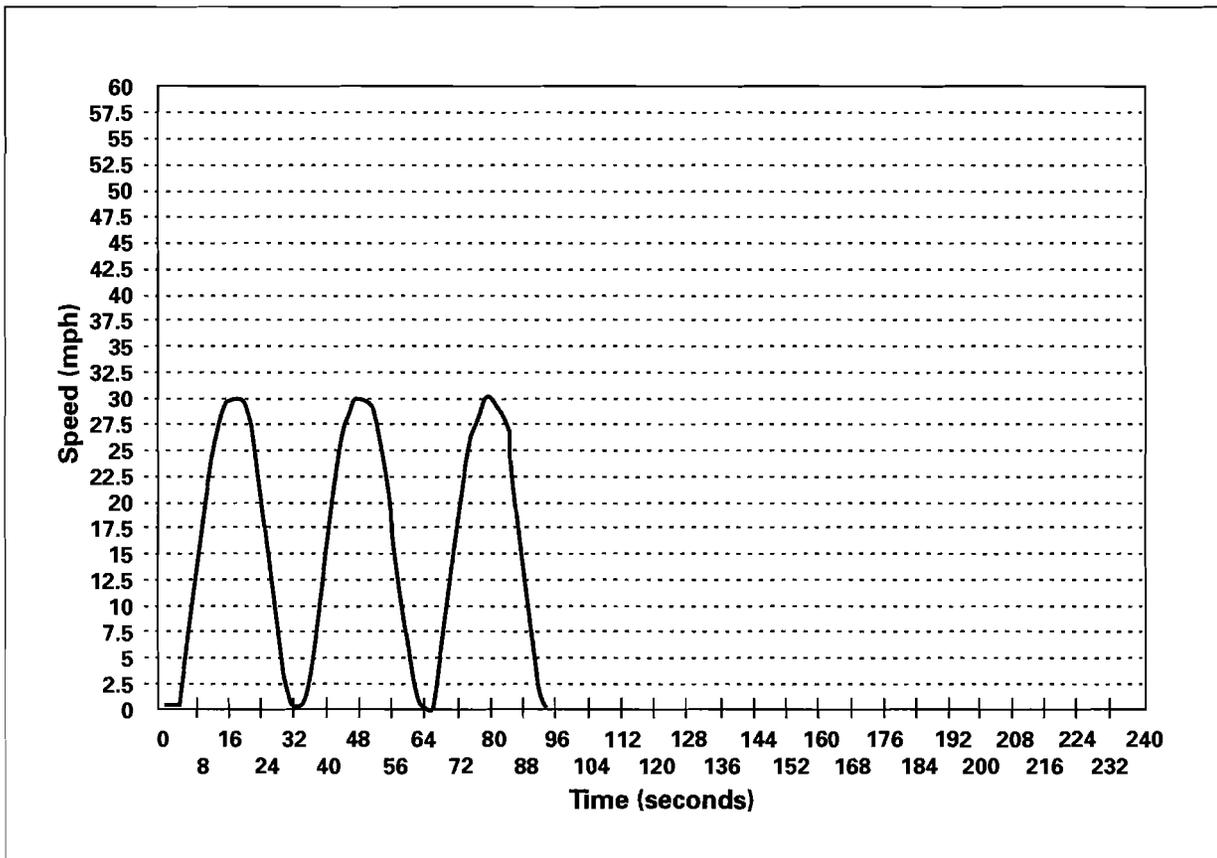
ASM stands for Acceleration Simulation Mode. The ASM is a steady state, rather than a transient, loaded mode test. During an ASM test, emissions are measured at a constant speed/load setting while the vehicle is driven on a dynamometer. This is different from the IM 240 and the BAR-31 tests where the emissions are tested at all speeds of the test cycle. As the name implies, this test simulates an acceleration load and measures associated emissions.

There are two common ASM tests. The ASM 5015 tests the vehicle at 15 mph (24 kmh) at 50 percent of the maximum accel-

eration load during the federal test procedures cycle. The ASM 2525 tests the vehicle at 25 mph (40 kmh) at 25 percent of the same load.

The ASM tester is also known as the BAR-97 analyzer. Hydrocarbons, carbon monoxide and oxides of nitrogen are sampled by the same type of tailpipe probe used for idle I/M tests. Emissions results are recorded as HC (ppm), NO_x (ppm) and CO percentage.

The ASM procedure has become the most utilized of all the Enhanced I/M tests. States including California, Connecticut, Georgia, Ohio and Virginia have implemented ASM programs. The Canadian province of Ontario also is using the ASM test in their I/M program.



Enhanced I/M Driving Cycles—Bar-31

Evaporative System Inspection

The United States Environmental Protection Agency (EPA) and various jurisdictions are in the process of redefining evaporative system inspections. A description of these new tests will be published in future revisions of this handbook.

Evaporative system inspections are designed to check for poor seals in the vehicle's gas cap and evaporative system. During the test, which is part of the I/M inspection program, the inspector checks the vehicle's gas cap with a pressurized tester to detect leakage. If the gas cap doesn't hold pressure beyond a certain tolerance, then the owner must replace the gas cap. A visual inspection of the evaporative system also may be required.

Although the cost of replacing a gas cap is relatively inexpensive, the benefits for air quality are significant, according to EPA modeling. It also should mean increased fuel economy for the motorist.

On-Board Diagnostic System (OBD)

The United States Environmental Protection Agency (EPA) and various jurisdictions are in the process of redefining On-Board Diagnostic I/M inspections. A description of these new tests will be published in future revisions of this handbook.

Early diagnostic provisions, known as OBD I, required the electronic control module (ECM) to monitor emissions-related electrical and electronic components, including itself, for circuit continuity and operation within design voltage/ampere tolerances. If a malfunction was detected, the system alerted the driver by illuminating a malfunction indicator light on the dashboard labeled “CHECK ENGINE” or “SERVICE ENGINE SOON,” and a fault code corresponding to the component or system in question was stored in the ECM memory for retrieval by a service technician.

Beginning with the 1994 model year, so-called “enhanced” OBD systems, known as

OBD II in California, were required by the California Air Resources Board (CARB) and were fully implemented by the 1996 model year. EPA implemented similar enhanced OBD requirements in 1996. Enhanced OBD systems require functional checks of emissions-related components/systems in addition to the electrical continuity monitoring required by OBD I. These functional checks are required for misfire detection, the catalyst system, the evaporative system, the fuel system, the oxygen sensor, the transmission, and any other component that could affect emissions.

For vehicles equipped with enhanced OBD systems, a simple check indicates that the vehicle emissions control system is in good working order. With the key turned to “ON,” but in the pre-start position, the inspector can verify that the “CHECK ENGINE” light or malfunction indicator light is working and that the malfunction indicator light turns off shortly after starting the engine.

Diesel Smoke Emissions Inspection

A. Diesel Engine Technology

Diesel engines are unthrottled as opposed to gasoline-fueled engines. In effect, they are constantly operating with a “wide-open” throttle. Power is varied by controlling the amount of fuel injected into the combustion chamber or pre-chamber, and the air/fuel ratio varies in accordance with power requirements. In comparison, in a gasoline engine, the air/fuel ratio is tightly controlled around stoichiometry, about 14.7/1. Typically, a diesel engine operates very lean of stoichiometry, which accounts in part for its relatively better fuel economy and lower hydrocarbon and carbon monoxide emissions.

On the other hand, the compression-ignition process using injected liquid fuel leads to the production of smoke. This smoke is comprised of unburned carbon particles that have other associated absorbed compounds such as sulfates and heavy hydrocarbons. Turbocharger diesel engines are especially susceptible to transient smoke production because of an inherent lag between a rapidly increased fuel delivery and a turbocharger’s ability to respond with additional air. Consequently, delay devices are installed on diesel fuel pumps to momentarily limit maximum fuel injection until the turbocharger has spooled up to deliver sufficient air. If these delay devices, called “puff-limiters,” are maladjusted or tampered with, a diesel engine will produce a momentary burst of black smoke due to transient over-fueling when it is accelerated from a stop or when the gears are shifted.

B. Federal Emissions Standards

In 1970, the U.S. EPA established standards for acceleration and lug-down smoke opacity for heavy-duty diesel engines, with an additional standard for peak smoke in 1973. Standards for particulate emissions were established with increasing stringency for model years 1988, 1991 and 1994.

C. Strategies to Improve Diesel Engine Emissions

1. ENGINE MODIFICATIONS

Diesel engine manufacturers responded to EPA particulate standards principally by employing electronic fuel controls, increasing injection pressure, using non-linear fuel-injection strategies, and changing combustion chamber shapes. EPA also required petroleum refineries to reduce the amount of sulfur in diesel fuels that lowered sulfate emissions.

2. EXHAUST AFTER-TREATMENT

Strategies have been examined to reduce particulate emissions downstream of the engine exhaust ports by using particulate traps and oxidation catalysts. Particulate traps literally trap particles in a metallic mesh or ceramic substrate where the accumulated soot is subsequently burned off. In engines with low particulate emissions, further reduction can

be effected by employing oxidation catalysts to burn off absorbed hydrocarbons, which comprise a large portion by weight of particulate matter from newer engines.

D. Heavy-duty Diesel Vehicle (HDDV) Opacity (Smoke) Tests

There are two basic types of tests that may be performed in a roadside environment on heavy-duty diesel vehicles: the Snap Acceleration Test and the Rolling Acceleration Test. These tests may be performed to quantify the smoke emissions in either a static location or over a short distance in a parking lot or roadside. At least three snap accelerations are conducted prior to each official test to purge the exhaust system of loose soot and to stabilize the emissions. Some states have adopted variations of these procedures in order to accommodate the conditions under which the tests are performed. This handbook seeks to describe the basics of the most popular heavy-duty diesel vehicle smoke emissions test procedures.

1. SNAP ACCELERATION TEST

The vehicle transmission is placed in neutral and all brakes on the tractor and trailer are released. The wheels are chocked for safety, and the smoke test equipment is placed in or on the exhaust stack depending on the type of smoke meter used.

The driver is instructed to quickly press the accelerator pedal to the floor and hold it until the signal to release is given. This is done a minimum of five times. If the pedal is not depressed quickly upon instruction to do so, the test may not be accurate and will need to be repeated.

2. ROLLING ACCELERATION TEST

The test equipment is attached to the exhaust stack, and the test operator sits in the cab of the truck. The brakes are released. Then, the transmission is placed in first gear with the clutch engaged to bring the vehicle to a slow roll. When the operator signals, the driver must accelerate rapidly, as if merging into traffic. The truck is driven approximately 25 feet under these conditions, and the opacity or smoke is measured. **Note:** Some test equipment is more suitable than others for this test.

Glossary

Air/Fuel Ratio. The number of pounds of air in combination with one pound of fuel provided by the fuel system of an engine, expressed as a numeric ratio, for example, 14.7(air):1 (fuel).

Ambient Air. The air surrounding a prescribed object or region, such as a vehicle or a metropolitan area.

Analyzer Calibration. The feeding of several calibration gases through an analyzer in order to set the response of the analyzer.

Centralized Testing. Emissions testing performed by a state or regional government or by a contractor hired by a state or regional government.

Clean Air Act (CAA). An Act of Congress, which has been amended several times since it was originally passed in 1970. I/M provisions were included in the 1977 and 1990 amendments.

Constant Volume Sampling (CVS). An emissions sampling method in which the total exhaust volume of a vehicle is analyzed for the presence of certain chemical compounds, including regulated emissions.

Cutpoint. The maximum allowable emission level that can be emitted from a motor vehicle for a particular pollutant, for a given test. Also called "standard."

Decentralized Testing. Conducted at privately owned testing facilities, usually licensed by the jurisdiction. Most decentralized testing facilities are equipped to perform both testing and servicing of motor vehicles.

Dynamometer. A stationary device on which a vehicle may be operated with the drive wheels rotating to simulate road conditions (load). It is used to simulate actual vehicle driving.

Environmental Protection Agency (EPA). The United States agency, established by the passage of the original Clean Air Act in 1970, which is responsible for establishing and administering programs aimed at controlling environmental degradation, subject to the requirements and limitations imposed on it by the United States Congress, as expressed in the Clean Air Act. EPA regulates sources of air and water pollution, solid waste disposal, pesticide use, environmental radiation and hazardous substances.

Federal Test Procedure (FTP). A multi-mode, mass emissions test that utilizes the constant volume sampling system. The vehicle is started after remaining at an ambient temperature of 60 to 86 degrees Fahrenheit (15.5 to 30 degrees Celsius) for 12 hours. The vehicle is then operated on a dynamometer through simulated urban and highway driving cycles. The mass emissions are measured during the test.

Gross Emitter. A vehicle whose in-use emissions levels are substantially higher than applicable emissions pass/fail levels.

Inversion. A climate condition in which an air mass above the ground is at a warmer temperature than the air mass at ground level.

Loaded Mode Test. An emissions measurement procedure used for sampling tailpipe emissions while subjecting the vehicle's engine to simulated road conditions using a chassis dynamometer.

National Ambient Air Quality Standards (NAAQS). The maximum allowable amount of specific pollutants in the ambient air for a prescribed geographical region. Standards have been established for carbon monoxide, ozone, hydrocarbons, nitrogen oxides, sulfur oxides, and particulates. There are two types of ambient air standards — the primary standards apply to human health, and the secondary standards apply to material damage.

Non-attainment Area. A geographic area classified by the EPA as having a moderate, serious, severe, or extreme air pollution problem, as measured in terms of the degree to which the region exceeds National Ambient Air Quality Standards (NAAQS).

Ozone. A photochemical oxidant that results from a reaction of hydrocarbon and nitrogen oxides in the presence of sunlight. Ozone is the primary ingredient in smog.

Pre-conditioning. Operation of a vehicle prior to testing for the purpose of stabilizing engine and catalyst temperatures in order to obtain exhaust emissions readings that are more accurate.

Purge. The process of drawing fuel vapor from the evaporative emissions canister and reintroducing the vapor to the combustion process during normal vehicle operation.

Quenching. The effect of combustion chamber surface cooling of the mixture temperature to a point below that of combustion.

Short Test. Any one of several emissions tests that are less complicated and less time-consuming and/or costly than the FTP, and that are specified by federal regulation for purposes of determining warranty liability.

Steady State Testing. A test in which the vehicle is maintained at a constant RPM throughout the test.

Stoichiometry. An air/fuel ratio for gasoline of 14.7:1, which, under ideal conditions, results in perfect combustion. It is relative to this air/fuel ratio that “lean” and “rich” are defined.

Stringency Factor. A measure (in percent) used to indicate the anticipated portion of the vehicle population whose emissions would exceed the specified cutpoints for hydrocarbon, carbon monoxide and/or nitrogen oxides. This is the portion of the vehicle population that would initially fail the inspection. Functionally, it is synonymous with failure rate.

Tampering. The intentional removal, disconnection, misadjustment or rendering inoperative of any required emissions control device or system on a motor vehicle.

Test Report. The enhanced I/M printed report given to the driver of a vehicle upon completion of a test.

Transient Test. A test conducted on a dynamometer “loaded” to simulate various on-road operating conditions.

Vehicle Emissions Control Information Label. A label located in the engine compartment of a vehicle that provides specific emissions control information to aid inspectors and repair technicians.

Waiver. A waiver-of-repair that allows the vehicle to continue to be used, even though it does not pass the emissions standards.

Acronyms

AIR	Air Injection Reaction	I/M	Inspection and Maintenance
ASM	Acceleration Simulation Mode	kmh	Kilometers per hour
BAR	(California) Bureau of Automotive Repair	O	Oxygen
CAA	Clean Air Act	OBD	On-Board Diagnostics
CARB	California Air Resources Board	OBD I	On-Board Diagnostics— First Generation
CCME	Canadian Council of Ministers of the Environment	OBD II	On-Board Diagnostics— Second Generation
CO	Carbon Monoxide	mph	Miles Per Hour
CO₂	Carbon Dioxide	N₂	Nitrogen
CVS	Constant Volume Sampling	NDIR	Non-Dispersive Infrared
ECM	Electronic Control Module	NO_x	Oxides of Nitrogen (x = 1 or 2)
EGR	Exhaust Gas Recirculation System	PCM	Power Control Module
EPA	Environmental Protection Agency	PCV	Positive Crankcase Ventilation
FTP	Federal Test Procedure	PM	Particulate Matter
gpm gm/mi	Grams Per Mile	ppm	Parts Per Million
HC	Hydrocarbon	RSD	Remote Sensing Devices
H₂O	Water		

About the Publishers

American Association of Motor Vehicle Administrators

Founded in 1933, AAMVA is a nonprofit, educational organization representing state and provincial motor vehicle and law enforcement agencies throughout the United States and Canada.

AAMVA's programs encourage uniformity and reciprocity among the states and provinces, and promote liaison activities with other levels of government and the private sector. AAMVA also stresses highway safety through its involvement in numerous national coalitions, and its program and research activities provide guidelines for more effective public service.

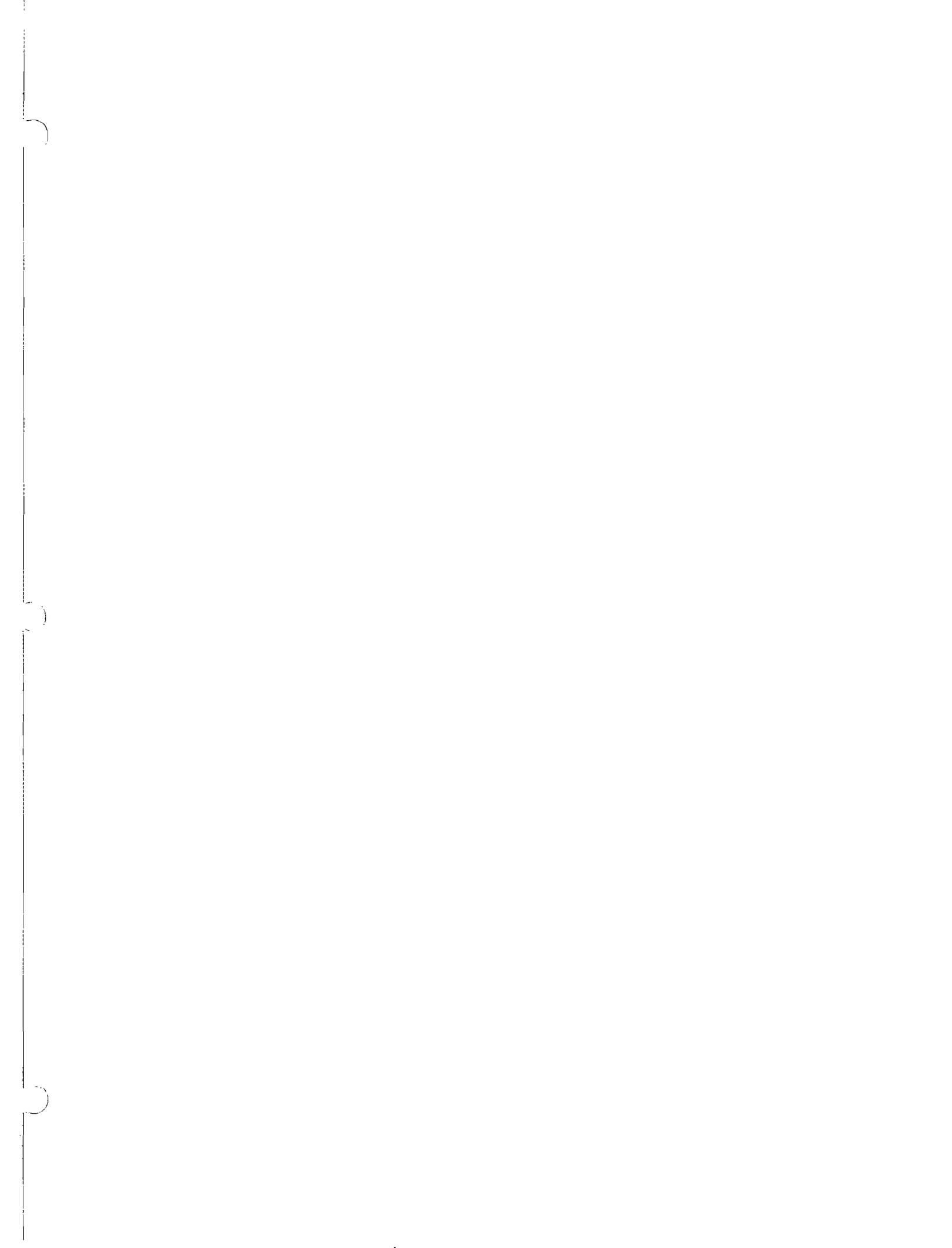
Association members include all United States and Canadian jurisdictions plus American Samoa, Guam, Puerto Rico and the Virgin Islands. AAMVA associate members include organizations, associations and business enterprises with interests compatible with AAMVA and its program objectives.

Canadian Council of Motor Transport Administrators

Established by the provincial, territorial and federal governments, CCMTA is a nonprofit organization that promotes understanding and cooperation in all matters concerning the administration, regulation and control of motor vehicle transportation and safety in Canada.

CCMTA reports to the Council of Ministers Responsible for Transportation and Highway Safety and is responsible for motor vehicle registration, driver licensing, road safety programs, motor carrier regulatory issues, compliance activities for commercial vehicles and drivers, and other transportation projects and agreements.

Members include senior representatives from all of the provincial and territorial governments, as well as representatives from the federal government. Private industry organizations and other government agencies in Canada and the United States participate as associate members.





American Association of Motor Vehicle Administrators
4301 Wilson Blvd., Suite 400, Arlington, VA 22203
703-522-4200
www.aamva.org

CCMTA • CCATM

Canadian Council of Motor Transport Administrators
2323 St Laurent Blvd., Ottawa, Ontario K1G 4J8
613-736-1003
www.ccmta.ca