

Crankcase Emission Control Test Code

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Scope—The purpose of this code is to provide standard test procedures for crankcase emission control systems and/or devices. The procedures included are for determining:

1. The flow rate of the blowby of an engine.
2. The flow rates through the crankcase emission control system inlet and outlet.

This code is written to cover crankcase emission control systems which are designed to reduce the emission of engine blowby gases to the atmosphere. The code includes the following sections:

1. Definitions and Terminology
2. Test Equipment
3. Test Procedures
4. Information and Data to be Recorded
5. Data Analysis
6. Presentation of Information and Data

1.0 Definitions and Terminology—The following definitions apply to the terms indicated as they are used in this code.

1.1 Engine—Internal combustion engines in which the crankcase is not a principal part of the induction system.

1.2 Crankcase—The volume within an engine which is connected to the oil sump section by internal passages through which gases can flow.

1.3 Blowby—Those gases which enter the crankcase as leakage past the piston rings and/or the intake and exhaust valve mechanisms.

1.4 Fresh Air—Any outside air introduced into the crankcase, generally to aid in ventilation (purging of blowby gases from the crankcase).

1.5 Crankcase Emission Control System—A system of passages designed to convey gases from and/or to the crankcase of an engine. The system may or may not include means to regulate the flow(s).

1.5.1 SYSTEM INLET—Any passage connecting the crankcase to the atmosphere; which passage is provided for the purpose of admitting fresh air into the crankcase. It may, under some conditions, allow the discharge of blowby gases from the crankcase.

1.5.2 SYSTEM OUTLET—Any passages from the crankcase which are designed to carry gases to points other than the atmosphere.

2.0 Test Equipment

2.1 Precautions—

(a) The material being measured is composed of one, or a mixture, of the following: air, carbureted air-fuel mixture, combustion products, lubricating oil, and its decomposition products. Any or all of these can be harmful to measuring equipment either by dirtying, and/or by long term corrosion or erosion effects, thus reducing instrument accuracy. For these reasons, it is necessary to use rigid maintenance practices to preserve instrument accuracy.

In addition, care must be taken to avoid condensing the vapors that are present in the material being measured.

In some cases, oil drops may be present in the crankcase gases being measured and it may be necessary to employ an oil separator to avoid erroneous flow readings due to oil accumulations in the flowmeter.

(b) The flow restrictions of the measurement equipment can greatly affect the volume of flow. For this reason, it is necessary to use some means such as the make-up blower shown in Fig. 1 to compensate for the restrictive effect.

(c) The pressures created by actual vehicle movement and engine operation, as well as crankcase opening(s) location(s) will affect flow rates on many types of emission control systems. Therefore, it will be necessary, if a test of a control system is to be conducted in the laboratory on a flow stand or dynamometer, that road operating conditions be simulated, insofar as they affect the system being tested.

2.2 Flow Measurement Instrumentation, Accuracy 0-2.0 cfm $\pm$ 0.1 cfm, Over 2.0 cfm, $\pm$ 5%—A suitable meter such as a rotometer, viscous flow meter, flow orifice, venturi, or integrating gas meter should be used.

2.3 Pressure Measurement Instrumentation, Accuracy 0-0.2 $\pm$ 0.01, Over 0.2 $\pm$ 5% in. H₂O or $\pm$ 0.1 in. Hg (Gage, Differential and Absolute)—The type of instrument selected will be dependent upon the

¹ This follows from the law of conservation of mass, that is, "mass flow in" plus "blowby mass flow" equals "mass flow out."
Expressed mathematically, this is:

$$Q_1 \rho_1 + Q_{BB} \rho_{BB} = Q_{OUT} \rho_{OUT}$$

Then, if all of these densities (ρ) are identical

$$Q_1 + Q_{BB} = Q_{OUT}$$

Therefore, all volume flow rates, expressed in cfm, must be reported at the same temperature and pressure for this to hold true.

measurement being made. One or more of the following may be suitable: water or mercury manometers, differential and absolute pressure gages. However, measurements below 2 in. Hg should be made in inches of water.

2.4 Temperature Measurement Instrumentation Accuracy $\pm$ 2 F—A suitable instrument such as a liquid filled, gas filled, or resistance thermometer, or a thermocouple may be used.

2.5 Vehicle Test—Road—For vehicle tests, it is convenient to mount the flow, pressure, and temperature measuring instruments as well as the make-up blower in a single instrument case (Fig. 1) for ease of use by the observer. In addition to these instruments, it is desirable to measure engine manifold vacuum (pressure gage) and engine speed (tachometer) and it may be necessary to provide means to measure actual vehicle speed. Figs. 2 and 3 show a typical installation of such instrumentation in a vehicle for road testing.

2.6 Vehicle or Engine Test—Dynamometer—In addition to measurements made in vehicles during road operation, it may be useful or necessary to simulate vehicle operation under laboratory conditions. The utility of such measurements is entirely dependent upon the ability to simulate those road conditions which may influence the performance of the particular crankcase emission control system under test or the quantity of blowby created by the engine. Most chassis dynamometers are custom installations and any particular installation may or may not have accessories needed for pertinent road simulation. These might include means for creating air movement past the vehicle and engine at road velocities and for accurate reproduction and control of power requirements including deceleration. Most engine dynamometer installations can reproduce road loads but few can simulate air movements, which may limit their use.

2.7 Flow Bench Equipment—Fig. 4 shows typical flow bench equipment. In addition to flow, pressure, and temperature instruments, means must be provided to supply air flow quantity at pressures required.

3.0 Test Procedures

3.1 Blowby—Measurements are made at the desired conditions of engine or vehicle speed and load. Seal all crankcase openings and system inlet and outlet passages except the normal major outlet. The rate of gases flowing through the remaining opening will be measured (Fig. 5). Among the openings to be sealed are the oil filler pipe, the dip stick opening, and, in some cases, the fuel pump breather. Since, on many engines, leaks are present around rocker arm cover gaskets, oil pan gaskets, and other seals, it will be necessary, if accuracy is required, to account for the escape of blowby through them or to reduce the error by keeping the crankcase at ambient pressure with a blower installed as illustrated in Fig. 1.

3.2 Crankcase Emission Control System Flow Rates—For the purpose of this code, the outlet flow rate is defined as the inlet flow rate plus the blowby flow rate:¹

$$\text{Inlet flow rate} + \text{Blowby flow rate} = \text{Outlet flow rate}$$

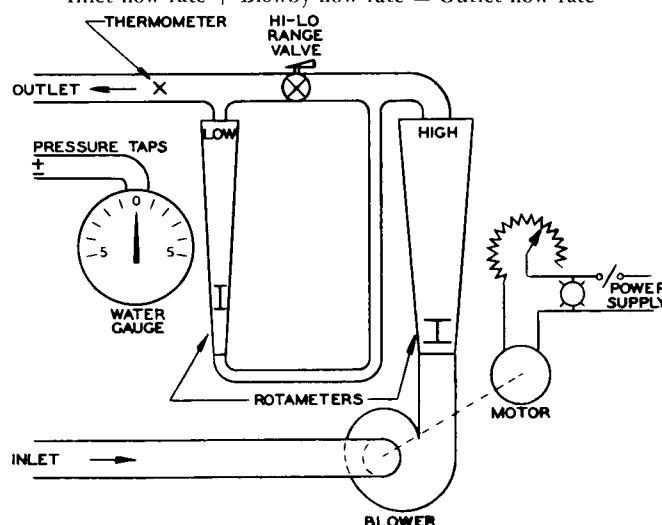


FIG. 1—SCHEMATIC OF TYPICAL TWO ROTAMETER BALANCING TYPE INSTRUMENT

If only two of the three rates can be measured directly, the other can be obtained by difference; however, in the interest of accuracy, it may be necessary to determine the smallest of these quantities by the pressure differential method given below.

Fig. 6 illustrates an installation of a control system where it is difficult to measure the fresh air flow into the crankcase directly and relatively easy to measure the outlet flow.

Fig. 7 shows a different type of system installed that makes outlet

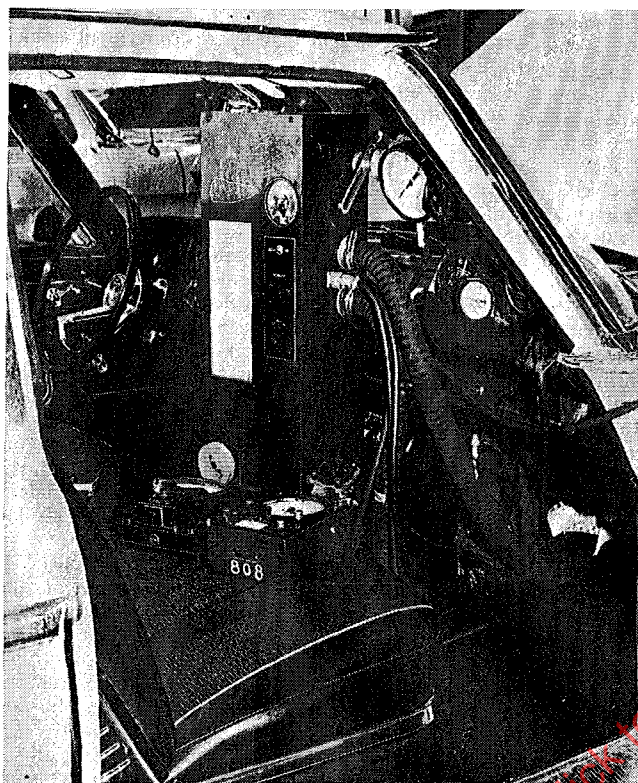


FIG. 2—TYPICAL INSTALLATION OF BLOWBY MEASURING EQUIPMENT FOR ROAD TEST



FIG. 3—TYPICAL INSTALLATION OF BLOWBY MEASURING EQUIPMENT FOR ROAD TEST

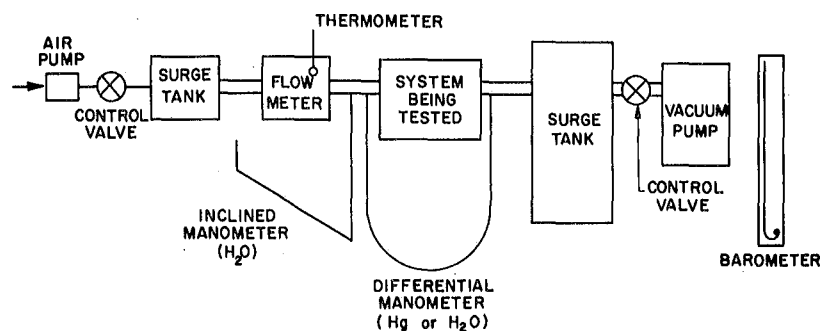


FIG. 4—BASIC LABORATORY FLOW BENCH EQUIPMENT

flow difficult to measure, since the control valve is inserted directly into the rocker arm cover. The fresh air inflow is measurable through the passage between the breather cap and the crankcase, or through the hose connecting the carburetor air cleaner and the oil filler cap.

Flow rates through the oil filler cap in Fig. 6 and through the control valve in Fig. 7 may be estimated by measuring the inlet and outlet pressures across them during vehicle operation and then reproducing these pressures in the laboratory, where flow can be measured.

3.2.1 MEASUREMENT AT SYSTEM OUTLET—Flow rate shall be measured on the engine for which the system was designed by installing the equipment such as shown in Fig. 1 to a typical system outlet shown in Fig. 6. With systems incorporating a modulating device, the flow rate measuring equipment should be used on the inlet side of the device (Fig. 6). If the capacity of the emission control system is influenced by the blowby rate of the engine, air may be added to the crankcase at such a location and manner to produce a volume of flow through the system equivalent to the desired blowby rate.

3.2.2 MEASUREMENT AT SYSTEM INLET—If the flow rate at the system inlet will not be materially affected by the installation of measuring equipment, its value may be measured directly. Flow rate shall be measured on the engine for which the system was designed by installing the equipment such as is shown in Fig. 1 to a typical system inlet as shown in Fig. 7.

The flow may be positive (inward) or negative (outward).

4.0 Information and Data to be Recorded

4.1 Information—

4.1.1 GENERAL—

- (a) Laboratory performing test.
- (b) Date of test.
- (c) Description of test equipment, including method of power absorption.

4.1.2 VEHICLE DESCRIPTION—

- (a) Manufacturer.
- (b) Model year.
- (c) Body style.
- (d) Transmission.

4.1.3 ENGINE DESCRIPTION—

- (a) Manufacturer.
- (b) Configuration—type and number of cylinders.
- (c) Displacement.
- (d) Carburetor—number of venturies.

4.1.4 CRANKCASE VENTILATION SYSTEM DESCRIPTION—

- (a) Manufacturer.
- (b) Part or system identification number.
- (c) Principle of operation.