
International Standard



4008/2

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Road vehicles — Fuel injection pump testing — Part 2 : Static conditions

Véhicules routiers — Essai de pompe d'injection à gazole — Partie 2 : Conditions statiques

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO member bodies). The work of developing International Standards is carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been set up has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 4008/2 was developed by Technical Committee ISO/TC 22, *Road vehicles*, and was circulated to the member bodies in October 1980.

It has been approved by the member bodies of the following countries :

Austria	Italy	Sweden
Belgium	Korea, Dem. P. Rep. of	Switzerland
Czechoslovakia	Korea, Rep. of	United Kingdom
Egypt, Arab Rep. of	Netherlands	USA
France	Romania	USSR
Germany, F.R.	South Africa, Rep. of	
Iran	Spain	

The member bodies of the following countries expressed disapproval of the document on technical grounds :

Brazil
Japan

Road vehicles — Fuel injection pump testing — Part 2 : Static conditions

Preamble

International Standard ISO 4008 aims to achieve correct setting and adjustment of fuel injection pumps for compression ignition engines by providing standardized conditions for testing.

This part of ISO 4008 deals with the test bench static elements concerned with the supply and control of calibration fluid to the pump under test and with the measurement of its performance.

Adherence to the other parts of ISO 4008 and to certain other International Standards listed in clause 3 is essential to the total application of this part.

0 Introduction

Notwithstanding the demands a fuel injection pump makes of the test bench to fulfil its dynamic requirements as specified in ISO 4008/1, it is also incumbent upon the test bench to control and supply calibration fluid to the injection pump in a satisfactory manner, to establish appropriate conditions in the hydraulic delivery circuits and to make all the necessary measurements, within acceptable tolerances, in order to test and adjust pumps to manufacturer's test specifications.

1 Scope

1.1 This part of ISO 4008 defines only the requirements and characteristics of test benches necessary to ensure consistent results when an injection pump is tested to its manufacturer's test specification regardless of the origin of the test bench.

1.2 This part of ISO 4008 establishes requirements for control and supply of calibration fluid to the fuel injection pump, for receipt of the fluid from the fuel injection pump, as well as requirements for the accuracy of the measuring equipment of test benches.

2 Field of application

2.1 This part of ISO 4008 is primarily applicable to test benches suitable for calibration of fuel injection pumps for compression ignition engines requiring fuel delivery up to 300 mm³/injection/cylinder at full load.

2.2 No distinction is made between test benches used for different applications, for example, laboratories, manufacturers of fuel injection equipment or service stations.

3 References

The following International Standards are essential to the total application of this part of ISO 4008 :

ISO 4008/1, *Road vehicles — Fuel injection pump testing — Part 1 : Dynamic conditions.*

ISO 4008/3, *Road vehicles — Fuel injection pump testing — Part 3: Application and test procedures.*¹⁾

ISO 4010, *Road vehicles — Calibrating nozzle, delay pintle type.*

ISO 4020/1, *Road vehicles — Fuel filters for automotive compression ignition engines — Part 1 : Test methods.*

ISO 4020/2, *Road vehicles — Fuel filters for automotive compression ignition engines — Part 2 : Test values and classification.*

ISO 4093, *Road vehicles — Fuel injection pumps — High pressure pipes for testing.*

ISO 4113, *Road vehicles — Calibration fluid for diesel injection equipment.*

4 Definitions

For the purpose of this part of ISO 4008, the following definitions apply :

4.1 supply pipe : Pipe connecting the calibration fluid pressure source to the injection pump inlet.

4.2 settling time : Specific time allowance to be made for fluid to drain down graduate walls between fluid being cut off and the operator reading the volume.

4.3 drainage time : Specific time over which graduates shall remain in the draining mode.

4.4 stroke count; count : Number of test bench driveshaft turns over which calibration fluid is delivered to the graduates or other form of measuring chamber.

¹⁾ At present at the stage of draft.

4.5 Pump delivery measuring system errors

4.5.1 overall error : Error of the indicated value relative to the true value under any one of the type test conditions.

4.5.2 zero error : Difference between the actual quantity of calibration fluid delivered to the test bench measuring system and the quantity indicated by that system.¹⁾ (See figure 1.)

4.5.3 count error : Difference between actual quantity of calibration fluid delivered to the test bench measuring system over the exact intended number of turns and the quantity, corrected for zero error, indicated by that system.²⁾ (See figure 1.)

4.6 delivery value : Injection pump delivery at any specific test condition and expressed in quantity per stroke per cylinder.

4.7 test bench value : Delivery value computed from a test bench (for example, graduate) volume reading and corrected to 40 °C.

4.8 true value : Delivery value computed from a measurement of the total quantity delivered from at least three test injectors, collected concurrently over a number of driveshaft turns (not less than 2 000) sufficient to fill a measuring cylinder to at least 90 % capacity, corrected to 40 °C, and conducted in accordance with the procedure described in A.1.3.3.1.

5 Symbols and units

5.1 Coefficients of cubic expansion, in reciprocal degrees Celsius:

- a) of measuring cylinders (see A.1.2.1 and A.1.2.2) : α ;
- b) of calibration fluid : β .

5.2 Delivery values of injectors, in cubic millimetres per stroke per cylinder:

5.2.1 Type test

- a) Test bench value of group "A" : G_A
 - b) Test bench value of group "B" : G_B
 - c) True value of group "A" : V_A
 - d) True value of group "B" : V_B
- } Corrected to 40 °C

5.2.2 Field test — Actual value : Q .

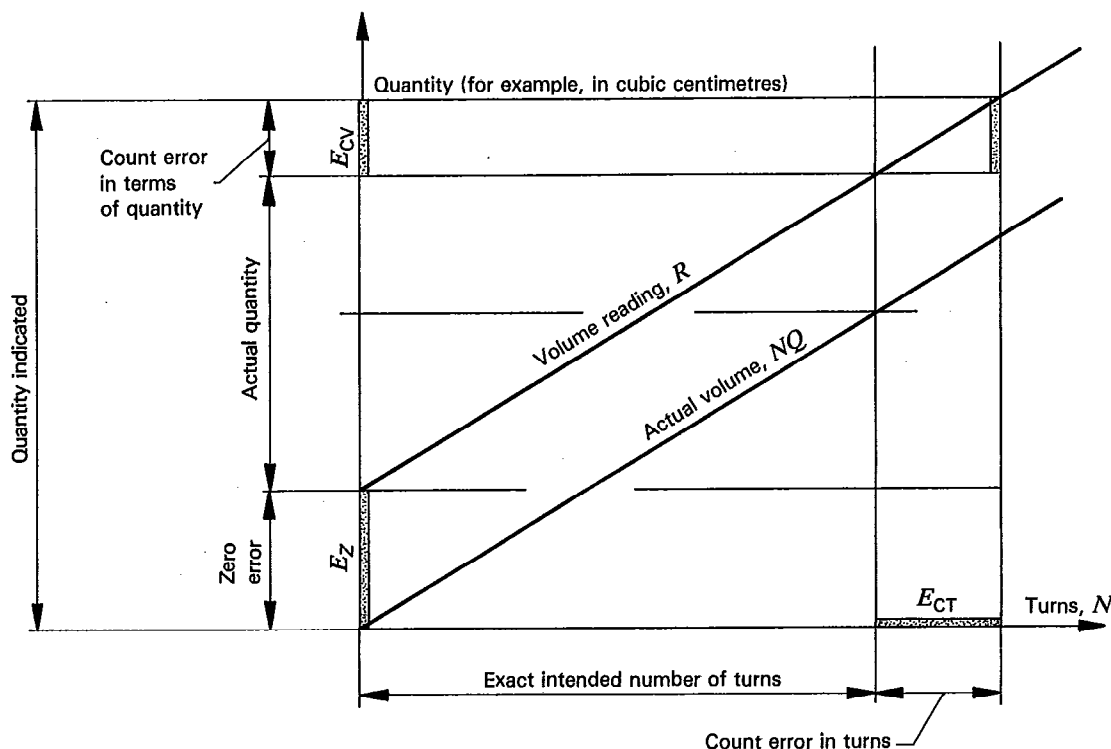


Figure 1 — Zero and count errors

1) A zero error may be caused, for example, by a residual quantity of calibration fluid adhering to the walls of a graduate.

2) A count error may be caused, for example, by errors in the counting mechanism itself, the fluid flow interruptor and its actuator.

5.3 Volume readings of measuring chambers in cubic centimetres:

- a) of the test bench (for example, graduate) : R ;
- b) of the external measuring cylinder (see A.1.2.1, A.1.2.2) : C .

5.4 Temperature, in degrees Celsius:

5.4.1 of calibration fluid at the time of reading :

- a) $R : t_R$;
- b) $C : t_C$.

5.4.2 at which measuring cylinder (see A.1.2.1, A.1.2.2) is calibrated : t_0 .

5.5 Exact stroke count (turns); N :

- a) basic stroke count : N_0 ;
- b) for delivery of volume R : N_R ;
- c) for delivery of volume C : N_C .

5.6 Errors:

5.6.1 Overall error as a percentage : e .

5.6.2 a) Zero error, in cubic centimetres : E_Z ;

- b) Zero error, percentage of measuring chamber capacity, M : e_Z .

5.6.3 a) Count error, in cubic centimetres : E_{CV} ;

- b) Count error (turns) : E_{CT} .

5.7 Relative variation of delivery value readings of a single group of injectors as a percentage :

- a) by the test bench measuring system : δ_G ;
- b) by the external measuring cylinder (see A.1.2.1, A.1.2.2) : δ_V .

5.8 Pump delivery measuring system chamber capacity, in cubic centimetres : M .

6 Static requirements

6.1 Low pressure calibration fluid system

6.1.1 Calibration fluid container

Tanks for containing calibration fluid which passes through the injection equipment in the normal operation of the test bench shall have :

- a) an internal surface resistant to corrosion up to 100 % humidity;
- b) a close fitting lid with connection to atmosphere;
- c) convenient means for draining and cleaning internally.

6.1.2 Calibration fluid supply

As necessitated by the type of injection pump to be tested equipment shall be supplied for :

- a) transferring calibration fluid from the tank to a connection point (preferably a bulkhead connection) for connecting the supply pipe to the injection pump, at a flowrate equal to at least 2,5 times the delivery flowrate from the injection pump;
- b) controlling the internal hydraulic pressure at the transverse exit plane of the connection for a supply pipe such that, having been set, it cannot, due to change in pump demand, reach a pressure high enough to damage the injection pump on test. In addition, with the injection pump supply pipe fitted to the bulkhead connection and with the remote end blanked off, at any feed pressure there shall be no cyclic fluctuation in excess of 5 % of the feed pressure from peak to peak measured at the bulkhead pressure point. This requirement does not apply when the mean feed pressure is $\leq 0,3$ bar;
- c) pressure measurement of the calibration fluid at the transverse exit plane of the bulkhead connection including a fluctuation damper;
- d) temperature control, by heating or cooling, of calibration fluid to within tolerance (see clause 8) measured at the bulkhead connection irrespective of the fluid demand of any of the injection pumps within the range of the test bench and running at any condition specified in the test specification;
- e) temperature measurement of calibration fluid, at a point immediately upstream of the transverse exit plane of the bulkhead connection.

6.2 High pressure injection pump delivery system

6.2.1 There shall be suitable provision for holding the test injectors specified in the manufacturer's test specifications of those injection pumps falling within the capacity of the test bench.

6.2.2 The test injector holder(s) shall be located (or capable of being located) sufficiently close to the injection pump to avoid smaller bend radii in the high pressure pipes than the minimum permitted in ISO 4093. The injector holders shall be sufficiently stable to facilitate tightening the pipe nuts without straining the pipes.

6.2.3 Direct observation of any leaks from any part of the high pressure system shall be possible.

6.3 Injection pump delivery measurement system

6.3.1 The calibration fluid delivered from each test injector shall be led to apparatus for measuring the delivery by a means displaying (directly or by simple calculation) the average specific delivery, Q , over not less than 25 strokes, expressed in cubic millimetres per stroke per cylinder.

6.3.2 There shall be provision for observing visually, or by other suitable means, the moment when flow from any of the test injectors stops.

7 Information to be supplied by manufacturers

7.1 The test bench manufacturer shall supply, with each individual test bench, documents stating :

7.1.1 Advice, recommendations or mandatory instructions concerning the operation of the injection pump delivery measuring system regarding the stroke count and size of graduate to use (where applicable) in relationship with :

- a) the injection pump delivery, Q mm³/stroke/cylinder;
- b) the test speed, n , min⁻¹;
- c) loss of achievable accuracy.

7.1.2 Details of any special adjustments or settings which could affect fluid measurement accuracy.

7.1.3 The servicing instructions necessary to ensure maintenance of performance to the requirements of this part of ISO 4008.

7.1.4 The performance characteristics detailed in 6.2 of ISO 4008/1.

7.2 The fuel injection equipment manufacturer shall state, in conjunction with its injection pump test specifications, complete details where appropriate, and the items essential to the proper conduct of the test in accordance with the International Standards listed in clause 3.

In addition :

- a) requirements, or details of any special apparatus or mechanism not covered by any International Standards referenced in this part of ISO 4008 but requiring special features or characteristics;

b) the full load power absorbed at rated pump speed and under test bench conditions;

c) those specific injection pump readings which, if they lie outside the permissible operating envelope (see figure 2 of ISO 4008/1) of any particular test bench, will not preclude the use of that bench;

d) injection pump deliveries in cubic millimetres per stroke per cylinder or cubic centimetres per thousand strokes per cylinder;

e) the numerical value of the stroke count to be used may, but need not, be stated.

8 Specifications and tolerances for test bench equipment

8.1 Calibration fluid supply : pressure and vacuum gauge(s) : ± 1 % of reading or $\pm 0,03$ bar¹⁾ whichever is the greater.

8.2 Calibration fluid :

Temperature : 40 ± 2 °C

Thermometer tolerance : $\pm 0,5$ °C at 40 °C

8.3 Ancillary pressure gauges for recording specified injection equipment pressures : ± 1 % of reading or $\pm 0,03$ bar whichever is the greater.

8.4 Driveshaft tachometer : $\pm 0,5$ % of reading or ± 5 min⁻¹ whichever is the greater.

8.5 Filtration : particle retention capability in accordance with ISO 4020/1, category 2. No filter by-pass shall be permitted. There shall be means to prevent rupture should blockage occur.

8.6 Output shaft angular measuring arrangement : error between any two divisions shall not exceed 15'.

Datum mark shall be arranged to produce no parallax error.

8.7 Calibration fluid heater: if this device is fitted, it shall be designed so as not to cause a breakdown of the fluid.

1) 1 bar = 10^5 N/m² = 10 kPa