INTERNATIONAL STANDARD

ISO 4008-3
First edition
1987-06-15

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION
ORGANISATION INTERNATIONALE DE NORMALISATION
МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ

Road vehicles — Fuel injection pump testing —

Part 3:
Application and test procedures

Véhicules routiers — Essais des pompes d'injection à gazole —

Partie 3: Application et modes opératoires d'essai

Reference number
ISO 4008-3 : 1987 (

Foreword

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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. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 4008-3 was prepared by Technical Committee ISO/TC 22, *Road vehicles*.

Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

Printed in Switzerland

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Contents

Road vehicles — Fuel injection pump testing —

Part 3 :
Application and test procedures

0 Introduction

This International Standard aims to achieve correct setting and adjustment of fuel injection pumps for the subject types of compression ignition engines by providing standardized conditions for testing.

Part 3 of ISO 4008 is a document for use in the workshop. It forms the complement to the injection pump test schedules and coordinates the detailed technical requirements of parts 1 and 2 and further referenced standards (see clause 3) with the procedural instructions necessary to apply and validate this International Standard as a whole.

1 Scope

This part of ISO 4008 defines conditions, in addition to those contained in parts 1 and 2, which are mandatory to the performance of fuel injection pump tests in conformity with the International Standard as a whole. Reference is also made to non-mandatory but desirable conditions.

2 Field of application

The conditions of this part of ISO 4008 apply to tests performed in accordance with fuel injection pump manufacturers', engine manufacturers' or other admissible test schedules which refer to ISO 4008 conditions of test.

This part of ISO 4008 is deemed to form an integral part of all such admissible test schedules.

3 References

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

ISO 4008-2, *Road vehicles — Fuel injection pump testing — Part 2: Static conditions.*

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.*

ISO 7440-1, *Road vehicles — Fuel injection equipment testing — Part 1: Calibrating nozzle and holder assemblies.*

ISO 7440-2, *Road vehicles — Fuel injection equipment testing — Part 2: Orifice plate flow measurement.*

ISO 8984-1, *Road vehicles — Fuel injector testing — Part 1: Hand lever operated testing and setting apparatus.* [1)]

ISO 8984-2, *Road vehicles — Fuel injector testing — Part 2: Testing procedures.* [1)]

4 Terminology

Many general terms, as well as those particular to this International Standard, are included in a list of definitions in annex F. This annex does not form an integral part of this International Standard.

5 Validity

5.1 Documentation

5.1.1 Parameters of a valid ISO test

A valid ISO test (see 5.2.2) shall include the parameters listed in table 1.

1) At present at the stage of draft.

Table 1 — Test conditions and maximum viable pump delivery values

Reference line	Parameter	Units	Value*	Origin and/or derivation of information
(1)	Test bench flywheel moment of inertia	$kg \cdot m^2$	0,5	Figure 2 of ISO 4008-1 (This shall be supplied with an ISO test bench)
(2)	Test bench driveshaft stiffness	$N \cdot m/°$	9 940	
(3)	Coupling stiffness	$N \cdot m/°$	800	
(4)	Calibration fluid specification	ISO 4113		Clause 5.2.1 of ISO 4008-3
(5)	Calibration fluid viscosity (actual value)	mm^2/s	2,8	Measurement
(6)	Calibration fluid temperature	°C	41	Measurement
(7)	High-pressure pipes (ISO No. or non-standard specification)	ISO 4093-2		Injection pump test schedule
(8)	Calibration or test injector (ISO No. or non-standard specification) Nozzle Holder	ISO 4010 ISO 7440		
(9)	Calibration or test injector opening pressure	bar	175	Table 5 of ISO 4008-3

Reference line	Parameter	1*	2*	3	4	5	Origin and/or derivation of information
(10)	Test No.	1*	2*	3	4	5	Test schedule
(11)	Test speed, min^{-1}	1 080	245				Test schedule
(12)	Max. effective flywheel capacity, mm^3/stroke	1 215	62,5				A.1 of ISO 4008-1 calculate**: (line 1) × (line 11)^2/480
(13)	Max. effective driveshaft capacity, mm^3/stroke	355	355				A.2 of ISO 4008-1 calculate**: (line 2)/28
(14)	Max. effective coupling capacity, mm^3/stroke	160	160				A.3 of ISO 4008-1 (line 3)/5 (stated on coupling)**
(15)	Max. effective pump mounting capacity, mm^3/stroke	475	240				Figure 2 of ISO 4008-1 (supplied with ISO test bench)

* The values and facts in these columns are examples of a typical test (see footnote to 5.1.3).

** Refers to the reference lines in this table.

5.1.2 Peak injection pressure, limiting delivery values

If the test schedule states a peak injection pressure, p_p, exceeding 625 bar [1], the limiting delivery values in lines (12), (13), (14) and (15) of table 1 shall be reduced as stated in annex A.

5.1.3 Calculated values of limiting delivery

When the values of limiting delivery have been calculated for lines (12), (13), (14) or (15) in table 1 [2], none of the readings of the pump delivery in any of the tests conducted under ISO test conditions shall exceed any of these calculated values.

5.2 Equipment

5.2.1 Minimum conditions mandatory to an ISO test

A valid ISO test shall be conducted in accordance with the minimum requirements given in table 2. Where non-mandatory equipment or conditions are adopted for test purposes (see 5.2.3), it is stressed that they shall conform to the mandatory serviceability requirements (see 6.3.2 and B.2 and B.3 of annex B).

Table 2 — Minimum test conditions for ISO test

Item	International Standard specifying requirements to be met
Test bench	ISO 4008-1 ISO 4008-2 ISO 4008-3 (see 6.1.1, 6.1.2, 7.2.3)
Test injectors	ISO 4008-3 (see 6.2)
High-pressure pipes	ISO 4008-3 (see 6.3)
Calibration fluid	ISO 4113 and ISO 4008-3 (see 6.4)
Calibration fluid temperature	ISO 4008-3 (see 6.4.2.7)
Environment	ISO 4008-3 (see clause 8)
Personnel and authorization	ISO 4008-3 (see clause 9)
Test schedule	ISO 4008-3 (see 7.1)
Test procedure	ISO 4008-3 (see 7.2)
Verification of equipment	ISO 4008-3 (see 7.2.2)

1) 1 bar = 10^5 N/m^2 = 100 kPa

2) In the example in table 1, if the pump delivery were, for example, 85 mm^3/stroke in test 1 and 84 mm^3/stroke in test 2, test 1 would be acceptable to ISO conditions and test 2 would not, because the flywheel was overloaded owing to insufficient moment of inertia.

5.2.2 Statement of ISO test conditions

The identity of the test facility shall be stated on the statement of ISO test, and the information entered thereon (including all relative requirements in this part of ISO 4008 deemed to be an integral part of the ISO test) shall be vouched for by the signature of an authorized person responsible for the ISO test. When a statement is requested it shall conform with annex E.

5.2.3 Non-mandatory conditions

Conformity of test injectors, nozzle opening pressure and high-pressure injection pipes to one of the relevant International Standards shall not be mandatory to the validity of an ISO test, or statements of ISO test conditions, provided that the test schedule defines them as specified in 7.1.2 (see 5.2.1).

6 Equipment

6.1 Test benches

6.1.1 Conformity and recognition

Test benches suitable for ISO testing shall be supplied with a certificate of conformity prepared and vouched by its manufacturer, stating compliance of the bench with ISO 4008-1 and ISO 4008-2. The graphs in figures 1 and 2 of ISO 4008-1 shall form an integral part of the certificate.

6.1.2 Instructions and maintenance

6.1.2.1 It is mandatory that the test bench manufacturer shall provide with the test bench proper operation, installation and maintenance instructions in conformity with the requirements of ISO 4008.

6.1.2.2 These instructions shall clarify and evaluate the errors which can occur if they are not fully observed. Particular attention shall be given to injection pump mounting adaptors, couplings, low-pressure pipes and the proper use of the pump delivery measurement system.

6.1.2.3 No spare parts which are not authenticated by the test bench manufacturer shall be fitted. This applies to mechanisms, or constituent components of mechanisms, regulated by sub-clause 5.1 of ISO 4008-1 and clause 8 of ISO 4008-2 respectively.

6.2 Test injectors

6.2.1 Conformity and recognition

6.2.1.1 Calibrating injectors

Injectors and nozzles conforming to the appropriate calibrating injector International Standard shall be accompanied by documentation [1] vouched for by the manufacturer and defining feature(s) on the injector and nozzle component(s) identifying the manufacturer and claiming conformity with the pertinent Standard.

6.2.1.2 Other test injectors

These are the other injector and nozzle types which may be specified in the appropriate pump test schedule.

6.2.2 Maintenance

6.2.2.1 A record shall be kept of the number of pumps tested with each test injector.

6.2.2.2 The test injector maintenance schedule, as detailed in annex B, is mandatory for calibrating injectors, and unless otherwise stated by the manufacturer, it is mandatory for use with other test injectors.

6.3 High-pressure pipes

6.3.1 Conformity and recognition

6.3.1.1 ISO high-pressure pipes for testing shall all bear the following two identification marks and be dimensioned in accordance with ISO 4093:

a) the manufacturer's mark which shall vouch for conformity with ISO 4093;

b) the ISO identification code which relates to the nominal dimensions shown in annex D.

6.3.1.2 Other high-pressure pipes have dimensions specified in the appropriate pump test schedule. Pipe dimensions in common usage and specified in ISO 4093 are tabulated in annex D.

6.3.2 Care and maintenance

The following requirements are mandatory for all high-pressure pipes.

6.3.2.1 Pipes shall be kept clean internally and externally and the ends shall be capped when not in use.

6.3.2.2 Pipes shall not be bent round a radius less than that shown in table 6 in annex D.

6.3.2.3 At least weekly, a reamer of a diameter 0,025 mm less than the nominal bore size shall be inserted through the nipple to prevent throttling. Proper care and cleanliness shall be maintained.

6.3.2.4 The overall length over the pipe ends shall not be reduced by more than 5 mm below the nominal length. Check by passing a flexible wire through the bore.

1) For example, by labelling or in the packaging.

6.3.2.5 In use, after blowing off with air, no seepage of fluid shall be visible at either connection.

6.4 Calibration fluid

6.4.1 Conformity and recognition

Calibration fluid conforming to ISO 4113 shall be obtained in sealed metal drums bearing two identification marks:

a) the manufacturer's (or supplier's) name which shall vouch for conformity with the relevant International Standard;

b) the number of the International Standard to which the fluid purports to conform. The manufacturer's code number shall not constitute an acceptable description.

6.4.2 Instruction and preservation

6.4.2.1 Calibration fluid shall be stored, in its sealed original identifiable container, under cover, until required for use.

6.4.2.2 Oil which has been subjected to temperatures below −10 °C shall not be used without reference to, and advice from, the manufacturer.

6.4.2.3 Conditions, in storage or in use, which could result in pollution by condensed moisture shall not be allowed to develop.

6.4.2.4 In use, deterioration of calibration fluid, due to evaporation of the more volatile constituents and to unavoidable contamination by lubricating and fuel oils, shall not be permitted beyond the point where the viscosity at 40 °C exceeds 3,0 mm^2/s.

6.4.2.5 The viscosity shall be measured weekly.

6.4.2.6 No attempt shall be made to compensate for deterioration by mixing with other liquids.

6.4.2.7 In use, the calibration fluid temperature shall be maintained at a true value of 40 ± 2 °C. This temperature shall be measured at the test bench bulkhead connection for the fuel pipe [1].

7 Testing

7.1 Test schedules (see 5.2.1)

7.1.1 Application

The three basic forms of the test schedule are as defined in annex F. Notwithstanding that production test schedules may be found in service workshops, this International Standard shall apply in all cases where ISO tests are specified. Where ISO tests are not specified, existing custom and practice will apply.

7.1.2 Content

7.1.2.1 All ISO test schedules shall be complete in themselves. They may require dependence on other data issued by the same source as part of the test schedule. ISO 4008-3 shall form an integral part of an ISO test schedule.

7.1.2.2 Test schedules shall state at least the following and shall not cancel any statement or requirement of this part of ISO 4008:

a) test schedule identity;

b) the injection pump manufacturer and address for enquiries;

c) the injection pump type(s) (complete details; description and type code);

d) the nature of the test;

e) test injectors [2], nozzle opening pressure;

f) high-pressure pipes [3], details of pump end pipe fitting;

g) pump mounting details: base, cradle, spigot, flange or other, including centre height and drive input details, and technical requirements for any special drive adaptor(s);

h) special services needed (other than obligatory) — for example: return flow measurement, control lever quadrant, automatic advance measurement, solenoids (electrical details), air pressure/vacuum, special pressure gauges;

i) test reference number for each test (or setting);

j) all test conditions for each test (or setting); tolerances shall be stated making allowance for permissible instrument error stated in clause 8 of ISO 4008-2;

k) injection pump delivery values in mm^3/stroke/cylinder;

l) speed in revolutions per minute (min^{-1});

1) As stated in 6.1.2 d) of ISO 4008-2.

2) Any type may be stated, provided the nozzle, holder and edge filter (where applicable) are completely specified, but ISO types are preferable. They will be more accurate and are more likely to be available.

3) Any type may be stated, provided they are specified by outside diameter/inside diameter and length, but ISO types are preferable. They will be more accurate and are more likely to be available.

m) test numbers that shall be nominated ISO tests (i.e. conducted under ISO 4008-1 dynamic test conditions as specified in 5.2);

n) direction of rotation of injection pump;

o) power required by injection pump in kilowatts (kW);

p) peak injection pressure (p_p) if it exceeds 625 bar (see 6.8 of ISO 4008-1 and annex A);

q) warming-up procedure and stabilization procedure between successive ISO test elements.

NOTE — Only ISO 4113 calibration fluid is permissible for ISO tests (see table 2).

7.1.2.3 An instruction referring to test bench operation given in a test schedule shall not override a test bench manufacturer's instruction given with the test bench (for example, graduate drainage time, number of strokes over which to take a measurement, etc.).

7.2 Test procedure

7.2.1 Injection pump testing

The following processes shall be observed.

7.2.1.1 Check the identity of the injection pump to be tested in comparison with the test schedule. Clean outside of pump.

7.2.1.2 Check the characteristics of the pump to be tested in comparison with the permissible operating envelope and basic data and the test bench power and speed characteristics published with the ISO test bench to be used.

7.2.1.3 Check that the test injectors, high- and low-pressure pipes, pump mounting and any other accessories agree with both the test schedule and/or test bench instructions.

Pumps which may contain foreign matter should not be run initially using calibrating injectors. They shall first be run using any suitable slave injectors. (This applies, for example, to pumps which have been stored for a time or have been received from a customer and have not been overhauled.)

7.2.1.4 Only couplings permitting no backlash and carrying a maximum ISO rating in mm^3/stroke and also the torsional stiffness, S_c, in $N \cdot m/^\circ$ may be used in an ISO test.

7.2.1.5 Check the integrity of the element connecting the drive coupling on the test bench to the drive shaft of the pump. This element shall be exactly as specified by either the test bench manufacturer or the pump manufacturer. If the pump requires a specially designed drive mechanism, the pump manufacturer's recommendation shall be followed.

7.2.1.6 The test bench shall be operated according to its manufacturer's instructions. When the manufacturer has not issued specific instructions regarding the operation of the fuel measuring system, the following rules shall be observed for ISO tests:

a) the graduates shall be drained for a period of 30 ± 3 s;

b) a reading of pump delivery shall be taken over an unbroken number of consecutive strokes sufficient to ensure that the graduates are filled to more than 50 % of their calibrated scale(s).

7.2.2 Verification of equipment

7.2.2.1 Equipment shall be subjected to a verification test at the time intervals stated in table 3, or more frequently if the equipment instructions or the test results so indicate. A purpose-made audit kit, having parallel reference equipment, the resolution of which is at least five times better than that of the equipment to be verified (where applicable), is desirable.

7.2.3 Overloading and misuse

NOTE — Using test equipment beyond its technical capability results in a change in injection pump delivery which can amount to over 10 %. Departure from specified equipment such as high-pressure pipes and injectors can change pump delivery by a further similar amount. Departure from the test bench manufacturer's instructions in the use of the test bench flow measuring system can impair its accuracy. The following requirements are of great importance.

7.2.3.1 Test benches shall not be used outside the area of the "permissible operating envelope" published with ISO test benches. See figure 2 of ISO 4008-1, shown in annex A.

Table 3 — Test schedule for measuring equipment [1)]

Item	Test method	Accuracy of reference equipment and method	Rectification	Months
Pressure gauge(s)	Parallel reference	± 0,2 % of full scale	Replace, rectify or add correction label	3
Temperature gauge(s)	Run fluid over reference	± 0,2 °C	Replace, rectify or add correction label	3
Tachometer	Tachometer reference	± 1 min^{-1}	Replace, rectify or add correction label	3
Fluid measurement system	See clause A.2 of ISO 4008-2	See 8.10.2 of ISO 4008-2	Rectify	6

1) See clause 8 of ISO 4008-2 for acceptable tolerances.

7.2.3.2 Couplings shall not be used beyond the maximum rating displayed on them.

7.2.3.3 The correct coupling/injection pump shaft adaptors shall be used.

7.2.3.4 The injection pump shall be mounted using the proper mounting adaptors supplied by the test bench manufacturer for the pump being tested and which shall be in accordance with any special requirements in the test schedule.

7.2.3.5 Injection pumps with governors, requiring readings to be taken or adjustments to be made at conditions where the pump delivery is directly under governor control, shall not be tested on benches which are not capable of maintaining speed stability at these conditions. The speed droop of the test bench in use, as shown in the "power and speed droop characteristics" supplied with ISO test benches, should not be more than approximately half that of the governor under test (at the power required by the pump).

8 Environment

In the absence of appropriate national rules or legislation, the following minimum conditions shall apply.

8.1 The test bench and all other workshop equipment shall be properly installed following the manufacturer's instructions.

8.2 Forced filtered ventilation shall provide fresh clean air to the working area. A small positive pressure is desirable.

8.3 Atmospheric condensation shall be prevented at all times.

8.4 Floors, walls, ceilings and work surfaces shall not have loose finishes which could release dust or abrasive matter.

9 Personnel and authorization

9.1 A person shall be authorized to be responsible for the maintenance and operation of the whole test facility and the servicing of fuel injection equipment in conformity with this International Standard.

9.2 The authorized person(s) (see 5.2.2) shall be in possession of a certificate issued by the test equipment manufacturers and the fuel injection equipment manufacturers, certifying that appropriate instruction in the servicing of the fuel injection equipment and/or test equipment in question has been given to the authorized person(s).

9.3 At least one authorized person shall be available on the premises at all reasonable times.

9.4 Persons engaged in servicing of fuel injection equipment who are not authorized shall operate only under the supervision of an authorized person.

Annex A

Downrating test bench capacity when injection pump peak pressure exceeds 625 bar

(This annex forms an integral part of the Standard.)

A.1 The following is reproduced from 6.8 of ISO 4008-1.

"In cases where injection pressure, using test injectors and pipes, exceeds the assumed typical value, stated in 4.3[1], by a known amount, proportional adjustment should be made to the value of Q_{max} used when referring to the permissible operating envelope in graph 2[2].

Example:

An injection pumps delivers 200 mm^3/injection/cylinder at full load and the actual peak injection pressure is known to be 900 bar when using test injectors and pipes:

$$p_{pa} = 900 \text{ bar},$$

thus

$$p_{ma} = \frac{2}{\pi} 900 \text{ bar} = 573 \text{ bar [see 4.3 d)]}^{3)}$$

By proportion:

$$Q_e = \frac{Q_{max}}{400} \times p_{ma} \text{ [see 4.3 b)]}^{3)}$$

thus

$$Q_e = 200 \times \frac{573}{400} = 286 \text{ mm}^3\text{/injection/cylinder}$$

The equivalent delivery Q_e of 286 mm^3/injection/cylinder should now be compared with graph 2 to determine whether this particular injection pump falls within the permissible operating envelope of the test bench."

A.2 To assist with the use of the preceding extract, the meanings of the symbols used are additionally listed below:

p_m is the mean injection pressure (typical value);

p_{ma} is the actual mean injection pressure;

p_p is the peak injection pressure (typical value);

p_{pa} is the actual peak injection pressure;

Q_{max} is the actual pump delivery at full load;

Q_e is the equivalent pump delivery at full load (for the purposes of figure 2 in ISO 4008-1).

A.3 Therefore, in the case of the injection pump in the example, instead of referring to the actual maximum pump delivery of 200 mm^3/stroke on the Q_{max} scale of the permissible operating envelope, an equivalent value of 286 mm^3/stroke shall be taken.[4)]

1) Clause 4.3 of ISO 4008-1 states that a typical value of mean injection pressure (p_m) shall be 400 bar (for the purposes of test bench capacity rating).

2) Graph 2 of ISO 4008-1 shall be included with the test bench (see 5.1.2); it is reproduced in figure 1.

3) Clause 4.3 of ISO 4008-1 states $p_p = p_m \times \frac{\pi}{2}$, thus $p_p = 628$ bar.

4) This also applies to coupling ratings.

Basic Data

Flywheel moment of inertia : $I = \ldots$[1] kg·m^2

Driveshaft torsional stiffness : $S_d = \ldots$[1] N·m/°

Coupling torsional stiffness : No. 1 : $S_c = \ldots$[1] N·m/°

No. 2 : $S_c = \ldots$[1] N·m/°

No. 3 : $S_c = \ldots$[1] N·m/°

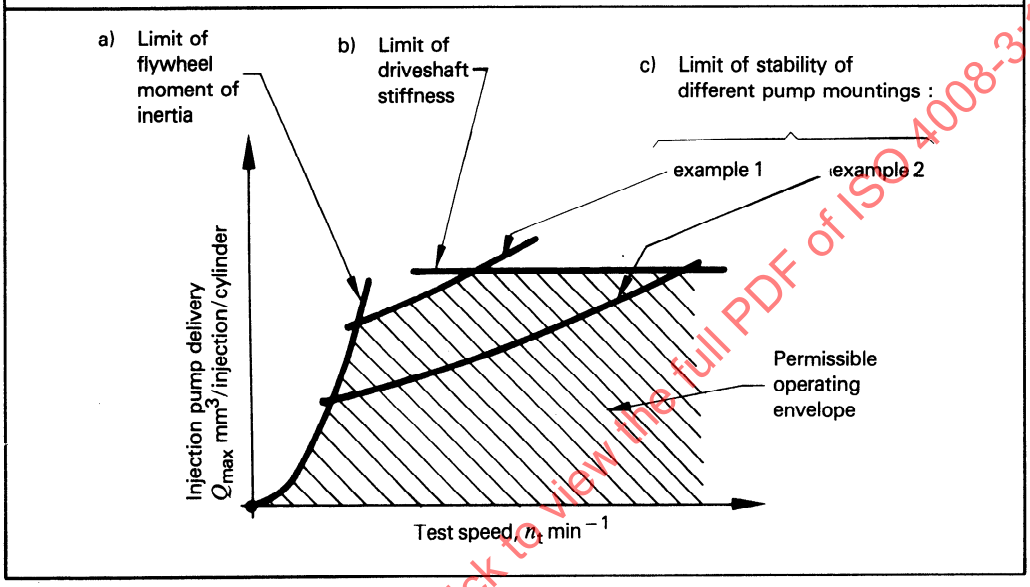

Figure 1 — Test bench permissible operating envelope and basic data
(Reproduced from ISO 4008-1, figure 2)

1) Insert the appropriate value.

Annex B

Test injector maintenance

(This annex forms an integral part of the Standard.)

B.1 Scope

This annex refers to test injectors (see 6.2). It provides the maintenance schedule and procedures (though not the setting and testing values) mandatory to calibrating injectors. The mandatory values are initially stated in the various International Standards or the appropriate injection pump test schedules.

Values are also shown in annex C which lists already-used test injector setting and testing values.

B.2 Test injector maintenance schedules

B.2.1 A record shall be kept of the number of pumps tested with each test injector.

B.2.2 The test injector maintenance schedules tabulated here are mandatory for calibrating injectors.

B.3 Maintenance procedure for test injectors

WARNING — The spray from a test injector can pierce human skin. To avoid injury keep clear of the spray.

Unless closer tolerances are required by the manufacturer, those quoted in annex C shall be used.

B.3.1 Nozzle opening pressure checking and setting

B.3.1.1 Fit the injector to the injector test apparatus specified in ISO 8984-1 filled with calibrating fluid as specified in ISO 4113 at ambient temperature.

B.3.1.2 Flush the injector through with five brisk pump strokes of even velocity.

Table 4 — Calibrating injector maintenance schedule

Schedule No.	Frequency	Action	Refer to
1	After injector maintenance	a) Run the injector, preferably with the largest pump for which the injector is specified, at full speed, full load for 5 min. b) Check opening pressure and reset if necessary.	 B.3.1
2	Weekly or after 100 pumps (max.), whichever occurs first	a) Check opening pressure and reset if necessary. b) Check back leakage. c) Check seat leakage.	B.3.1 B.3.4 B.3.1.5
3	a) Orifice plate injector assemblies: every 1 000 pumps b) Pintle nozzle injector assemblies: every 1 000 pumps	a) Only for injectors with single hole orifice plate: fit new needle valve assembly and/or orifice plate or complete nozzle and holder assembly as necessary in accordance with manufacturer's instructions. b) Only for injectors with delay pintle type nozzle: fit new nozzle assembly.	ISO 7440-1 B.3.2 ISO 7440-1 B.3.2
4	Every 5 000 pumps (max.)	Check flow-rate of inlet stud with edge filter. NOTE — This item is the subject of further study. Until this is completed, operators shall follow manufacturer's instructions. In the absence of specific instructions, refer to 4.2.3 of ISO 7440-1.	 Manufacturer's instructions or 4.2.3 of ISO 7440-1
5	Every 5 000 pumps	Visually examine functional surfaces of injector components.	B.3.1.6

B.3.1.3 Set the nozzle opening pressure adjustment until the nozzle cracks at the appropriate pressure stated in annex C. Check for any sealing face leakages.

B.3.1.4 Check that the nozzle chatters where applicable.

B.3.1.5 Check seat leakage as follows.

B.3.1.5.1 For pintle nozzle injectors, with the nozzle facing down, wipe the tip and check that no drop separates from the tip after holding the pressure as stated in annex C for 10 s.

B.3.1.5.2 For orifice plate injectors, with the nozzle facing downwards at 45°, spray the nozzle a few times. Hold the pressure to within 5 bar of opening pressure until a drop falls from the tip. Now hold the pressure to that stated in annex C and measure the time between the fall of the second and third drops. This time shall not be less than 10 s.

B.3.1.6 If chatter and/or seat leakage is/are unsatisfactory (and if permitted by the manufacturer) disassemble the injector and clean the components. If still unsatisfactory, the defective component(s), nozzle assembly or complete injector shall be replaced. Any interference with any of the functional surfaces of the components shall negate compliance with the relevant International Standard and also use in a non-standardized test injector.

B.3.2 Changing the nozzle or needle valve assemblies (if permitted by the manufacturer)

B.3.2.1 Wash the injector(s) in calibration fluid or use another non-corrosive cleaning process.

B.3.2.2 Release the opening pressure adjustment. Dismantle the injector and inspect the components for wear and damage.

B.3.2.3 Verify the identification marks of the holder assembly and the nozzle components to be assembled.

B.3.2.4 Wash out the nozzle and holder assemblies.

B.3.2.5 Fit the nozzle onto the holder [engaging dowel(s) where present] and then fit the cap nut.

B.3.2.6 Tighten the cap nut to the appropriate torque stated in annex C.

B.3.2.7 Follow the procedure of sub-clause B.3.1.

B.3.2.8 Observe any special instructions supplied with either the nozzle or holder assemblies.

B.3.3 Replacing the inlet stud with edge filter

B.3.3.1 It is good practice to remove the nozzle assembly from the injector, if permitted by the manufacturer.

B.3.3.2 Remove the inlet stud with edge filter and sealing washer.

B.3.3.3 Wash the new inlet stud with edge filter. Screw into the nozzle holder using a new sealing washer. Tighten to the appropriate torque stated in table 5.[1)]

B.3.3.4 Refit the nozzle assembly and set to the appropriate opening pressure. (Refer to B.3.2 and then to B.3.1.)

B.3.4 Checking back leakage

B.3.4.1 Fit injector to a nozzle tester and flush through with five pump strokes. Ensure there are no leaks in the pump or nozzle connection.

B.3.4.2 Raise the pump pressure to pressure "A" (see annex C), let go of the pump handle and allow the pressure to fall slowly of its own accord.

B.3.4.3 Measure the calibration fluid temperature and, using a stop watch, measure the time taken for the pressure to fall from pressure "B" to pressure "C". If the time is below the minimum back leakage time t_{min}, as indicated by the curve in figure 2, replace the nozzle.

B.3.4.4 Repeat the test several times but flush the nozzle through between each test.[2)]

1) It is desirable to flush through the assembled inlet stud/nozzle holder assembly to avoid contaminating the nozzle.

2) If the nozzle is not flushed, the back leakage time will increase considerably.

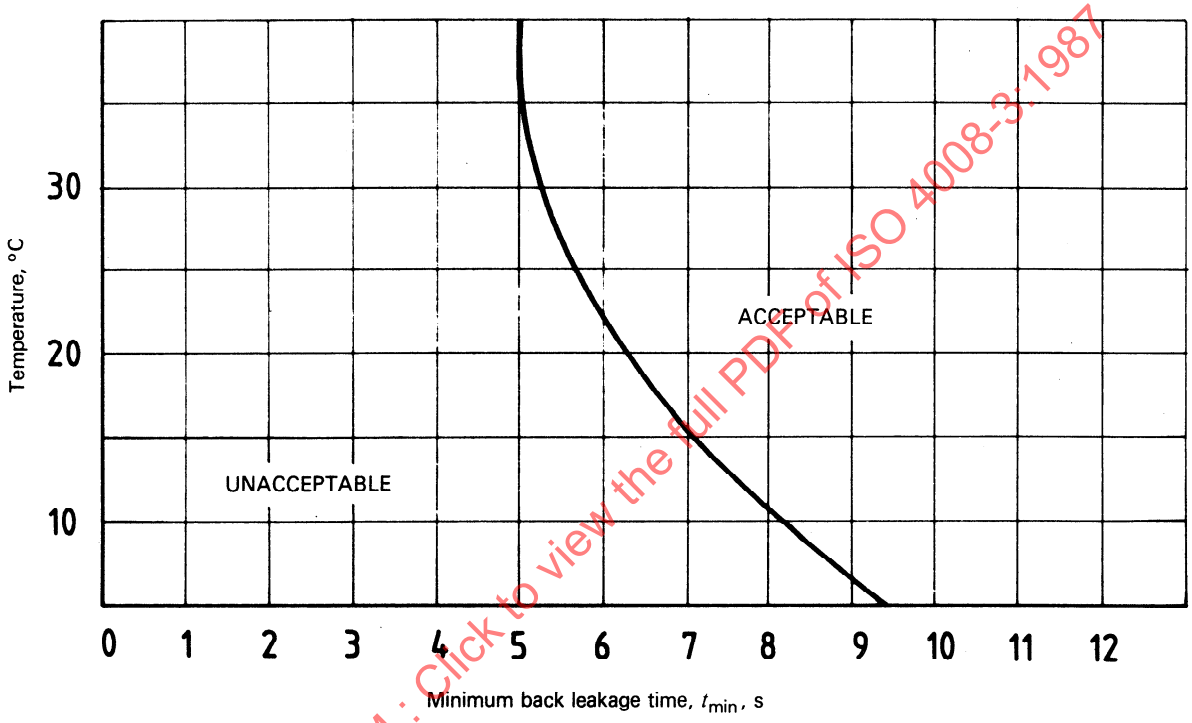

Figure 2 — Relationship between temperature and minimum back leakage time, t_{min}

Annex C

Test injector setting and testing values

(This annex does not form part of the Standard.)

This annex refers to test injectors (see 6.2). It places on record, for convenient reference by service workshops, those test injector setting and testing values in common usage. Additions can therefore be made to table 5 as information becomes available.

Table 5 — Test injector setting and testing values

No.	Injector or nozzle type	Nozzle opening pressure [1] bar	Seat leakage pressure [1] bar	Cap nut torque [1] N·m	Edge filter assembly torque [1] N·m	Back leakage test pressures A bar	B bar	C bar
			For all types					
	Nozzle holder assemblies [1] with							
1	Delay pintle type nozzle							
	a) calibrating nozzle to ISO 4010	$125\ ^{+3}_{0}$						
	b) calibrating nozzle to ISO 4010	$147\ ^{+3}_{0}$						
	c) calibrating nozzle to ISO 4010	$172\ ^{+3}_{0}$	20 bar below actual nozzle opening pressure	$60\ ^{+30}_{0}$	$45\ ^{+20}_{0}$	120	100	70
2	Single hole orifice plate [1]							
	a) No. .4 (ϕ 0,4 mm orifice)	$207\ ^{+3}_{0}$						
	b) No. .5 (ϕ 0,5 mm orifice)	$207\ ^{+3}_{0}$						
	c) No. .6 (ϕ 0,6 mm orifice)	$207\ ^{+3}_{0}$						
	d) No. .7 (ϕ 0,7 mm orifice)	$207\ ^{+3}_{0}$						
	e) No. .8 (ϕ 0,8 mm orifice)	$207\ ^{+3}_{0}$						

1) As specified in ISO 7440-1.