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Diesel engines — High-pressure fuel injection pipe assemblies — General requirements and dimensions

Moteurs diesels — Lignes assemblées d'injection de carburant à haute pression — Exigences générales et dimensions

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

The committee responsible for this document is ISO/TC 22, *Road vehicles*, Subcommittee SC 34, *Propulsion, powertrain, and powertrain fluids.*

This fourth edition cancels and replaces the third edition (ISO 13296:2012), which has been technically revised by making normative reference to ISO 4288 for the measurement of surface texture.

Diesel engines — High-pressure fuel injection pipe assemblies — General requirements and dimensions

1 Scope

This document specifies dimensions and requirements for high-pressure fuel injection pipe assemblies and assembled pipe sets for both integral and fabricated 60° female cones used on diesel (compression-ignition) engines.

NOTE Dimensions of integral and fabricated 60° female cone connectors are specified in ISO 2974.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 2974:2011, *Diesel engines — 60° female cones for high-pressure fuel injection components*

ISO 4288, *Geometrical Product Specifications (GPS) — Surface texture: Profile method — Rules and procedures for the assessment of surface texture*

ISO 8535-1:2011, *Diesel engines — Steel tubes for high-pressure fuel injection pipes — Part 1: Requirements for seamless cold-drawn single-wall tubes*

ISO 8535-2:2003, *Compression-ignition engines — Steel tubes for high-pressure fuel injection pipes — Part 2: Requirements for composite tubes*

ISO 12345, *Diesel engines — Cleanliness assessment of fuel injection equipment*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 7876-4 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

4 Dimensions and tolerances

The requirement and configuration drawing for a pipe assembly shall include at least the following:

a) an indication of compliance with this document, i.e. ISO 13296;

b) the outside diameter and inside diameter of the pipe and an indication of compliance with ISO 8535-1 or ISO 8535-2;

c) the thread and the hexagon size of the connector nuts according to Table 2 or Table 4;

d) the type of connection ends as specified in 7.2;

e) a graphic representation of the centre-line of the pipe with the connection ends and each bend intersection labelled as a point, with each point listed in a table with Cartesian coordinates *x*, *y* and

z with the orthogonal distance from the axis and the bend radius (the beginning and end points are given as the "*S*" dimension for the defined configuration);

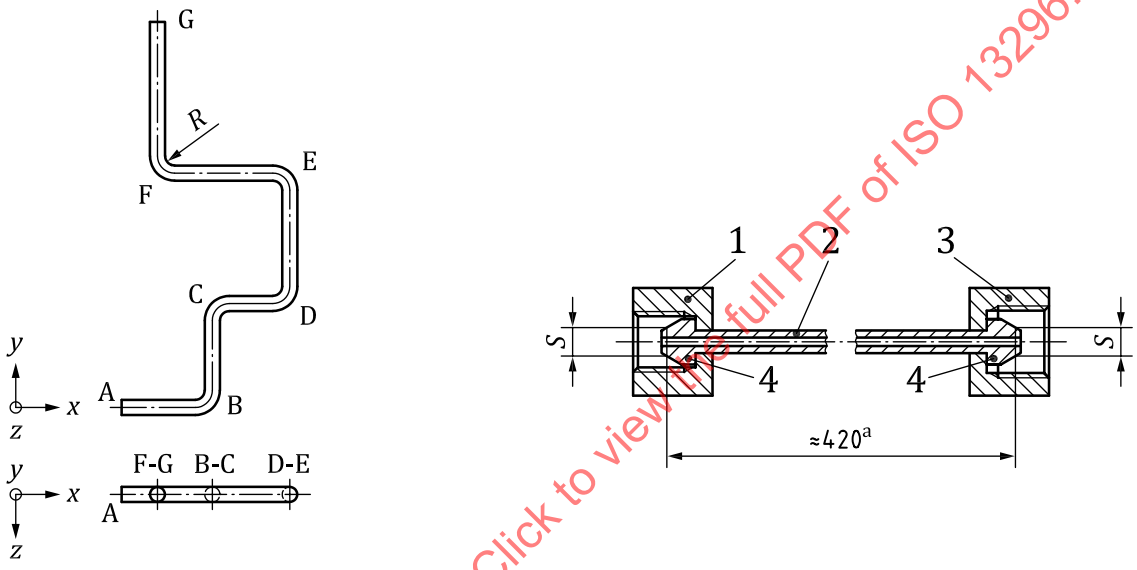
NOTE The coordinates are used to specify the theoretical exact centre-line of the pipe. See the example given in Figure 1.

f) the developed length of the pipe as an approximated value;

g) the material and surface finish requirements of the pipe and connector nuts according to ISO 8535-1 or ISO 8535-2.

The dimensional tolerance of a pipe assembly shall be stated in terms of the actual outside contour of the tube in relation to the specified maximum outside contour and the variance of the actual pipe connection end from the specified position, as agreed between supplier and customer.

Dimensions in millimetres



Point	*x*	*y*	*z*	Radius
A	0	0	0	0
B	65	0	0	15
C	65	100	0	15
D	140	100	0	15
E	140	150	0	15
F	40	150	0	15
G	40	185	0	0

Key

1 connector nut: thread M12; hexagon across flats 17

2 pipe: tube outside diameter 6 mm

3 connector nut: thread M14; hexagon across flats 19

4 pipe connection ends: both of Type C

a Developed length.

Figure 1 — Example of a requirement and configuration drawing

5 Cleanliness

The bore of a high-pressure fuel injection pipe assembly shall be clean, and this shall be assessed in accordance with ISO 12345. Unless otherwise agreed between supplier and customer, cleanliness of pipe assemblies shall be designated using the Fuel Injection Equipment Cleanliness Code (FIECC), as defined in ISO 12345.

6 Minimum bend radii

The radius of any bend made in fabricating high-pressure pipe assemblies shall be not less than two and a half times (2,5×) the outside diameter of the pipe as measured from the pipe centre-line. Bends shall be a sufficient distance from the end connections so as to allow easy fitting of the pipe assembly for its intended use. Bends shall be a sufficient distance from one another so as not to impair fabrication. Bend radii shall be of uniform size in each pipe assembly, whenever possible.

7 Pipe end connections

7.1 General

The relationships of connection ends to the connector nut and with the dimensions *G* and *S* are shown in Table 1 for the integral 60° female cone and in Table 3 for the fabricated 60° female cone.

The design of the shoulders of the connection end and of the related connector nut shall be agreed between supplier and customer.

NOTE The dimensional characteristics of integral 60° female cones and of fabricated 60° female cones for high-pressure fuel injection components are specified in ISO 2974.

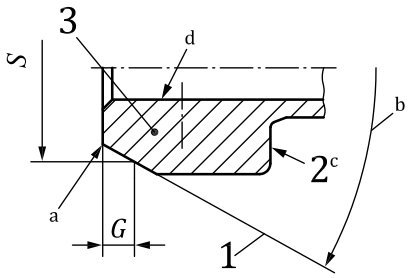
7.2 Types of connection ends

Figure 2 and Figure 3 show two fundamentally different designs of connection ends for high-pressure fuel injection pipe assemblies:

— Type C, with conical sealing face;

— Type S, with spherical sealing face.

Details of a Type C connection end are shown in Figure 2 while those of a Type S connection end are shown in Figure 3.



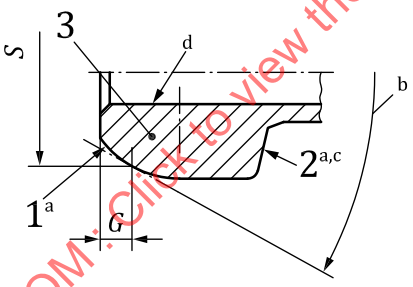
Key

1 connection-end sealing face (conical)
2 shoulder of connection end[c]
3 connection end of pipe
a Rounding of the leading edge of the sealing face is necessary for the straight connection-end sealing face.
b 58° ± 1° included angle for Type C connection-end sealing face.
c Design of the shoulder is not specified (see 7.1).
d The connection-end bore entrance configuration is shown in Figure 6.

NOTE For dimensions *G* and *S*, see Table 1.

Figure 2 — Connection end Type C (conical)

Details of a Type S connection end are shown in Figure 3.



Key

1 connection-end sealing face (spherical)
2 shoulder of connection end[c]
3 connection end of pipe
a Spherical shape of the connection-end sealing face and of the shoulder in order to allow an inclined position of the pipe connection end to the matching female cone.
b Spherical connection end to fit into the 60° female cone specified in ISO 2974.
c Spherical shoulder in order to achieve a constant transmission of the axial force to the circumference of the shoulder and the connection-end sealing surface. Details of the shoulder design are not specified (see 7.1).
d The connection-end bore entrance configuration is shown in Figure 6.

NOTE For dimensions *G* and *S*, see Table 1.

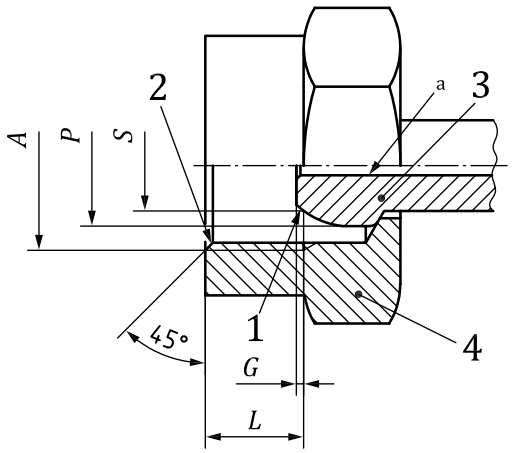
Figure 3 — Connection end Type S (spherical)

7.3 Pipe end assembly for integral 60° female cones

Figure 4 shows the basic requirements and relationships of a connection end assembled to the related connector nut (valid for both Type C and Type S connection ends).

For dimensions, see Table 1.

NOTE The dimensions of Table 1 correspond to the values specified in ISO 2974:2013, Table 1.



Key

1 connection-end sealing face (conical or spherical)

2 chamfer to root of thread

3 connection end of pipe (according to Figures 2 or 3)

4 connector nut (according to Table 2)

a The connection-end bore entrance configuration shall be so chosen that, after final assembly, the pipe inside diameter is not reduced (see 7.5).

Figure 4 — Pipe end assembly for integral 60° female cones (schematically)

Table 1 — Dimensions of pipe end connections for integral 60° female cones

Dimensions in millimetres

Tube outside diameter	Thread[a] *A*	Reference diameter *S*	*P* ±0,5	*G* ±0,3	*L* max.
4,5	M10 × 1,25 M12 × 1,5	5	7	0,5	7
6	M12 × 1,5 M14 × 1,5	6,5	8,0 to 9,5	0,5 or 1,0	8
6,35	M12 × 1,5 M14 × 1,5 M16 × 1,5	6,5	8,0 to 9,5	0,5 or 1,0	8
7	M14 × 1,5 M16 × 1,5	6,5	8,5 to 10,5	0,5	8
8	M14 × 1,5	7,5	10,5 to 12	0,6	8
	M16 × 1,5	8,5	10,5 to 12	0,6	8
	M16 × 1,5 M18 × 1,5 M22 × 1,5	8,5	11 to 12	0,9	11
9	M16 × 1,5	8,5	12	0,9	8

[a] Tolerance classes of threads: 6H for connector nuts.

Table 1 *(continued)*

Tube outside diameter	Thread[a] *A*	Reference diameter *S*	*P* ±0,5	*G* ±0,3	*L* max.
10	M16 × 1,5	8,5	13,5	0,9	8
	M20 × 1,5 M22 × 1,5 M24 × 1,5	10,5	13,5	0,9	12,5
12	M22 × 1,5 M26 × 1,5	12,5	15,5	1,8	15,5
a Tolerance classes of threads: 6H for connector nuts.					

The preferred hexagon sizes for the connector nuts are given in Table 2.

Table 2 — Connector-nut wrench size for integral 60° female cones

Dimensions in millimetres

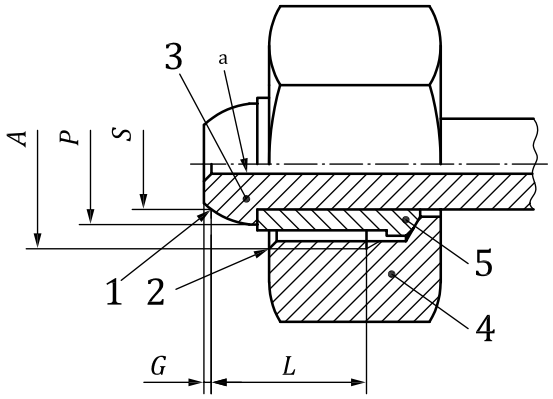
Tube outside diameter	Thread	Wrench size
4,5	M10 × 1,25	14
	M12 × 1,5	17
6	M12 × 1,5	17
	M14 × 1,5	19
6,35	M12 × 1,5	17
	M14 × 1,5	19
	M16 × 1,5	24
7	M14 × 1,5	19
	M16 × 1,5	24
8	M14 × 1,5	19
	M16 × 1,5	24
	M18 × 1,5	24
	M22 × 1,5	32
9	M16 × 1,5	24
10	M16 × 1,5	24
	M20 × 1,5	30
	M22 × 1,5	32
	M24 × 1,5	36
12	M22 × 1,5	32
	M26 × 1,5	36

7.4 Pipe end assembly for fabricated 60° female cones

Figure 5 shows the basic requirements and relationships of a pipe connection end assembled to the related connector nut (valid for both Type C and Type S connection ends).

For dimensions, see Table 3. For connector-nut wrench sizes, see Table 4.

NOTE The dimensions in Table 3 correspond to the values specified in ISO 2974:2013, Table 2.



Key

1 connection-end sealing face (conical or spherical)

2 chamfer to root of thread

3 connection end of pipe (according to Figure 2 or Figure 3)

4 connector nut (according to Table 4)

5 loading sleeve

a The connection-end bore entrance configuration shall be so chosen that, after final assembly, the pipe inside diameter is not reduced (see 7.5).

Figure 5 — Pipe end assembly for fabricated 60° female cones (schematically)

Table 3 — Dimensions of pipe end connections for fabricated 60° female cones

Dimensions in millimetres

Tube outside diameter	Thread *A*	Reference diameter *S*	*P* ±0,5	*G* ±0,3	*L* min.
6	M14 × 1	6,15	8 to 9	0,5	15
	M15 × 1	6,5	8 to 9,5	0,5	13
	M16 × 1,5[a]	6,5	8 to 9,5	0,5	17
6,35	M14 × 1	6,15	8 to 9	0,5	15
	M15 × 1	6,5	8 to 9,5	0,5	13
	M16 × 1,5[a]	6,5	8 to 9,5	0,5	17
8	M18 × 1,5	7,5	10,5 to 12	0,6	18
8	M19 × 1,5	8,23	11 to 13	0,6	18

[a] Preferred.

Table 4 — Connector-nut wrench size for fabricated 60° cones

Dimensions in millimetres

Tube outside diameter	Thread	Wrench size
6	M14 × 1	17
	M15 × 1	19
	M16 × 1,5[a]	19

[a] Preferred.

[b] Wrench size achieved by using a stepped nut with the hexagon located away from the thread.

Table 4 *(continued)*

Tube outside diameter	Thread	Wrench size
6,35	M14 × 1	17
	M15 × 1	19
	M16 × 1,5[a]	19
8	M18 × 1,5	19[b]
9	M19 × 1,5	19[b]

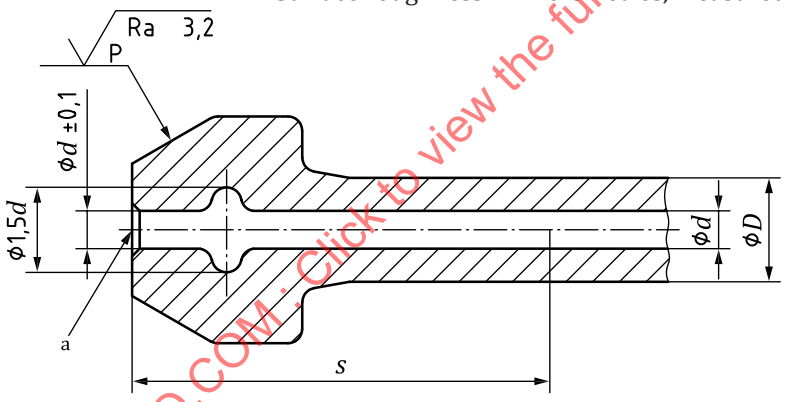
[a] Preferred.

[b] Wrench size achieved by using a stepped nut with the hexagon located away from the thread.

7.5 Bore entrance configuration

The connection end and bore configuration shall be chosen such that, after final assembly, the inside diameter of the tube is not less than that which is shown in Figure 6. After manufacture, the connection ends of the pipe shall comply with the dimensional characteristics given in Figure 6. This figure also determines any internal distortion limits. If, by agreement between supplier and customer, a chamfer is to be put in the bore, the maximum tolerance of d_1 at the front of the male sealing face may be increased.

Dimensions in millimetres
Surface roughness in micrometres, measured according to ISO 4288



Key

D	nominal outside diameter of the pipe
d	nominal inside diameter of the pipe
d ± 0,1	distortion of inside diameter at length s, excluding inside bulge
1,5d	maximum inside diameter at the inside bulge
s	length over which internal distortion is permitted = $3D_{max}$
a	In this area, the transition from the tube bore to the tube end face shall be achieved by uniformly widening the inside diameter, giving it a rounded run-out. No sharp edges are permitted.

Figure 6 — Tube connection end and bore entrance configuration

8 Assembly clamps

Pipe assemblies may be formed in such a manner that they are attached to the engine and/or held to one another by means of an assembly clamp. Clamp placement should be such that it will prevent damage to the pipe assemblies from engine-induced vibration.