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Aerospace fluid systems — Clamp blocks for tube lines having axial alignment — Design requirements and qualification testing (metric series)

Systèmes de fluides pour l'aéronautique et l'espace — Peignes supports de tuyauteries à alignement axial — Exigences de conception et essais de qualification (série métrique)

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Foreword

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This document was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 10, *Aerospace fluid systems and components*.

This second edition cancels and replaces the first edition (ISO 7661:1984), which has been technically revised.

The main changes are as follows:

— the reference to ISO/TR 2685 has been updated in 7.4 and in the bibliography because ISO/TR 2685 has been replaced by ISO 2685;

— Clause 2, normative references, has been updated;

— Clause 3, terms and definitions, has been updated;

— the upper limit of the tube outside diameters range has been increased from 32 mm to 36 mm.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Aerospace fluid systems — Clamp blocks for tube lines having axial alignment — Design requirements and qualification testing (metric series)

1 Scope

This document describes clamp blocks for tube lines having axial alignment, with or without electrical grounding, designed for a range of tube outside diameters from 4 mm to 36 mm selected from ISO 2964. This document specifies the dimensions of clamp blocks and the test methods for qualification testing.

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 6771, *Aerospace — Fluid systems and components — Pressure and temperature classifications*

ISO 7137, *Aircraft — Environmental conditions and test procedures for airborne equipment*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

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

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

3.1
axial alignment
axes of supported tubings located in the same plane

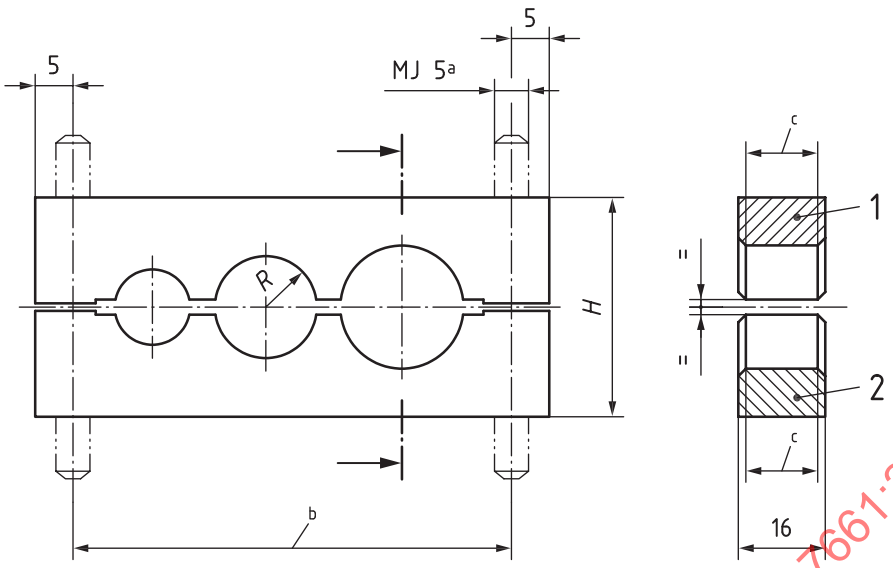
3.2
clamp block for tubing
device used on aerospace vehicles for fixing tubings, the dimensions of which may be different and which are constituted from different materials.

Note 1 to entry: These clamp blocks permit the fastening of tubes, used for different purposes in fluid systems.

3.2.1
monobloc clamp block
clamp block for tubing (3.2) consisting of two monobloc parts

EXAMPLE See Figure 1.

Dimensions in millimetres



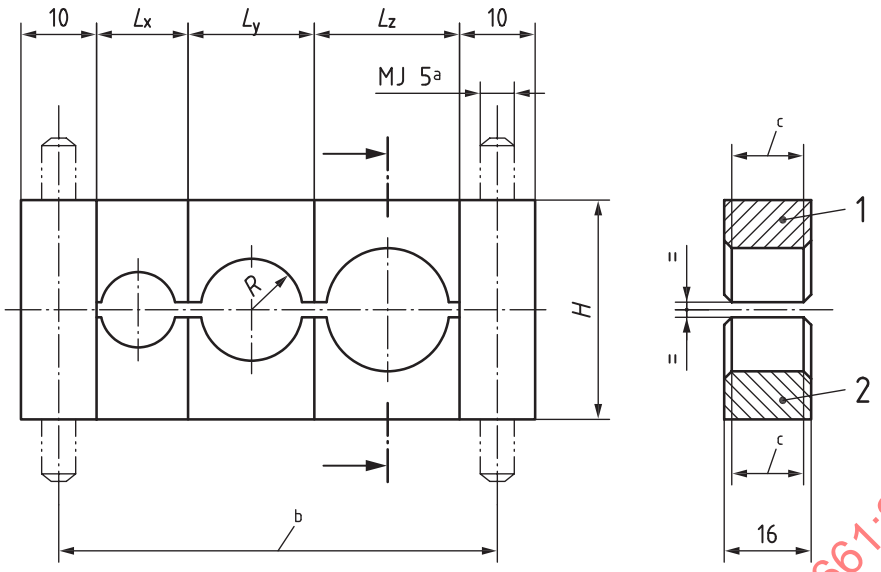
Key

1 upper part
2 lower part
R radius of tube support
H height of clamp block
a See ISO 5855-2.
b Bolt spacing ±0,125.
c Width of tube support.

Figure 1 — Monobloc clamp block

3.2.2
modular clamp block
clamp block for tubing (3.2) consisting of *removable parts* (3.3), with or without *insert(s)* (3.4)

EXAMPLE See Figure 2.



Key

1 upper part
2 lower part
R radius of tube support
H height of clamp block
L_x length of part X
L_y length of part Y
L_z length of part Z
[a] See ISO 5855-2.
[b] Bolt spacing ±0,125.
[c] Width of tube support.

Figure 2 — Modular clamp block (without insert)

3.3
removable part
part of a *modular clamp block* (3.2.2) which ensures a standardized clearance between two adjacent tubings

3.4
insert
part that can be assembled between two *removable parts* (3.3) in order to obtain the required centre-to-centre distance, standardized or not, between tubes

4 Classification of clamp blocks

The clamp blocks are divided into three classes, A, B and C, each corresponding to a range of tube outside diameters and to a maximum clamp block height (see Table 1), as follows:

Class A: tube outside diameters from 4 mm to 12 mm

Class B: tube outside diameters from 4 mm to 20 mm

Class C: tube outside diameters from 4 mm to 36 mm

5 Dimensions of clamp blocks

5.1 Maximum height

Table 1 gives, for each clamp block class and for each tube outside diameter, the maximum height, *H*, of the clamp block (see Figures 1 and 2).

Table 1 — Maximum height of the clamp block

Dimensions in millimetres

Identification class of the clamp block	Tube outside diameter											
	04	05	06	08	10	12	14	16	20	25	32	36
	Maximum height of the clamp block, *H*											
A	27	27	27	27	27	27						
B	35	35	35	35	35	35	35	35	35			
C	48,5	48,5	48,5	48,5	48,5	48,5	48,5	48,5	48,5	48,5	48,5	48,5

5.2 Nominal radius

Table 2 gives, for each tube outside diameter, the nominal radius *R*, of the clamp block (see Figures 1 and 2).

Table 2 — Nominal radius of the clamp block

Dimensions in millimetres

Tube outside diameter	04	05	06	08	10	12	14	16	20	25	32	36
Nominal radius, *R*	2	2,5	3	4	5	6	7	8	10	12,5	16	18

5.3 Width of removable parts

Two models of removable parts for modular clamp blocks are standardized, as follows:

— model 1 allows a clearance of 3 mm between adjacent tubes;

— model 2 allows a clearance of 5 mm between adjacent tubes.

NOTE Model 2 can be composed of a removable part and an insert.

Table 3 gives, for each tube outside diameter, the width L_{Mi} (L_{M1} for model 1 and L_{M2} for model 2) of removable parts for modular clamp blocks.

Table 3 — Width of removable parts

Dimensions in millimetres

Tube outside diameter	Width of removable parts, L_{Mi}	
	Model 1	Model 2
	$L_{M1}{}^{0}_{-0,1}$	$L_{M2}{}^{0}_{-0,1}$
04	–	9
05	8	10
06	9	11
08	11	13
10	13	15
12	15	17

Table 3 *(continued)*

Tube outside diameter	Width of removable parts, L_{Mi}	
	Model 1	Model 2
	$L_{M1}{}^{0}_{-0,1}$	$L_{M2}{}^{0}_{-0,1}$
14	17	19
16	19	21
20	23	25
25	28	30
32	35	37
36	39	41

5.4 Clamp block bolt spacing

5.4.1 Modular clamp block

The bolt spacing for modular clamp blocks is equal to the sum of the widths of removable parts (see Figure 2 and Table 3) and the widths of inserts, if any, increased by 10 mm.

5.4.2 Monobloc clamp block

The bolt spacing for monobloc clamp blocks is equal to that of a modular clamp block designed for supporting the same tubes.

6 Temperature conditions

The clamp blocks shall be designed for service within the following types of operating temperature ranges, in accordance with ISO 6771:

Type I: −55 °C to +70 °C

Type II: −55 °C to +135 °C

Type III: −55 °C to +200 °C

7 Qualification tests

7.1 Electrical tests (for clamp blocks with electrical grounding)

7.1.1 Measurement of the electrical contact resistance

This measurement shall be carried out before and after the mechanical tests (7.2) and climatic tests (7.3).

Measure the potential drop between one of the fastening screws of the clamp block and each one of the test tubes, using a direct current power source (1 A to 4 A) and a millivoltmeter.

Before carrying out any test, the contact resistance shall be less than or equal to 150 mΩ. In order to obtain a contact resistance with a lower value, a different electrical continuity procedure shall be considered.

7.2 Mechanical tests

7.2.1 Sliding test under temperature

7.2.1.1 General

The following test does not apply in the case of clamp blocks where there is no possibility of retention on the tubes they support.

7.2.1.2 Samples

Three samples shall be provided for this test and shall consist of clamp blocks for three parallel tubes, of length 50 mm, of the same material (aluminium alloy, stainless steel or titanium) and with the same diameter: 4 mm, 12 mm and 20 mm respectively.

7.2.1.3 Test apparatus

A suitable device, in conformity with Figure 3, shall allow the sliding of the tubing in a clamp block with a displacement of 6 mm (i.e. ±3 mm). The displacement shall be effected at a frequency of 1 cycle per second.

7.2.1.4 Test conditions

The sliding test under temperature shall be carried out at the following temperatures:

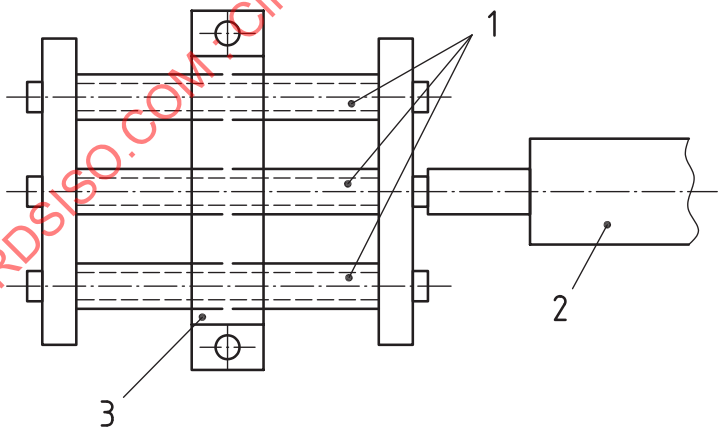
(55 ± 3) °C

(110 ± 3) °C

(160 ± 3) °C

The tightening torque for the fastening screw shall be 2 N·m.

The number of cycles performed under these conditions shall be 50 000.



Key

1 tubing (moving assembly)

2 drive

3 clamp block test sample (stationary assembly)

Figure 3 — Apparatus for sliding test

7.2.1.5 Initial measurements

Before mounting each tube in the device, take the following initial measurements at room temperature:

a) the sliding force, F, for each tube: 15 N < F < 30 N, according to the service temperature range of the clamp block, the nature and the area of the tube;

b) the electrical contact resistance: see 7.1.1.

7.2.1.6 Final measurements

After dismantling each tube from the test device, take the following final measurements at room temperature:

a) the sliding force for the tubes;

b) the electrical contact resistance (see 7.1.1): the measurement of the electrical resistance shall be made before the tubes are dismantled;

c) examination and measurement of the tube and clamp contact areas for grooves and wear marks, after the clamp block has been dismantled.

7.2.1.7 Acceptance criteria

After the test, the following requirements shall be met:

a) the sliding force for each tube shall remain greater than 5 N;

b) the electrical contact resistance shall remain less than 150 mΩ;

c) the wear marks on the tubes after slide testing shall not exceed the following values:

   — aluminium alloy tubes: 40 µm

   — stainless steel tubes: 15 µm

   — titanium tubes: 15 µm

d) whatever the material, the allowable wear on the diameter of the tubes shall remain lower than or equal to the following values:

   — tube outside diameters from 4 mm to 10 mm: wear less than or equal to 0,05 mm relative to the nominal diameter

   — tube outside diameters from 12 mm to 36 mm: wear less than or equal to 0,08 mm relative to the nominal diameter

7.2.2 Sliding test combined with contamination

7.2.2.1 Samples

Three samples shall be provided for this test and shall consist of clamp blocks for three parallel tubes, of length 50 mm, of the same material (aluminium alloy, stainless steel or titanium) and with the same diameter: 4 mm, 12 mm and 20 mm respectively.

7.2.2.2 Aim of the test

This sliding test is intended to determine the consequences on the behaviour of a clamp block and of its tube when exposed to certain fluids used in aerospace vehicles, in a sand- and dust-laden atmosphere with a definite saturation concentration.

The fluids to be considered for this test shall be as follows:

— fuel;

— phosphate ester based hydraulic fluid;

— ester silicate;

— de-icing fluid;

— cleaning fluid;

— fire extinguishing liquid.

7.2.2.3 Test method

Assemble the clamp block and tubes as laid down in 7.2.1. Coat all of the external surfaces of the clamp block assembly by brushing or spraying with the fluid under consideration. Install the clamp block assembly in a test chamber for the operating test in a sand- and dust-contaminated atmosphere.

Submit the clamp block assembly to a sand and dust test in accordance with ISO 7137.

7.2.2.4 Acceptance criteria

After the test, the following requirements shall be met:

a) the sliding force for each tube shall remain greater than 5 N;

b) the electrical contact resistance shall remain less than 150 mΩ;

c) the depth of the wear marks on the tubes shall not exceed 5 % of the tube thickness for stainless steel and titanium tubes and it shall not exceed 10 % of the tube thickness for light alloy tubes;

d) allowable wear on the tubes: the reduction of the tube thickness shall remain less than 10 % of the minimum thickness determined during initial checks.

7.2.3 Vibration test

7.2.3.1 Test method

Rigidly fasten onto the test apparatus an assembly comprising two clamp blocks, spaced 50 cm apart, fitted with three tubes, of length 1 m, with the same diameter and of the same material (aluminium alloy, stainless steel or titanium). Submit this assembly to a severe vibration test in accordance with ISO 7137 [see curve E1 in Figure 8-4 in 8.7 of the publication EUROCAE ED-14G[4] (identical to RTCA DO-160G[5])].

7.2.3.2 Acceptance criteria

After the test, the following requirements shall be met:

a) there shall be no damage of the clamp block (cracking, failure or significant wear) nor loosening of the screws;

b) the sliding force for each tube shall remain greater than 5 N;

c) the electrical contact resistance shall remain less than 150 mΩ;

d) the depth of the wear marks on the tubes shall not exceed 5 % of the tube thickness for stainless steel and titanium tubes and it shall not exceed 10 % of the tube thickness for light alloy tubes;

e) allowable wear on the tubes: the reduction of the tube thickness shall remain less than 10 % of the minimum thickness determined during initial checks.

7.3 Climatic tests

7.3.1 General

The climatic tests described in 7.3.2 to 7.3.4 are static tests.

7.3.2 Low temperature test

Submit the clamp block assembly to a low temperature test (at the minimum temperature specified in Clause 6) in accordance with ISO 7137.

7.3.3 High temperature test

Submit the clamp block assembly to a high temperature test (at the maximum service temperature specified in Clause 6) in accordance with ISO 7137.

7.3.4 Salt spray test

7.3.4.1 General

When the materials constituting the clamp blocks have previously been found satisfactory in salt spray tests meeting the requirements of ISO 7137, the clamp block may be qualified by analogy.

7.3.4.2 Initial measurements

Measure the electrical contact resistance (see 7.1.1).

7.3.4.3 Test

Submit the clamp block provided for this test to a salt spray test in accordance with ISO 7137.

7.3.4.4 Final measurements

Check the appearance and measure the electrical contact resistance (see 7.1.1).

7.3.4.5 Acceptance criteria

After the condition of the tube and clamp block assembly has been checked, the following requirements shall be met:

a) corrosion shall not affect the appearance of any one of the clamp block components;

b) the electrical contact resistance shall be less than 150 mΩ.

7.4 Flame resistance test

7.4.1 General

If the clamp block is to be used in a fire zone and if the specific conditions of its use require fire resistance capability, this clamp block shall be submitted to the same fire test as the tubes which are to be supported (see ISO 2685).

7.4.2 Test apparatus

The test apparatus shall comprise:

a) draught-free vessel, provided with a glass window so that the samples being tested can be observed; the vessel shall be provided with adjustable supports (in the vertical direction) for positioning the samples;

b) Bunsen burner, with a rated internal diameter of 9,5 mm;

c) thermocouple, to measure the flame temperature.

7.4.3 Test procedure

Set the clamp block up inside the vessel with its largest dimension vertical and its lowest part located 19 mm from the upper part of the burner. Apply the flame to the lowest side so that one-third of the flame is in contact with the assembly (see Figure 4).

Adjust the burner to provide a blue flame, with an approximate height of 38 mm, so that the temperature of the hottest point of the flame is 843 °C.

Place a piece of cotton with sides 100 mm in length 300 mm below the sample.

Apply the flame for 12 s, then withdraw it.

7.4.4 Acceptance criteria

After the test, the following requirements shall be met:

a) the burning of the clamp block shall not continue for more than 12 s (after the withdrawal of the heat source) and harmful smoke shall not be given off;

b) the particles or drops released from the sample shall not continue to burn for more than 5 s and shall not set fire to the cotton.

For some applications, toxic gas and smoke emissions may occur in the event of a fire. It may prove necessary to carry out supplementary tests to check the suitability of clamp block materials in this respect.