INTERNATIONAL STANDARD

ISO 2685

Second edition
1998-12-15

Aircraft — Environmental test procedure for airborne equipment — Resistance to fire in designated fire zones

Aéronefs — Méthode d'essai en environnement des équipements embarqués — Tenue au feu dans les zones désignées «zones de feu»

Reference number
ISO 2685:1998(E)

Contents

Page

International Organization for Standardization
Case postale 56 • CH-1211 Genève 20 • Switzerland
Internet iso@iso.ch

Printed in Switzerland

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established 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. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 2685 was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*.

This second edition cancels and replaces the first edition (ISO 2685:1992), of which it constitutes a technical revision.

Annexes A and B form an integral part of this International Standard. Annexes C to G are for information only.

NOTE — Annexes C, D and E are temporarily maintained for information purposes pending the preparation of standards regarding specific test conditions for the products concerned.

Aircraft — Environmental test procedure for airborne equipment — Resistance to fire in designated fire zones

CAUTION — Precautions shall be taken to safeguard the health of personnel conducting tests against the risk of fire, inhalation of smoke and/or toxic products of combustion.

1 Scope

This International Standard specifies the tests conditions applied to all components, equipments and structures located in zones designated as "fire zones" and built to satisfy the minimum specified level for resistance to fire.

Two grades of resistance to fire are applicable to components, equipments and structures.

Annexes A and B give details of the types of burners providing the standard flame and how they shall be used.

This International Standard does not relate to the resistance to fire outside designated fire zones, nor to flammability requirements, nor to those conditions induced by the flame coming from the combustion chamber.

2 Definitions

For the purposes of this International Standard, the following definitions apply.

2.1 designated fire zone: Region of an aircraft, for example compartments containing main engines and auxiliary power units, designated as such by the aircraft designer in accordance with the requirements of the approving authority.

2.2 standard flame: Flame having the following characteristics:

– temperature: 1 100 °C ± 80 °C

– heat flux density received by the standard apparatus described in B.4.2: (116 ± 10) kW/m^2

2.3 fire resistant: Grade designating components, equipments and structures capable of withstanding the application of heat by a standard flame for 5 min.

2.4 fireproof: Grade designating components, equipments and structures capable of withstanding the application of heat by a standard flame for 15 min.

3 Test equipment

The burner shall produce a flame having the characteristics of the standard flame.

Examples of this burner (gas or liquid fuel) are given in annex A.

4 Test requirements

4.1 Test procedure

The following procedure applies to all the fire tests. Particular conditions to be applied during the fire tests shall be detailed in the specification of the equipment under consideration.

4.1.1 Mounting of specimen

The component, equipment or structure shall be installed on a test rig defined in the specification of the equipment under consideration, in conditions at least equivalent to those encountered in the aircraft.

4.1.2 Choice of burner

The type and number of burners shall be chosen such that, during the fire test, the critical parts of the components or items of equipment are enveloped in the test flame(s) from the appropriate direction(s).

For that, the following conditions shall be fulfilled:

$$A \leq 2B$$

where

A is the major cross-section of the equipment or specimen, in square metres;

B is the area of the flame at the nozzle of the burner, in square metres.

The nominal axial distance between the burner nose(s) and the surface of the item under test shall be as defined in annex A.

4.1.3 Calibration of burner

The burner shall be calibrated in accordance with annex B.

4.1.4 Test duration

The component or item of equipment to be tested shall be subjected to the standard flame for the duration corresponding to its grade of resistance to fire, i.e.:

– 5 min for a "fire resistant" classification (see 2.3);

– 15 min for a "fireproof" classification (see 2.4).

4.2 Test acceptance conditions

As conditions of acceptance, the item shall be capable of withstanding the fire test corresponding to the appropriate requirements and/or to its detailed specification.

Annex A
(normative)

Examples of burners providing the standard flame

A.1 Gas burner

A.1.1. Equipment

A.1.1.1 Supply of low pressure compressed air

The actual pressure requirement will depend on how the user sets up the equipment, but a low pressure supply (for example 35 kPa) with a free air flow of 25 m^3/h is usually sufficient. Alternatively, tapping a higher pressure supply through a regulator is acceptable.

A.1.1.2 Means of controlling and setting gas and air supplies

Means of controlling and setting gas and air supplies include manual valves and metering devices to measure differential pressure of gas and air, and, eventually, feature valve upstream pressure monitoring. For flow setting, figure A.3 indicates how to proceed using differential pressure across each orifice.

NOTE — BS 3G 100 part 2, section 3, subsection 3.13 (1983) shows measuring devices mounted with the burner head, but it has been established that they can be used satisfactorily at a console up to 4 m away if connected to the burner by pipes with a minimum bore diameter of 10 mm.

A.1.2 Details of the burner

The design of the burner is shown in figures A.1, A.2 and A.3 and a photograph of the burner is shown in figure A.4. Important features include:

a) the means of mixing gas and air for combustion at the "mixing base";

b) the design of the flame head;

c) the means of introducing cooling air within the structure of the flame head.

A.1.2.1 Mixing base

Air and gas are introduced and mixed in a small chamber. From this chamber, the mixed gas and air enters a larger plenum chamber before reaching the flame head.

A.1.2.2 Burner head

The burner head must act as a flame stabilizer and prevent flashback into the plenum chamber containing the combustible mixture. To do this, the burner is made up of 373 copper tubes which are cooled by air flowing around them. The cooling air is supplied through 332 holes at the flame head, thus maintaining the burner temperature at the level required for the test.

A.1.2.3 Cooling air

The cooling air shall be well-distributed within the structure of the flame head for the purpose described in A.1.2.2. The top plate and tubing, shown in figure A.1, are designed to produce the correct overall effect.

A.1.3 Flame setting

A.1.3.1 Lighting

It is easier to light the burner when the gas flow is reduced, but gas-rich. The following procedure is recommended:

– turn on the gas at a flow rate of about 0,5 m^3/h (12 mm differential water pressure);

– ignite the gas;

– if ignition does not occur within a few seconds, turn off the gas, purge the burner with mixing air and wait for low-lying gas near the burner to disperse;

– when ignition occurs, introduce mixing and cooling air, then immediately increase the gas flow rates and air flow rates to the intended level;

– in order for the heating conditions to stabilize, allow the apparatus to run for at least 5 min before calibrating the burner or starting the test.

A.1.3.2 Gas and air differential pressure settings

Table A.1 gives the typical gas and air settings needed to achieve the characteristics of the standard flame according to the metering devices of figure A.3.

Table A.1 — Typical settings for fire testing

	Gas	Mixing air	Cooling air
Differential pressure	440 Pa (45 mmH_2O)	4 265 Pa (435 mmH_2O)	2 940 Pa (300 mmH_2O)
NOTE — The above values may need adjusting to achieve the characteristics of the standard flame (see 2.2) and are established for a calorific value close to 93 000 kJ/m^3.			

A.1.4 Calibration

The burner shall be calibrated in accordance with annex B and shall meet the requirements for the standard flame (see 2.2). The nominal axial distance, *h*, between the burner nose and the surface of calibration equipment in practice is close to 75 mm (see figures A.1, B.2 and B.3).

A.1.5 Distance between burner and test specimen

The nominal axial distance $h \pm 10$ %, between the burner nose and the surface of the test specimen, shall be the one determined by the calibration of the flame.

A.1.6 Shut-down

After the test, the gas shall be turned off first.

The air flow shall be turned off only when the burner has cooled sufficiently.

A.2 Liquid fuel burner

The details of the liquid fuel burner specified in this annex are equivalent to those found in FAA Powerplant Engineering Report No. 3A. A typical liquid fuel burner complying with the requirements of this annex is shown in figure A.5.

A.2.1 Details of the burner

The liquid fuel burner shall :

a) be of a modified gun type;

b) have an 80° spray angle nozzle, nominally rated at 8,5 l/h (assuming a typical fuel calorific value of 42,8 x 10^3 kJ/kg);

c) have a 318 mm burner nozzle fixed at the end of the tube, with a 152 mm high and 280 mm wide opening, as shown in figures A.6 and A.7; and

d) have a burner fuel pressure regulator that is capable of adjusting the fuel flow to achieve the characteristics of the standard flame (see 2.2).

A.2.2 Flame setting

The burner shall be lit and adjusted in accordance with the manufacturer's instructions. The flame shall be allowed to stabilize for at least 5 min before calibration or testing.

A.2.3 Calibration

The burner shall be calibrated in accordance with annex B and shall meet the requirements for the standard flame (see 2.2). The nominal axial distance *h* between the end of the burner nozzle and the calibration equipment in practice is close to 100 mm (see figures A.6, B.2 and B.3).

A.2.4 Distance between burner and test specimen

The nominal axial distance *h* ± 10 % between the end of the burner nozzle and the test specimen shall be the one determined by the calibration of the flame.

Dimensions in inches,
in millimetres in parentheses

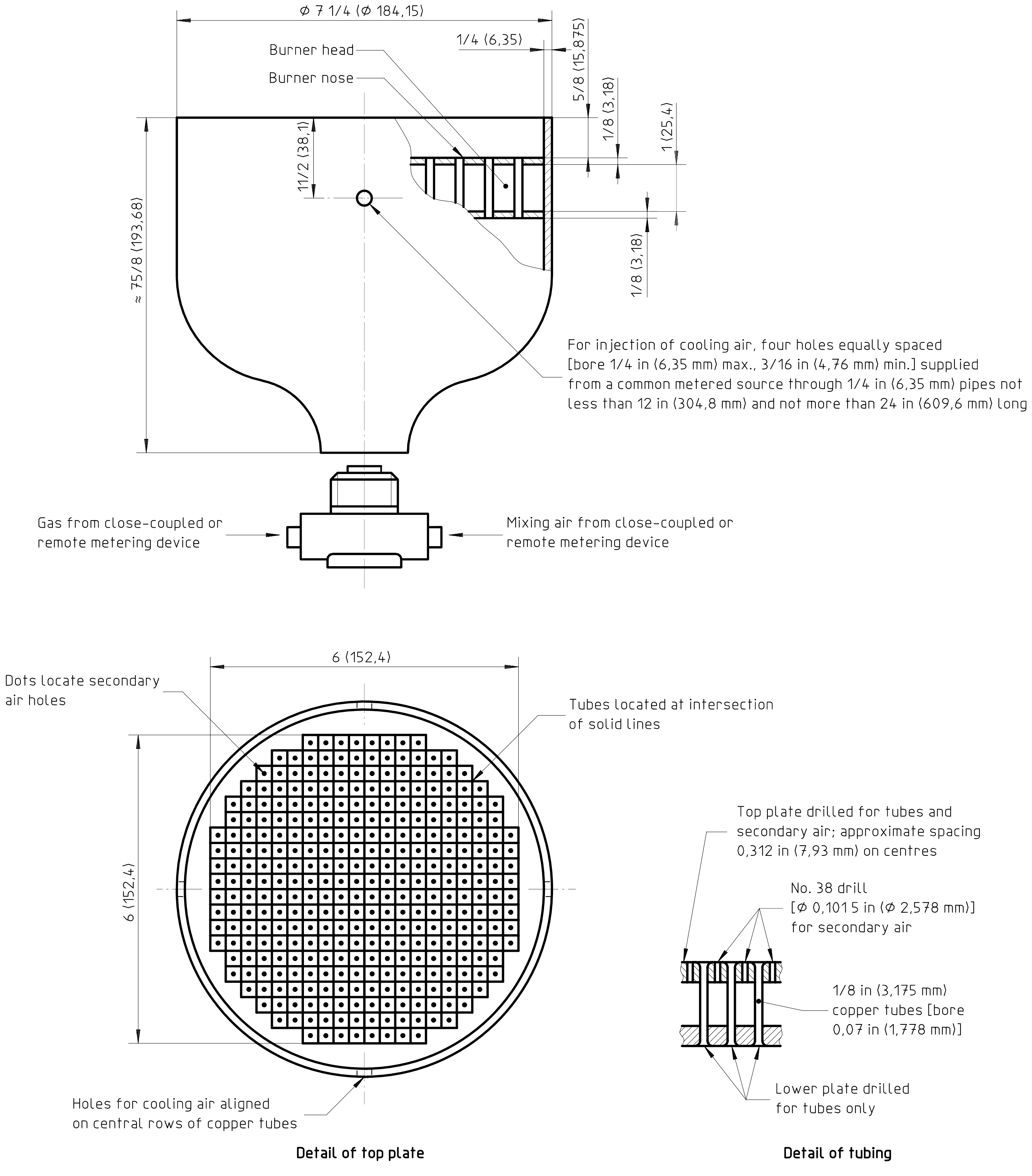
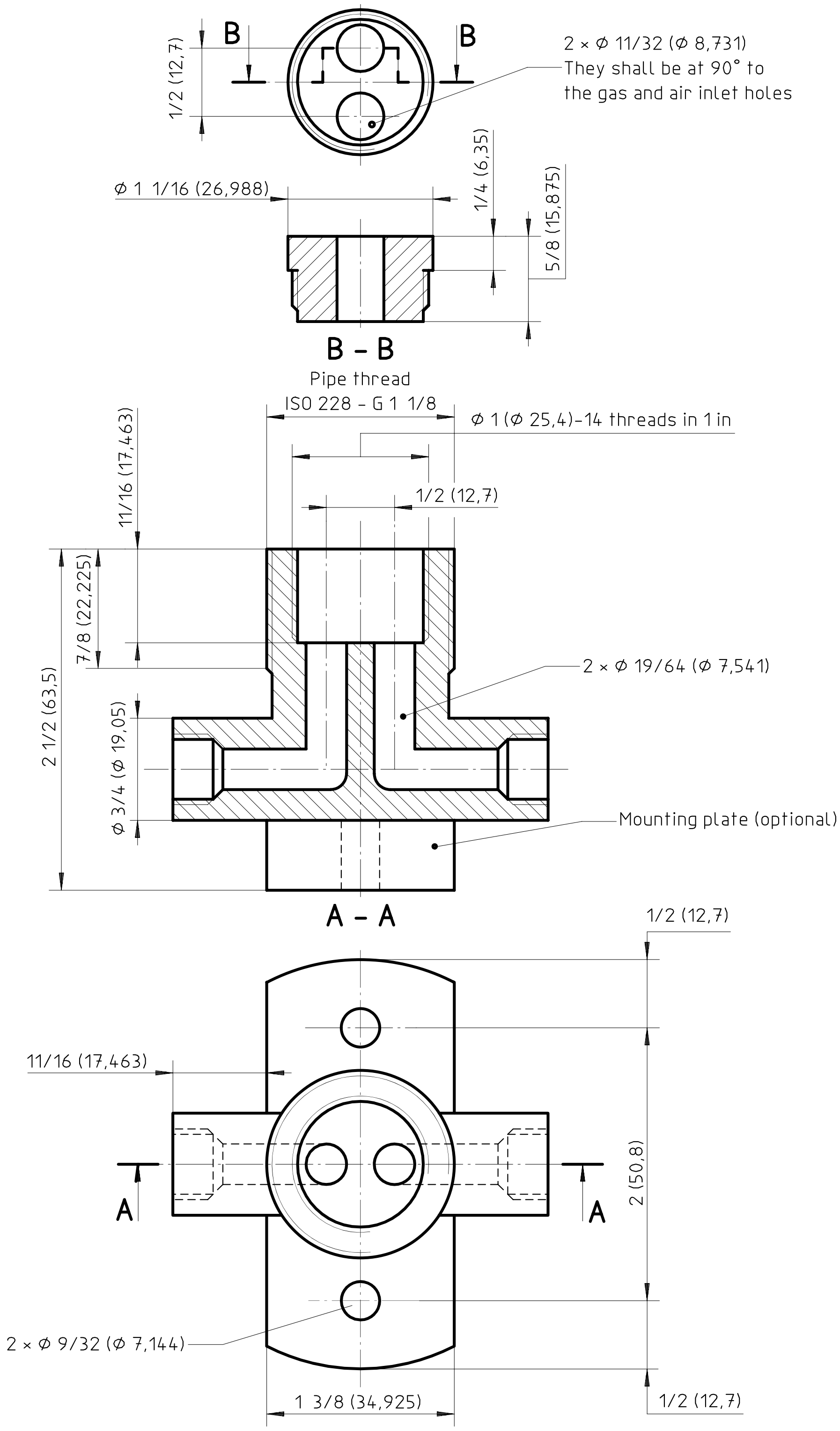


Figure A.1 — Gas burner

Dimensions in inches,
in millimetres in parentheses



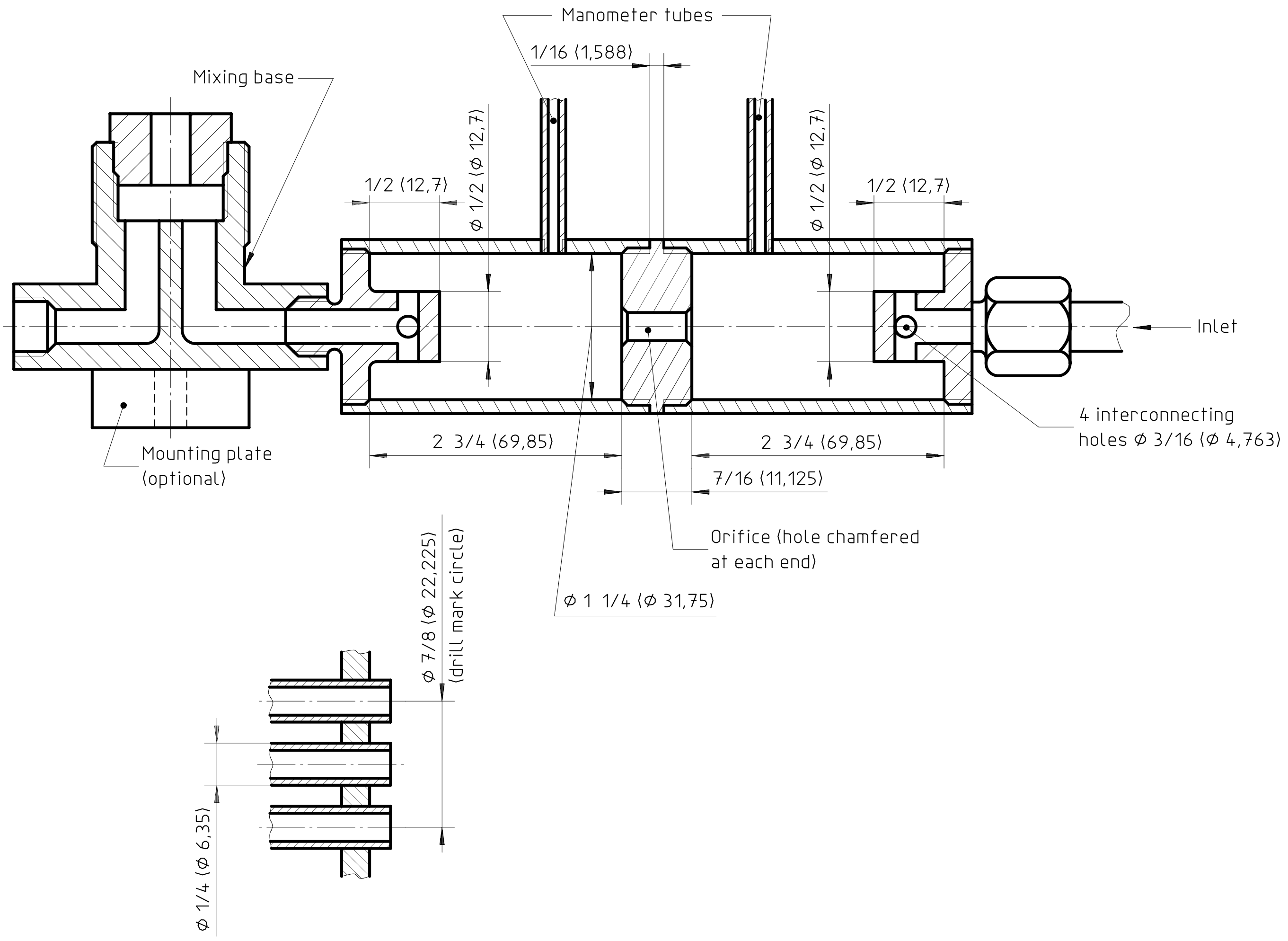
NOTES

1 AS401B gives additional constructional details.

2 The threads shall be sealed during mounting.

Figure A.2 — Gas burner — Mixing base

Dimensions in inches,
in millimetres in parentheses



4 pipes for cooling air

Metering end for cooling air

Orifice sizes

Gas	5/32 (3,969)
Mixing air	1/4 (6,35)
Cooling air	5/16 (7,938)

NOTES

1 When differential pressure values are stated for setting gas and air flows (see table A.1), they relate to the metering device above.

2 The equipment may be close-coupled to the burner, or may be remote if a different end-fitting with an air manifold for the cooling air connections is used.

3 The threads shall be sealed during mounting.

Figure A.3 — Gas burner — Metering device

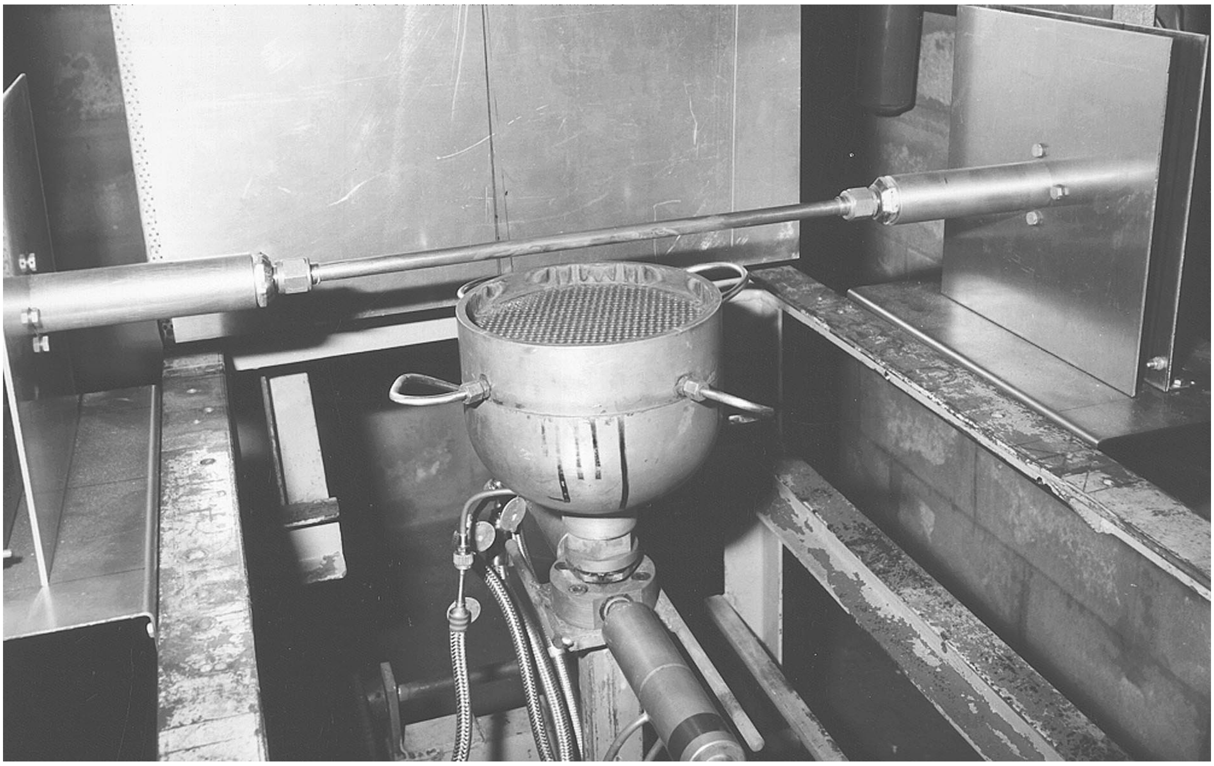


Figure A.4 — Gas burner

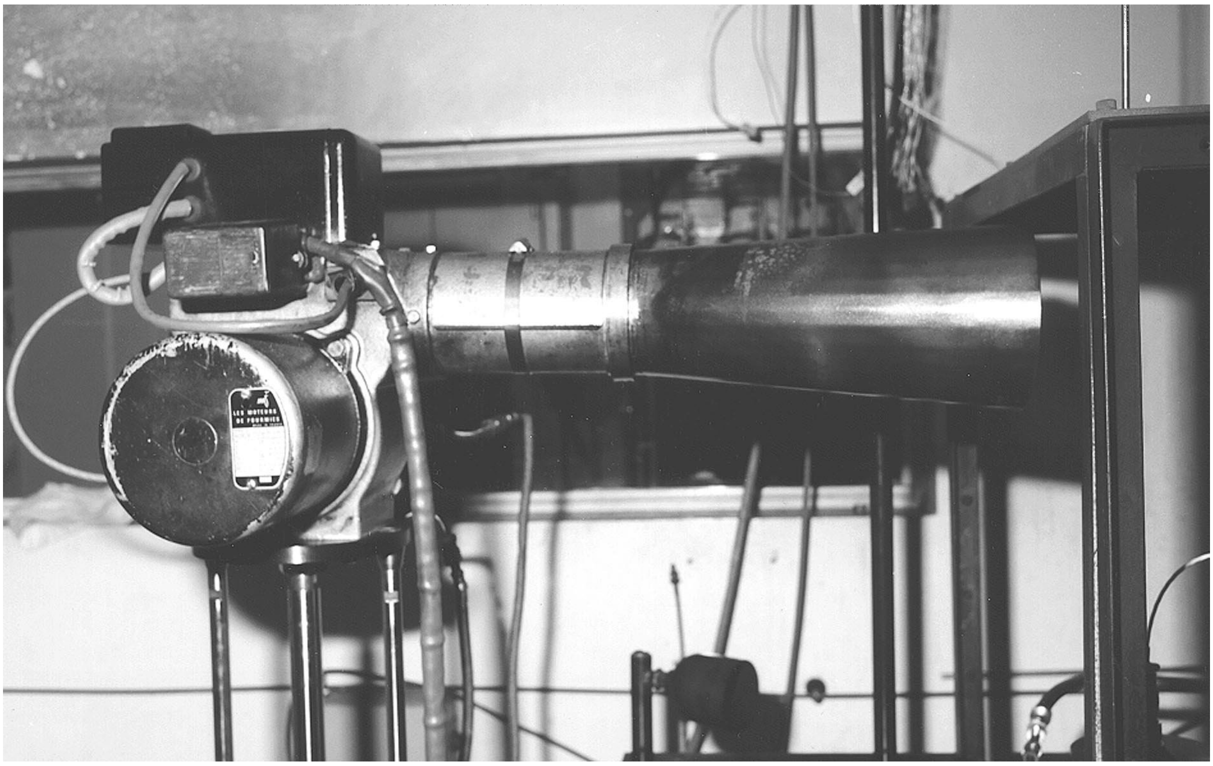
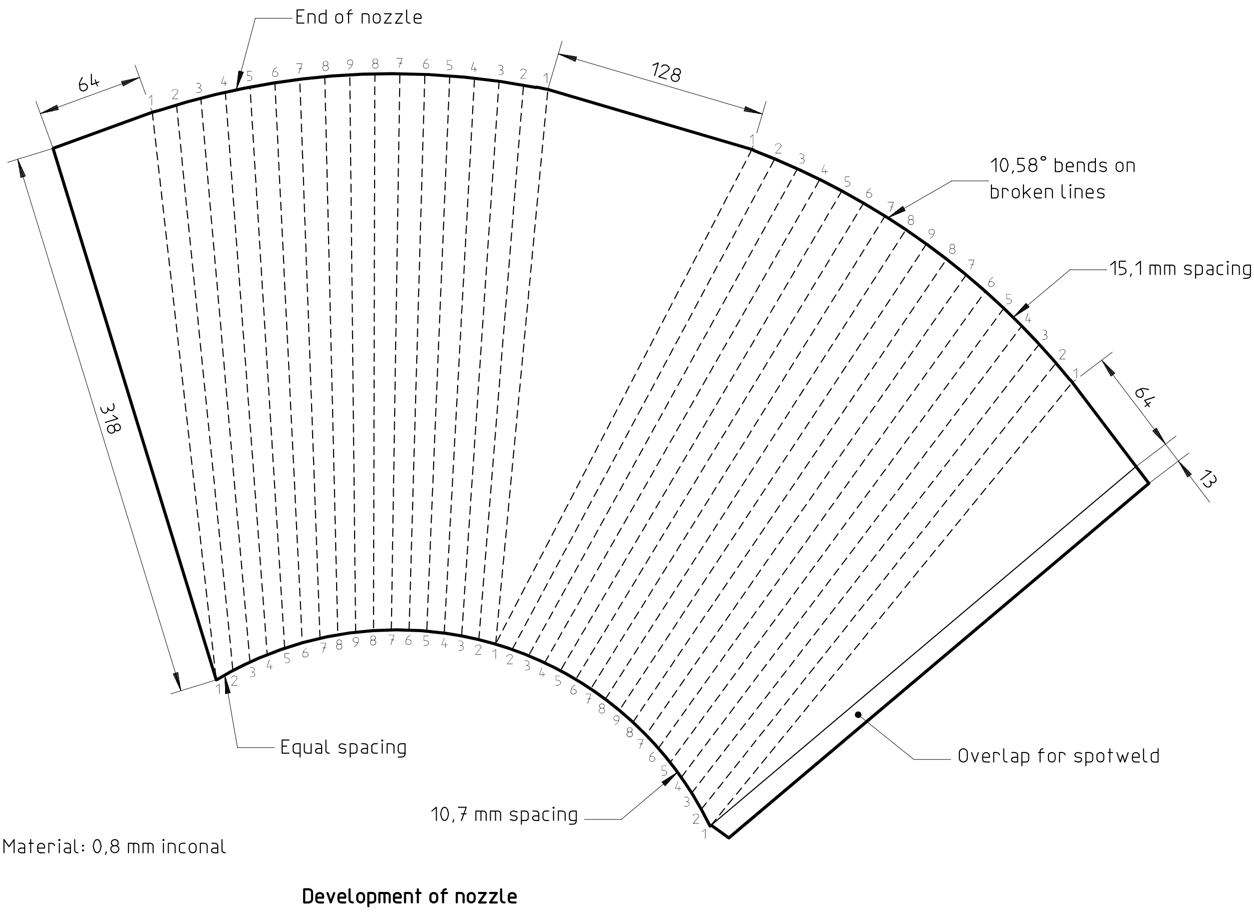
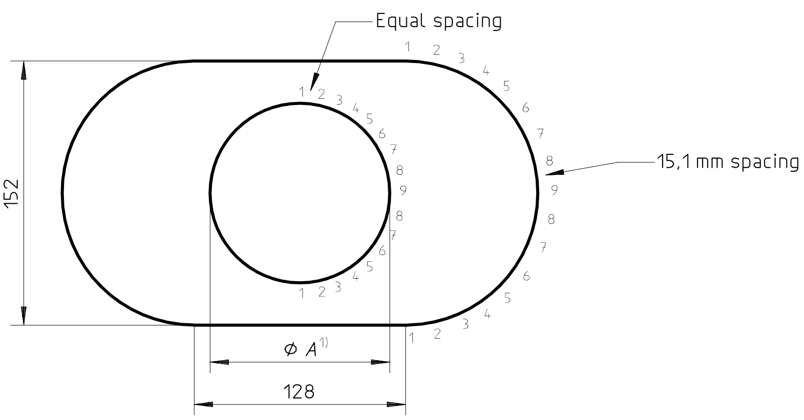


Figure A.5 — Liquid fuel burner

Dimensions in millimetres

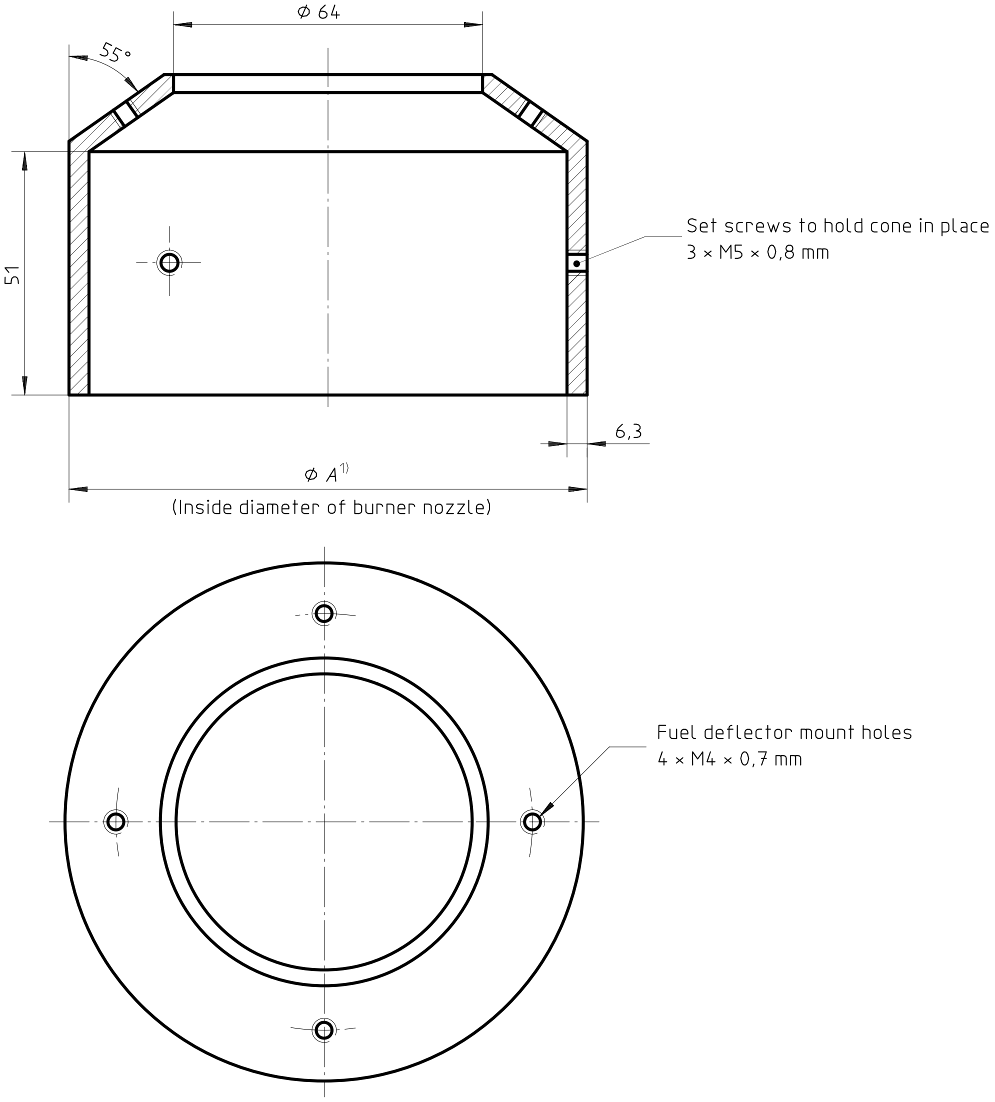




1) See figure A.7.

Figure A.6. — Liquid fuel burner nozzle

Dimensions in millimetres



Material: mild steel

1) See figure A.6.

Figure A.7 — Liquid fuel burner air tube reducing cone

Annex B
(normative)

Calibration procedure for burners

B.1 Calibration of burners

B.1.1 General

Before carrying out the calibration procedure, ignite the burner and adjust it in accordance with the relevant procedures. Run the burner for the prescribed warm-up period to allow the flame to stabilize.

It is recommended that the burner be set up away from the test specimen or the calibration equipment, but it should be possible to move it quickly to the correct position for fire testing or calibration. All such work should be carried out under essentially still conditions.

B.1.2. Temperature measurements

The flame temperature shall be measured at the appropriate axial distance from the burner (see annex A) to confirm that the conditions of the standard flame are achieved (see 2.2). The required equipment and the procedures to be used are described in B.3.

B.1.3 Measurements of heat flux density

Heat flux density shall be measured at the appropriate axial distance from the burner (see annex A) to verify that the conditions of the standard flame are achieved (see 2.2). The required equipment and the procedures to be used are described in B.4.

B.2 Calibration intervals

Once the burner has been calibrated in accordance with B.1, check the temperature according to annex A before proceeding with any tests. The burner shall be calibrated within periods acceptable to the approving authority, but they shall be no longer than 6 months.

B.3 Temperature calibration method

B.3.1 Thermocouple

The thermocouple shall be in accordance with the specifications given in figure B.1.

B.3.2 Procedure

The measured flame temperature shall ensure the required tolerance over at least 25 % of the burner area. For liquid fuel burners, the temperature measurement is acceptable if each of the seven thermocouple measuring points shown in figure B.2 measures a temperature of 1 100 °C ± 80 °C.
A similar approach is acceptable for other burners.

B.3.3 Other apparatus

An alternative type of temperature-measuring may be used if it offers the same guarantee of measurement.

B.4 Heat flux density calibration method

B.4.1 General

The burners may be calibrated by either of the equipments described in B.4.2 or B.4.3.

B.4.2 Heat flux density measuring standard apparatus

B.4.2.1 Details of apparatus

Burners may be calibrated using the continuous flow calorimeter apparatus shown in figure B.3. A constant head of water above the heat-transfer tube ensures consistent flow conditions. A valve on the outlet pipe enables the water flow rate to be adjusted during the test. Figures B.4 to B.9 specify the materials and dimensions of the heat-transfer tube and its associated fittings and thermometers location.

Since the temperature rise across the heat-transfer tube is small, mercury thermometers capable of reading to within 0,1 °C or immersion thermocouples shall be used.

B.4.2.2 Procedure

The following procedures shall be carried out:

a) the clean external surface of the copper tubing with fine steel wool before each test;

b) the water supply shall have a temperature between 10 °C and 21 °C;

c) adjust the water flow rate to 225 l/h (i.e. 62,5 x 10^{-6} m^3/s);

d) light the burner and adjust it to give 1 100 °C ± 80 °C at the appropriate axial distance from the burner (see annex A);

e) with the water flowing through the device, position the burner so that the heat-transfer tube is in the appropriate location (see annex A). Allow a 3 min warm-up period in order to obtain stable conditions before recording the temperature measurements.

NOTE — When warming up the flame, do not expose the heat-transfer tube to the flame; this minimizes carbon build-up on the tube.

f) during the test, record the temperatures indicated by the inlet and outlet thermometers every 30 s over a 3 min period.

B.4.2.3 Calculation of heat flux density

The heat flux density, q, in kilowatts per square metre, is given by:

$$q = \frac{q_V \rho c (T_2 - T_1)}{37{,}7 \times 10^{-3} \times L}$$

where:

q_V is the water volume flow rate, in cubic metres per second;

ρ is the density of water, in kilograms per cubic metre, at the mean temperature $(T_1 + T_2)/2$, i.e. approx. 1 000 kg/m^3;

c is the specific heat of water, in kilojoules per kilogram kelvin, at the mean temperature $(T_1 + T_2)/2$, i.e. approx. 4,185 kJ/(kg·K);

T_1 is the time-averaged water temperature, in degrees Celsius, at the entry to the heat transfer tube;

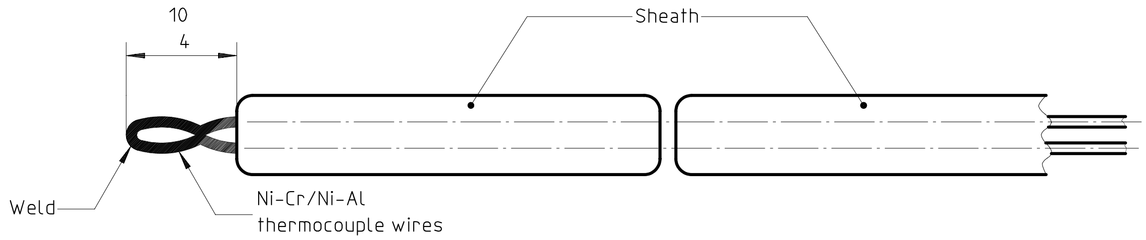
T_2 is the time-averaged water temperature, in degrees Celsius, at the exit from the heat-transfer tube;

L is the length, in metres, of the portion of the heat-transfer tube exposed to the flame.

B.4.3 Other equipment

Any alternative equipment may be used if it is calibrated with the equipment defined in B.4.2.

Dimensions in millimetres



NOTES

1 The diameter of the thermocouple wire shall be between 0,6 mm and 1 mm.

2 If a metal sheath is used, the maximum diameter shall not exceed 3 mm.

3 The thermocouple shall be unshielded and non-aspirated.

Figure B.1 — Details of thermocouple

Dimensions in millimetres

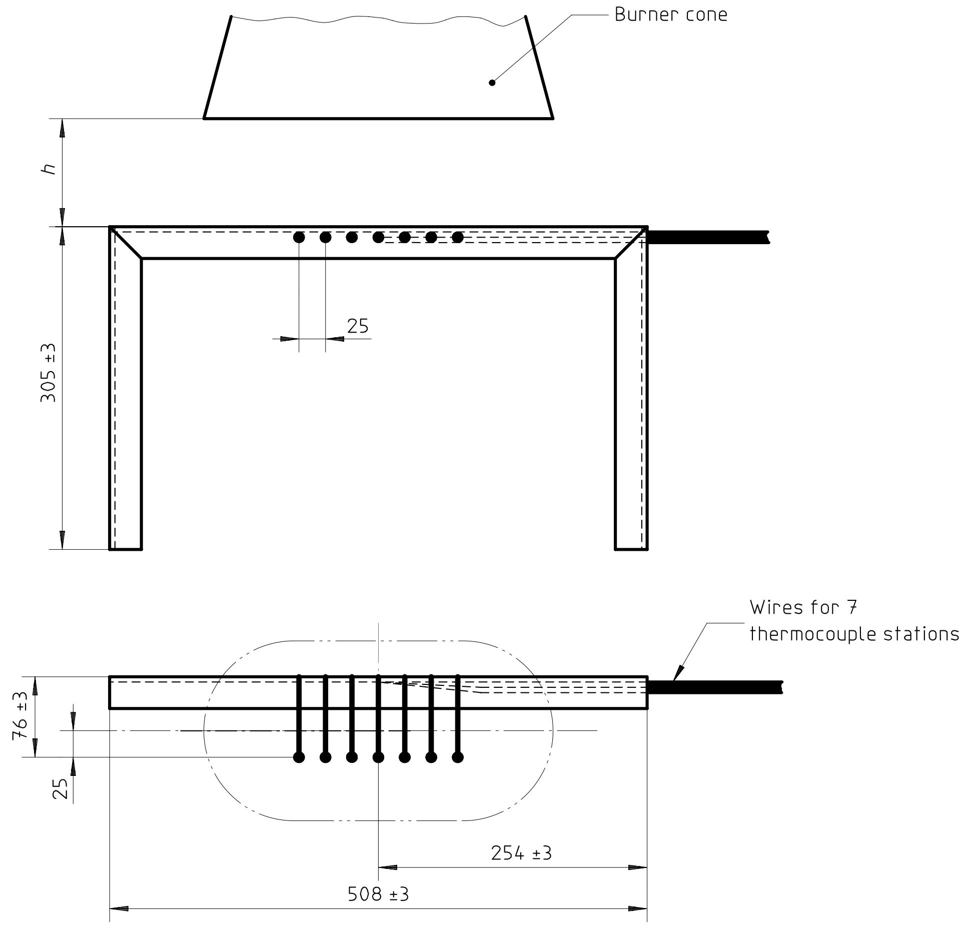


Figure B.2 — Liquid fuel burner — Thermocouple positions

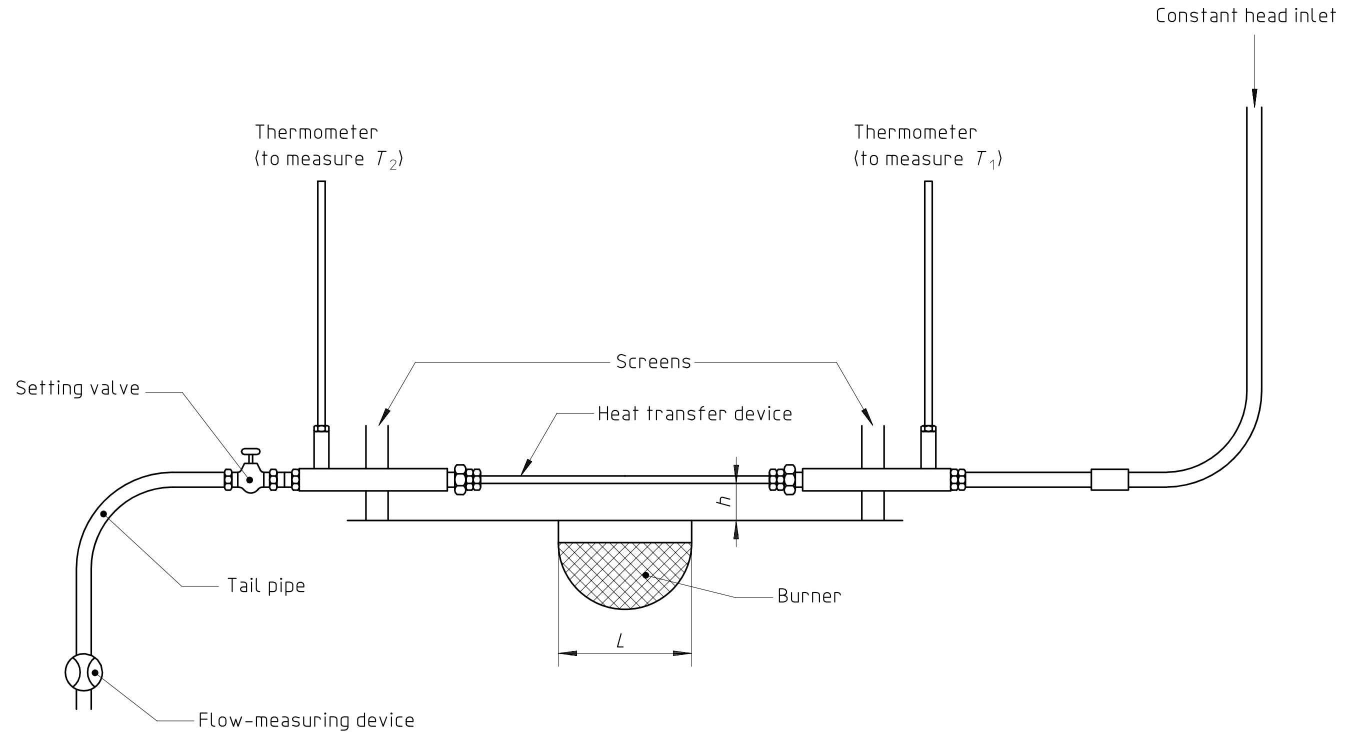


Figure B.3 — Set-up of the standard heat flux density measuring apparatus

Dimensions in millimetres

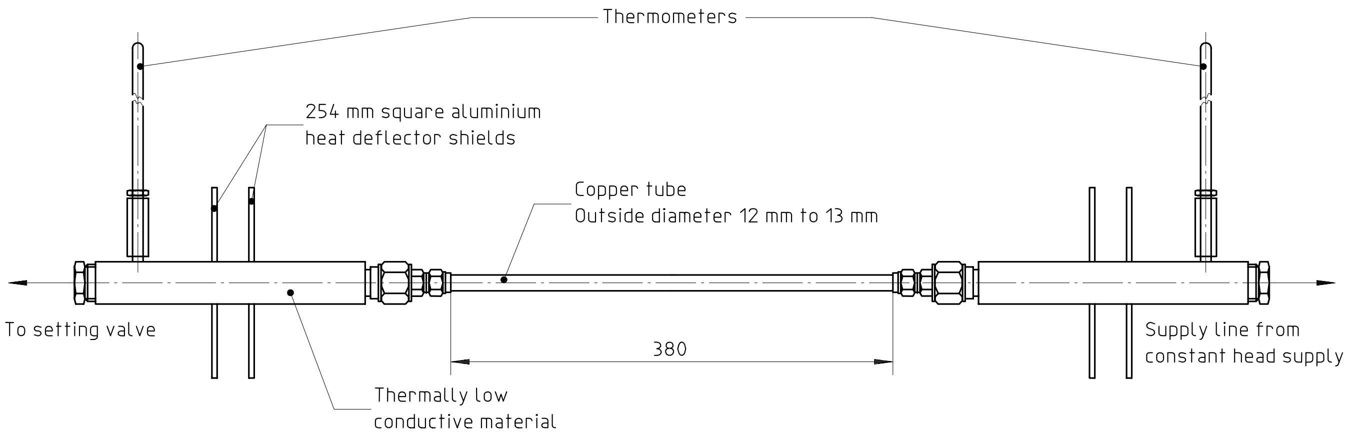
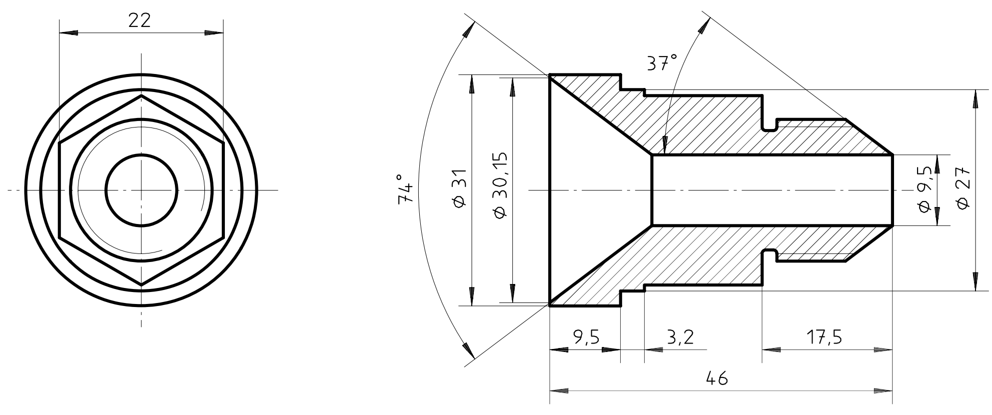


Figure B.4 — Overall view of the mounting of the standard heat flux density measuring tube

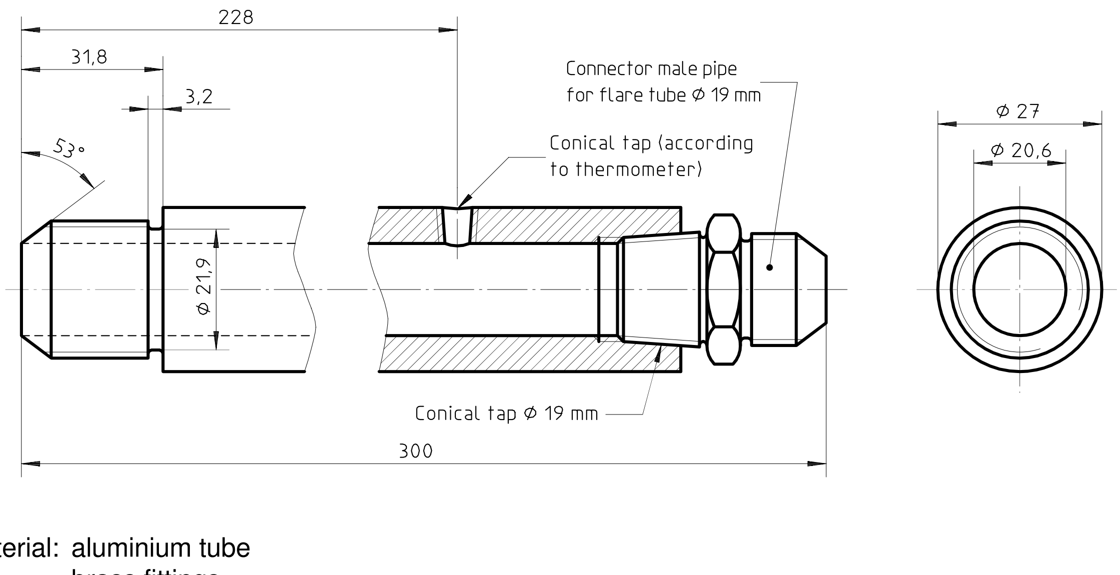
Dimensions in millimetres



Material: brass

Figure B.5 — Reducing fitting of the standard heat flux density measuring tube

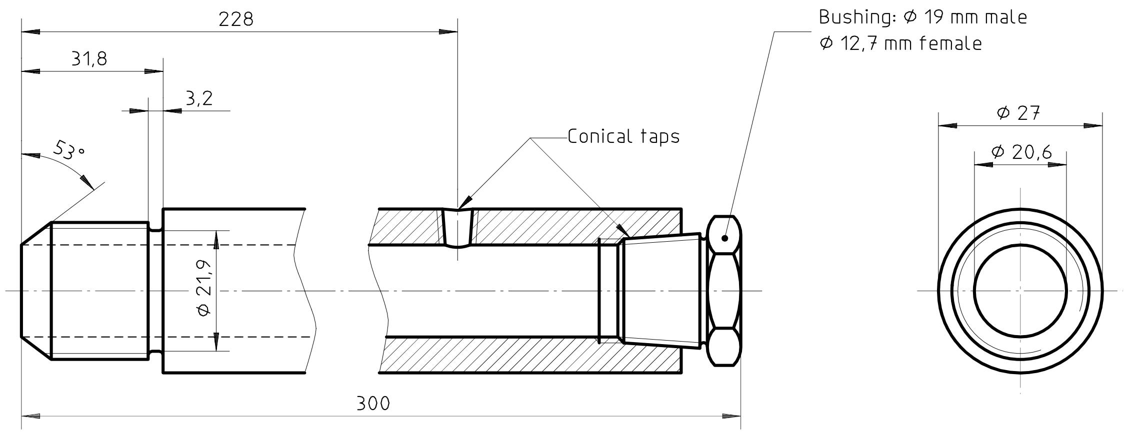
Dimensions in millimetres



Material: aluminium tube
brass fittings

Figure B.6 — Supply fitting of the standard heat flux density measuring tube

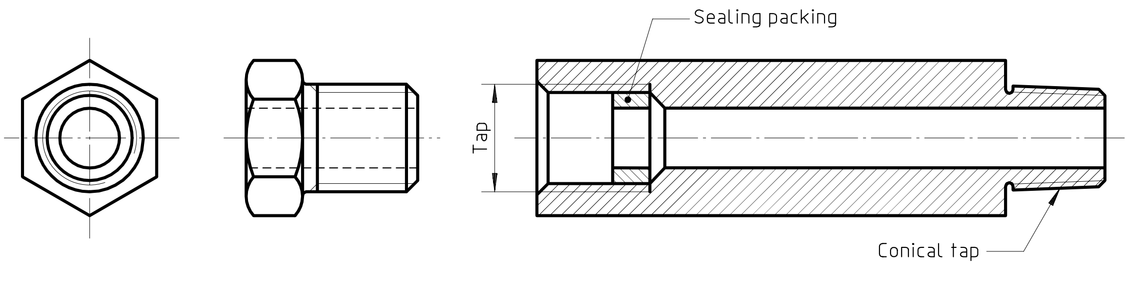
Dimensions in millimetres



Material: aluminium tube

Figure B.7 — Exit fitting of the standard heat flux density measuring tube

Dimensions in millimetres



Material: brass
Dimensions: function of the thermometer

Figure B.8 — Example of mounting of the thermometer of the standard heat flux density measuring tube

Dimensions in millimetres

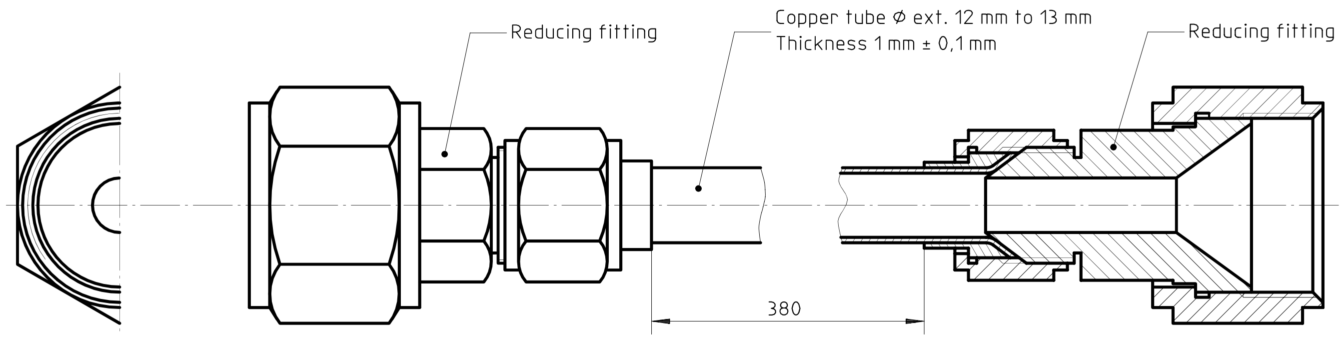


Figure B.9 — Overall view of the standard heat flux density measuring tube

Annex C
(informative)

Test conditions for fluid system components

C.1 General

This annex specifies the particular test conditions for flammable fluid systems and pneumatic systems components.

C.2 Standard flame

The component under test shall be subjected to a standard flame (see 2.2 and annex A).

C.3 Vibration

Flexible hose assemblies and components shall be vibrated along or perpendicular to the axis of the component at a frequency of 33 Hz and with a minimum amplitude of 1,6 mm.

C.4 Particular conditions

C.4.1 Pressure

The pressure shall be the working pressure of the component or, where specified, the system pressure may be substituted during the test.

C.4.2 Flow rates

Unless more critical flow rates are specified for the particular installation, the flow rates for the full test period shall be given as in C.4.2.1 to C.4.2.3.

NOTE — Fire tests in accordance with the American standard SAE AS 1055 D for equivalent flow rates are considered equivalent qualification.

C.4.2.1 Fuel and lubricating systems

– Pipes and flexible hose assemblies: flow rate, in litres per minute, shall be equal to

$$0{,}03\, d^2$$

where d is the internal diameter, expressed in millimetres.

– Other components: the flow rate shall be determined in the same way using the internal diameter of the inlet coupling.

The fluid shall be the system fluid or equivalent.

C.4.2.2 Hydraulic systems

– Pipes and flexible hose assemblies: flow rate, in litres per minute, shall be equal to

$$0{,}006\, d^2$$

where d is the internal diameter, expressed in millimetres.

– Other components: the flow rate shall be determined in the same way, using the internal diameter of the inlet coupling.

The fluid shall be the system fluid or equivalent.

C.4.2.3 Pneumatic systems

The flow rate in pneumatic pipes, hoses and components shall be zero unless otherwise specified.

C.5 Test procedure for hoses

The hose to be tested shall be not less than 60 cm long. Hoses shall be mounted horizontally and shall include one 90° bend. One end fitting and at least 12 cm of hose shall be enveloped by the test flame.

C.6 Fluid temperature

C.6.1 Liquid

The temperature of the fuel, lubricant or hydraulic fluid inside hoses shall be at least 93 °C to 110 °C. The fluid temperature for other components shall be the same unless otherwise specified.

C.6.2 Pneumatic

The temperature of the air or gas inside the component shall be not less than the maximum normal design temperature.

C.7 Test acceptance criteria

C.7.1 Fuel, lubricating and hydraulic systems

In addition to complying with 4.2, system components shall show no evidence of leakage over the test period specified in 4.1.4.

C.7.2 Pneumatic systems

In addition to complying with 4.2, system components shall show no evidence of significant leakage over the test period specified in 4.1.4.

Annex D
(informative)

Test conditions for electrical cables and connectors

D.1 General

This annex specifies the particular test conditions for electrical cables and connectors.

D.2 Vibration

The cable or connector specimen shall be vibrated across the axis of the component at a frequency of between 30 Hz and 60 Hz and with a minimum acceleration of $4g_n$.

D.3 Particular conditions for electrical cables

D.3.1 Standard flame

The cable specimen shall be subjected to a standard flame (see 2.2 and annex A).

D.3.2 Single core cables

Three test specimens 0,75 m long shall be selected at random from a quantity of cable and prepared for test in the following manner.

Each length of cable shall have the middle half-metre immersed in one of the listed fluids at ambient temperature for 24 h. A separate typical specimen shall be used for each fluid:

a) aviation fuel;

b) engine lubricating oil;

c) hydraulic oil.

After removal of surplus fluids from the cables, each length in turn shall be mounted onto a frame as shown in figure D.1. Each sample shall be wrapped once around with two nickel-chrome ribbons with their inner edges spaced 25 mm ± 5 mm apart. The sample and test ribbons shall be weighted, as shown in figure D.1, and the test assembly adjusted so that the area wrapped by the ribbons is located at the appropriate distance above the burner where the temperature is 1 100 °C. After tensioning with weights, thesamples and test ribbons shall be locked at the pulley position to avoid the weights giving high loading under vibration/resonant conditions.

The test sample shall be connected to a circuit as shown in figure D.2. Sample continuity is shown when a current flow of 2 A is registered with the electrical supply switched on. The insulation degradation detection circuit shall be checked by depressing the test switch; an indication of 25 mA flow should be registered.

D.3.3 Multi-core cables

Three test specimens shall be prepared for test as described in D.3.2.

Each test specimen shall be mounted onto the test frame over the burner in a manner similar to that shown in figure D.1, using the appropriate weight.

The test samples shall in turn be connected to a circuit as shown in figure D.3, test 1. Pre-test checks shall be carried out as described in D.3.2. Vibration on the mounting frame shall be as described in D.2.

D.3.4 Multi-screened cables

Multi-core screened cables are overall screen (metal braid) cables in close contact with the individual cores.

Three test specimens shall be prepared for test as described in D.3.2.

Each test specimen shall be mounted onto the test frame over the burner in a manner similar to that shown in figure D.1, using the appropriate weight.

The test samples shall in turn be connected to a circuit as shown in figure D.3, test 2. Pre-test checks shall be carried out as described in D.3.2. Vibration on the mounting frame shall be as described in D.2.

D.3.5 Acceptance criteria

The cables shall be declared fire resistant if there is continuity through the test specimen for 5 min of flame impingement, and the resistance of the insulation during the same period is not less than 10 000 Ω. If the cable is to be declared fireproof, the test period shall be extended to 15 min.

D.4 Particular conditions for electrical connectors

D.4.1 Standard flame

The connector shall be subjected to a standard flame (see 2.2 and annex A).

D.4.2 Wiring of specimen connector

The connector shall be wired as shown in figure D.4, using fire resistant wiring. Each contact shall be connected in series. The load shall be set to give a constant current equal to the nominal value specified for the connector.

D.4.3 Mounting of connector specimen

The mated connector pair, together with the required accessories, shall be mounted as shown in figure D.5.

D.4.4 Acceptance criteria

Connectors with a requirement for electrical functioning shall be declared fire resistant if no electrical failure occurs over a period of 5 min. During the 5 min application of the flame, switch 1 shall be closed and switch 2 shall be open. After 5 min, open switch 1 and close switch 2.

Electrical failure will be assumed if, during the first 5 min, there is any electrical discontinuity or if, during a further 1 min, there is any leakage in excess of the value specified for the connector.

In the case of connectors intended for use in firewall applications, no flame shall pass from one side of the mounting plate to the other, nor shall there be any spontaneous ignition on the side of the plate away from the flame, over a period of 15 min.

The above tests may be carried out simultaneously.

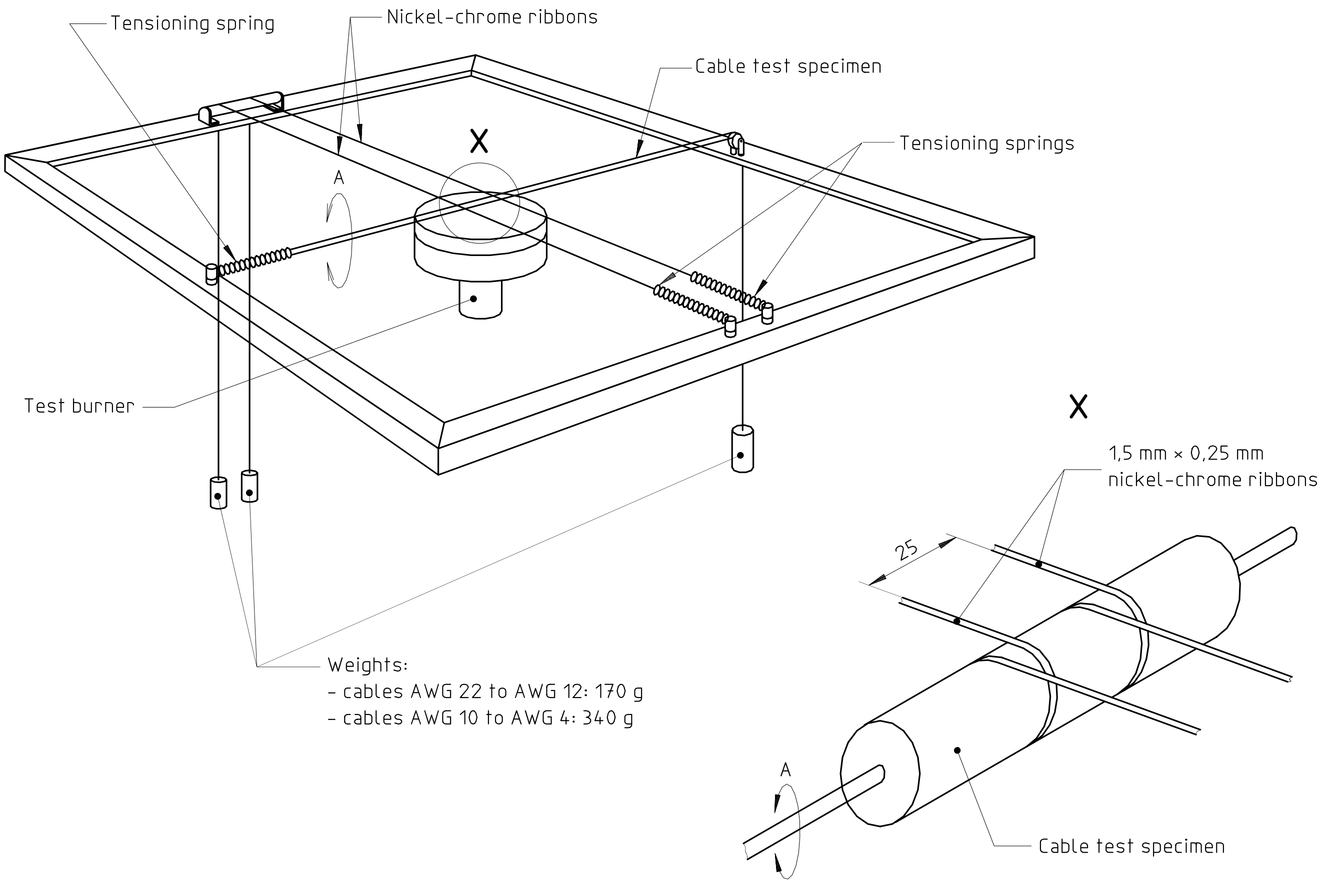
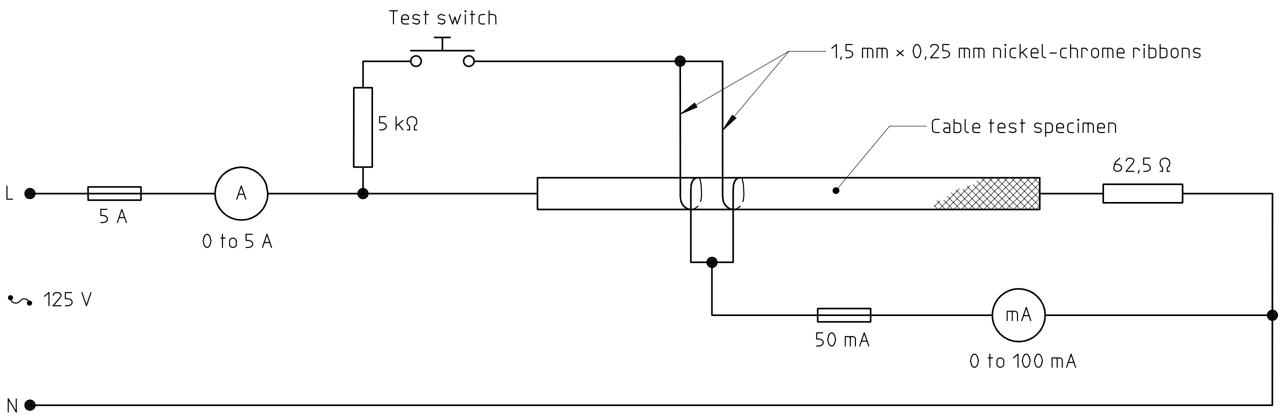


Figure D.1 — Electrical cable test rig



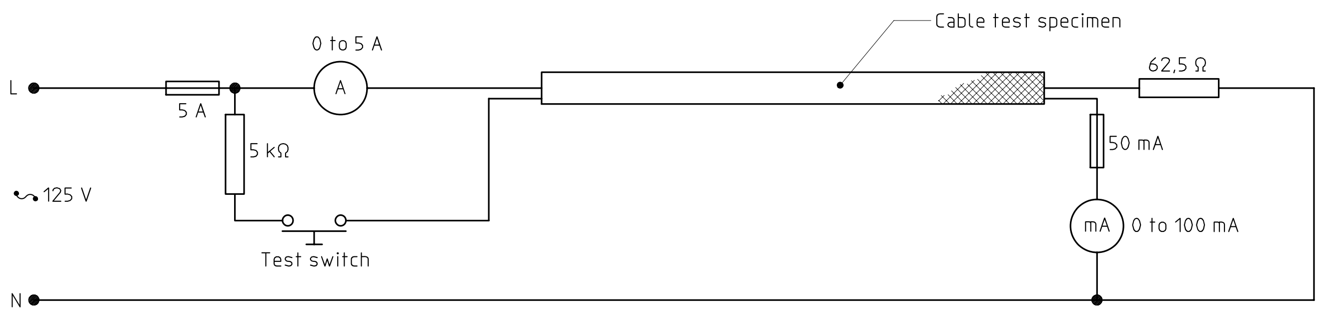
Procedure:

a) Note the line current (approximately 2 A).

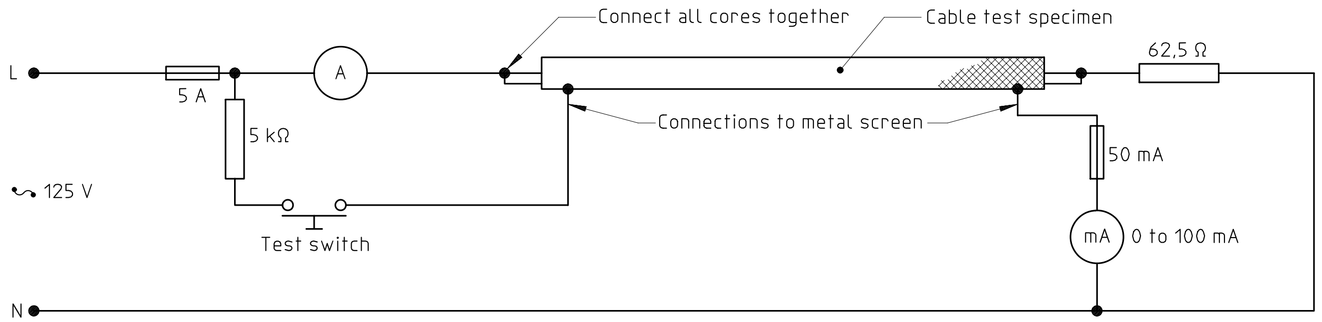
b) Operate the switch and observe a 25 mA reading.

c) Leakage current flow shall not exceed 12,5 mA during the test period.

Figure D.2 — Circuit diagram for single-core cables



a) Test 1 - Core-to-core integrity



b) Test 2 - Core-to-screen integrity

Procedure:

a) Note the line current (approximately 2 A).

b) Operate the switch and observe a 25 mA reading.

c) Leakage current flow shall not exceed 12,5 mA during the period of tests 1 and 2.

Figure D.3 — Circuit diagram for multicore cables

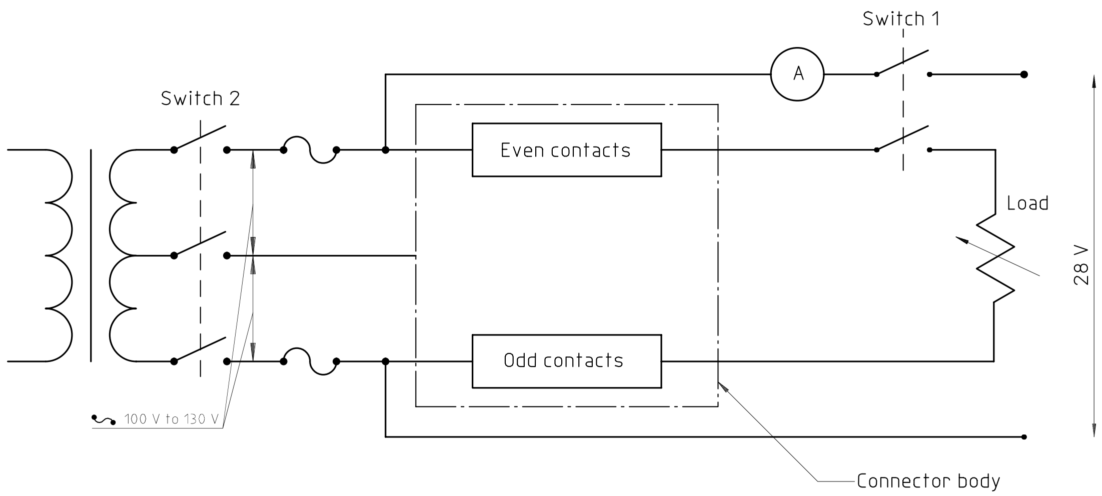


Figure D.4 — Test circuit diagram for connectors

Dimensions in millimetres

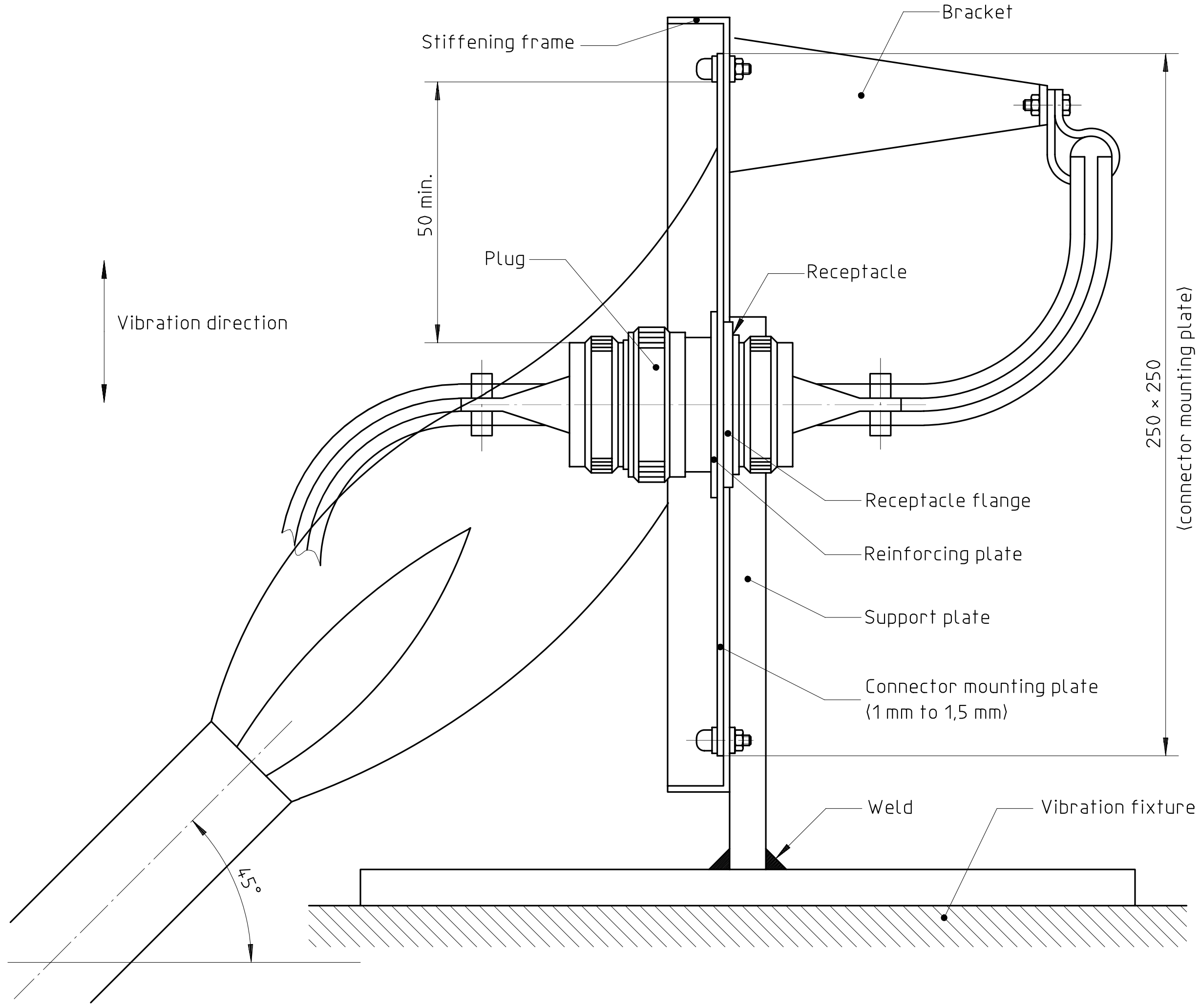


Figure D.5 — Test rig for connectors

Annex E
(informative)

Test conditions for structural components

E.1 General

This annex specifies the particular test conditions for structural components (for example engine mountings, cowlings, firewalls).

E.2 Standard flame

The component shall be subjected to a standard flame (see 2.2 and annex A).

E.3 Vibration

Components shall be vibrated at an amplitude of 0,4 mm at the non-resonant frequency closest to 50 Hz.

It is expected that all metallic matrix structures, non-metallic structures and other non-metallic fire barrier coatings will be vibrated during the fire-test. Large metallic structures may not be required to be vibrated.

E.4 Test periods

For the first 5 min of the test, structural components shall be tested while subjected to loads corresponding to normal manoeuvres and any superimposed loads resulting from vibration normally experienced in flight. After the first 5 min, fireproof grade tests shall be carried out using loads corresponding to those which apply after engine shut-down.

E.5 Acceptance criteria

Structural components shall meet the acceptance criteria of 4.2 and shall be capable of withstanding the loads specified in E.4 throughout the test period.

Annex F
(informative)

Conversion factors

NOTE — In clauses F.1, F.3 and F.5, exact values are printed in bold face type.

F.1 Length

	m	mm	ft	in
1 m (metre)	**1**	**1 000**	3,280 84	39,370 1
1 mm (millimetre)	**0,001**	**1**	0,003 28	0,039 37
1 ft (foot)	**0,304 8**	**304,8**	**1**	**12**
1 in (inch)	**0,025 4**	**25,4**	0,083 33	**1**

F.2 Volume flow rate

	US gal/min	UK gal/min	m^3/h
1 US gal/min (US gallon per minute)	**1**	0,832 67	0,227 12
1 UK gal/min (UK gallon per minute)	1,200 95	**1**	0,272 77
1 m^3/h (cubic metre per hour)	4,402 86	3,666 15	**1**

F.3 Pressure

	lbf/in^2	inH_2O	kPa	mbar
1 lbf/in^2 (pound force per square inch)	**1**	0,036 127	6,894 76	68,947 6
1 inH_2O (inch of water)	27,680 1	**1**	0,249 089	2,490 89
1 kPa (kilopascal)	0,145 04	4,014 63	**1**	**10**
1 mbar (millibar)	0,014 504	0,401 463	**0,1**	**1**

F.4 Temperature

Degrees Celsius = $\frac{5}{9}$ (degrees Fahrenheit – 32)

F.5 Heat and related values

Heat:

1 CHU (centigrade heat unit) = **1,8** Btu (British thermal units)

1 Btu (British thermal unit) = 1,055 06 kJ (kilojoules)

Calorific value (volume basis)

1 kJ/m^3 (kilojoules per cubic metre) = 26,839 2 × 10^{-6} Btu/ft^3 (British thermal units per cubic foot)

Calorific value (mass basis)

1 Btu/lb (British thermal unit per pound) = **2,326** kJ/kg (kilojoules per kilogram)

Power:

1 CHU/s (centigrade heat unit per second) = 1,899 1 kW (kilowatts)

1 Btu/s (British thermal unit per second) = 1,055 06 kW (kilowatts)

Heat flux density

1 CHU/($ft^2 \cdot s$) (centigrade heat unit per square foot second) = 20,441 74 kW/m^2 (kilowatts per square metre)

1 Btu/($ft^2 \cdot s$) (British thermal unit per square foot second) = 11,356 52 kW/m^2 (kilowatts per square metre)

F.6 Acceleration

$1g_n$ = 9,806 65 m/s^2 (metres per second squared)

Annex G
(informative)

Bibliography

[1] ISO 228-1:1994, *Pipe threads where pressure-tight joints are not made on the threads — Part 1: Dimensions, tolerances and designation.*

[2] BS 3G 100, Part 2, Section 3, Sub-section 3.13:1973, *Specification for general requirements for equipment for use in aircraft. All equipment. Environmental conditions. Resistance to fire in designated fire zones.*

[3] FAA Powerplant Engineering Report n° 3A, *Standard Fire Test Apparatus and Procedure*, March 1978.

[4] FAA AC 20-135, *Powerplant installation and propulsion system component fire protection — Test methods, standards and criteria.*

[5] AS1055D:1997, *Fire testing of flexible hose, tube assemblies, coils, fittings, and similar system components.*

ICS 49.020

Descriptors: aircraft, aircraft equipment, tests, environmental tests, fire tests, determination, fire resistance, testing conditions, test equipment.

Price based on 29 pages