BRITISH STANDARD

Specification for direct gas-fired forced convection air heaters with rated heat inputs greater than 330 kW but not exceeding 2 MW for industrial and commercial space heating – Safety and performance requirements (excluding electrical requirements) (2nd family gases)

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Contents

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 40, an inside back cover and a back cover.

Foreword

Publishing information

This British Standard was published by BSI and came into effect on 20 July 2006. It was prepared by Subcommittee GSE/20/4, *Air heaters (gas)*, under the authority of Technical Committee GSE/20, *Non-domestic space heaters (gas)*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

This British Standard supersedes BS 5990:1990 (including Amendment 1:1990), which is withdrawn.

Relationship with other publications

Requirements for appliances with rated heat inputs up to 300 kW based on the net calorific value are given in BS EN 525:1998.

Corresponding requirements for indirect gas fired forced convection air heaters are specified in BS 5991.

Electrical requirements, applicable for both direct and indirect gas-fired forced convection air heaters, are specified in BS 5986.

Information about this document

This new edition of BS 5990 incorporates changes made necessary by the publication of BS EN 525:1998. It does not represent a full review or revision of the standard, which will be undertaken in due course.

This edition has been prepared in order to fulfil the obligation to withdraw conflicting national standards. As a consequence, it no longer applies to appliances with rated heat inputs up to 330 kW based on the gross calorific (300 kW based on the net calorific value).

Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its requirements are expressed in sentences in which the principal auxiliary verb is “shall”.

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

1 Scope

This British Standard gives detailed requirements, including safety and performance requirements and methods of test, for direct gas fired forced convection air heaters having heat inputs greater than 330 kW but not exceeding 2 MW, intended for industrial and commercial applications. Appliances covered by this standard are not intended for installation in domestic dwellings.

The scope of this standard includes direct gas fired forced convection air heaters for use both with and without ducting, and intended primarily for space heating applications. It therefore includes air heaters designed to provide make-up air, door curtain heaters, spray booth heaters, portable air heaters and direct fired air heaters capable of providing full space heating.

This standard specifies the requirements for direct gas fired forced convection air heaters designed for permanent outdoor installation. It also specifies the requirements for transportable direct gas fired forced convection air heaters.

This standard applies to appliances designed to operate on normal low pressure district supplies of 2nd family gas.

For appliances fitted with gas boosters, additional requirements may apply.

2 Normative references

The following referenced documents are indispensable for the application 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.

BS 10, *Specification for flanges and bolting for pipes, valves and fittings*

BS 476-4, *Fire test on building materials and structures – Part 4: Non-combustibility test for materials*

BS 476-7, *Fire test on building materials and structures – Part 7: Method for classification of the surface spread of flame of products*

BS 476-12, *Fire test on building materials and structures – Part 12: Methods of test for ignitability of products by direct flame impingement*

BS 1042-2.1 (ISO 3966), *Measurement of fluid flow in closed conduits – Part 2.1: Method using Pitot static tubes*

BS 1179-6, *Glossary of terms used in the gas industry – Part 6: Combustion and utilization including installation at consumers' premises*

BS 4921, *Specification for sherardized coating on iron or steel*

BS 5000-11, *Specification for rotating electrical machines of particular types or for particular application – Part 11: Small power electric motors and generators*

BS 5986, *Specification for electrical safety and performance of gas fired space heating appliances with inputs 60 kW to 2MW*

BS 6230, *Specification for installation of gas-fired forced convection air heaters for commercial and industrial space heating (2nd and 3rd family gases)*

BS 6501-1, *Metal hose assemblies – Guidance on the construction and use of corrugated hose assemblies*

BS EN 88, *Pressure governors for gas appliances for inlet pressures up to 200 mbar*

BS EN 161, *Automatic shut-off valves for gas burners and gas burning appliances*

BS EN 257, *Mechanical thermostats for gas burning appliances*

BS EN 298, *Automatic gas burner control systems for gas burners and gas burning appliances with or without fans*

BS EN 437, *Test gases – Test pressures – Appliance categories*

BS EN 525:1998, *Non-domestic direct gas-fired forced convection air heaters for space heating not exceeding a net heat input of 300 kW*

BS EN 1092-1, *Flanges and their joints – Circular flanges for pipes, valves, fittings and accessories, PN designated – Part 1: Steel flanges*

BS EN 1092-3, *Flanges and their joints – Circular flanges for pipes, valves, fittings and accessories, PN designated – Part 3: Steel flanges*

BS EN 1515-1, *Flanges and their joints – Bolting – Part 1: Selection of bolting*

BS EN 10143, *Continuously hot-dip metal coated steel sheet and strip – Tolerances on dimensions and shapes*

BS EN 10226-1, *Pipe threads where pressure tight joints are made on the threads. Taper external threads and parallel internal threads – Part 1: Dimensions, tolerances and designation*

BS EN 10226-2, *Pipe threads where pressure tight joints are made on the threads. Taper external threads and taper internal threads – Part 2: Dimensions, tolerances and designation*

BS EN 12329, *Corrosion protection of metals – Electrodeposited coatings of zinc with supplementary treatment on iron or steel*

BS EN 12540, *Corrosion protection of metals – Electrodeposited coatings of nickel, nickel plus chromium, copper plus nickel and copper plus nickel plus chromium*

BS EN 55014-1, *Electromagnetic compatibility – Requirements for household appliances, electric tools and similar apparatus – Part 1: Emission*

BS EN 60730-2-9, *Automatic electrical controls for household and similar use – Part 2-9: Particular requirements for temperature sensing controls*

BS EN 61032, *Protection of persons and equipment by enclosures – Probes for verification.*

BS EN ISO 1461, *Hot dip galvanized coatings on fabricated iron and steel articles – Specifications and test methods*

3 Terms and definitions

For the purposes of this British Standard, the terms and definitions given in BS 1179-6, BS 6230 and the following apply.

3.1 air-gas ratio control

system that automatically controls gas and air flow rates so as to maintain the desired air-gas ratio throughout the heat input range of the appliance

3.2 air temperature control

temperature-actuated control intended to maintain the temperature of the discharged air between specified limits; this is the normal means of air temperature control

3.3 automatic recycling

automatic repetition of the starting up sequence without manual intervention

3.4 burner

combustion system under the control of a single system of safety shut-off valves

NOTE 1 An appliance may have more than one burner and a burner may comprise a number of separate nozzles or bars.

NOTE 2 This definition differs from that given in BS 1179-6.

3.5 direct fired forced convection air heater

forced convection air heater in which the products of combustion mix with the heated air being supplied to the space

3.6 forced convection air heater

appliance designed to provide space heating from a central source by distributing heated air, by means of an air-moving device, either through ducting or directly into the heated space

3.7 hazardous condition

condition that could result in damage external to the appliance and/or injury to personnel

3.8 high temperature direct fired forced convection air heater

direct fired forced convection air heater designed to operate with an air temperature rise through the appliance greater than 55 K

3.9 lock-out

safety shut-down condition of a control system such that restart cannot be accomplished without manual intervention

3.10 low temperature direct fired forced convection air heater

direct fired forced convection air heater designed to operate with a maximum air temperature rise through the appliance of 55 K or less

3.11 overheat (limit) control

overheat control is a temperature-actuated device preset and sealed by the manufacturer and designed to protect the appliance and its surroundings in the event of failure of the normal means of temperature control

NOTE This definition differs from that given in BS 1179-6.

3.12 profile plates

adjustable plates fitted for the purpose of setting the air flow velocity across the burner

3.13 proved air flow

minimum air flow at which the air proving device indicates the presence of air flow

3.14 rated heat input

appliance manufacturer's declared heat input for the appropriate reference test gas

3.15 safety shut-down

action of shutting off all gas and ignition energy by means of a safety control such that restart takes place only after manual intervention or automatic recycling

3.16 setting pressure

pressure, measured at the pressure test point, that is specified by the manufacturer for the purpose of adjusting the appliance heat input

3.17 start-gas flame

flame established at the start-gas rate

NOTE This may either be a pilot flame or the main burner flame at reduced rate.

3.18 transportable direct fired forced convection air heater

trolley or skid-mounted direct fired forced convection air heater designed to operate with a maximum air temperature rise through the appliance of 55 K or less

4 Classification of appliances

4.1 By category

BS EN 437 describes the category system of appliance classification in which an appliance is denoted by a category number I, II or III according to the number of gas families that it is designed to burn, these families being identified by subscript numbers 1, 2 and 3 for the 1st, 2nd and 3rd families respectively, and subscript letters identifying specific gas groups.

This standard is concerned with appliances of category I_{2H} only.

4.2 By flue type

Appliances are also classified according to the flue system for which they are designed and the source of combustion air.

- Type A: flueless appliances.
- Type B: open-flued appliances.
- Type C: room-sealed appliances.
- Type C_1: balanced flue appliances.
- Type C_2: se-duct appliances.

This standard is concerned with appliances of type A only.

5 General requirements

The appliance shall conform to the requirements of this standard when tested using the test gases specified in BS EN 437 for group H 2nd family gas.

Appliances submitted for test shall be supplied complete with all ancillary equipment, e.g. air filter, bird screens, etc. necessary for normal installation and operation.

Any new features incorporated in an appliance for which no provision for testing is made in this standard shall not adversely affect the safe and correct operation of the appliance. The new features shall be examined in the light of the manufacturer's claims and instructions. The claims shall be checked against the instructions and shall be valid.

Notwithstanding the requirements in this standard, any new designs, materials and methods of assembly are permissible provided that at least equivalent results are achieved.

6 General conditions of test

6.1 Test room

The test room shall be adequately ventilated but free from draughts that are likely to affect the performance of the appliance.

The temperature in the test room shall be maintained at (20 ± 5) °C.

The air in the test room, and any external air supply, shall contain not more than 1 000 parts per million (0.1% (*V/V*)) of carbon dioxide, 10 parts per million (0.001% (*V/V*)) of carbon monoxide, 0.5 parts per million (0.000 05% (*V/V*)) of nitric oxide or 0.5 parts per million (0.000 05% (*V/V*)) of nitrogen dioxide.

6.2 Preparation of appliance for test

The appliance shall be set up in accordance with the manufacturer's instructions, with particular reference to minimum declared clearances round the appliance. It shall then be adjusted in accordance with the manufacturer's instructions using the test gas G20 at an inlet pressure of 17.5 mbar[1)].

Before any tests are made, the appliance shall be operated at its maximum rated heat input, using normal distributed gas, for a period sufficient to dry any insulation and remove any temporary finish that might interfere with observations.

6.3 Test procedure

The appliance shall be examined for gas soundness before and after the tests specified in this standard.

The test results shall be deemed to be invalid unless the gas system is sound.

The appliance shall be at room temperature at the start of each test unless the test method specifies otherwise.

During testing, the initial adjustment of the appliance shall not be altered unless specifically required by the test method.

Precautions shall be taken to prevent thermostats or other variable controls from acting so as to interfere with the gas flow, except as necessitated by the test.

Gas test pressures shall be accurate to within ± 0.2 mbar and so controlled that the variation does not exceed ± 0.2 mbar.

In general, except for tests involving governor performance, the appliance governor may be put out of action and the specified test pressure obtained by adjustment of the gas pressure at the inlet to the appliance.

The heat input to the appliance shall be determined as specified in **6.3.2** of BS EN 525:1998.

7 Design and construction

7.1 All appliances

7.1.1 Materials, fittings and finishes

The appliance, including all its component parts, shall be soundly constructed and of a high standard of workmanship and finish.

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1) 1 mbar = 100 N/m^2 = 100 Pa.

Materials shall be of a type, quality and thickness appropriate to the application. In particular, all parts of the equipment shall be resistant to mechanical stresses, including shock, vibrationally or chemically or thermally induced, to which they may be exposed during any conditions of operation. Under normal conditions of use, maintenance and adjustment, they shall show no changes that might adversely affect their function.

Such materials, fittings and finishes shall conform to the requirements of the relevant British Standards and shall all be appropriate to the conditions arising in the part of the appliance in which they are used.

The appliance and its components shall be free from swarf, grit or other foreign matter.

7.1.2 Component location

Parts that are intended to be removable for maintenance or cleaning shall be readily accessible, shall be easy to assembly correctly and impossible to assemble incorrectly where incorrect assembly would create a hazardous condition or result in damage to the appliance and its controls.

The burner(s) shall be positively located and so arranged that misalignment cannot occur.

It shall not be possible to loosen complete burner assemblies, jet or injectors without the use of tools.

7.1.3 Materials in contact with gas

Copper tubing shall not be used where it is likely to be exposed to temperatures above 100 °C.

Solder that has a melting point below 450 °C after application shall not be used for gas-carrying parts.

7.1.4 Insulation

Thermal or acoustic insulation shall be non-combustible in accordance with the requirements of BS 476-4, shall be securely located and shall be protected against mechanical damage, condensate and vermin.

Gas-carrying in contact with, or passing through, insulating material shall be adequately protected against possible corrosive effects of the insulant.

7.1.5 Fire behaviour properties

The appliance shall, wherever possible, be constructed of materials that are non-combustible in accordance with the requirements of BS 476-4. Any coating that may be applied to the outside surface of the appliance shall have class 1 surface spread of flame characteristics when tested on the substrate according to the requirements of BS 476-7.

Air filter material shall possess ignitability characteristics designated 'P' when tested in accordance with BS 476-12.

7.1.6 Fan compartment

Access to the air fan compartment for maintenance shall not be possible without the use of tools.

7.1.7 Gas connections

Gas inlet connections shall be suitable for connection to one of the following.

a) Tapered thread installation pipes in accordance with BS EN 10226-1 and BS EN 10226-2;

b) Flanged pipes and fittings in accordance with BS EN 1092-1, BS EN 1092-3 and BS EN 1515-1, or BS 10.

7.1.8 Bolts and screws

Drillings for bolts and screws shall not connect with fuel gasways. The minimum wall thickness shall be at least 1 mm.

Self-tapping screws are not recommended but, where they are used to secure components that are removed during servicing, they shall be fitted with spire-type clips.

Where hexagon headed screws are used to secure components that are removed during servicing, they shall be provided with screwdriver slots, where possible, if this facilitates servicing.

7.1.9 Viewing port

Means shall be provided to allow the installer, commissioning engineer or servicing engineer to observe the pilot and main burner flames. If the means of observation is a viewing port, it shall, when located in an area of positive pressure and high temperature, be covered with heat resistant, toughened glass and sealed with a suitable heat resistant sealant.

7.1.10 Servicing

There shall be easy access to components and controls that may require servicing or adjustment.

The appliance shall be fitted with access doors or removable panels to facilitate servicing.

In addition, union for flanged connections shall be provided to permit the removal of the burner assembly from the appliance and disconnection of the appliance from the gas supply.

The burner which can be retracted from the appliance, or which is provided with swivel flanges to allow it to be swivelled from the appliance, shall be provided with a safety device to prevent accidental retraction or swivelling and an interlock which will prevent operation of the burner if it is not located in its normal firing position.

Appliances shall be so designed that periodic servicing, inspection or parts replacement are not normally required more than once per year. Any known deviation from this requirement shall be the subject of negotiation between the manufacturer and the testing authority.

NOTE Filters may require changing or cleaning more often than once per year, and this is acceptable.

7.1.11 Panel anchorage

Panels that are normally removed for servicing shall be fitted with anchor lines where the appliance is intended to be installed other than at floor level.

The fittings of suitable hinges is deemed to satisfy this requirement.

7.1.12 Unions and flanges

Unions in fuel gasways shall be of the cone or spherical-seated type. Flange joints shall include a gasket resistant to the action of components of the gas and suitable for the temperature to which it is likely to be exposed.

7.1.13 Components and controls

Components and controls fitted to the appliance shall conform to the requirements of relevant British Standards.

Gas carrying controls shall be sited externally to the air duct so as to prevent ingress of gas into the discharged air.

Where controls are enclosed in a separate compartment, the compartment shall be adequately ventilated. The vent, shall be so sited that it cannot be obstructed by foreign matter, birds, etc.

Bypasses shall not be provided around any item of safety equipment.

7.1.14 Air strainer

A strainer shall be fitted on the air inlet to the appliance. The maximum strainer hole dimension shall be not less than 6.5 mm, nor shall it permit the entry of a ball of diameter 16 mm applied with a force of 5 N.

The strainer shall be readily accessible for cleaning or replacement; it may be of the cleanable or throw-away type.

7.1.15 Air inlets

Air heaters, other than portable air heaters, shall have flanged or spigot connections on the air inlet.

7.1.16 Air outlets

The air outlet(s) of a ductless heater, other than a transportable heater, shall be fitted with directional louvres that are capable of adjustment between horizontal discharge and discharge at an angle of at least 45° downwards from the horizontal. When the louvres are in the position of maximum closure, the minimum requirements for functional purposes shall be satisfied.

Ducted air heaters shall have air outlets equipped with flanges or spigots to facilitate connection of ductwork or flexible connectors.

7.1.17 Facility for remote control

Appliances shall be capable of being controlled remotely by means of thermostats and a time control.

7.1.18 Durability of protective finishes

7.1.18.1 General

Materials that are used for the construction of parts that are not normally subject to service and maintenance shall be adequately protected against corrosion.

7.1.18.2 Galvanized parts

Galvanized parts shall conform to the requirements of BS EN ISO 1461, BS EN 10143 or BS 4921 as appropriate.

Galvanized parts, or samples thereof, shall be subjected to non-destructive tests as specified in BS EN 12329, or other relevant standards, and shall conform to the requirements specified in those standards.

7.1.18.3 Painted and plastics coated parts

Painted or plastics coated surfaces shall conform to the following requirements.

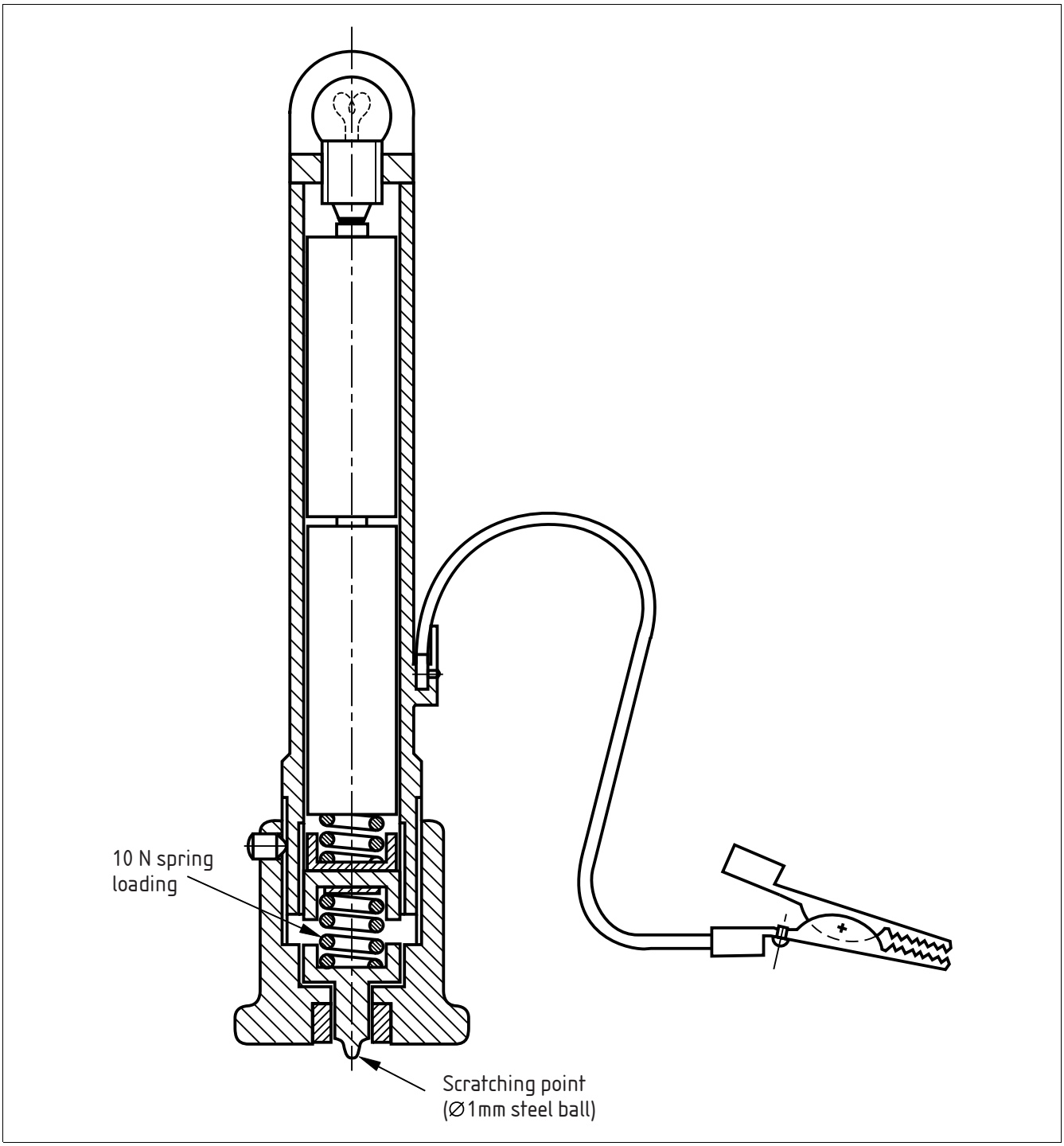
a) *Resistance to heating*. There shall be no appreciable change of colour on any part of the appliance and the finish shall not become tacky or show other signs of deterioration at the end of the drying out period as specified in 6.2.

   This requirement does not apply to parts that come into direct contact with the flame.

b) *Resistance to abrasion*. Surfaces shall be tested for resistance to scratching. The hardness shall be such that the protective film is not penetrated when subjected to the following test. The scratch shall not have a width greater than 1 mm at any point along its length.

   Method. Apply the apparatus (see Figure 1) to the surface under test and move the ball, after loading with a force of 10 N, at 30 mm/s to 40 mm/s relative to the surface. If the indicator lamp lights, the surface is deemed to have been penetrated. A metallic paint applied directly to a metal surface will cause the lamp to light without penetration and, in this case, the paint surface should be visually examined for penetration. Clean the ball after each test and inspect if frequently to verify that it remains a 1 mm sphere.

Figure 1 **Paint scratch test apparatus**
(see **7.1.18.3**)



7.1.18.4 Plated parts

Electroplated metal parts shall have a standard of adhesion and resistance to corrosion equivalent to the requirements of BS EN 12540 for service condition no.2 (appliance designed for indoor installation) or service condition no.3 (appliance designed for permanent outdoor installation) as appropriate.

7.1.18.5 Other protective finishes

Protective finishes other than those specified may be employed. Where an appropriate British Standard exists, the finish shall conform to its requirements. Where no British Standard is available, tests on the proposed finish shall be agreed between the manufacturer and the test authority.

7.1.19 Noise

Noise emission shall not be excessive with regard to the application of the air heater.

7.1.20 Smell

After the initial burning-off period, the appliance shall not give rise to any unpleasant smell.

7.1.21 Injectors and jets

Injectors and jet orifice areas shall be non-adjustable.

7.1.22 Gas rate restrictors

Adjustable gas rate restrictors shall be readily distinguishable from other manual valves. The setting of restrictors shall be protected by a method that discourages unauthorized adjustment.

7.1.23 Flexible pipes

Flexible pipes shall conform to the requirements of BS 6501-1 and have screwed or flanged connections. Flexible pipes shall withstand at least three times the working gas pressure with a minimum of 3.5 bar at the both maximum and minimum service temperatures. There shall be electrical continuity across such pipes. There shall be a manual isolating valve in a readily accessible position upstream of the inlet of any section of flexible pipe.

7.2 Appliances designed for permanent outdoor installation

7.2.1 General

Appliances designed for permanent outdoor installation shall be so constructed that they are fully protected against the rigours of the environmental conditions under which they are expected to operate.

NOTE The top of outdoor units should preferably be so shaped as to prevent the collection of water.

7.2.2 Combustion air inlets

Combustion air inlets shall be so sited that their lowest edge is at least 500 mm above the base of the appliance, or 500 mm above the floor level if this is specified in the manufacturer's installation instructions.

Air inlets shall be so designed as to avoid accidental blockage.

7.2.3 Ventilation

The appliance and its casing shall be adequately ventilated.

7.2.4 Access panels and doors

Access panels and doors and such insulation as needs to be removed during normal servicing shall be so designed that repeated removal and replacement does not damage or impair the weather-proofing of the appliance.

7.2.5 Dimensions of openings

No dimension of any opening from the inside of the appliance to the outside air shall be less than 6.5 mm, nor shall any opening permit the entry of a ball of diameter 16 mm applied with a force of 5 N.

7.2.6 Fixing screws

External panels shall be fixed using only hexagon headed screws, except in the case of access panels, which may be fixed by approved hinges and door catches.

8 Soundness

8.1 General

All gas-carrying parts of the appliance shall be sound and, when connected, shall form a complete assembly that is sound. The test specified in **8.2** shall be carried out on the complete assembly.

Where automatic soundness proving systems are fitted, means shall be provided to enable the soundness test specified in **8.2** to be carried out.

8.2 Complete assembly

That part of the system between the inlet and last shut-off valve(s), whether automatic or otherwise, shall be sound when tested to 1.5 times the manufacturer's stated maximum inlet pressure, or 50 mbar, whichever is the greater.

Gas-carrying parts downstream of the last shut-off valve(s) shall be tested for external leakage at the setting pressure, using any suitable method, and shall be sound.

These requirements shall be deemed to be satisfied if the leakage rate over a period of 1 min does not exceed 85 cm^3/h.

Method. Connect to the appliance inlet an air supply maintained constant at the appropriate pressure and embodying a suitable meter for measuring air flow. Subject all gas-carrying parts of the appliance to this pressure under the following conditions.

a) With all gas valves in the CLOSED position.

b) With all gas valves in the OPEN position, the flame supervision devices maintained, by suitable means, in the open position and all igniters or pilots capped off.

NOTE Care should be taken to ensure that any means (e.g. thermal or mechanical) used to maintain the flame safeguard in the open position is compatible with the normal operation of the control.

9 Heat input

9.1 Measurement

For the purposes of this British Standard, the heat input is determined as specified in **6.3.2** of BS EN 525:1998.

The heat input shall be measured with the appliance at thermal equilibrium and in its normal operating condition.

9.2 Tolerance

Burners operated individually or in combination shall have a heat input within ± 5% of that stated by the manufacturer when operated at the manufacturer's stated setting pressure.

With the air heater adjusted to give the rated heat input at an inlet pressure of 17.5 mbar, the actual heat input shall be within ± 10% of the rated heat input over the range of inlet pressure from 15.0 mbar to 25.0 mbar.

With the inlet pressure adjusted to 17.5 mbar on test gas G20, the heat input shall not exceed 120% of the rated heat input when:

a) any governor adjustment accessible for the setting of rating (i.e. one that does not involve the use of tools) is at its maximum setting;

b) all other gas rate adjusters are fully open.

9.3 Adjustment

Any means of adjustment of the heat input to the appliance shall be preset by the manufacturer at the maximum rated heat input and locked or sealed to discourage unauthorized interference.

10 Combustion

10.1 Combustion requirements

10.1.1 Low temperature air heaters

When the appliance is tested under the conditions described in **10.3**, the concentrations of oxides of carbon and nitrogen and the concentration of aldehyde, attributable to the appliance, in the discharged air shall not exceed those given in Table 1.

Table 1 **Limiting concentrations**

Component	**Limiting concentration (C_L)** parts per million (% (*V/V*))
Carbon monoxide	10 (0.001)
Carbon dioxide	2 800 (0.28)
Nitric oxide	5 (0.000 5)
Nitrogen dioxide	1 (0.000 1)
Aldehydes	0.4 (0.000 04)

10.1.2 High temperature air heaters

When the appliance is tested under the conditions specified in **10.3**, the measured concentrations of oxides of carbon and nitrogen and the concentration of aldehyde, attributable to the appliance, in the discharged air shall be such that the limiting concentrations calculated using the following equation do not exceed the values specified in **10.1.1**:

$$C_m \times \frac{V_a}{V_a + V_s} \leq C_L$$

where

C_L is the limiting concentration of component, parts per million (% (*V/V*)).

C_m is the measured concentration of component, parts per million (% (*V/V*)).

V_a is the maximum volume flow (in m^3/s) of fresh air supplied through the appliance corresponding to the maximum rated heat input.

V_s is the minimum volume flow (in m^3/s) of additional fresh air specified by the manufacturer to be supplied to the heated space and corresponding to the maximum rated heat input.

10.1.3 Transportable air heaters

When tested under the conditions specified in **10.3**, the measured concentrations of oxides of carbon and nitrogen and the concentration of aldehyde, attributable to the appliance, in the discharged air shall not exceed the values specified in **10.1.1**.

10.1.4 General test method

The general test method is as follows.

The appliance is set up in accordance with the requirements of **6.2**.

The air is sampled at the appliance inlet and outlet in such a manner as to ensure collection of a representative sample. The air is analyzed for oxides of carbon, oxides of nitrogen and aldehydes by the methods described in **10.2**.

Tests shall be made at a sufficient number of heat input rates to determine the combustion performance over the whole of the prescribed range. No extrapolation shall be made.

10.2 Methods of analysis

10.2.1 Carbon dioxide

The carbon dioxide content of the discharged air shall be measured by means of a non-dispersive infra-red analyser (see BS 1756) or by any other method giving at least an equivalent accuracy, e.g. gas chromatography. The carbon dioxide content shall be determined to an accuracy of ± 5% of the actual reading.

10.2.2 Carbon monoxide

The carbon monoxide content of the discharged air shall be measured by means of a suitably sensitive non-dispersive infra-red analyser (see BS 1756) or by any other method giving at least an equivalent accuracy, e.g. gas chromatography. The carbon monoxide content shall be determined to an accuracy of ± 10% of the actual reading.

10.2.3 Oxides of nitrogen

The concentration of oxides of nitrogen in the discharged air shall be determined by using a chemiluminescence analyser or any other equivalent technique.

10.2.4 Aldehydes

The concentration of aldehydes in the discharged air shall be determined by means of a standard wet chemical technique of suitable accuracy.

10.3 Conditions of test

10.3.1 General

The combustion requirements specified in **10.1** shall be satisfied under the test conditions given in **9.3.2** or **9.3.3**.

10.3.2 Appliances without the facility for recirculated air

The appliance shall be tested under the conditions given in Table 2 and with the air flow rate adjusted to give the manufacturer's specified air flow rate corresponding to the maximum rated heat output.

Table 2 **Heat input conditions**

Test gas	Heat input
G20	1.05 × maximum rated input
G21	Setting pressure corresponding to 1.05 × maximum rated input when using G20

In addition, for an appliance designed to operate over a range of heat input (i.e. a range rated appliance) the combustion requirements shall be satisfied when the appliance is adjusted to each input rate within the specified range and with the air flow adjusted to give the manufacturer's specified air flow rate corresponding to each input rate.

10.3.3 Appliances with facility for recirculated air

For an appliance with a facility for recirculated air, tests shall be carried out under the following conditions.

a) The combustion tests shall be carried out with the test gases and at the heat input rates given in **10.3.2**.

b) The temperature of the recirculated air shall be maintained, during the tests, within the limits given in **6.1**.

c) Where the manufacturer specifies a fixed level of recirculated air, the combustion test shall be carried out with the recirculation air damper set to give the specified air recirculation rate.

d) Where the air recirculation rate is specified to be variable up to a maximum level the combustion test shall be carried out with the recirculation air damper set to give the specified maximum and the minimum air recirculation rate.

e) Where the level of recirculated air is not specified the combustion test shall be carried out with any recirculation air damper set in the fully open position and in the fully closed position.

f) If the recirculated air intake is upstream of the burner, the recirculated air shall be vitiated with products of combustion such that the concentration of CO_2 is 0.28% (*V/V*).

NOTE 1 In order to maintain the temperature of vitiated recirculated air within the specified limits, it may be necessary to dilute the recirculated air with vitiated air having a lower heat content than that of the delivered air, e.g. by means of a gas-fired boiler. In this event, additional room ventilation will be required.

NOTE 2 If it is difficult to adjust the level of vitiation in the recirculated air exactly, tests should be made at a sufficient number of CO_2 concentrations in the recirculated air to determine the combustion performance at the specified CO_2 concentrations of 0.28% (V/V). No extrapolation should be made.

11 Ignition

11.1 Pilot burners and ignition devices

11.1.1 General

All pilots should be protected by design or position against diminution or extinction, e.g. by products of combustion, overheating, condensation or particulate matter.

11.1.2 Pilot supply

The gas supply to a pilot burner shall be taken from such a position as to avoid starvation that is likely to impair ignition when gas is admitted to the main burner, and shall be fitted with a manual isolation valve.

Pilot supply lines shall be connected to the main gas line in such a way as to preclude blockage of the pilot line by gas borne dust, dirt or condensate.

11.1.3 Pilot and detector location

Pilots, ignition devices and their mountings shall be so designed that they can only be located rigidly and correctly in relation to every component and burner in conjunction with which they are designed to operate.

11.2 Ignition performance: burner systems with permanent pilots

11.2.1 Pilot ignition

The pilot shall ignite smoothly and the flame shall not light back, lift, roar, cause discoloration on any external surface of the appliance, deposit soot, or smell when tested over the range of appliance inlet pressures and test gases given in Table 3.

Table 3 **Test gas conditions**

Test gases	Pressure range
G20, G21, G22, G23	12.5 mbar to 27.5 mbar

Any adjustable pilot shall have been previously adjusted in accordance with the manufacturer's instructions and shall not be re-adjusted during the test.

During commissioning, servicing and normal operation it shall be possible rapidly to determine that the pilot is alight.

11.2.2 Main burner ignition

Ignition of the main burner shall be smooth and the flame shall carry over to all ports. Ignition shall be checked with the appliance operating at its minimum stated and maximum rated input with respect to reference test gas G20.

The following test gases shall be used: G20, G21, G22, G23.

11.2.3 Pilot flame reduction

The arrangement of the flame safeguard system shall be such that, in the event of the pilot gas rate being reduced to 75% of the heat input required to hold open the valve of the flame safeguard system, ignition of the main gas is achieved without undue noise, flame roll-out or light-back with the appliance operating at its minimum stated and maximum rated inputs using test gas G20. At the start of each test the appliance shall be in the cold condition.

11.2.4 Main burner ignition at reduced inlet pressure

With the appliance adjusted in accordance with the requirements of **6.2**, ignition of the main gas shall occur smoothly when the inlet pressure is reduced to 12.5 mbar and the gas is ignited in accordance with the manufacturer's instructions.

When the inlet pressure is progressively reduced below 12.5 mbar, the gas supply to the main burner shall be automatically shut off before ignition becomes violent.

Confirmatory tests shall be carried out, on test gas G20, with the appliance in the hot condition and also in the cold condition.

11.3 Ignition performance: burner systems with interrupted or intermittent pilots

Ignition and establishment of the start-gas and main gas flames shall be:

a) smooth and reliable;

b) without undue noise;

c) without damage to the appliance.

These requirements shall be satisfied with the air heater operating at its minimum stated and maximum rated heat inputs relative to test gas G20 both when cold and in the fully heated condition using test gases G20, G21, G22 and G25.

Ignition of the main burner shall be achieved as required in a), b) and c) at all conditions that allow the flame safeguard system to pass main gas to the burner. This requirement shall be satisfied with the appliance operating at the manufacturer's minimum and maximum rated heat inputs using test gas G20, both in the cold and in the fully heated conditions.

The appliance shall continue to ignite and operate safely at inlet gas pressures down to 12.5 mbar, and below this pressure shall either continue to ignite and operate safely or proceed to safety shut-down.

11.4 Ignition performance: burner systems employing direct main flame spark ignition

11.4.1 Main flame ignition

Ignition and establishment of the main gas flame shall conform to **11.3**.

11.4.2 Delayed ignition

When ignition is deliberately delayed by up to 50% longer than the main flame ignition period, the ignition of the main flame shall be:

a) smooth and reliable;

b) without undue noise;

c) without damage to the appliance;

d) without flame discharge beyond the confines of the appliance casing or ducting.

This requirement shall be satisfied with the appliance operating at the maximum rated heat input using test gas G20, both in the cold condition and in the fully heated condition.

NOTE In order to delay the ignition it will generally be necessary to provide independent control of the main gas valves and the operation of the ignition device. A suitable arrangement is to provide a voltage supply independently of the burner control system to the main gas safety shut-off valves and to the ignition device.

For safety reasons the delay in ignition should be increased in stages.

12 Flame stability

12.1 Requirement

The main burner flames shall remain stable without lifting off when operated on the limit test gas G23 at the adjustment pressure.

12.2 Method

Adjust the appliance at thermal equilibrium on test gas G20. Substitute the limit test gas G23 without further adjustment to the appliance or the supply pressure and turn off the appliance. With the appliance in the cold condition, relight the appliance and observe the flames on the main burner until thermal equilibrium is reached.

13 External temperatures

13.1 Surface temperatures

13.1.1 Requirement

When the heater is operated on test gas G20 the temperature rise of the parts listed in Table 4 shall not exceed the values specified when tested in accordance with **13.1.2**.

Table 4 **Surface temperature rise**

Parts of the appliance	**Temperature rise** K
Handles, knobs, grips and the like that, in normal use, are held for short periods only:	
Metal	35
Porcelain or vitreous material	45
Plastics, rubber or wood	60
Parts that are likely to be touched accidentally (excluding working surfaces: see Note):	
Metal	80
Porcelain or vitreous material	95
Plastics, rubber or wood	100

NOTE Working surfaces include external primary flues and draught diverters.

13.1.2 Method

Surface temperatures are measured by means of a surface contact pyrometer when the appliance has reached thermal equilibrium. Where surfaces are inaccessible to a surface pyrometer, the temperatures shall be measured by means of thermocouples soldered to the surface under test, or by some equally satisfactory method. The appliance is operated on test gas G20 at the maximum rated heat input and with the air flow adjusted to the manufacturer's specified air flow rate.

13.2 Component temperatures

The temperature of any component shall not exceed the maximum allowable temperature stated by the manufacturer of the component.

14 Manual gas valves

Manual valves shall be of the 90° turn type.

Manual valves shall be so designed or positioned as to prevent inadvertent operation but shall be easy to operate when required. They shall be so designed that, in operation, the 'OPEN' and 'CLOSED' positions are readily distinguishable.

Where an appliance isolating valve is provided as an integral part of the appliance, it shall be capable of operating at a pressure equal to 1.5 times the maximum supply pressure and shall be readily accessible.

Manual valves used solely for OPEN/CLOSED operation shall be provided with positive stops at the 'OPEN' and 'CLOSED' positions.

15 Automatic controls

15.1 General

Electrically operated controls other than ignition transformers shall conform to BS EN 55014-1 in respect of radio and television interference.

Automatic burner controls systems shall conform to the requirements of BS EN 298.

The operation of push buttons, switches, etc. incorrectly or out of sequence shall not adversely affect the safety of the control system.

15.2 Governors

A constant pressure governor shall be fitted upstream of the main safety shut-off valves and of the safety shut-off valve(s) for any separate pilot or start gas burner.

The governor shall conform to BS EN 88.

15.3 Gas strainers

A strainer shall be fitted at the inlet of the safety shut-off system to prevent ingress of foreign matter. The strainer may be integral with the upstream safety shut-off valve. The maximum strainer hole dimension shall be not greater than 1.5 mm and the mesh shall not pass a 1 mm pin gauge.

NOTE 1 In multiple valve safety shut-off systems, only one strainer need be fitted, provided it gives adequate protection to all valves.

NOTE 2 For valves incorporating a self-cleaning or shearing action, and for valves 12.5 mm and below, the strainer may be omitted.

15.4 Safety shut-off valves

15.4.1 General requirements

Safety shut-off valves shall conform to the requirements of BS EN 161. This standard defines three classes of valve and specifies minimum requirements for, e.g. reverse pressure capability and maximum permitted leakage.

15.4.2 Application

Each main gas supply shall be under the control of two safety shut-off valves in series of a standard not less than that specified in Table 5.

Table 5 **Main gas safety shut-off valve system requirements**

System rating kW	**Valve system requirements**
Up to 600	1 × class A plus 1 × class B
From 600 up to 1 000	2 × class A
From 1 000 up to 2 000	2 × class A with a system check e.g. closed position indicator switches

Where the main flame establishment is by means of a start-gas flame, the start-gas supply shall either:

a) be under the control of the downstream main gas safety shut-off valve incorporating a start-gas rate control. The valve shall incorporate a device to enable the start-gas rate to be set such that the energy available during the start-gas flame ignition period cannot exceed the values given in **15.7**; or

b) be under the control of at least one class A safety shut-off valve.

Where a main gas safety shut-off valve incorporates a start-gas rate control, it shall not be possible to adjust the start-gas rate to a level exceeding 50% of the fully open flow rate at the same differential pressure.

Where the start-gas rate is greater than 10% of the stoichiometric gas rate corresponding to the proved purge air rate, the start gas supply shall be under the control of two safety shut-off valves in series. Where a separate start-gas safety shut-off valve(s) is fitted the resulting valve train shall incorporate a valve(s) having the same class(es) as that controlling the main gas supply.

*NOTE These requirements should be read in conjunction with those given in **14.7**.*

15.4.3 Shut-down

The flame supervision system and the overheat control shall effect closure of all safety shut-off valves in all systems specified. On shut-down the air fan shall not be switched off before the start-gas and main gas safety shut-off valves have been de-energized.

15.4.4 Restart

Following safety shut-down due to the operation of any overheat control, restart shall only be possible after manual reset.

15.5 Combustion air, pre-purge and post-purge

The burner shall be fitted with a suitable device for proving adequate air flow during the pre-purge, ignition and operation of the burner. Air flow failure at any time during the pre-purge, ignition or operation of the burner shall cause safety shut-down. The air proving device shall be proved in the 'no air' position prior to start-up. Failure to prove 'no air' shall prevent start up or cause lock-out.

Proof of adequate air flow can be achieved as follows.

a) By static or differential pressure sensing, where it can be shown that it provides satisfactory and reliable proof of air flow during the pre-purge, ignition and operation of the burner.

b) By flow sensing.

c) For on/off burners with a fixed or preset air damper (when fitted) by means of a centrifugal switch connected directly to the fan impeller. This switch shall be direction sensitive when used with three-phase fan motors.

Means shall be provided to prevent large objects from entering the fan, to minimize the risk of blockage and to prevent accidental injury to personnel. This requirement shall be deemed to be met if entry is prevented of the standard test fingers specified in BS EN 61032.

Immediately before any attempt at ignition or the opening of gas safety shut-off valves, the appliance shall be purged. The pre-purge period shall be a minimum of 30 s at full combustion air rate, or pro rata longer periods at lower air rates.

The pre-purge shall be at the highest flow rate possible, shall not be less than 25% of the full combustion air rate and shall be such as to give at least five volume changes of the combustion chamber and gas passages up to the flue gas exit from the appliance.

In the case of door curtain heaters, the total pre-purge period may be reduced below 30 s provided that the heater and its outlet ductwork are purged to give at least five volume changes and that the flame safeguard safe start check exists for at least 10 s during the pre-purge period.

The purge air shall be proved to be at the required rate. If the pre-purge air flow falls below the required rate at any time during the pre-purge period, then either:

a) the burner shall go to safety shut-down; or

b) the purge may be continued upon restoration of the required air rate provided that the air flow does not fall below 25% of the full combustion air rate and that the total purge time at the required air rate is not reduced.

Post-purge is optional.

15.6 Flame supervision system

The burner shall be fitted with a flame supervision device.

The flame supervision device shall incorporate a suitable means to provide safety shut-down or lock-out if the flame detector signals flame presence at any time during the pre-purge. This is the safe-start check. The safe-start check may cease during the 5 s preceding an attempt at

ignition. If a flame-simulating condition lasts for 5 s or more, lock-out shall occur.

Flame simulation by electrical interference shall be prevented.

Upon flame failure the flame supervision device shall cause lock-out. There shall be no attempt at re-ignition by spark restoration, automatic recycling or other means. A restart cycle shall only occur after manual reset.

The time for the flame supervision device to de-energize the burner safety shut-off valves upon flame failure shall be not more than 1 s. Notwithstanding this requirement, where a self-checking flame supervision device is used, the time for the flame supervision device to de-energize the burner safety shut-off valves upon flame failure shall conform to the requirements of Table 6.

Table 6 **Flame supervision device drop-out times**

Frequency of check	**Drop-out time excluding any delay due to the action of the checking circuits** s	**Drop-out time including any delay due to the action of the checking circuits** s
More frequently than once per 2 s	—	2
Less frequently than once per 2 s but more frequently than once per minute	1	2
Less frequently than once per minute but more frequently than once per hour	1	3

15.7 Start-gas flame establishment

Where the main flame establishment is by means of a start-gas flame, the start-gas rate shall not exceed 200 kW. The start-gas flame shall be established either at the main burner or at a separate pilot burner.

The start-gas flame establishment shall consist of two periods.

a) The start-gas flame ignition period, the duration of which shall be not more than 5 s and preferably not less than 2 s.

b) The start-gas flame proving period, the duration of which shall be not less than 5 s.

The ignition spark (or other means of ignition) shall not be energized before the completion of the pre-purge period and shall be de-energized at or before the end of the start-gas flame ignition period.

The start-gas valve(s) shall not be energized before the ignition spark (or other means of ignition) is energized.

If the flame is not detected by the end of the start-gas flame ignition period, safety shut-down and lock-out shall result.

The start-gas flame proving period shall establish that the flame is stable on its own. If the flame fails during this period, safety shut-down and lock-out shall result.

The energy released during the start-gas flame ignition period shall be limited in such a way that any explosive pressure rise resulting from a delayed ignition will not cause damage to the appliance or flueways.

This requirement shall be deemed to be satisfied when the start-gas rate, expressed as a percentage of the stoichiometric gas rate for the proved air flow (at the time of ignition) of the burner to be fired, does not exceed 25%.

On burners with a heat input rating equal to or greater than 330 kW and on which the start-gas supply is taken from between the main gas safety shut-off valves, the downstream main gas safety shut-off valve shall be checked for closure prior to start-up. If the check indicates that the valve is not closed, start-up shall be prevented.

Where the start-gas rate is controlled by a start-gas rate position contained within the downstream main safety shut-off valve, this valve shall conform to BS EN 161. In addition, any means of adjustment of the start-gas rate or the operating position of an interlock, if fitted, shall be pre-set and sealed by the manufacturer.

On burners with a heat input rating equal to or greater than 330 kW and where the start-gas position of the valve is controlled by an interlock, the interlock shall be proved in the correct state throughout the start-gas flame establishment period.

If the interlock indicates that the start-gas rate has been exceeded, the time taken to de-energize the valve shall be not more than 1 s and the burner shall proceed to lockout.

15.8 Main flame establishment

15.8.1 Establishment by means of a start-gas flame

The main gas safety shut-off valves shall not be energized to admit the main gas flow to the burner until after the start-gas flame has been established.

The main flame shall ignite reliably and smoothly from the start-gas flame.

If the start-gas flame has been ignited and proved as a separate pilot flame, there shall be a limited main flame establishment period of not more than 5 s and preferably not less than 2 s at the end of which the pilot flame shall be extinguished and supervision of the main flame alone shall begin. If the main flame is not detected after this period, safety shut-down and lock-out shall result.

Where the separate pilot flame remains in use during main burner operation, separate flame detectors shall be fitted to monitor the pilot and main flames. The main flame detector shall be so positioned that it cannot in any circumstance detect the pilot flame. The main flame shall be stable without the pilot flame. In addition, the safe-start check required by **15.6** shall continue to be carried out on the main flame detector during the pilot ignition and proving periods.

If the start-gas flame is at a separate pilot burner, the flame detector shall, under the conditions of operation, detect the pilot flame only at gas flow rates at which it will light the main flame reliably and smoothly. The need to protect against shrinkage, detector drift or maladjustment, gas pressure reduction and dimensional instability shall be taken into account.

15.8.2 Establishment by spark ignition

Spark ignition of the main flame shall not be used.

15.9 Air-gas ratio control (where fitted)

The air-gas ratio system shall prevent excessively gas-lean firing if such firing could give rise to instability or other hazardous conditions.

For high/low and modulating burners where the air and gas flows are not controlled simultaneously, there shall be either air lead on increasing firing rate and gas lead on reduced firing, or sufficient excess air to prevent gas-rich firing.

On high/low or modulating burners where the air and gas flows are not controlled simultaneously, there shall be either air lead on increasing firing rate and gas lead on reduced firing, or sufficient excess air to prevent gas-rich firing.

On high/low or modulating burners the air gas ratio control system shall be designed and constructed to minimize the risk of off-ratio firing. Either the system shall lead to a safe condition in the event of its mechanical failure (i.e. not go gas-rich), or the operation of the system shall be checked during the start sequence (e.g. by means of pressure or position switches).

15.10 Thermostats and control of air temperature

15.10.1 General requirements

Thermostats shall conform to the relevant requirements of BS EN 60730-2-9 or BS EN 257 as appropriate.

15.10.2 Control of air temperature in the heated space

Means shall be provided for controlling the air temperature in the heated space during normal running conditions. This means shall be fitted either in the discharged air or in the heated space.

When the heater is installed in accordance with the manufacturer's instructions, no hazardous condition or damage to the heater shall occur as a result of failure of the normal means of air temperature control.

15.10.3 Overheat (limit) control

15.10.3.1 Requirements

An overheat control shall be provided, in addition to the air temperature control, to cause shut-down and lock-out in the event of an overheat condition occurring.

Where flame detection is achieved other than by means of a direct-acting thermoelectric heat sensitive type device, the lock-out action shall not rely on the operation of the flame detection circuits. In particular, the overheat control shall not be wired in series with either the flame sensor or the line supply from a flame safeguard to any safety shut-off valve.

The appliance shall conform to the requirements specified in **5.6** of BS EN 525:1998 when tested under the conditions given in **15.10.3.2**.

15.10.3.2 Method

The appliance is tested as described in **6.3.6** of BS EN 525:1998.

16 Motors and fans

16.1 General

Motors shall conform to the requirements of BS 5000-11.

Motors and fans shall be so protected by suitable guards, shields or screens of adequate size, strength and durability that they are not liable to be touched accidentally (see also BS EN 61032). Removal of such guards, shields or screens shall be possible only with the use of standard tools.

Belt drives, where used, shall be so designed or positioned as to afford protection to the operator.

Means shall be provided to facilitate adjustment of belt tension. Access to such means shall be possible only with the use of standard tools.

Motors and fans shall be mounted in such a way as to minimize noise and vibration.

16.2 Fan motor temperature

16.2.1 Motor bearings

16.2.1.1 Requirement

The maximum temperature of the fan motor bearings shall not exceed the maximum stated by the motor manufacturer when measured as described in **16.2.1.2**.

16.2.1.2 Method

Operate the appliance at its rated heat input on the appropriate reference test gas with the electricity supply at the most unfavourable voltage between 85% of the minimum and 110% of the maximum stated operating voltage. Take temperature measurements when the appliance has reached an equilibrium condition and after the appliance has been switched off.

16.2.2 Motor windings

The maximum temperature rise of the motor windings shall not exceed that given in Table 7 according to the class of insulation when the appliance is operated at its rated heat input on the appropriate reference test gas and with the electricity supply at the most unfavourable voltage between 85% of the minimum and 110% of the maximum stated operating voltage, and when the appliance is switched off.

At the beginning of the test the windings are at room temperature.

Table 7 **Fan motor windings: permissible temperature rises**

Windings (see Note 1) and core laminations in contact therewith, if the winding insulation is:	**Temperature rise** K
of class A material (see Notes 2 and 3)	75
of class E material (see Notes 2 and 3)	90
of class B material (see Notes 2 and 3)	95
of class F material (see Note 2)	115
of class H material (see Note 2)	140

NOTE 1 The value of the temperature rise of a winding is calculated from the formula:

$$t = \frac{R_2 - R_1}{R_1}(C + t_1) - (t_2 - t_1)$$

where

t is the temperature rise (in K);
R_1 is the resistance at the beginning of the test (in Ω);
R_2 is the resistance at the end of the test (in Ω);
t_1 is the room temperature at the beginning of the test (in °C);
t_2 is the room temperature at the end of the test (in °C);
C = 234.5 °C for copper.

NOTE 2 The classification is in accordance with BS EN 60085.

NOTE 3 For totally enclosed motors, the permissible temperature rise for class A, class B and class E material may be increased by 5 K. A totally enclosed motor is one so constructed that circulation of air between the inside and the outside of the case is prevented, but not necessarily sufficiently enclosed to be termed 'airtight'.

It is recommended that the resistance of the windings at the end of the test be determined by taking resistance measurements as soon as possible after switching off and then at short intervals so that a curve of resistance against time can be plotted for ascertaining the resistance at the instant of switching off.

16.3 Lubrication

Lubrication points shall be readily accessible.

16.4 Marking

The direction of rotation of motors and fans shall be clearly marked.

17 Electricity supply

The appliances covered by this British Standard shall conform to the relevant requirements for electrical safety and performance given in BS 5986. The following additional requirements shall apply.

The burner and its associated safety equipment shall function normally when the electricity supply voltage is (a) reduced to 85% of the minimum stated operating voltage and (b) increased to 110% of the maximum stated operating voltage and shall remain safe outside these limits or proceed to safety shut-down.

Interruption of the electricity supply at any time during the starting up or operation of the heater shall result in safety shut-down.

Interruption and subsequent restoration of the electricity supply shall not override any 'lock-out condition.

Where three-phase supplies are used and one phase is used to provide the remaining power requirements of the appliance, this phase shall be clearly and unambiguously identified.

Where the ignition device incorporates a repetitive high voltage generator that provides more than 20 sparks at each output during a 3 s energization period, all the high voltage outputs shall be regarded as electrically 'live'. Suitable protection against electric shock, as required by BS 5986, shall be provided when such a device is fitted to the appliance, e.g. by requiring the use of tools to gain access to the high voltage output(s) and electrode(s).

18 Manufacturer's instructions

18.1 General

Installation, commissioning, servicing and user instructions shall be provided by the manufacturer.

The description of parts given in the manufacturer's instructions shall agree, where applicable, with the definitions given in BS 1179 and in Clause **2** of this British Standard.

The instructions shall include reference to relevant British Standards, codes of practice, regulations for the electrical equipment of buildings and any statutory regulations governing the installation of the appliance.

18.2 Installation instructions

The installation instructions shall be provided with the appliance. Such instructions shall include information as to the method of assembly, the siting of the appliance, the combustion and ventilation air requirements, the gas and electricity supply and connections, and the procedure to be followed for commissioning the appliance.

In addition the installation instructions shall include a complete wiring diagram and a technical data table. The technical data table shall include the appliance heat input, heat output, burner pressure, gas connection size, physical dimensions, mass, electric motor details, fan ratings, air delivery volumes, and such other technical data as may be required by the installer and commissioning engineer.

The installation instructions shall state that:

a) a means for electrical isolation, having a contact separation of at least 3 mm in all poles, has to be provided;

b) an isolation valve, or valves, has to be fitted immediately adjacent to the appliance which, when closed, allow(s) the complete burner and control assembly to be disconnected for maintenance or repair.

18.3 Servicing instructions

The servicing instructions shall indicate the frequency of servicing and the scope of the service programme recommended by the manufacturer. They shall also specify such special tools or equipment as are necessary for any servicing procedure.

The procedure for removing or gaining access to parts or components to be serviced, together with the recommended service work and associated procedures, shall be clearly defined.

The instructions shall also include complete electrical functional and wiring diagrams and a short list of appliance parts and part numbers of those items that the manufacturer considers may be required for replacement purposes during the life of the appliance.

A fault-finding chart shall be incorporated as an aid to servicing. The service instructions shall also include a line or block diagram showing the arrangement of the gas controls.

The servicing instructions shall contain any specific recommendations for emergency servicing under wet conditions, including the provision of weatherproof covers, of appliances designed for permanent outdoor installation.

18.4 User's instructions

User's instructions shall be provided by the manufacturer and shall contain notes on the care and operation of the appliance including the lighting and shut-down procedures for short periods, e.g. weekends, and for long periods, e.g. during the summer.

19 Facilities for commissioning and testing

Means shall be provided for checking the gas soundness of safety shut-off valves.

Means shall be provided for checking the governor inlet and outlet pressures and the burner manifold pressure.

A purpose-designed point of measurement, external to the flame supervision control box (where fitted), shall be provided for measurement of the flame detector signal.

All air heater shall be provided with manual valves such as are essential for the normal operation and commissioning of the appliance.

To facilitate commissioning, permanent means shall be provided to prevent gas flowing at rates other than the start-gas flow rate.

Conformance to this requirement shall be by any of the following means.

a) A manual valve downstream of the main gas safety shut-off valve; or

b) A removable air-break electrical link other than a disconnection of the electrical wiring, e.g. a fuseholder/ cartridge or purpose made link, in the electrical supply to the main gas safety shut-off valves or the main gas control function within a safety shut-off valve; or

c) For systems designed to meet the requirements of item a) of **15.4.2**, a manually applied mechanical device incorporated within the valve required by that clause; or

d) An air-break switch, requiring the use of a tool for its operation. to isolate the electrical supply to the main gas safety shut-off valves or the main gas control function within a safety shut-off valve; or

e) An air-break switch, not requiring the use of a tool for its operation, to isolate the electrical supply to the main gas safety shut-off valves or to the main gas control function within a safety shut-off valve.

In this particular case, where the main gas valve(s) is fitted with a closed position indicator switch, or a proof of closure switch, or an interlock in accordance with item a) of **15.4.2**, then the switch or interlock shall be checked for correct position throughout the start-gas ignition and proving periods and subsequent period of main gas isolation. Failure to prove correct positioning shall cause safety shut-down.

When using the systems described in b), c), d) or e) the commissioning instructions shall draw attention to the need to ensure that the safety shut-off valves are operating correctly and are leak tight when closed.

Conformity shall be checked by inspection.

NOTE 1 A multifunctional control incorporating the facility required by a) is deemed to meet this requirement.

NOTE 2 Additional circuitry over and above that provided by normal control boxes may be necessary to satisfy requirement e).

NOTE 3 Designers should be aware that the intention of this requirement is to prevent inadvertent release of the main gas supply at all times that the commissioning engineer is setting or checking the start-gas flame.

20 Identification and marking

20.1 General

All technical data shall be expressed in appropriate SI units, with imperial units in parentheses if desired.

20.2 Data plate

A plate, or plates, shall be securely fitted to the appliance in a readily accessible position.

The plate(s) shall have a matt surface and the contrast between lettering and background shall be as great as possible.

The minimum lettering size shall correspond to Helvetica Medium 10 point (2.5 mm) or any other comparable type face.

The plate shall be indelibly marked with the following information:

a) the name and address of the manufacturer, and his agent, if the manufacturer is not based in the United Kingdom;

b) the country of origin, if other than the United Kingdom;

c) the appliance type, name and/or serial number, with identification of more detailed variations or modifications, e.g. by suffix or prefix, by serial number, batch number, date of manufacture, etc.;

d) the gas family for which the appliance is designed, i.e. Cat. I_{2H};

e) stated range of nominal heat inputs and outputs in kilowatts, expressed on a gross calorific value basis;

f) gas injector jet identification;

g) the burner setting pressure in millibars.

20.3 Name badge

A name badge, which provides for general identification by the user, shall be fitted to, or permanently marked on, the appliance externally, or behind a door, and shall conform to the following requirements.

a) It shall include the type, name and/or number of the appliance.

b) The minimum lettering size shall correspond to Helvetica Medium 36 point (10.0 mm) or any other comparable type face.

c) It shall be readily accessible to the user.

The name badge shall be combined with the data plate, in which case the combined plate/badge shall conform to the requirements of this clause and **20.2**, as appropriate.

20.4 Appliance parts

Burners, jets and any injectors shall be marked for identification.

20.5 Electrical data

A wiring diagram showing appropriate internal and external connections shall be marked on the appliance in an easily visible position.

The wiring coding shall be such that it is easily identifiable with the wiring diagram.

Every fuse or circuit breaker shall have on its case or cover, or in an adjacent position, indelible indication of its rated current in amperes (A) appropriate to the circuit(s) it protects.

All electrical components shall be marked with their electrical characteristics, e.g. capacitance, resistance, etc.

The electrical supply requirements, e.g. voltage in volts (V), frequency in hertz (Hz), starting and running current in amperes (A) switch ratings and voltage of any external controls shall be clearly marked on the air heater.

Electrical components supplied for service replacement shall conform to the requirements of this clause.

20.6 Warning notices

Permanent warning notices shall be provided in a readily visible position on the appliance requiring the appliance to be switched off and the gas isolated before carrying out any service operation.

The warning notice shall be of red lettering on a white background. The minimum lettering size shall correspond to Helvetica Medium 12 point (3.0 mm) or any other comparable type face.

The notices shall also draw attention to the need to replace any protective covers that give direct access to live components before the electrical supply is restored.

Removable panels covering live components shall be fitted with warning notices to that effect.

Transportable heaters shall have a plate securely fixed to the appliance in a conspicuous position, which shall read:

'Adequate ventilation must be provided for the continued safe operation of this heater (see User's instructions)'.

20.7 Lighting instructions

Lighting and shut-down instructions shall be affixed to the appliance in an accessible and readily visible position.

The minimum lettering size shall correspond to Helvetica Medium 10 point (2.5 mm) or any other comparable type face.

The instructions shall be printed or marked on a matt surface and the contrast between the lettering and background shall be as great as possible.

21 Air handling

21.1 Air flow rate

The manufacturer shall specify the maximum air flow rate corresponding to the maximum rated heat input of the appliance.

In the case of range rated appliances, the manufacturer shall specify the maximum air flow rate corresponding to each heat input within the specified range of the appliance.

In the case of high temperature appliances, the manufacturer shall specify the minimum flow rate of additional fresh air to be supplied to the heated space corresponding to the maximum rated heat input.

Means shall be provided to cause safety shut-down if the delivered air flow rate falls below 80% of the air flow rate, specified by the manufacturer, corresponding to the heat input rate for which the appliance is adjusted.

Such means shall be fitted in a position where the safe operation of the gas burner is assured at all times.

21.2 Air flow adjustment

When an air heater is designed for a range of heat outputs, means shall be provided for adjusting the air flow rate to give the required temperature rise through the appliance. This requirement need not apply to appliances fitted with separate fans for combustion air supply.

21.3 Profile plate (where fitted)

The manufacturer shall specify the maximum and minimum pressure differential across the profile plate.

Means shall be provided to cause safety shut-down and lock-out if the minimum pressure differential is not achieved.

The position of the profile plates corresponding to the optimum air velocities for satisfactory combustion for the rated heat input or range of heat inputs shall be clearly and indelibly marked.

The profile plates shall be capable of being locked in position so as to avoid inadvertent movement.

21.4 Recirculation air

Where the appliance is intended to be used with recirculation, the recirculation air intake shall preferably be downstream of the burner.

22 Surface heat dissipation

22.1 Requirement

For appliances designed to be installed outside the space to be heated, the radiative and convective heat dissipated from the appliance shall not exceed 3% of the rated heat input expressed on a gross calorific value basis, when tested in accordance with **22.2**.

22.2 Method

The appliance is set up in accordance with the relevant sections of Clause **6** and adjusted to the maximum rated heat input using test gas G20. The air flow rate is set to the manufacturer's specified air flow rates and the appliance operated until thermal equilibrium is reached.

Divide the outer surfaces of the heater into areas approximately 150 mm square and measure the surface temperature at the centre of each area as specified in **13.1**. The areas are then taken in groups at 5 K intervals and the heat dissipation computed from the following formulae:

Convective heat dissipation = $\sum C\, A_c (t_1 - t_0)^{5/4} W$

where

C is 2.5 for horizontal surfaces facing upwards

C is 1.9 for vertical surfaces

C is 1.3 for horizontal surfaces facing downwards

A_c is the sum of the areas of similar orientation and temperature t_1 (in m^2)

t_1 is the average surface temperature (in °C)

t_0 is the average ambient temperature (in °C)

Radiative heat dissipation = $\sum 5.67 \times 10^{-8} E\, A_R (T_1^4 - T_0^4) W$

where

E is the emissivity of the surface

A_R is the sum of the areas of temperature T_1 (in m^2)

T_1 is the average surface temperature (in K)

T_0 is the average ambient temperature (in K).

23 Air delivery volume

23.1 Requirement

The volumetric flow rate of air delivered by a ducted heater to the heated space shall be specified by the manufacturer for the maximum and minimum static pressures for which the heater is designed.

The volumetric flow rates shall be specified in terms of volume flow of air at 15°C and 1 013.25 mbar pressure.

The volumetric air flow rates at the minimum and maximum static pressures shall be within -0, +10% of the manufacturer's specified flow rates. A suitable method is described in **23.2**.

23.2 Method

The heater is installed and adjusted according to the manufacturer's instructions and as specified in **6.2**. The heated air outlet is connected, by means of an appropriate adapter, to a horizontal test duct of suitable cross section and at least 13 diameters in length.

The test duct shown in Figure 2, comprises an anti-swirl device two diameters in length (see Figure 3), a measuring section at least nine diameters in length and an air flow regulating device (see Figure 4).

Where the heated air outlet discharges vertically, the connection is made by means of a bend of equivalent cross section. If the air outlet, and hence the bend, is rectangular in cross section, the bend is fitted with guide vanes as shown in Figure 5.

Total and dynamic pressure in the air stream are determined in a section ten diameters from the inlet to the test duct using a pitot-static tube according to the method specified in BS 1042-2.1. Corresponding temperature measurements are taken in a section 10.5 diameters from the inlet to the test duct.

The volumetric air flow rate is calculated as specified in BS 1042-2.1.

The maximum and minimum static pressures are obtained by adjustment of the air flow regulating device and the air flow determination is carried out with the appliance operating at its maximum rated heat input.

NOTE Where the air delivery fan is upstream of the heat exchanger, the air flow rates may be determined with the appliance in the unlit condition.

Figure 2 **Test duct for air flow measurement**

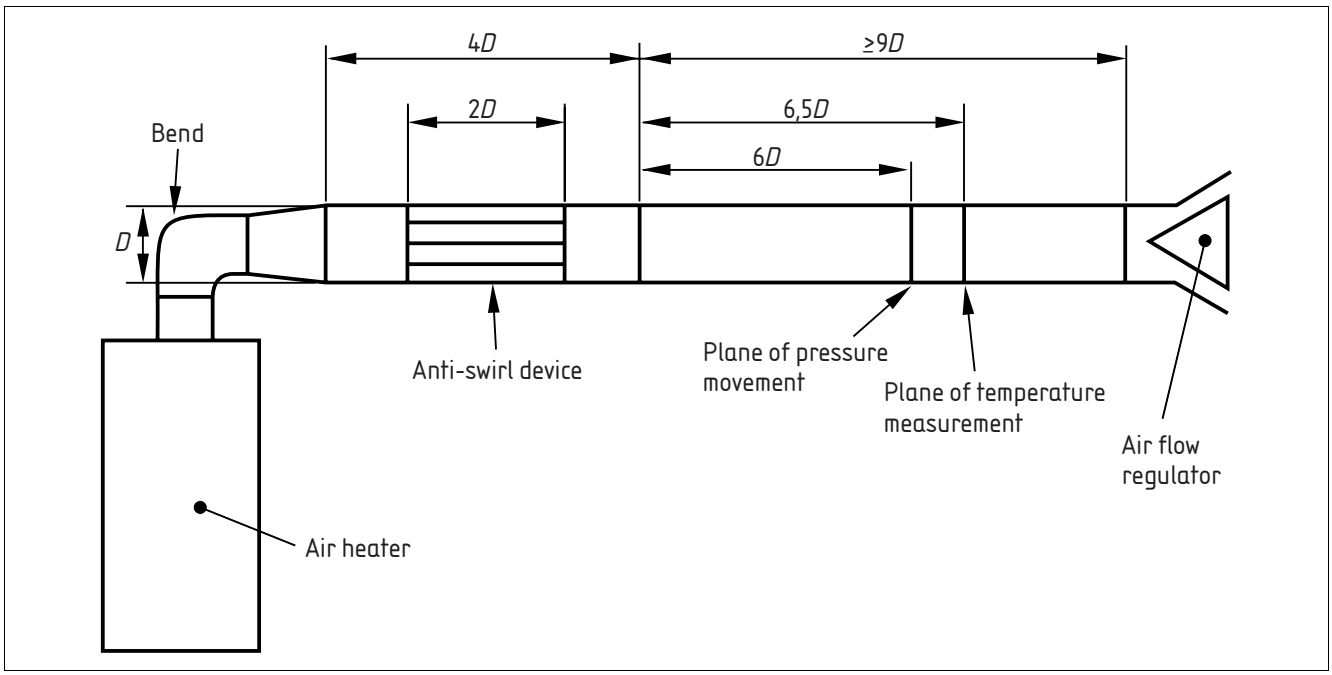


Figure 3 **Anti-swirl device**

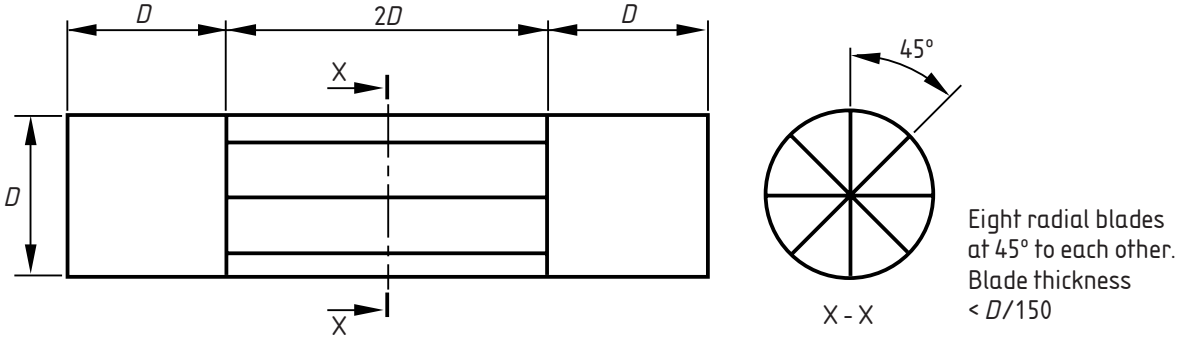


Figure 4 **Air flow regulation device**

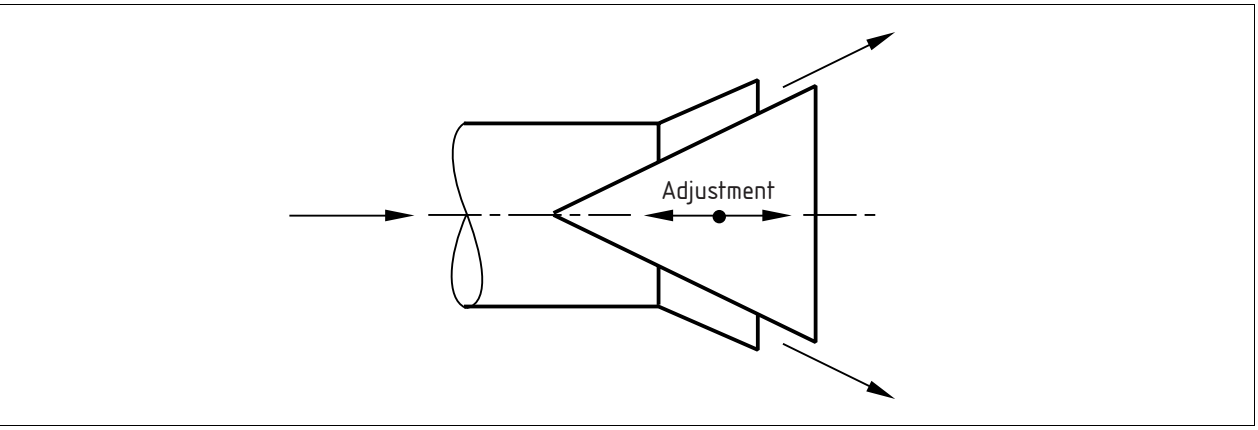
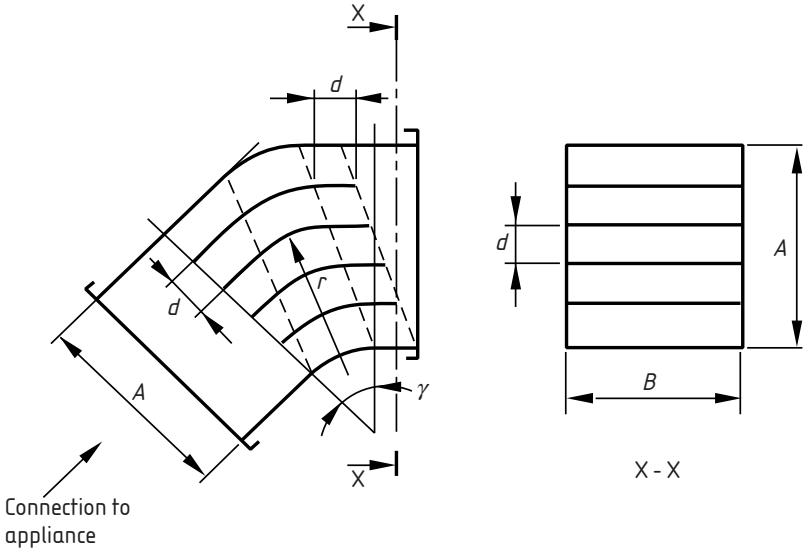


Figure 5 **Connecting bend**



Key

A, B = dimensions of appliance outlet connection

$d = \frac{A}{5}$

r = 2.5d

γ = angle of bend, as small as possible

Guide vane thickness to be equal to wall thickness of bend.

24 Weather resistance

24.1 Requirement

Appliances designed for permanent outdoor installation shall continue to function normally, with the burner(s) and pilot(s) operating, when subjected to the rain test described in **24.2**.

With access doors and panels in place, no water shall accumulate in any part of appliances designed for permanent outdoor installation such that normal functioning is affected when subjected to the rain test described in **24.2**.

24.2 Rain test

Two independent sets of adjustable spray units, each as shown in Figures 6 and 7, are used. Each spray unit is adjustable in height from 2 m to 3 m above the floor and in any lateral direction.

The two spray units are placed in opposition with the spray heads equidistant from the floor and from the appliance under test.

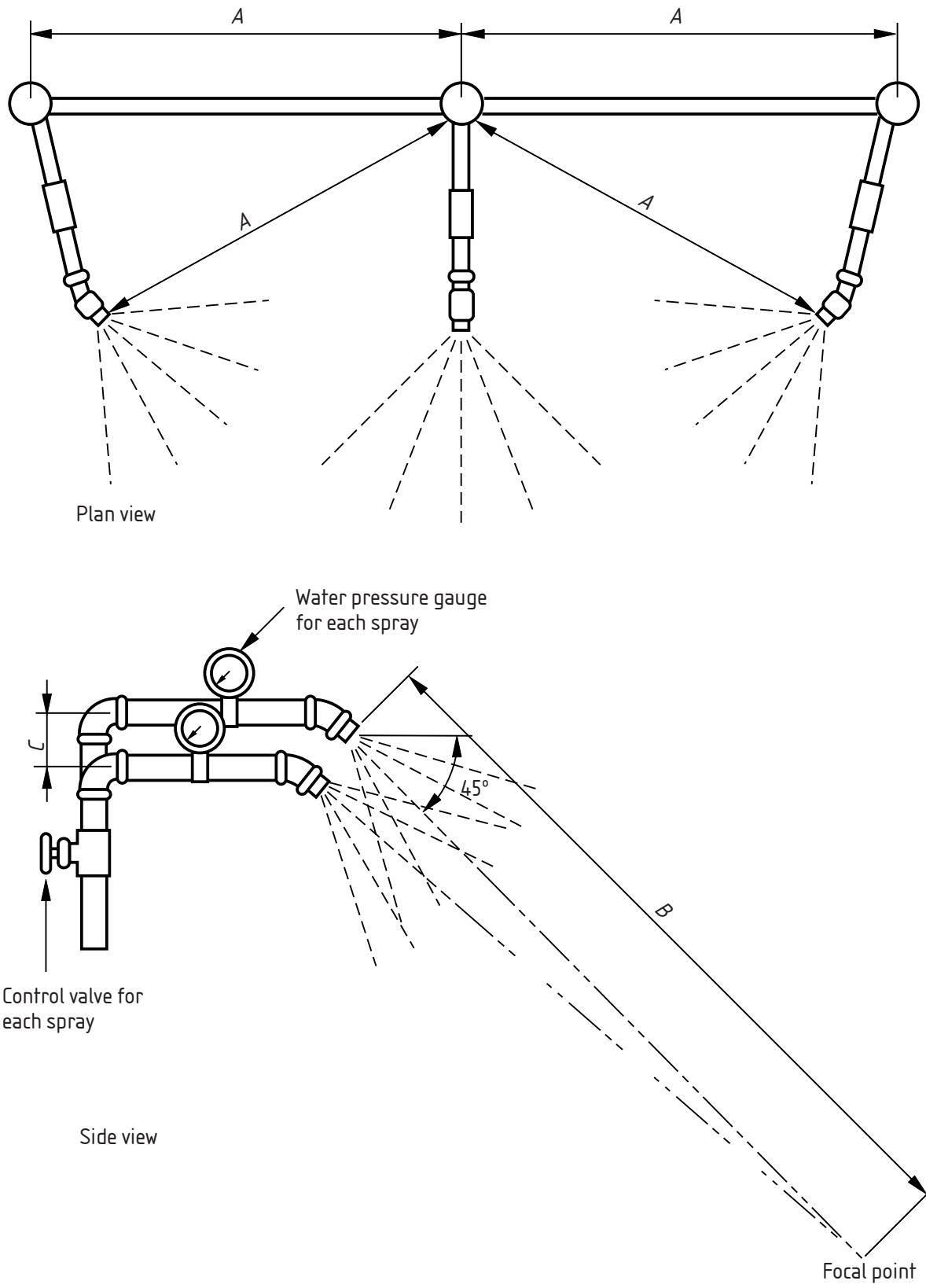
Install the appliance in accordance with the manufacturer's instructions on a test platform of such size as to accommodate the appliance easily and support it at a height of 100 mm above the floor.

The spray heads are set to operate at 350 mbar and the units adjusted to varying elevations and horizontal distances from the appliance to determine the most critical location. Exposure at the location deemed most critical by the test authority is maintained throughout the test.

After adjustment of the spray units, any pilot is ignited and the rain test applied for a period of 15 min. The main burners are then ignited and the test continued for a further 15 min.

The test is repeated with the appliance located in any other position relative to the spray units as may be required by the test authority.

Figure 6 **Arrangement of spray heads and associated piping for rain test** (see Clause **22**)



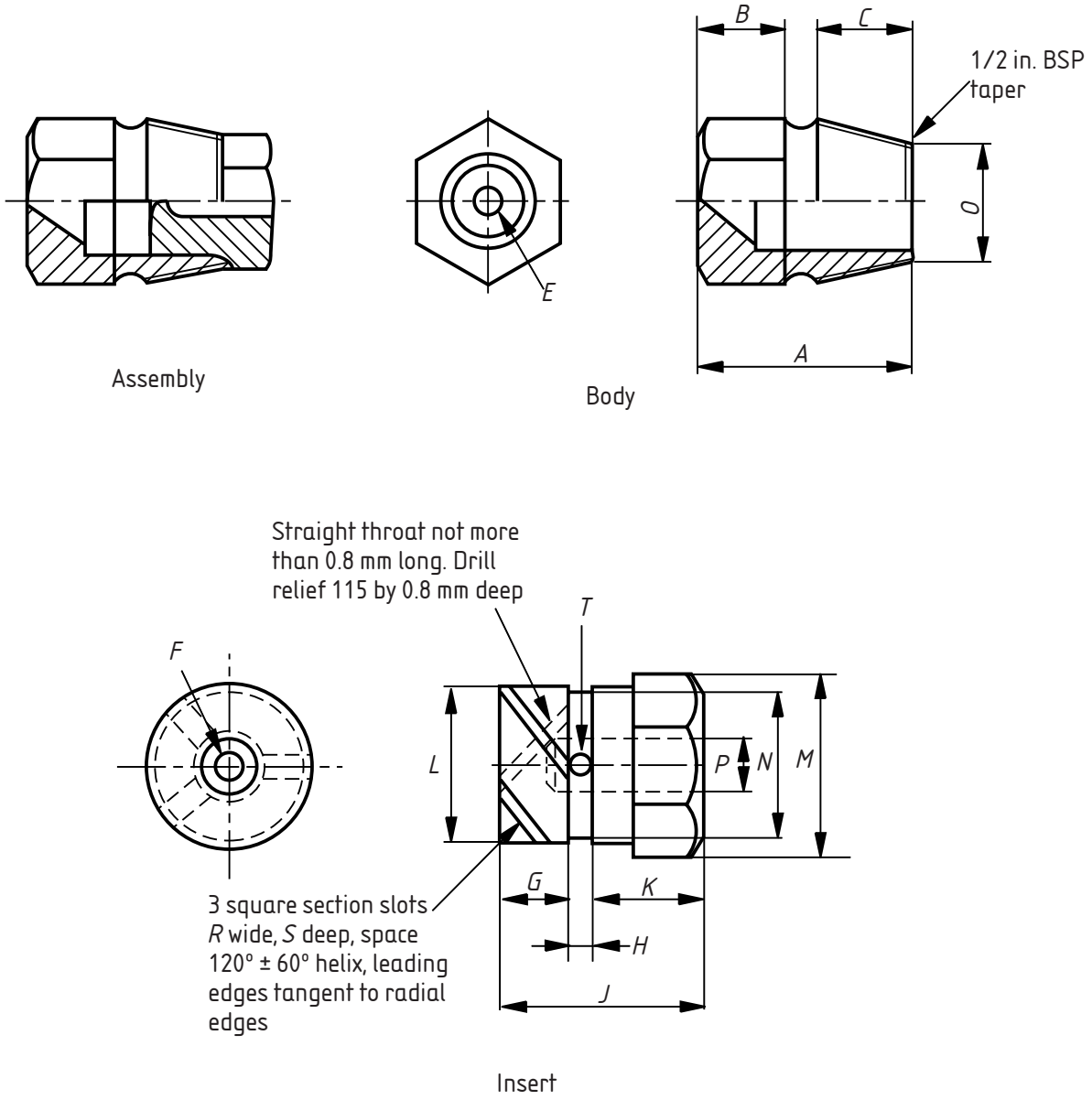
Dimensions

A 710 mm

B 1400 mm

C 75 mm

Figure 7 **Details of spray head assembly and construction** (see Clause **22**)



Dimensions

A	31.0 mm	K	4.0 mm
B	11.0 mm	L	14.6 mm
C	14.0 mm	M	16.0 mm
D	14.7 mm	N	11.5 mm
E	5.0 mm	P	6.4 mm
F	2.5 mm	R	1.5 mm
G	6.4 mm	S	1.5 mm
H	2.4 mm	T	2.8 mm
J	18.3 mm		

Bibliography

For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 1756 (all parts), *Methods for the sampling and analysis of flue gases*

BS 5991, *Specification for indirect gas fired forced convection air heaters with rated inputs greater than 270 kW but not exceeding 2MW for industrial and commercial space heating: Safety and performance requirements (excluding electrical requirements) (second family gases)*

BS EN 1092-2, *Flanges and their joints. Circular flanges for pipes, valves, fittings and accessories, PN designated – Part 2: Cast iron flanges*

BS EN 60085, *Electrical insulation – Thermal classification*

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