BRITISH STANDARD

Specification for indirect 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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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 51 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This British Standard supersedes BS 5991:1989, which is withdrawn.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 621:1998 and BS EN 1020:1998 as appropriate.

Corresponding requirements for direct gas fired forced convection air heaters are specified in BS 5990.

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 5991 incorporates changes made necessary by the publication of BS EN 621:1998 and BS EN 1020:1998. 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 value (300 kW based on the net calorific value).

In anticipation of this standard being the subject of third party certification schemes, it provides for a claim by the appliance manufacturer of a numerical value for the thermal efficiency of a product model. The test authority will then ascertain that a sample submitted for type approval meets this claimed value within a specified test equipment tolerance. Any sample selected from subsequent production of the particular model will be expected to conform to a verification value that will also take into account a specified production tolerance.

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 specifies detailed requirements, including safety and performance requirements and methods of test, for indirect 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 indirect gas fired forced convection air heaters for use both with and without ducting, and intended primarily for space heating applications.

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

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

For appliances fitted with gas boosters and/or flue dampers, additional requirements may apply.

This standard does not apply to portable and transportable indirect gas fired forced convection air heaters.

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 1041 (all parts), *Code for temperature measurement*

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 5000-11, *Specification for rotating electrical machines of particular types or for particular applications – 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 EN 88, *Pressure governors for gas appliances for inlet pressures up to 200 mbar*

BS EN 125, *Specification for flame supervision devices for gas burning appliances – Thermoelectric types*

BS EN 126, *Multifunctional controls for gas burning appliances*

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, *Specification for test gases, test pressures and categories of appliance, for gas appliances*

BS EN 621:1998, *Non-domestic gas-fired forced convection air heaters for space heating not exceeding a net heat input of 300 kW, without a fan to assist transportation of combustion air and/or combustion products*

BS EN 1020:1998, *Non-domestic gas-fired forced convection air heaters for space heating not exceeding a net heat input of 300 kW, incorporating a fan to assist transportation of combustion air and/or combustion products*

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

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 60730-2-9, *Specifications for 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*

PD CEN/TR 1749[1)], *European scheme for the classification of gas appliances according to method of evacuation of the combustion products (types)*

[1)] In preparation.

3 Terms and definitions

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

3.1 air temperature control

temperature-actuated control intended to maintain the temperature of the discharged air, the return air to the heater, or the air in the heated space between specified limits

NOTE This is the normal means of air temperature control.

3.2 automatic burner system

burner system in which, when starting from the completely shut-down condition, the start-gas flame is established and the main gas valve(s) is actuated without manual intervention

NOTE 1 Automatic burners may have pilots that are interrupted or intermittent.

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

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 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

3.6 hazardous condition

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

3.7 indirect fired air heater

appliance in which the products of combustion are separately vented and do not mix with the heated air being supplied to the space

3.8 lock-out

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

3.9 minimum operational rate

70% of the minimum rate of the control system

3.10 multifunctional control

assembly comprising two or more gas control devices in addition to a gas tap and any gas rate adjuster within a single housing

3.11 natural draught burner

burner that does not employ a fan for the entrainment of air, either forced or induced

NOTE 1 The term includes atmospheric injectors and neat gas burners

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

3.12 non-automatic burner system

burner system that is non-automatic within the meaning of **3.2**, i.e. a burner with a permanent pilot ignited under manual supervision

3.13 overheat (limit) control

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.

3.14 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 be either a pilot flame or the main burner flame at reduced rate.

3.18 claimed efficiency (E_c)

net efficiency of an appliance claimed by the manufacturer

3.19 test house efficiency (E_t)

net efficiency of an appliance measured at the test house on a sample submitted for type approval purposes

3.20 verification efficiency (E_v)

net efficiency of an appliance measured during any surveillance or check testing of production appliances

3.21 heater with integral fan in the secondary flue

appliance incorporating an integral fan downstream of the draught diverter which is used to assist in the evacuation of products of combustion

3.22 equivalent resistance

resistance to flow in mbar, measured at the outlet of the appliance, which is equivalent to that of the flue

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 covers appliances of type B only.

The definitions of the specific variations of type B appliances are as given in PD CEN/TR 1749.

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.

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 or 10 parts per million (0.001% (*V/V*)) of carbon monoxide.

6.2 Preparation of appliance for testing

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 test gas G20 at an inlet pressure of 17.5 mbar[2)].

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.

Appliances with an integral fan in the secondary flue (natural draught burners) shall be installed on a flue of manufacturer's minimum specified equivalent resistance unless otherwise directed in the particular test.

Other appliances having a vertical flue outlet shall be fitted with the minimum length of vertical secondary flue specified by the manufacturer and having the same nominal diameter as the flue outlet.

Other appliances having a horizontal flue outlet shall be fitted in accordance with the manufacturer's instructions; these shall include the maximum length of horizontal run and the method of adaptation to a vertical flue. Thereafter the vertical flue shall be fitted as above.

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.

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2) 1 mbar = 100 N/m^2 = 0.1 kPa.

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

Unless the test method specifically requires otherwise, the appliance shall be operated at the design temperature rise ± 10%.

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 621:1998 or **6.3.2** of BS EN 1020:1998 depending on whether the appliance incorporates a fan to assist transportation of combustion air and/or combustion products.

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.

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.

Materials containing asbestos shall not be used.

7.1.2 Flueways: natural draught burners

For air heaters fitted with natural draught burners, the combustion chamber and flueways shall be so designed that there is no descending section that is capable of creating reverse flows.

7.1.3 Component location

Parts that are intended to be removable for maintenance or cleaning shall be readily accessible, shall be easy to assemble 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, jets or injectors without the use of tools.

7.1.4 Injectors and jets

Injector and jet orifice areas shall be non-adjustable.

7.1.5 Gas rate adjusters

Adjustable gas rate adjusters shall be readily distinguishable from other manual valves.

The setting of adjusters shall be protected by a method that discourages unauthorized adjustment.

7.1.6 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.

7.1.7 Aeration adjustment (natural draught burners)

Any means of adjusting the primary aeration of natural draft burners shall be preset and locked by the manufacturer.

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

7.1.9 Fire 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.

7.1.10 Fan compartment

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

Products of combustion shall not be drawn into the air distribution system either under normal operating conditions or when user access panels are removed.

7.1.11 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 10 or BS EN 1092-1 and BS EN 1515-1.

7.1.12 Bolts and screws

Drilling 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.

7.1.13 Viewing port

Means shall be provided to allow observation of pilot and 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.

7.1.14 Servicing

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

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

In addition, union or 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.

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.

A burner that can be retracted from the combustion chamber or is provided with swivel flanges to allow the burner to be swivelled from the combustion chamber shall be provided with a safety device to prevent accidental swivelling. If the burner can be retracted or swivelled without the use of tools it shall also be provided with an interlock to cause lock-out if the burner is retracted or swivelled from the firing position.

7.1.15 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. This requirement shall be deemed to be satisfied if suitable hinges are fitted.

7.1.16 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.

7.1.17 Flexible pipes

Flexible pipes shall be metal armoured and have screwed or flanged connections. Flexible pipes shall withstand at least three times the working pressure with a minimum of 3.5 bar at 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.

7.1.18 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.

7.1.19 Air inlets

Where the inlet air is intended to be ducted to the heater, the appliance shall be provided with flanged or spigot connections on the air inlet. If necessary the manufacturer shall supply a suitable adaptor in order to meet this requirement.

7.1.20 Air outlets

The air outlet(s) of a ductless 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.

7.1.21 Facility for remote control

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

7.1.22 Durability of protective finishes

7.1.22.1 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.

7.1.22.2 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 of those standards.

7.1.22.3 Painted and plastics coated parts

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

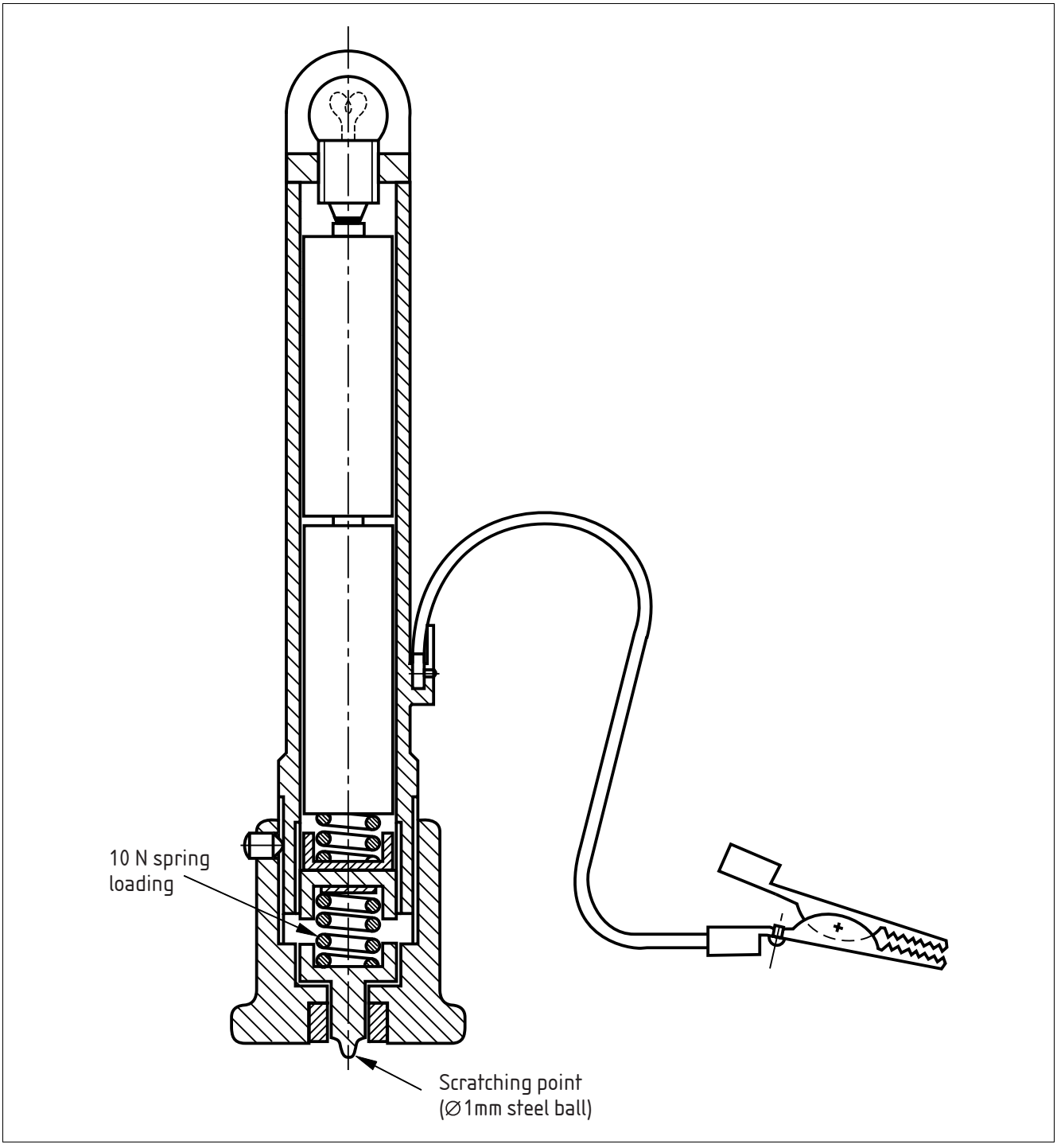
a) *Resistance to heating*
There shall be no appreciable change of colour on any part of the appliance, and the finish shall not become tacky or show other signs of deterioration at the end of the drying out period as specified in **6.2**.

NOTE 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 it frequently to verify that it remains a 1 mm sphere.

Figure 1 **Paint scratch test apparatus** (see **7.1.22.3**)



7.1.22.4 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.

7.1.23 Noise

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

7.1.24 Smell

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

7.1.25 Disposal of condensate

An appliance with a claimed thermal efficiency in excess of 92% (based on the net calorific value) shall be provided with means for collection and disposal of condensate.

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

8.2 Complete assembly

8.2.1 Requirements

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.

8.2.2 Method

Connect to the appliance inlet an air supply maintained constant at the appropriate pressure and embodying 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 values in the CLOSED position;

b) with all gas valves in the OPEN position, the flame supervision device 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 621:1998 or **6.3.2** of BS EN 1020:1998 depending on whether the appliance incorporates a fan to assist transportation of combustion air and/or combustion products.

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

An appliance of type B_{11} shall conform to the requirements applicable to type B_{11} appliances given in **5.1.5** of BS EN 621:1998.

An appliance of type B_{12}, B_{13}, B_{14}, B_{22} or B_{23} shall conform to the requirements applicable to such appliance types given in **5.1.5** of BS EN 1020:1998.

10.2 Methods of test

An appliance of type B_{11} is tested as described in **6.3.5** of BS EN 621:1998, using only the procedures appropriate to type B_{11} appliances.

An appliance of type B_{12}, B_{13}, B_{14}, B_{22} or B_{23} is tested as described in **6.3.5** of BS EN 1020:1998, using only the procedures appropriate to the specific appliance type concerned.

11 Ignition

11.1 Pilot burners and ignition devices

11.1.1 General

All pilots shall 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 would be likely to impair ignition when gas is admitted to the main burner, and shall be fitted with a manual isolation valve.

This requirement shall be deemed to be satisfied if a multifunctional control is fitted.

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.

The gas supply to a permanent pilot shall be protected against blockage by gas-borne particulate matter.

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.

For ladder pilots and extended surface burners, e.g. multi-bar burners over 1 m in length, and for main burners directly ignited at a reduced rate, the flame detector(s) shall be located at a point(s) distant from the point of ignition such that flame run is proven.

11.2 Ignition performance: burner systems with permanent pilots

11.2.1 Pilot ignition (general)

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 1.

Table 1 **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.

11.2.1.1 Heater with integral fan in the secondary flue (natural draught burners)

The heater shall be operated at the setting pressure and with the pilot only alight, utilizing test gas G20. With the heater installed in accordance with **6.2**, the secondary flue outlet shall be progressively restricted until the outlet is completely blocked. The test shall be carried out with the fan operating at the rated voltage and, if appropriate, with the fan inoperative. The pilot flames shall ignite and remain stable without light-back or lift and any flame supervision device shall continue to function normally throughout the test.

11.2.2 Main burner ignition

Ignition of the main burner shall be smooth and the flames shall carry over to all ports. Ignition shall be checked with the appliance operating at its minimum stated and maximum rated inputs 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 shall be achieved without undue noise, flame roll-out or light-back with the appliance operating at its minimum stated and maximum rated inputs with respect to reference test gas G20. At the start of each test the appliance shall be in the cold condition.

The following test gas shall be used: G20.

11.2.4 Main burner ignition at reduced inlet pressure

With the appliance adjusted in accordance with 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 with the appliance in the hot condition and also in the cold condition on test gas G20.

11.3 Ignition performance: burner systems without permanent 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;

d) without flame roll-out or light-back.

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 G23.

Ignition of the main burner shall be achieved as required in a) to d) 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 its minimum stated 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 12.2 mbar, and below this pressure shall either continue to ignite and operate safely or proceed to safety shut-down.

12 Flame stability

12.1 Still air conditions

12.1.1 Requirement

The main burner flames shall remain stable without lighting back to the injector(s) or lifting off when operated on the light-back and lift limit test gases under the conditions given in Table 2.

Table 2 **Heat input conditions**

Test gas	Conditions
G22	Minimum operational rate to the maximum rated heat input
G23	Maximum rated input

12.1.2 Method

Adjust the appliance at thermal equilibrium on test gas G20. Substitute the appropriate test gas G22 or 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.

12.2 Abnormal draught conditions (natural draught burners)

12.2.1 General requirement

There shall be no appreciable distortion or disturbance of the main burner flames, and pilots shall remain stable when tested under the conditions specified in **10.1.3.1**.

12.2.2 Requirement for internal installations

With the appliance set up in its normal operating condition, a wind of 2 m/s in a horizontal plane at the burner level and centred on the burner shall not cause permanent flame lift, blow-off or light-back of either the pilot or the main burner at input rates from the minimum stated heat input to the maximum rated input. This test shall be carried out using test gas G20.

12.2.3 Requirement for external installations

In the special case of an appliance designed for external installation, the appliance shall be subjected to a wind of 15 m/s and shall conform to the requirements of **12.2.1**.

12.2.4 Method for internal and external installations

A fan of at least 0.25 m^2 cross-sectional area is used and the distance from it at which the wind speed is 2 m/s, for internal installations, or 15 m/s for external installations, is found using a vane anemometer.

The fan is then placed to give this wind speed at the air heater with the air stream directed at the heater. A shield, large enough to cover the fan

outlet, is placed downstream of the fan and between the fan and the heater.

Immediately after lighting the heater, the shield is removed for periods of 3 s so that gusting is produced. This test is repeated at steps of 30° round the heater in the horizontal plane.

During the test the draught diverter shall be protected from the effects of the fan wind.

12.2.5 Heater with integral fan in the secondary flue

When the heater is tested under the conditions specified in **10.1.3.3**, there shall be no light-back or flame lift of the main burner flame as blockage of the secondary flue is progressively increased.

NOTE Minor disturbance of the flame is permissible provided that this does not give rise to permanent flame lift.

12.3 Leakage characteristics

12.3.1 Ductless air heaters

When the air outlet louvres of a ductless air heater are set in the position of maximum closure and when the appliance is operated at its maximum rated heat input on test gas G20, there shall be no observable interference with the main burner flames nor shall there be any appreciable change in the carbon dioxide content of the combustion products in the primary flue.

12.3.2 Ducted air heaters

When a ducted air heater is operated against a static pressure of 0.5 mbar in the outlet air duct and when the appliance is operated at its maximum rated heat input on test gas G20, there shall be no observable interference with the main burner flames nor shall there be any appreciable change in the carbon dioxide content of the combustion products in the primary flue.

13 Flue system

13.1 Effectiveness of flue system

When the appliance is installed and operated in accordance with the manufacturer's instruction (see **6.2**), there shall be no escape of combustion products other than to the chimney flue. The manufacturer shall specify the minimum effective height of the chimney flue, where appropriate, and/or the minimum flue draught required.

For appliances capable of being fitted with a flue of nominal diameter 200 mm or less, the manufacturer shall also state the type(s) of flue termination which shall be used. The design of the termination shall be such that it will not allow the entry of a ball of 16 mm diameter.

For appliances with an integral fan in the secondary flue which connect to vertical flues of nominal diameter greater than 200 mm, means shall be provided to protect the fan from damage arising from objects dropping into the flue.

13.2 Flue connections

Where the flue and its termination are not an integral part of the appliance:

a) the flue outlet of the appliance shall be suitable for connection to round flue pipe sized in accordance with the manufacturer's instructions;

b) the flue outlet shall be of the socket type having a minimum depth of 25 mm, or be designed to prevent condensation from running down the outside of the appliance.

13.3 Flue breaks

A natural draught appliance shall incorporate a draught diverter or a stabilizer of the double swing type.

13.4 Induced draught fans

When a fan is integral with the heater to assist in the supply of combustion air, the heater shall conform to the requirements set down for automatic forced and induced draught burners (see **17.6.3**, **17.7.3** and **17.8.3**).

13.5 Air heater designed for outdoor installation

13.5.1 Requirements

The flue outlet shall be so designed and positioned that it cannot be obstructed (e.g. by products of corrosion, air borne dirt, leaves or snow, etc.) and that staining of adjacent surfaces is minimized.

The flue outlet, if integral with the heater, shall be protected against the ingress of rain or snow. Any opening in the protective guard shall not permit the entry of a ball 16 mm in diameter applied with a force of 5 N.

If the manufacturer's instructions permit the installation of the appliance other than with a vertical flue, the appliance shall be subjected to horizontal, plunging and ascending winds of speeds of 2.5 m/s, 5 m/s, 10 m/s and 15 m/s centring on the terminal. Under these conditions there shall not be any permanent flame lift, blow-off or light-back of the pilot and main burner flames at heat input rates from the minimum stated input rate to the maximum rated heat input when the appliance is operated on test gas G20.

13.5.2 Method

An axial flow fan of at least 0.25 m^2 cross-sectional area is used and the distance from it at which the wind speed is 15 m/s is found using a vane anemometer.

The fan is then placed at this distance from the terminal with the air stream directed at the terminal.

With the appliance lit and the fan in operation, the appliance is slowly rotated about a vertical axis relative to the fan and the flames are observed. At positions of the appliance where, by inspection, there appears to be maximum flame interference, the rotation of the appliance is halted.

The appliance is shut down and allowed to cool to room temperature.

A shield, large enough to cover the fan outlet, is placed between the fan and terminal.

Immediately after lighting the appliance the shield is removed for periods of 3 s so that gusting is produced.

Tests with ascending and plunging winds are carried out as for horizontal winds except that the wind is continuous and directed at an angle of 45° to the horizontal plane upwards and downwards.

All the above tests are repeated with the terminal subjected to horizontal, plunging and ascending winds of speeds 10 m/s, 5 m/s and 2.5 m/s.

13.6 Heater with integral fan in the secondary flue (natural draught burners)

13.6.1 When the appliance is operated with the appropriate reference test gas at adjustment pressure while connected to a flue of the manufacturer's minimum and maximum specified equivalent resistance all the products of combustion shall pass through the secondary flue when the static pressure immediately before the secondary flue outlet is increased, by throttling at the outlet, to a value equal to h + 0.75 mbar, where h is the static pressure measured under normal discharge in still air.

13.6.2 When tested using a flue of the manufacturer's minimum specified equivalent resistance all the products of combustion shall pass through the secondary flue for all fan voltages that allow gas to be applied to the main burner.

13.6.3 The dimensions of any terminal guard shall be such that, when fitted in accordance with the manufacturer's instructions, no part of the guard is less than 50 mm from any part of the terminal, not including any wall plate.

The guard shall not have any sharp edges likely to cause injury nor shall any opening permit the entry of a ball of 16 mm diameter when applied with a force of 5 N.

The material, finish, and mechanical strength, of the guard shall be such as to ensure a reasonable life in normal working conditions.

NOTE In the case of appliances having a rated heat input of 330 kW and above, due account should be taken of the Chimney Heights Memorandum 3rd Edition, of the Clean Air Act (1956).

14 External temperatures

14.1 Surface temperatures

14.1.1 Requirement

When the heater is operated on test gas G20, the temperature rise of the parts listed in Table 3 shall not exceed the values specified when tested in accordance with **14.1.2**.

Table 3 **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:	
of metal	35
of porcelain or vitreous material	45
of plastics, rubber or wood	60
Parts that are likely to be touched accidentally (excluding working surfaces: see Note):	
of metal	80
of porcelain or vitreous material	95
of plastics, rubber or wood	100

NOTE Working surfaces include external primary flues and draught diverters.

14.1.2 Method

Surface temperatures are measured when the appliance has reached thermal equilibrium by means of a surface contact pyrometer (see BS 1041). 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.

14.2 Component temperatures

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

15 Heat exchanger: working life

15.1 Requirements

An appliance of type B_{11} shall conform to the requirements given in **5.1.7** of BS EN 621:1998.

An appliance of type B_{12}, B_{13}, B_{14}, B_{22} or B_{23} shall conform to the requirements given in **5.1.7** of BS EN 1020:1998.

15.2 Methods of test

An appliance of type B_{11} is tested as described in **6.3.7** of BS EN 621:1998.

An appliance of type B_{12}, B_{13}, B_{14}, B_{22} or B_{23} is tested as described in **6.3.7** of BS EN 1020:1998.

16 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.

17 Automatic controls

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

17.1 General

Electrically operated controls other than ignition transformers shall conform to the requirements of BS 800 in respect of radio and television interference.

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

17.2 Governors

Governor(s) shall conform to BS EN 88. The main and start gas or pilot supplies shall be under the control of a constant pressure governor(s) upstream of the safety shut-off valve.

*NOTE For natural draught heaters the gas supplies to permanent pilots and other independent pilots or start-gas burners need not be governed where it can be demonstrated that, at a maximum inlet pressure of 50 mbar, the pilot or start-gas rate does not exceed that specified in **17.7.1** or **17.7.2** as appropriate.*

17.3 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 not be 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.

17.4 Safety shut-off valves

17.4.1 General requirements

Electrically operated safety shut-off valves shall conform to BS EN 161.

17.4.2 Application

17.4.2.1 Appliances fitted with natural draught burners

All gas supplies shall be under the control of valves, connected into the gas line in series, of a requirement not less than that specified in Table 4.

Table 4 **Valves required for natural draught systems**

Input	Main gas valves required		Start gas valves required	
	Non-automatic systems	Automatic systems	Non-automatic systems	Automatic systems
Above 330 kW up to 600 kW	2 × class B	2 × class B	1 × class B [A]	2 × class B [B] [C]
Above 600 kW up to 2 MW	2 × class B	2 × class B	1 × class B	2 × class B [B]

[A] This valve may be the class B valve controlling the main gas supply.
[B] These two valves may include one of the main gas valves, subject to the requirements of **17.7.2**.
[C] Where the start gas rate is less than 10% of the main gas rate one of these valves may be omitted.

17.4.2.2 Appliances fitted with forced or mechanically induced draught burners

Each main gas supply shall be under the control of two safety shut-off valves in series of a requirement 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

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 **17.7.3**; or

b) be under the control of at least one class 1 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 The requirements given in **17.4.2.2** should be read in conjunction with those given in **17.7.3**.*

17.4.3 Shut-down

The flame supervision system and the overheat control shall effect closure of all shut-off valves in the systems specified.

In no case shall the air temperature and overheat controls effect closure of the same single shut-off valve.

17.4.4 Restart

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

17.5 Air flow through the combustion circuit and flow of products of combustion

17.5.1 Combustion air, pre-purge and post-purge (appliances fitted with forced or mechanically induced draught burners)

17.5.1.1 Combustion air

Appliances 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.

NOTE 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 direction sensitive centrifugal switch connected directly to the fan impeller.

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 satisfied if entry is prevented, of the standard test fingers specified in BS EN 61032.

17.5.1.2 Pre-purge and post-purge

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 the combustion air rate appropriate to maximum rated heat input, or pro rata longer periods at lower air rates. The pre-purge shall be at the highest flow possible, but shall not be less than 25% of the above rate or products extract rate.

The pre-purge shall either:

a) be such as to give at least five volume changes of the combustion chamber and gas passages up to the flue exit from the appliance, and shall also include the volume of the space below the combustion chamber where unburnt gas may be present or;

b) when the heater is tested in accordance with the method specified in **17.5.1.3** and under still air conditions, be such as to give a gas concentration equal to or less than 1.25% (*V/V*) in the combustion chamber/heat exchanger and flue ways at the end of the manufacturer's specified pre-purge time.

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:

1) the burner shall go to safety shut down; or

2) the purge shall be continued upon restoration of the required air rate provided that the air flow does not fall below 25% of the combustion air rate appropriate to the maximum rated input and that the total purge time at the required air rate is not reduced.

On shut-down the forced or induced draught burner fans shall not be switched off before the start gas and main gas shut-off valves have been de-energized.

NOTE Post-purge is optional.

17.5.1.3 Method

17.5.1.3.1 Appliance preparation

The heater is installed and adjusted in accordance with the manufacturer's instructions and as specified in **6.2**, except that for the purposes of this test:

a) the fuel supply is disconnected;

b) the heater control unit is electrically isolated;

c) an independent electrical supply to the combustion air fan is provided.

A separate means of test gas supply is connected, incorporating appropriate equipment for measurement and control of pressure and flow rate, in the pipework downstream of the start gas valve(s).

17.5.1.3.2 Test procedures

The test gas specified in Table 6 is supplied to the burner and its flow rate is adjusted to be equivalent to 10% of the stoichiometric fuel gas rate corresponding to the air purge rate.

The test gas concentration within the heater is monitored, by continuous measurement of the CO_2 concentration, until an equilibrium concentration is reached. The combustion air fan is then energized without making any adjustment to the test gas flow rate and the test gas concentration monitored until it falls below 1.25% (*V/V*).

A graph of the fall in test gas concentration against time is plotted and the time interval between fan energization and the concentration reaching 1.25% (*V/V*) is recorded.

The procedure is repeated for each installation orientation specified by the manufacturer.

17.5.1.3.3 Accuracy of measurement

Measurements are made with the appropriate accuracy as follows:

atmospheric pressure	± 1 mbar
test gas pressure	± 0.1 mbar
test gas quantity	± 0.5% by volume
time	± 0.2 s
carbon dioxide	± 0.5% of actual reading
helium	± 0.5% of actual reading

17.5.1.3.4 Sampling and response time

Sampling and response times are as follows:

a) *Probe positioning*. The sampling probe is positioned centrally in the exit from the combustion chamber.

b) *Response time*. The response time, i.e. the delay occurring between the sample being taken and the gas concentration being recorded, should be kept to a minimum.

It is therefore necessary to carry out a preliminary investigation to establish that response time so that the recorded concentration can be correlated with the correct sample.

Table 6 **Purge test gas**

Component	**Concentration** % (V/V)
Carbon dioxide	33 + 0.5, -0.4
Helium	67 + 0.4, +0.5
NOTE The relative density of the test gas should be 0.597 ± 1%.	

17.5.1.3.5 Determination of test gas flow rate (Q_{tg})

The appliance is operated on test gas G20 at the manufacturer's maximum specified heat input until steady state conditions are attained. The CO_2 content of the undiluted combustion products in the primary flue is determined at a point no more than 150 mm from the appliance flue outlet.

Sufficient measurements are taken to ensure consistency of results.

The test gas flow rate Q_{tg} (in m^3/h) is calculated as follows:

$$Q_a = Q_g \left[0.21 A_s + \frac{100C}{C_m} - C \right]$$

$$Q_{tg} = 0.1 \frac{Q_a}{A_s}$$

where

A_s is the stoichiometric air requirement of fuel (*V/V* of fuel);

C is the CO_2 produced by combustion of fuel (*V/V* of fuel);

C_m is the measured CO_2 content of combustion products (in %);

Q_a is the proved air purge rate (in m^3/h);

Q_g is the maximum specified gas rate (in m^3/h).

NOTE For G20, C has the value 9.52. For natural gas, C has the value 9.72.

17.5.1.3.6 Determination of test gas concentration (C_{tg})

The test gas concentration C_{tg} (in %) is determined from the measured CO_2 concentration as follows:

$$C_{tg} = \frac{(C_m - C_a)}{C_n} 100$$

where

C_a is the CO_2 content of the ambient air (in %);

C_m is the measured CO_2 content of combustion products (in %);

C_n is the CO_2 content of the test gas (in %).

NOTE For practical purposes the CO_2 content of the ambient air may be ignored.

17.5.2 Extraction of products of combustion (Heater with an integral fan in the secondary flue (natural draught burners))

17.5.2.1 General

Appliances shall be fitted with a suitable device for proving adequate air/products flow prior to and during ignition and operation of the burner.

NOTE Proof of adequate air/products 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 flow during a pre-purge, or during ignition and operation of the burner; or

b) by flow sensing.

17.5.2.2 Appliances fitted with permanent pilots

The proving device shall be proved in the 'no flow' state prior to start-up of the main burner. Failure to prove 'no flow' shall prevent start-up of the main burner.

Prior to any attempt at ignition of the main burner or opening of the main burner gas safety shut-off valves, adequate air/products flow shall be proved. Failure to prove adequate air/products flow shall either cause safety shut-down to occur or prevent the opening of the main gas safety shut-off valve(s) providing that one of these valves is at least class B as defined in BS EN 161.

Air/products flow failure during operation of the main burner shall either cause safety shut-down to occur or cause the main gas valves to close providing that one of these valves is at least class B as defined in BS EN 161.

17.5.2.3 Appliances fitted with automatic natural draft burners

The proving device shall be proved in the 'no flow' state prior to start-up. Failure to prove 'no flow' shall prevent start-up or cause lock-out to occur.

Prior to any attempt at ignition or the opening of the gas safety shut-off valves, adequate air/products flow shall be proved. Failure to prove adequate air/products flow shall cause safety shut-down or lock-out to occur.

Air/products flow failure during operation of the burner shall cause safety shut-down or lock-out to occur.

17.6 Flame supervision system

17.6.1 Appliances fitted with non-automatic natural draught burners

The burner shall be fitted with a flame supervision device to monitor the pilot flame and protect the main flame.

Upon flame failure, the control system shall cause lock-out. The total time for the flame supervision system to shut down the burner shall be not more than:

a) 60 s for permanent pilots in air heaters with inputs up to and including 2 MW;

b) 2 s for main burners in air heaters with inputs above 330 kW

Flame supervision devices shall be designed either to fail safe (e.g. thermoelectric type), or prevent any shut-off valve opening and/or any electric ignition, if the flame detector erroneously signals the presence of a flame when the burner is started from the completely shut-down condition.

Means shall be provided to prevent electrical interference from giving rise to flame detector signals that falsely indicate the presence of a flame.

Where thermoelectric flame supervision devices are fitted with electric ignition, gas shall not flow to the main burner unless the pilot is alight when any tap or equivalent device that is accessible to the user is turned OFF and then ON again after 3 s.

17.6.2 Appliances fitted with automatic natural draught burners

The burner shall be fitted with a flame safeguard system.

When the burner is started from the shut-down condition, the flame safeguard system shall prevent any attempt at ignition or the opening of any gas valve if a fault or flame simulating condition is present. This safe-start check shall last for more than 5 s and shall cease not more than 5 s prior to any attempt at ignition. (Where the flame safeguard system incorporates thermionic valves, etc. requiring warm-up time, the safe-start check shall last for at least 5 s longer than the maximum warm-up time). For air heaters of 600 kW and above, the flame safeguard system shall incorporate suitable means to provide lock-out if a fault or flame simulation condition is present for more than 5 s during the safe-start check. While proceeding to lock-out under these conditions, there shall be no attempt at ignition or the opening of any safety shut-off valve.

NOTE Care should be taken to prevent electrical interference from giving rise to flame detector signals that falsely indicate the presence of a flame.

Upon flame failure the control system shall cause safety shut-down. The total time for the flame safeguard system to detect the absence of flame and shut-down the burner(s) shall be not more than 2 s.

During the shut-down condition, the appliance shall ;have sufficient natural ventilation to ventilate safely any minor gas leakage.

17.6.3 Appliances fitted with forced or mechanically induced draught burners

In such appliances, 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 occur only 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 7.

Table 7 **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

17.7 Pilot or start-gas flame establishment

17.7.1 Appliances fitted with non-automatic natural draught burners

The gas rate of a permanent pilot shall be as low as possible, consistent with satisfactory ignition, and shall not exceed 0.6 kW or 1% of the main burner rating up to a maximum of 1.5 kW.

Provision shall be made to establish the pilot flame safely and easily, either manually or by means of an ignition device incorporated in the air

heater. Where an ignition device is incorporated in the appliance, it shall also be possible to ignite the pilot gas by manual means.

The manufacturer's ignition instructions shall state any minimum time interval, including ventilation time, between attempts to establish the pilot flame in the event of pilot gas failing to ignite, or the pilot flame being extinguished, and also the minimum time interval between the flame failure of the main burner and any attempt to re-ignite.

The main gas valve shall not admit gas to the burner until the pilot gas flame has been detected by the flame supervision system.

For burners with nominal inputs greater than 330 kW, and where the start-gas flame has been established and proved at a separate pilot burner, there shall be a limited main gas ignition period of not more than 5 s at the end of which supervision of the main flame shall begin.

If the start gas flame is established at a separate pilot burner, the flame detector, under all conditions of operation, shall detect the pilot flame only at rates which will ignite the main gas reliably and smoothly.

17.7.2 Appliances fitted with automatic natural draught burners

A start-gas flame shall be established either at the main burner or at a separate pilot burner.

The pilot or start-gas rate shall be such that the system is safe on ignition after a delay of twice the manufacturer's maximum declared start-gas ignition period.

No start-gas rate shall exceed 25% of main burner rating or 100 kW whichever is the smaller.

Where the start-gas flame is established at a separate pilot burner, the pilot rate shall not exceed 10% of the main burner rating.

The ignition source shall not be energized before a safe-start check has been made of the flame safeguard system. The ignition source shall be de-energized at, or before, the end of the start-gas ignition period. If the start-gas flame has not been detected by the end of the start-gas ignition period, safety shut-down and lock-out shall result.

The pilot or start-gas ignition period shall be not more than 5 s, except that for pilots with gas rates not exceeding 1.5 kW the pilot gas ignition period shall be not more than 15 s.

For air heaters of heat inputs greater than 600 kW, the start-gas flame shall, in addition, be proved to be present and stable after removal of the primary ignition source and during a start-gas flame proving period of at least 5 s. If the start-gas flame fails during this period, safety shut-down and lock-out shall result.

In the event of start-gas flame failure after establishment of the start-gas flame, but before the main gas safety shut-off valves have been signalled to open, either safety shut-down or a single immediate attempt at re-ignition by direct spark restoration shall occur.

For air heaters with heat inputs of more than 330 kW but not exceeding 600 kW and where the start-gas rate, established on a separate pilot burner is less than 1 kW + 1% of the main burner rating.

If re-ignition is attempted and the start-gas flame is not detected within the start-gas ignition period, safety shut-down and lock-out shall result.

For air heaters where the start-gas rate exceeds 1 kW + 1% of the main burner rating, safety shut-down and lock-out shall occur in the event of start-gas flame failure after its establishment and before the main gas safety shut-off valves have been signalled to open.

However, the upstream safety shut-off valve in the main gas supply may be opened to permit gas flow where the start-gas supply is taken from downstream of the first main gas safety shut-off valve, provided that the downstream main gas safety shut-off valve is checked for closure prior to start-up, e.g. valves fitted with closed-position indicator switches. If the check indicates that the valve is not closed, start-up shall be prevented or lock-out will occur.

17.7.3 Appliances fitted with forced or mechanically induced draft burners

A 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 so limited 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 either:

1) 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%; or

2) the energy release during the start-gas ignition period does not exceed 53 kJ per cubic metre of combustion chamber volume for every 100 mbar pressure rise the combustion chamber and gas passages will withstand.

On burners with a heat input rating of 330 kW and above 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 preset and sealed by the manufacturer.

On burners with a heat input rating of 330 kW and above 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.

On burners with a heat input rating of 330 kW and above and where a start-gas rate interlock is not fitted, the valve shall be checked for closure prior to start-up by means of a closed position indicator switch. If the check indicates that the valve is not closed start-up shall be prevented.

17.8 Main flame establishment

17.8.1 Appliances fitted with non-automatic natural draught burners

Main gas shall not be available to be admitted to the burner until the start-gas flame has been detected by the flame safeguard system and manual intervention has occurred (e.g. release of a push-button).

17.8.2 Appliances fitted with automatic natural draught burners

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.

For burners with nominal input greater than 600 kW and where the start-gas flame has been established and proved at a separate pilot burner, there shall be a limited main gas ignition period of not more than 5 s at the end of which supervision of the main flame shall begin.

NOTE Conformance with this requirement can be achieved either by extinguishing the pilot flame or by providing a second flame detector capable of detecting the main flame, but which is incapable of detecting the pilot flame.

Flame failure at any time after the main gas safety shut-off valves have been signalled to open shall lead to safety shut-down and, in the case of air heaters with inputs greater than 600 kW, to lock-out.

17.8.3 Appliances fitted with forced or mechanically induced draught burners

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 circumstances detect the pilot flame. The main flame shall be stable without the pilot flame. In addition, the safe-start check required by **17.6.3** 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 rates which 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.

17.9 Air/gas ratio control for appliances with forced or mechanically induced draught burners

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

For high/low and modulating burners where the air and gas flows are controlled simultaneously, the system shall be such as to maintain the specified air/gas ratio over the whole of the range of operational heat inputs without a fuel rich condition occurring.

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 rate, 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 tend 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).

17.10 Thermostats and control of air temperature

17.10.1 General requirements

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

17.10.2 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, in the return air to the heater, 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.

17.10.3 Overheat (limit) control

17.10.3.1 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 thermo-electric 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.

An appliance of type B_{11} shall conform to the requirements given in **5.1.6** of BS EN 621:1998 when tested under the conditions of **17.10.3.2**.

An appliance of type B_{12}, B_{13}, B_{14}, B_{22}, or B_{23} shall conform to the requirements given in 5.1.6 of BS EN 1020:1998 when tested under the conditions of **17.10.3.2**.

17.10.3.2 Methods of test

An appliance of type B_{11} is tested as described in 6.3.6 of BS EN 621:1998.

An appliance of type B_{12}, B_{13}, B_{14}, B_{22}, or B_{23} is tested as described in **6.3.6** of BS EN 1020:1998.

17.10.4 Fan delay controls

17.10.4.1 Delayed start

Where means are provided to delay the operation of the air delivery fan after ignition of the burner to prevent the discharge of cold air into the heated space, the manufacturer shall specify in the installation instructions the temperature of the discharged air at which the fan operates. The temperature at which the air delivery fan starts up shall be within ± 10 K of the specified value.

The fan start delay period shall not be so long as to cause the overheat control to operate.

17.10.4.2 Delayed shut-down

Means shall be provided to delay the shut-down of the air delivery fan after shut-down of the appliance to prevent excessive temperatures occurring in the heat exchanger. The manufacturer shall specify in the installation instructions the temperature of the discharged air at which the fan is switched off.

The temperature at which the air delivery fan is switched off shall be within ± 5 K of the specified value.

The fan shut-down delay period shall be sufficiently long as to prevent the overheat control from operating.

Thermoelectric flame supervision devices shall conform to the requirements of BS EN 125.

17.11 Multi-functional controls

Multi-functional controls shall conform to BS EN 126.

18 Motors and fans

18.1 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.

18.2 Fan motor temperature

18.2.1 Motor bearings

18.2.1.1 Requirement

The maximum temperature of the fan motor bearings shall not exceed the maximum stated by the motor manufacturer when measured as described in **18.2.1.2**.

18.2.1.2 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.

18.2.2 Motor windings

The maximum temperature rise of the motor windings shall not exceed that given in Table 8 according to the class of insulation when the appliance is operated at its rated heat input on the appropriate reference test gas with the electricity supply of 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 shall be at room temperature.

NOTE 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.

18.3 Lubrication

Lubrication points shall be readily accessible.

18.4 Marking

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

Table 8 **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 W);*

R_2 *is the resistance at the end of the test (in W);*

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 the requirements of 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'.

19 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 either the continued safe operation of the appliance or safety shut-down.

Where the ignition device incorporates a repetitive high voltage generator that provides more than 20 sparks at each output during a three second 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 electrodes.

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.

20 Manufacturer's instructions

20.1 General

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

The descriptions of parts given in the manufacturer's instructions shall agree, where applicable, with the definitions given in BS 1179 and in Clause **3** 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.

20.2 Installation instructions

The installation instructions shall be provided with the appliance. Such instructions shall include information as to the method of assembly, the use and siting of thermostats and other controls, the siting of the appliance, including the type of flooring on which it is to stand, flueing, 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, rating of permanent pilot (where fitted), burner pressure, injector sizes, number of injectors, gas connection size, flue 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) means for electrical isolation, having a contact separation of at least 3 mm in all poles, have 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.

20.3 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.

20.4 User's instructions

User 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. Where thermoelectric flame safeguards are fitted, the user shall be advised not to use the appliance isolation valve in any case other than long term shut-down, emergencies, or during servicing.

21 Facilities for commissioning and testing

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

This requirement shall be accomplished 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 conform to **17.4.2.2**a), 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 on 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 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 **17.4.2.2**a) 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.

NOTE 1 A multi-functional control incorporating the facility required by a) is deemed to meet the 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.

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

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.

Means shall be provided on air heaters fitted with forced and mechanically induced draught burners for the combustion products to be analysed as required in Clause **10**. Such means shall include a plugged or capped orifice with a diameter of at least 10 mm.

Connections or test points shall be provided for measurement of the flame detector signal on all appliances except those fitted with thermoelectric flame supervision devices.

22 Identification and marking

22.1 General

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

22.2 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.

It 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 manufacturer 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) Heat input of any continuous pilot, in kilowatts.

g) Gas injector jet identification.

h) The burner setting pressure, in millibars.

22.3 Name badge

A name badge that 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 typeface.

c) It shall be readily accessible to the user.

Where the name badge is combined with a data plate, the combined plate/badge shall conform to the requirements of this clause and of **22.2**, as appropriate.

22.4 Appliance parts

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

22.5 Electrical data

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

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.

22.6 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 black lettering on a yellow background. The minimum lettering size shall correspond to Helvetica Medium 12 point (3.0 mm) or any other comparable typeface.

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.

22.7 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 typeface.

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.

23 Air handling

23.1 Air flow rate

The manufacturer shall specify the air flow rates and, in the case of ducted air heaters, the corresponding static pressures.

23.2 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.

24 Combustion chamber pressure reliefs

24.1 The appliance manufacturer shall certify that the appliance has been designed to withstand sudden internal pressure rises of up to 275 mbar without causing hazard to personnel in the vicinity of the appliance.

24.2 Where a pressure relief is fitted and it is on the same side of the appliances as any user-operated controls, means shall be provided to prevent hazard to personnel in the event of its operation, any shields or deflectors shall not interfere with the operation of the relief, and the installation instructions shall draw attention to the location and free area required to provide safe operation. Any such pressure relief shall be capable of withstanding the temperature of the enclosed combustion products.

25 Thermal efficiency

25.1 Efficiency

25.1.1 Requirements

The manufacturer shall claim a net overall efficiency, E_c, that shall relate to the method described in **25.1.2** and that shall be not less than 87%[3)].

The test house efficiency, E_t, measured in accordance with the method described in **25.1.2** shall be not less than $(E_c - 2)\%$[3)] at the maximum rated heated input and, for heaters designed to be operated on a modulating or high low basis, shall be not less than 79%[3)] at the minimum operational heat input specified by the manufacturer.

The verification efficiency, E_v, measured in accordance with the method described in **25.1.2** shall be not less than $(E_c - 4)\%$[3)].

[3)] The gross efficiency value is related to the net value for reference gas, G20, as follows:

gross value = 0.901 × net value.

25.1.2 Method

The efficiency is determined by measuring the percentage flue loss and subtracting this from 100. For heaters designed to be installed outside the space to be heated, the radiant and convective heat dissipations (see **25.3**) are added to the flue loss for the calculation of thermal efficiency.

The heater is installed and adjusted in accordance with the manufacturer's instructions and fitted with the appropriate length of flue as specified in **6.2**.

The efficiency is determined at the heat input(s) specified in Clause **9** and, in the case of ducted air heaters, at the manufacturer's static air pressures.

The appliance is operated on test gas G20 until steady state conditions are attained. The CO_2 content and the temperature of the undiluted combustion products in the primary flue are determined at a point not more than 150 mm from the appliance's flue outlet.

Sufficient measurements are taken to ensure consistency of results.

The percentage flue loss is calculated as follows:

$$\text{heat content of products} = [aE_a + bE_b \times b_a\,(A_s + A_e)\,E_b + (c + c_e + c_f)\,E_c + dE_d]\,\Delta t$$

$$= [aE_a + bE_b \times b_a\,(A_s + A_e)\,E_b + 0.79\,(A_s + A_e)\,E_c + c_f E_c + 0.21\,A_e E_d] \times \Delta t$$

$$\text{and \% flue loss} = \{[aE_a + bE_b \times b_a\,(A_s + A_e)\,E_b + 0.79\,(A_s + A_e)\,E_c + c_f E_c + 0.21\,A_e E_d]\,\Delta t\}\,\frac{100}{H_i}$$

where

A_e is the excess air in products (V/V of fuel) = $\dfrac{100a}{a_m} - (a + 0.79\,A_s)$;

A_s is the stoichiometric air requirement of fuel (*V/V* of fuel);

a is the CO_2 produced by combustion of fuel (*V/V* of fuel);

a_m is the CO_2 content of combustion products (in %);

b is the H_2O produced by combustion of fuel (*V/V* of fuel);

b_a is the H_2O content of combustion air (*V/V*);

c is the N_2 remaining from stoichiometric air consumed (= 0.79 A_s) (*V/V* of fuel);

c_e is the N_2 in excess air (= 0.79 A_e) (*V/V* of fuel);

c_f is the N_2 content of the fuel (*V/V* of fuel);

d is the O_2 in excess air (= 0.21 A_e) (*V/V* of fuel);

E_a is the mean enthalpy change between 15°C and t °C for CO_2 (in MJ/(m^3·K));

E_b is the mean enthalpy change between 15°C and t °C for H_2O (in MH/(m^3·K));

E_c is the mean enthalpy change between 15°C and t °C for N_2 (in MJ/(m^3·K));

E_d is the mean enthalpy change between 15°C and t °C for O_2 (in MJ/(m^3·K));

H_i is the net calorific value of fuel at 15°C and 1 013.25 mbar (in MJ/m^3);

t is the temperature of products (in °C);

Δt is the temperature rise of products above 15°C (in K).

Enthalpy data[4] for the constituents of combustion products are given in Table 9 for a range of combustion products temperatures and are expressed in MJ/(m^3·K) for the gas as measured at 15 °C and 1 013.25 mbar.

NOTE 1 For temperatures of combustion products intermediate between those given in Table 9 the enthalpy change may be determined by interpolation without significant loss of accuracy.

Combustion data for test gas G20 are given in Table 10. However, in general, the gas used will correspond to the local distributed supply.

NOTE 2 The analysis of the distributed supply, from which the combustion data may be calculated, may be obtained from the gas supplier.

Table 9 **Enthalpy data for combustion products**

Dimensions in MJ/(m^3·K)

Constituent	**Change in enthalpy between 15 °C and t °C**			
	150 °C	**200 °C**	**250 °C**	**300 °C**
CO_2	0.001 69	0.001 72	0.001 76	0.001 79
N_2	0.001 24	0.001 24	0.001 25	0.001 25
H_2O	0.001 43	0.001 44	0.001 45	0.001 46
O_2	0.001 26	0.001 27	0.001 28	0.001 29

Table 10 **Combustion data for test gas G20**

CO_2 produced	1.00 *V/V* fuel burned
H_2O produced	2.00 *V/V* fuel burned
N_2 produced	7.52 *V/V* fuel burned
Air required	9.52 *V/V* fuel burned
Net calorific value	34.09 MJ/m^3 at 15 °C and 1 013.25 mbar

25.2 Heat input

The thermal efficiency shall be determined at the rated heat input.

For air heaters designed to operate on a modulating or high/low basis, the thermal efficiency shall be determined at the maximum rated heat input and at the minimum operational heat input specified by the manufacturer.

25.3 Surface heat dissipation

25.3.1 Requirements

For appliances designed to be installed outside the space to be heated, the radiative and convective heat dissipated from the appliance shall not exceed 3.3% of the rated heat input expressed on a net calorific value basis, when tested in accordance with the method described in **25.3.2**.

[4] Data derived from 'Technical Data on Fuel': 1962, Sixth Edition, second impression; published by the British National Committee, World Power Conference.

25.3.2 Method

The appliance is set up in accordance with 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 rate 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 centres of each area as specified in **14.1**. The areas are then taken in groups at 5 K intervals and the heat losses are computed from the following formulae:

Convective heat dissipation (in W) = $\Sigma\, CA_c\,(t_1 - t_o)^{5/4}$

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_o is the average ambient temperature (in °C);

Radiative heat dissipation (in W) = $\Sigma\, 5.67 \times 10^{-8}\, EA_R\,(T_1^4 - T_o^4)$

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_o is the average ambient temperature (in K);

26 Air delivery volume

26.1 Requirements

The volumetric air 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 of flow of air at 15°C and 1 013.25 mbar.

The volumetric 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 **26.2**.

26.2 Method

The heater is installed and adjusted according to the manufacturer's instructions and as specified in **6.2**. The heater air outlet is connected, by means of an appropriate adapter, to a horizontal test duct of suitable circular 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 (Figure 3), a measuring section at least nine diameters in length and an air flow regulating device (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 outlets, and hence the bend, is rectangular in cross section, the bend is fitted with guide vanes as shown in Figure 5.

Total and dynamic pressures 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**

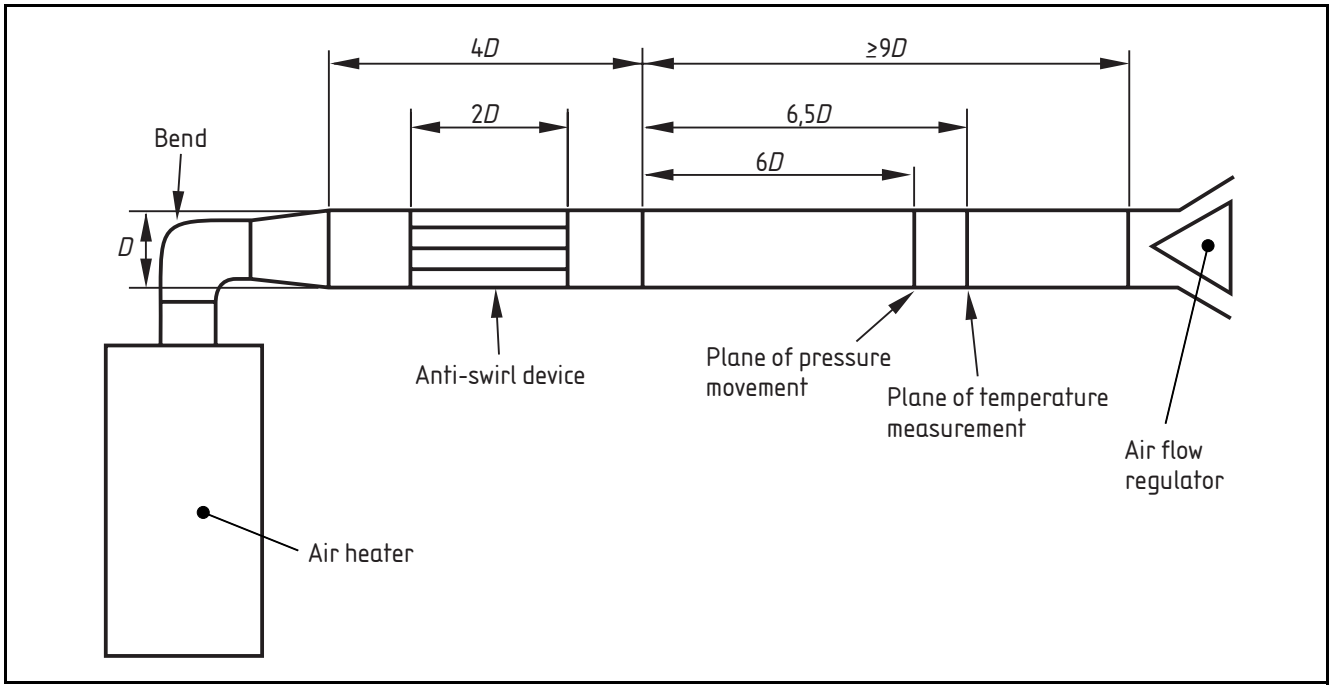


Figure 3 **Anti-swirl device**

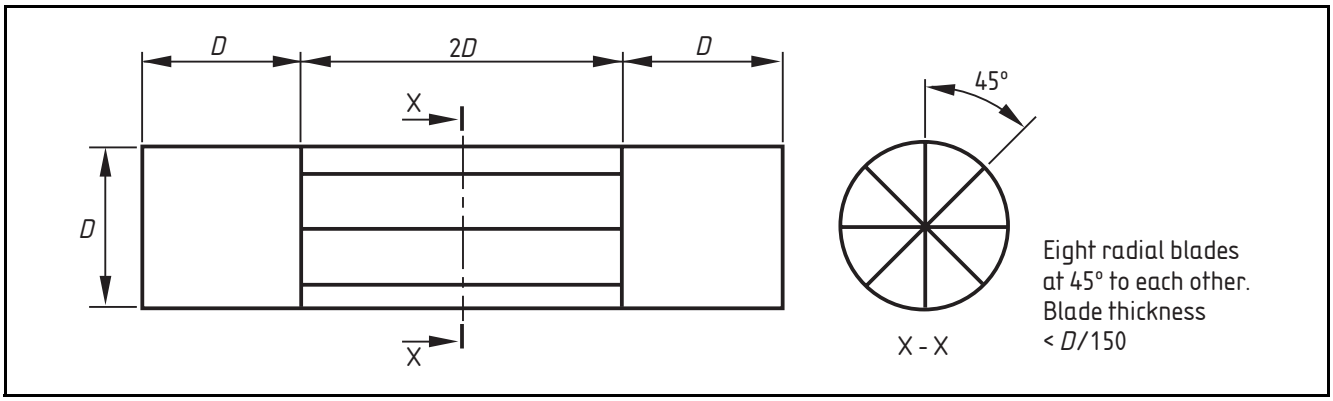


Figure 4 **Air flow regulation device**

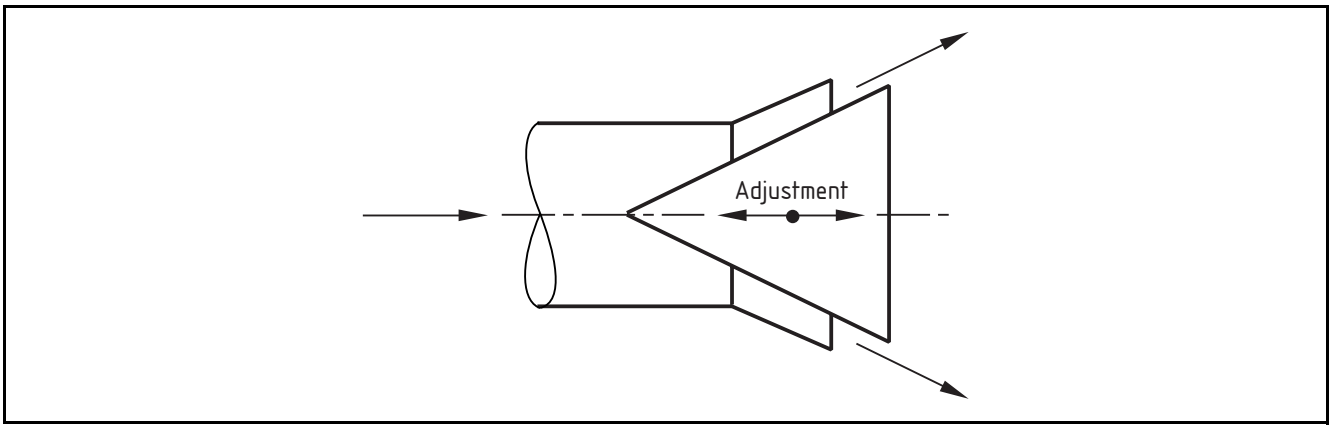
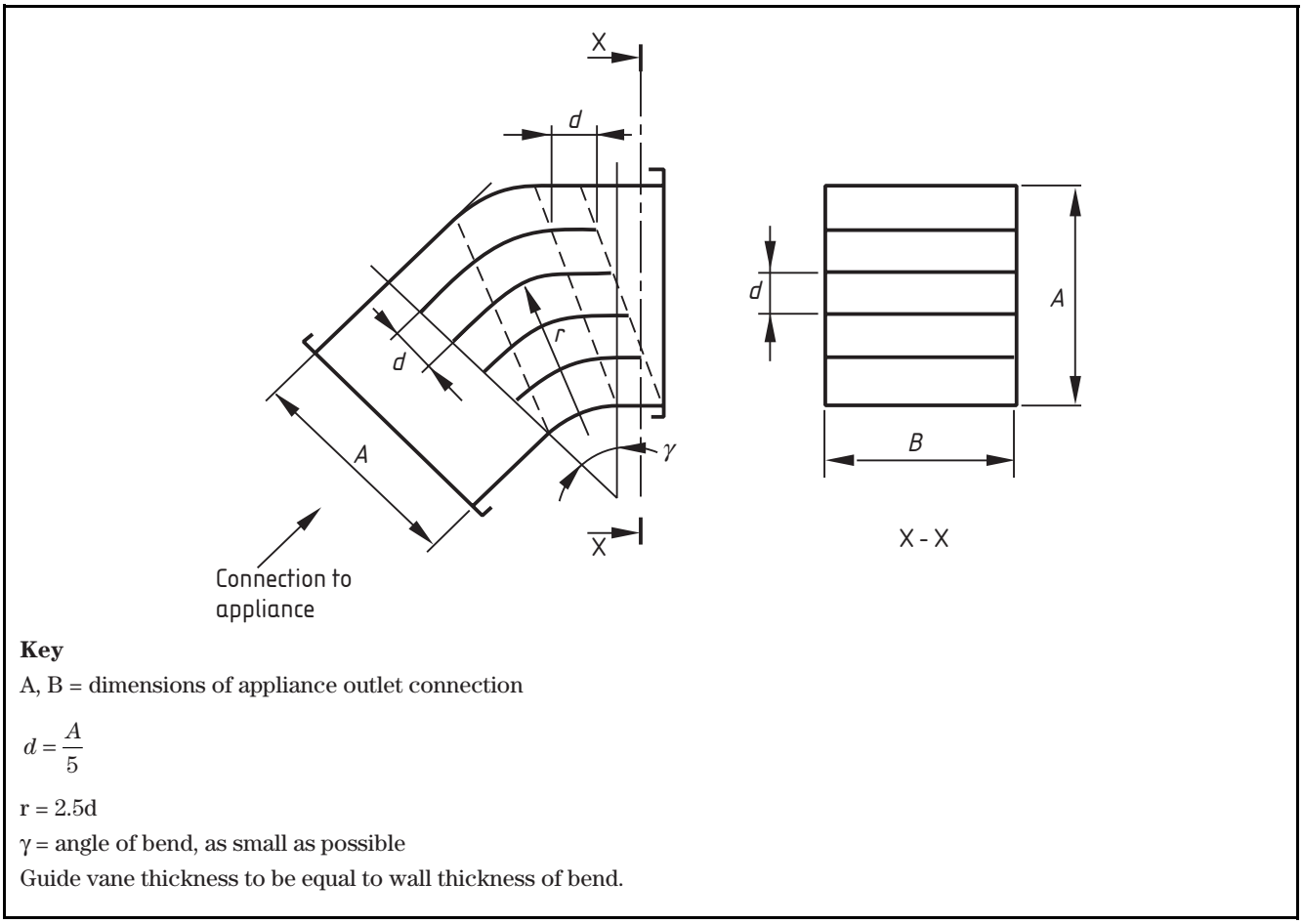


Figure 5 **Connecting bend**



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.

27 Weather resistance

27.1 Requirements

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 **27.2**.

With access doors or panels in place, no water shall accumulate in any part of the appliances designed for permanent outdoor installation such that normal functioning is affected when subjected to the rain test described in **27.2**.

27.2 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.

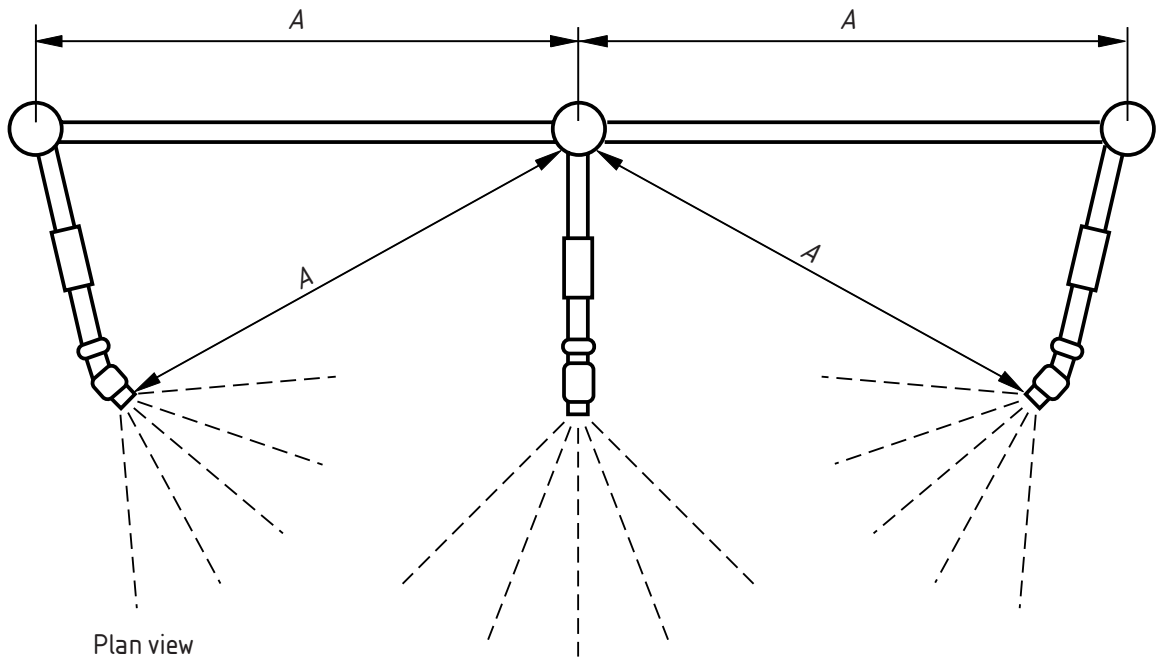
Install the appliance in accordance with the manufacturer's instructions on a test platform of such size as to accommodate the appliance easily and support it at a height of 100 mm above the floor.

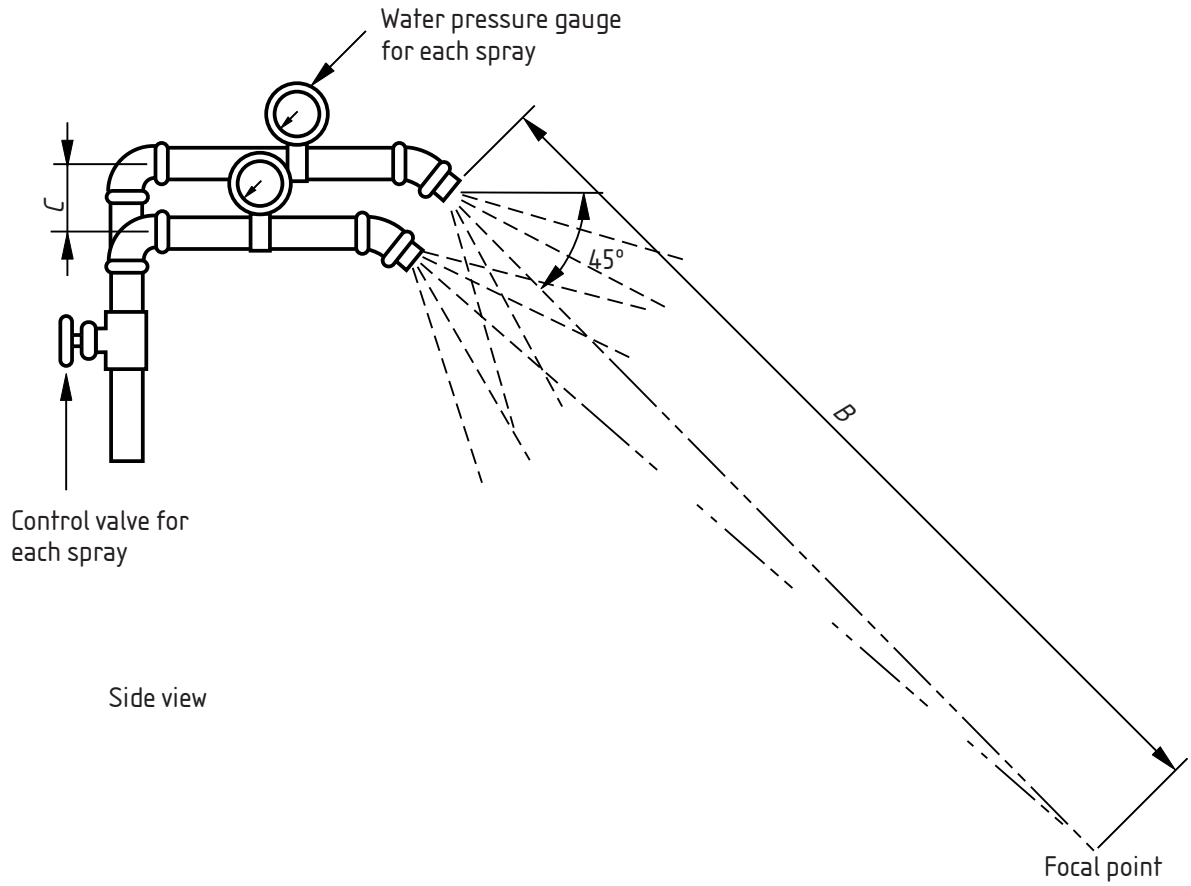
The spray heads are set to operate at 350 mbar and the units adjusted to varying elevations and horizontal distances from the appliance to determine the most critical location. Exposure at the location deemed most critical by the test authority is maintained throughout the test.

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 mm.

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 **27**)





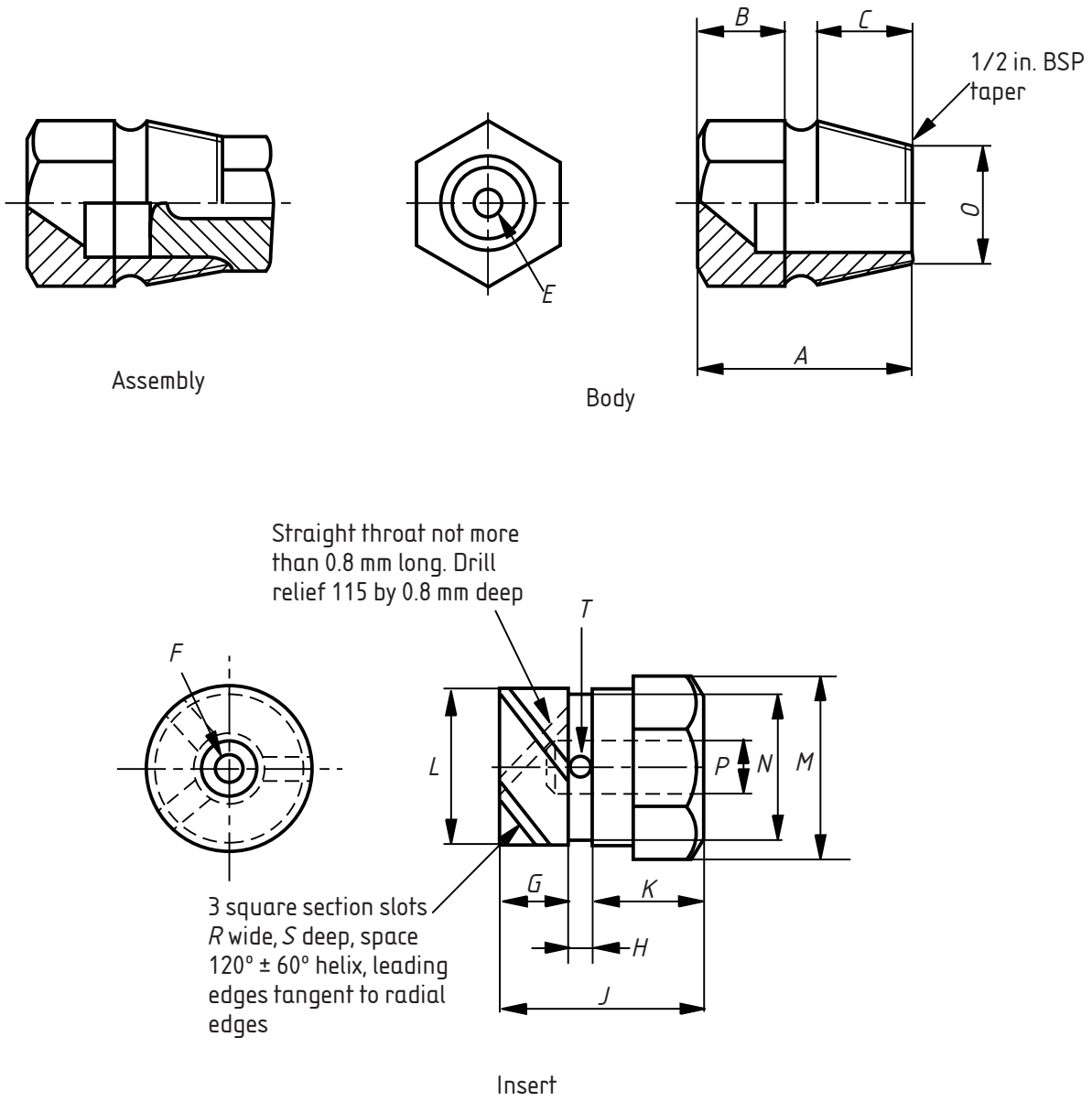
Dimensions

A 710 mm

B 1400 mm

C 75 mm

Figure 7 **Details of spray head assembly and construction** (see Clause **27**)



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

BS 5990:2006, *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).*

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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