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Plastics — Reaction to fire — Test method for flame spread and combustion product release from vertically oriented specimens

Plastiques — Réaction au feu — Méthode d'essai de propagation de flamme et de dégagement de produits de combustion à partir d'éprouvettes orientées verticalement

Reference number
ISO 21367:2007(E)

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
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Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

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

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 21367 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 4, *Burning behaviour*.

Plastics — Reaction to fire — Test method for flame spread and combustion product release from vertically oriented specimens

WARNING — Avoidance of misleading inferences

This standard method of test should be used solely to measure and describe the properties of materials, products or systems in response to heat or flame under controlled laboratory conditions, and should not be considered or used by itself for describing or appraising the fire hazard of materials, products or systems under actual fire conditions or as the sole source on which regulations pertaining to smoke production can be based.

WARNING — Avoidance of danger to test operators

So that suitable precautions to safeguard health are taken, the attention of all concerned in fire tests is drawn to the fact that harmful gases are evolved in combustion of test specimens.
Attention is drawn to the hazards arising from the hot radiator, and the use of a mains-voltage electricity supply.

1 Scope

This International Standard specifies a test method for plastics for the determination of the heat release rate, ignitability, surface spread of a flame, falling droplets/particles and smoke production using a “medium” scale specimen that simulates the early development stage of the fire. This test method can be used as a screening test for intermediate scale and large scale tests in addition to its use in factory production control, research and product development.

This test method provides data that is suitable for comparing reaction-to-fire performance of many materials, products, composites or assemblies under end use application conditions.

The results of this test method are limited to specimens with heat release rates of less than 10 kW.

WARNING — Specimens having the dimensions specified in this International Standard may generate heat release rates well in excess of 10 kW. In such cases, the test shall be stopped immediately once the heat release rate exceeds 10 kW.

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.

ISO 291, *Plastics — Standard atmospheres for conditioning and testing*

ISO 554, *Standard atmospheres for conditioning and/or testing — Specifications*

ISO 5660-1, *Reaction-to-fire tests — Heat release, smoke production and mass loss rate — Part 1: Heat release rate (cone calorimeter method)*

ISO 13943, *Fire safety — Vocabulary*

ISO/TS 14934-1, *Fire tests — Calibration and use of radiometers and heat flux meters — Part 1: General principles*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 13943 and the following apply.

3.1
essentially flat surface
surface whose irregularity from a plane does not exceed ± 1 mm

3.2
flashing
existence of flame on or over the surface of the specimen for a period of less than 1 s

3.3
ignition
onset of sustained flaming

NOTE See 3.10.

3.4
heat flux
amount of thermal energy emitted, transmitted or received per unit area and unit time

3.5
material
single substance or uniformly dispersed mixture

NOTE Types of material include metal, stone, timber, concrete, mineral fibre, polymers.

3.6
oxygen consumption principle
proportional relationship between the mass of oxygen consumed during combustion and the heat released

3.7
product
material, composite or assembly about which information is required

3.8
specimen
representative piece of the product that is to be tested together with any substrate or treatment

3.9
sustained flaming
existence of flame on or over the surface of the specimen for periods of over 10 s

3.10
transitory flaming
existence of flame on or over the surface of the specimen for periods equal or more than 1 s but less than 10 s

4 Symbols

Symbol	Designation	Units
C	orifice flow meter calibration constant	$(\text{m}\cdot\text{kg K})^{1/2}$
Δh_c	net heat of combustion	kJ g^{-1}
ΔP	orifice meter pressure differential	Pa
q	heat release rate	kW
r_o	stoichiometric oxygen/fuel mass ratio	(dimensionless)
t	time	s
t_d	delay time of the oxygen analyser	s
t_{ig}	time to ignition (onset of sustained flaming)	s
Δt	sampling time intervals	s
T_e	absolute temperature of gas at the orifice meter	K
X_{O_2}	oxygen analyser reading, mole fraction of oxygen	(dimensionless)
$X_{O_2}^0$	initial value of oxygen analyser reading	(dimensionless)
$X_{O_2}^1$	oxygen analyser reading, before delay time correction	(dimensionless)

5 General principles

In an open ventilation condition, the test specimen is held in a vertical position and is subjected to an irradiative heat source at its base in the presence of a pilot flame.

The smoke and gases that are generated are collected by a hood in the extraction duct, where an oxygen-depletion measurement device measures the heat release rate, and an opacimeter measures the smoke opacity.

The vertical and lateral flame spread and the falling of flaming droplets and/or particles are also measured.

NOTE An alternative method for measuring the heat release rate using a set of thermocouples is outlined in Annex B.

6 Test apparatus

6.1 General.

An example of the test apparatus is given in Figure 1 and should consist of the following components:

— stainless steel hood;

— radiant electric heater (see 6.2);

— dummy specimen (see 6.3);

— backing board and spacers (see 6.4);

— specimen holder (see 6.5);

— pilot burner (see 6.6);

— exhaust gas system with flow measuring instrumentation (see 6.7);

— gas sampling system (see 6.8);

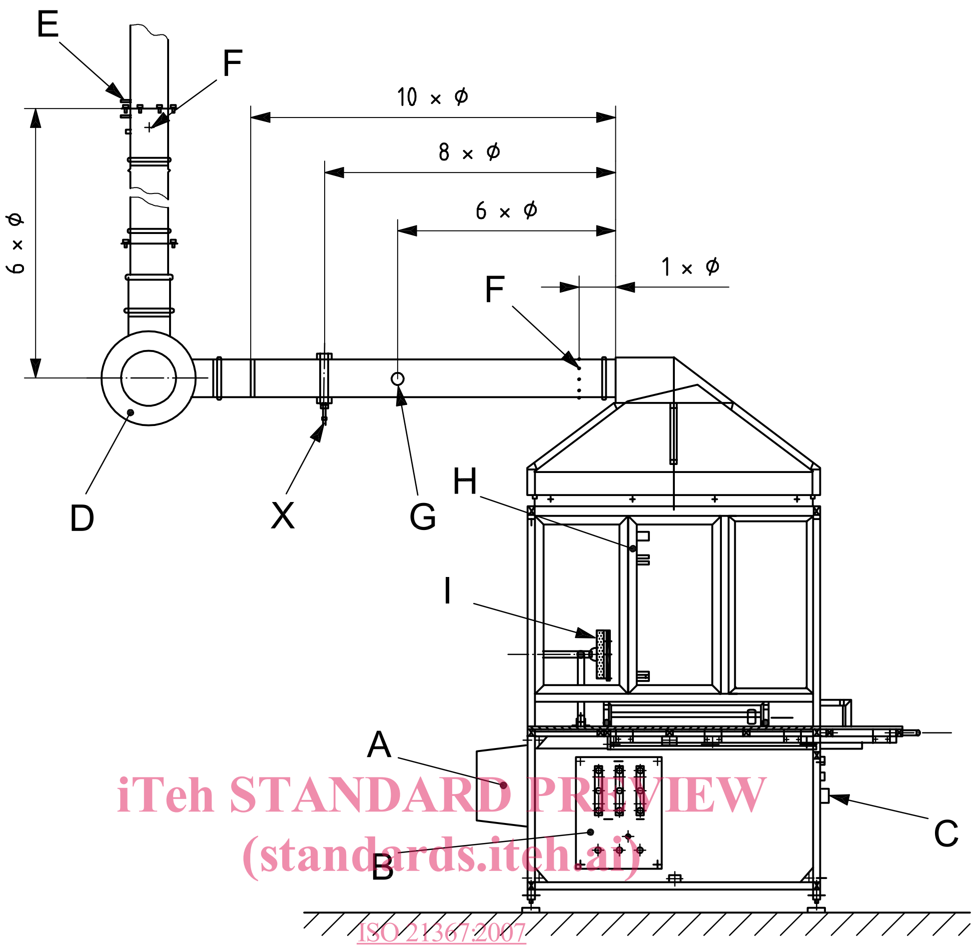
— oxygen analyser (see 6.9);

— opacimeter for the smoke opacity measurement (see 6.10);

— heat flux meter (see 6.11);

— calibration burner (see 6.12);

— data collection and analysis system (see 6.13).



Key

A regulation of the ventilation
B gas flow meter
C radiant electric heater control device
D fan
E restrictive orifice with differential pressure measurement
F thermocouples
G opacimeter
H specimen holder
I electric radiant heater
X probe sampler

Figure 1 — Example of apparatus

The individual components of the apparatus are described in detail in the following subclauses.

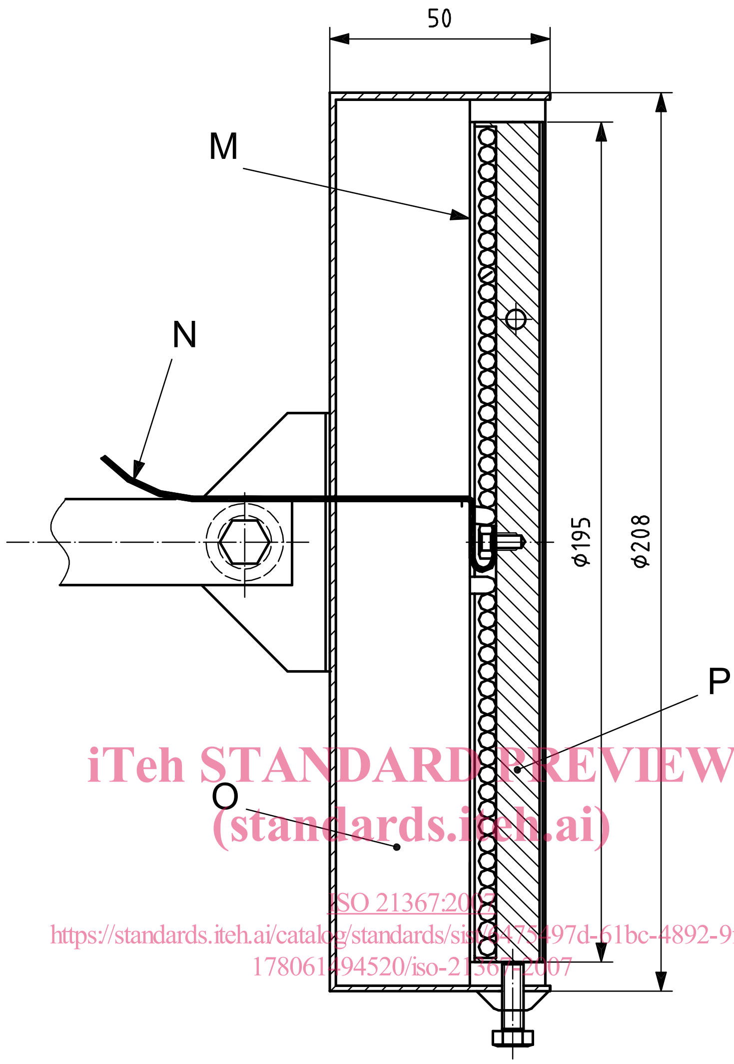
NOTE For factory production control with a simplified version of the apparatus, thermocouples inside the exhaust duct could be used to replace the oxygen monitoring for the heat release measurement. An example of a schematic representing the assembly is given in Figure 1.

6.2 Radiant electric heater.

6.2.1 A radiant electric heater shall be capable of producing irradiance on the surface of the specimen of up to 75 kW/m^2 when the distance between the radiant heater and the specimen is at least 50 mm. The heat flux shall be uniform at least over the central 100 mm × 100 mm area of exposed specimen surface. The following radiant electric heaters (see 6.2.2 and 6.2.3) can satisfy these requirements.

6.2.2 If a cylindrically shaped radiant electric heater (Figure 2) is used, the active element of the heater shall consist of an electric heater rod, capable of delivering 9 kW at the operating voltage, tightly wound into the shape of a spiral with an external diameter of 190 mm. The heater element is welded on a nickel-chromium alloy plate, which has a thickness of 10 mm, and encased in a cylindrical metal box. The radiation from the heater shall be maintained at a preset level by controlling the electric power level.

Dimensions in millimetres



Key

M electric heater rod

N thermocouple

O insulating material (ceramic fibre)

P inconel plate

Figure 2 — Electric heater

6.2.3 If a conically shaped radiant electric heater is used, the heater shall be in accordance with ISO 5660-1.

6.3 Dummy specimen.

The dummy specimen shall consist of a calcium silicate board with a surface area of 700 mm × 500 mm, a thickness of (12 ± 3) mm and a density of (800 ± 150) kg/m^3. It shall be placed on the specimen holder during warm up and before and after each test.

6.4 Backing boards and spacers.

Backing boards shall be cut from non-combustible board (for example, calcium silicate board) (12 ± 3) mm thick with the same dimensions as the dummy specimen and an oven-dry density of (800 ± 150) kg/m^3. Spacers used to create the air gap specified in 7.6 shall be made of the same material as the backing board, cut into wide strips and attached to the whole perimeter of the backing board.

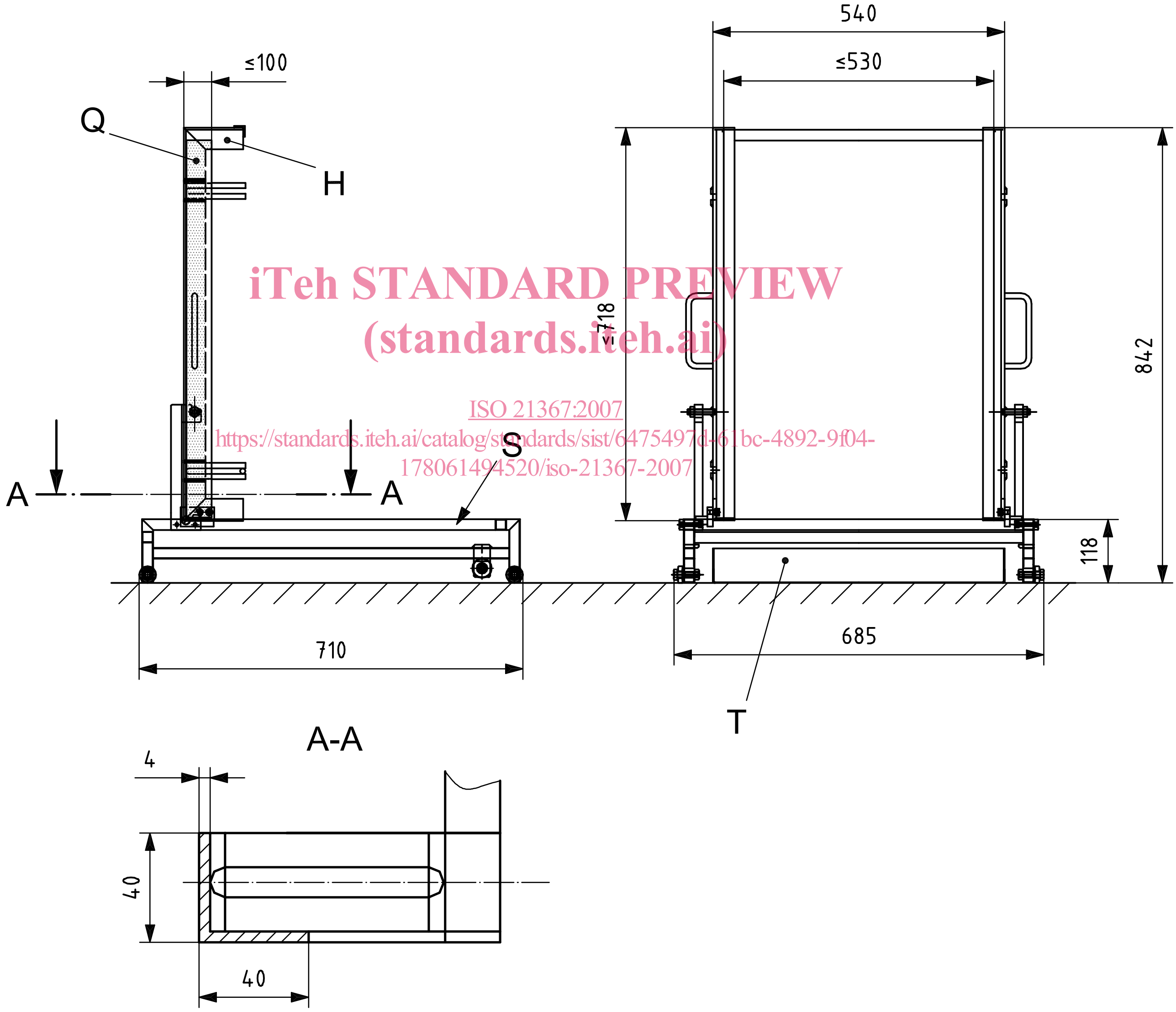
Backing boards and spacers may be re-used if they are not contaminated by combustible residues. Immediately before re-use, however, they shall be conditioned in the atmosphere specified in 7.5 for a minimum of 24 h. If there is any doubt about the cleanliness of a backing board or spacer, it shall be placed in a ventilated oven at a temperature of approximately 250 °C for a period of 2 h to remove any volatile residue. If there is still any doubt about the condition, it shall be discarded.

6.5 Specimen holder.

6.5.1 The specimen holder shall be composed of a frame that is fixed on a carriage (Figure 3).

6.5.2 The frame shall be constructed of stainless steel with a thickness of (3,5 ± 0,2) mm in a rectangular shape, and shall be able to support test specimens with a surface area of (700 ± 5) mm × (500 ± 5) mm and a maximum thickness of 90 mm (Figure 3).

Dimensions in millimetres



Key

H steel frame

Q sample

S carriage

T tray

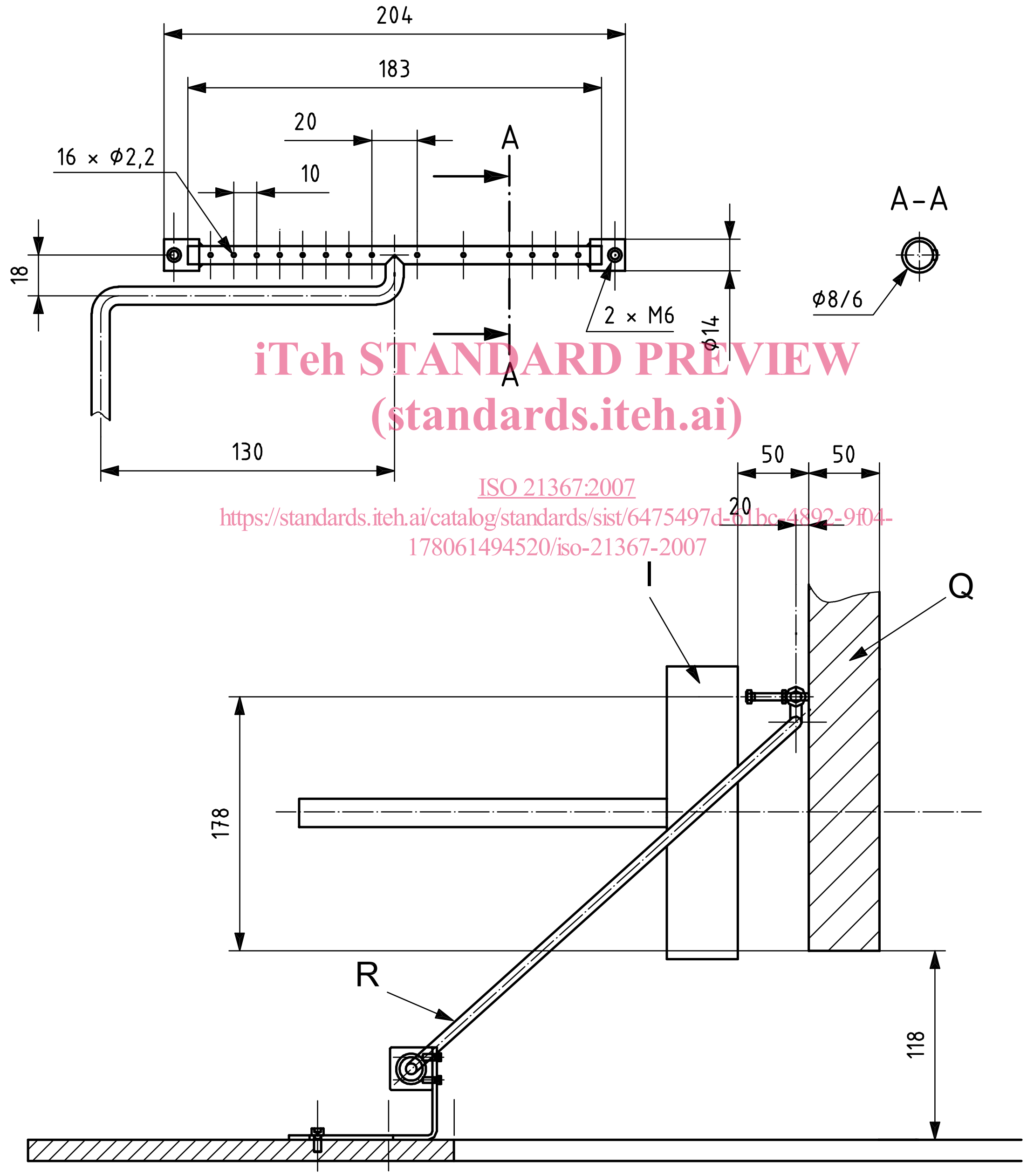
Figure 3 — Specimen holder

6.6 Pilot burner.

6.6.1 The pilot burner shall be a stainless steel tube of 6 mm internal diameter. It has 16 holes of 1 mm diameter and shall be placed, when operating, between the test specimen and the heater (Figure 4). The burner shall be adjustable to compensate for the thickness modification of the specimen during combustion. Two metallic spacers shall be located at each side of the burner to maintain a constant distance of (20 ± 5) mm between the specimen surface and the pilot flame.

6.6.2 An air/gas mixture shall be used to fuel the burner to obtain flames that are 20 mm long. The flow delivered to the burner shall be (3 ± 0,1) l/min for air and (1 ± 0,1) l/min for propane gas to obtain horizontal flames.

Dimensions in millimetres



Key

I electric heater

Q sample

R pilot burner ramp

Figure 4 — Pilot burner