

BS ISO 22968:2010



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Forced draught oil burners

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National foreword

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A list of organizations represented on this committee can be obtained on request to its secretary.

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INTERNATIONAL STANDARD

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Forced draught oil burners

Brûleurs à air soufflé pour combustibles liquides



Reference number
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Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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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 22968 was prepared by Technical Committee ISO/TC 109, *Oil and gas burners*.

Introduction

This International Standard is primarily intended for application to automatic forced draught oil burners having a combustion air fan, operated with liquid fuels and intended to be marketed as a complete assembly.

Many burners are designed to operate using a wide range of fuel oils with little or no modification other than adjustment of the air supply.

When applying the requirements specific to a country or region, which are given in the various annexes, it is essential that a level of safety be ensured that is at least equivalent to that provided for by the requirements of the main body of this International Standard.

Forced draught oil burners

1 Scope

This International Standard specifies the terminology, test procedures and general requirements for the construction and operation of automatic forced draught oil burners supplied with a fuel having a viscosity at the burner inlet of 1,6 mm²/s (cSt) to 6 mm²/s (cSt) at 20 °C or higher, boiling petroleum in accordance with ISO 8217-based first raffinates, and the provision of related control and safety devices.

It is applicable to the following:

- a) automatic oil burners (hereinafter called “burners”) fitted with a combustion air fan and equipped as described in Clause 5, intended for use in appliances of different types and operated with fuel oils;
- b) single burners with a single combustion chamber, for which, where such burners are fitted to a single appliance, the requirements of the relevant appliance standard also apply;
- c) single-fuel and dual-fuel burners when operating only on oil;
- d) the oil function of dual-fuel burners designed to operate simultaneously on gaseous and liquid fuels, which, for the former, the requirements of ISO 22967 also apply.

It is not applicable to burners used in direct fired processes either with defined combustion chamber applications or where the combustion chamber wall surface temperature is greater than 750 °C or the heat-transfer medium temperature is greater than 500 °C.

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 7-1, *Pipe threads where pressure-tight joints are made on the threads — Part 1: Dimensions, tolerances and designation*

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

ISO 1129, *Steel tubes for boilers, superheaters and heat exchangers — Dimensions, tolerances and conventional masses per unit length*

ISO 3183, *Petroleum and natural gas industries — Steel pipe for pipeline transportation systems*

ISO 6806, *Rubber hoses and hose assemblies for use in oil burners — Specification*

ISO 7005 (all parts), *Pipe flanges*

ISO 8217, *Petroleum products — Fuels (class F) — Specifications of marine fuels*

ISO 9329-1, *Seamless steel tubes for pressure purposes — Technical delivery conditions — Part 1: Unalloyed steels with specified room temperature properties*

ISO 9330-1, *Welded steel tubes for pressure purposes — Technical delivery conditions — Part 1: Unalloyed steel tubes with specified room temperature properties*

ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*

ISO 22967, *Forced draught gas burners*

ISO 23550, *Safety and control devices for gas burners and gas-burning appliances — General requirements*

ISO 23552-1, *Safety and control devices for gas and/or oil burners and gas and/or oil appliances — Particular requirements — Part 1: Fuel/air ratio controls, electronic type*

ISO 23553-1, *Safety and control devices for oil burners and oil-burning appliances — Particular requirements — Part 1: Shut-off devices for oil burners*

IEC 60204-1, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements*

IEC 60335-1:2001, *Household and similar electrical appliances — Safety — Part 1: General requirements*, as amended 2004 and 2006

IEC 60335-2-102:2004, *Household and similar electrical appliances — Safety — Part 2-102: Particular requirements for gas, oil and solid-fuel burning appliances having electrical connections*

IEC 60529, *Degrees of protection provided by enclosures (IP code)*

IEC 60730-2-5:2004, *Automatic electrical controls for household and similar use — Part 2-5: Particular requirements for automatic electrical burner control systems*

IEC 60747-5-2, *Discrete semiconductor devices and integrated circuits — Part 5-2: Optoelectronic devices — Essential ratings and characteristics*

IEC 60947-5-1, *Low-voltage switchgear and controlgear — Part 5-1: Control circuit devices and switching elements — Electromechanical control circuit devices*

IEC 61810-1, *Electromechanical elementary relays — Part 1: General requirements*

3 Terms and definitions

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

3.1 General

3.1.1

forced draught burner

burner in which the total air for combustion is supplied by means of a fan

3.1.2

automatic forced draught burner

burner that is fitted with an automatic ignition, flame monitoring and burner control devices where the ignition, flame monitoring and the on/off switching of the burner occur automatically

NOTE The heat input of the burner can be adjusted during operation either automatically or manually.

3.1.3

dual-fuel burner

burner in which both gaseous and liquid fuels can be burnt either simultaneously or in succession

3.1.4

combustion chamber

part of the appliance in which the combustion takes place

3.1.5

burner head

device for mixing fuel and air comprising, for example, a stabilizing disc and nozzle, that keeps the flame in its safe position during operation of the burner

3.1.6

heat-transfer medium

gaseous or liquid substance for the transport of heat energy from the appliance

3.1.7

appliance

heat generator into which the burner fires having a combustion chamber and heat exchanger used to indirectly transmit the heat input from the burner combustion gases to the heat-transfer medium

3.2 Fuel mass flow rate and performance

3.2.1

mass flow rate

q_m

mass of oil consumed by the burner in unit time during continuous operation

NOTE It is expressed in kilograms per hour (kg/h) or grams per hour (g/h).

3.2.2

maximum mass flow rate

mass of fuel consumed during one hour at the highest mass flow rate stated by the manufacturer

NOTE It is expressed in kilograms per hour (kg/h).

3.2.3

minimum mass flow rate

mass of fuel consumed during one hour at the lowest mass flow rate stated by the manufacturer

NOTE It is expressed in kilograms per hour (kg/h).

3.2.4

calorific value

quantity of heat produced by the combustion, at a constant pressure equal to 0,101 325 MPa, of unit volume or mass of fuel oil, the constituents of the combustible mixture being taken at reference conditions and the products of combustion being brought back to the same conditions

NOTE 1 A distinction is made between

- a) the superior calorific value (H_s) in which the water produced by combustion is assumed to be condensed, and
- b) the inferior calorific value (H_i) in which the water produced by combustion is assumed to be in the vapour state.

NOTE 2 It is expressed in megajoules per kilogram (MJ/kg).

NOTE 3 See ISO 14532.

3.2.5
heat input

Q_F
amount of heat as a function of time released by the burner at a given mass flow rate

NOTE It is expressed in kilowatts (kW) and calculated as the oil flow rate $\times$ lower calorific value ($q_{l0} H_l$) of the fuel.

3.2.6
maximum heat input

Q_{Fmax}
maximum heat input of the burner as stated by the manufacturer

NOTE It is expressed in kilowatts (kW).

3.2.7
minimum heat input

Q_{Fmin}
minimum heat input of the burner as stated by the manufacturer

NOTE It is expressed in kilowatts (kW).

3.2.8
start heat input

Q_s
maximum heat input at the start of ignition as a percentage of heat input (Q_F)

3.2.9
nominal heat input

Q_{FN}
value of the heat input declared by the manufacturer

NOTE 1 It is expressed in kilowatts (kW).

NOTE 2 Fixed heat input or range-rated burners have a single nominal heat input. Range-rated burners can be adjusted between the maximum nominal heat input and the minimum nominal heat input declared by the manufacturer.

3.2.10
heat load rate
ratio between heat input (Q_F) and volume or cross-sectional area of the combustion chamber

NOTE It may be expressed in kilowatt hours per cubic metre (kWh/m³) or per square metre (kWh/m²).

3.2.11
turndown rate
ratio between maximum heat input (Q_{Fmax}) and minimum heat input (Q_{Fmin})

3.3 Test rig and combustion chamber

3.3.1
combustion chamber pressure

p_F
effective positive pressure or negative pressure relative to the atmospheric pressure prevailing in the combustion chamber

NOTE Combustion chamber pressure is measured in kilopascals (kPa).

3.3.2

length of the combustion chamber

l_1

distance between the face of the nozzle or the fuel outlet and the rear wall of the test flame tube or combustion chamber or any lateral contraction

NOTE The length of the combustion chamber is measured in metres (m).

3.3.3

diameter of the combustion chamber

d_1

inner diameter of the combustion chamber around the flame tube of the burner

NOTE The diameter of the combustion chamber is measured in metres (m).

3.3.4

burner flame tube

device which hosts the mixing device and the root of the flame

3.3.5

test flame tube

cylindrical part of the test rig where the combustion takes place

3.4 Composition of the gaseous combustion products

3.4.1

content of carbon dioxide

CO_2

ratio of the volume of carbon dioxide to the total volume of dry gaseous products in which it is present

NOTE The carbon dioxide content is expressed as a percentage volume fraction.

3.4.2

content of oxygen

O_2

ratio of the volume of oxygen to the total volume of dry gaseous products in which it is present

NOTE The oxygen content is expressed as a percentage volume fraction.

3.4.3

content of carbon monoxide

CO

ratio of the volume of carbon monoxide to the total volume of dry gaseous products in which it is present

NOTE The carbon monoxide content is expressed as a volume fraction, in units of millilitres per cubic metre (ml/m^3) for measuring purposes and in milligrams per kilowatt hour (mg/kWh) related to inferior calorific value (H_i) for calculation purposes and declaring values.

3.4.4

content of nitrogen oxides

NO_x

ratio of the combined volume of nitrogen oxides to the total volume of dry gaseous products in which they are present

NOTE The nitrogen oxides content is expressed as a volume fraction, in units of millilitres per cubic metre (ml/m^3) for measuring purposes and in milligrams per kilowatt hour (mg/kWh) related to inferior calorific value (H_i) for calculation purposes and declaring values.

3.4.5

content of unburnt hydrocarbons

ratio of the volume of unburnt hydrocarbons to the total volume of dry gaseous products in which they are present

NOTE It is expressed in millilitres per cubic metre (ml/m³), calculated as C₃H₈.

3.4.6

smoke number

sample reference whose shade is closest to that of the test mark

NOTE See Annex A.

3.4.7

excess air ratio

λ

ratio between the effectively introduced quantity of air and the theoretically required quantity of air

3.5 Adjustment, control and safety devices

3.5.1

flame detector device

device by which the presence of a flame is detected and signalled

NOTE It can consist of a flame sensor, an amplifier and an element for signal transmission. These parts, with the possible exception of the actual flame sensor, may be assembled in a single housing for use in conjunction with a programming unit.

3.5.2

automatic burner control system

system comprising at least a programming unit and all the elements of a flame detector device

NOTE The various functions of an automatic burner control system may be in one or more housings.

3.5.3

programming unit

unit that reacts to signals from control and safety devices, gives control commands, controls the start-up sequence, supervises the burner operation and causes controlled shut-down and, if necessary, safety shut-down and non-volatile lock-out

NOTE The programming unit follows a predetermined sequence of actions and always operates in conjunction with a flame detector device.

3.5.4

safe start check

procedure employing a protection circuit or circuits to establish whether or not a fault in a safety system or flame simulating condition exists prior to start-up

3.5.5

controlled shut-down

process by which the power to the fuel shut-off valve(s) is immediately removed before any other action takes place (e.g. as a result of activating a controlling function)

3.5.6

safety shut-down

process that is effected immediately following the response of a safety limiter or the detection of a fault in the automatic burner control system and which puts the burner out of operation by immediately removing the power to the fuel shut-off valve(s) and the ignition device

NOTE Safety shut-down can also occur as a result of an interruption/decrease of the power supply.

3.5.7

non-volatile lock-out

safety shut-down condition of the system, such that a restart can only be accomplished by a manual reset of the system and by no other means

3.5.8

safety shut-off device

device that opens and that is held open by auxiliary energy and that closes by interruption or failure of the auxiliary energy that automatically cuts off the fuel supply

3.5.9

reignition

operation by which the fuel is reignited after the extinction of the flame during operation without the fuel supply being interrupted

3.5.10

recycling

process by which, after a safety shut-down, a full start-up sequence is automatically repeated

3.5.11

pressure switch

switch that compares the actual value of a pressure with the desired value, gives a signal when the actual value exceeds or drops below the desired value and initiates the shut-off sequence

3.5.12

ignition device

any means used to ignite the fuel at the ignition burner or at the main burner

EXAMPLE Flame, electrical ignition.

3.5.13

pressure monitoring device

device which monitors the actual value of a pressure and compares with the desired value, giving a signal when the actual value deviates from the desired value by a predetermined amount

3.5.14

output regulator

component on the burner intended to be used for adjusting the heat input, within a range of heat inputs stated by the manufacturer, to suit actual heat requirements of the installation

NOTE This adjustment may be progressive or in discrete steps.

3.6 Sequencing times

3.6.1

total ignition time

period during which the ignition device is in operation

NOTE 1 Pre-ignition, ignition and post-ignition times make up the total ignition time.

NOTE 2 It is expressed in seconds (s).

3.6.2

pre-ignition time

period between the start of the ignition cycle and the release of the fuel

NOTE It is expressed in seconds (s).

3.6.3

ignition time

period between the release of the fuel and the first indication of the flame by the flame detector device

NOTE It is expressed in seconds (s).

3.6.4

post-ignition time

period between the first indication of the flame by the flame detector device and the ignition device shut-off

NOTE It is expressed in seconds (s).

3.6.5

safety time

t_s

duration of the maximum permissible time during which the burner control unit allows the fuel to be released without there being a flame

NOTE It is expressed in seconds (s).

3.6.6

ignition safety time

period starting from the signal for release of the fuel and terminating at the moment at which the signal for interrupting the fuel supply is given

NOTE It is expressed in seconds (s).

3.6.7

flame extinction safety time

period that starts with the signal that the flame has been extinguished and ends with the signal to de-energize the safety shut-off valve of the oil supply

NOTE It is expressed in seconds (s).

3.6.8

purge time

period during which the combustion chamber is compulsorily ventilated without any fuel being supplied

NOTE It is expressed in seconds (s).

3.6.9

pre-purge time

period during which purging takes place at the proven air rate prior to energizing of the safety shut-off device

NOTE It is expressed in seconds (s).

3.6.10

post-purge time

period between any shut-down and the moment the fan is switched off

NOTE It is expressed in seconds (s).

3.6.11

flame simulation

signal indicating the existence of a flame when no flame is actually present

3.6.12

operational state

state commencing with the presence of a flame after the permissible ignition safety time has expired

NOTE It is the end of the starting process. Starting can, however, be considered not to have taken place if the fuel release is not authorized or if it is interrupted after expiry of the safety time by the lock-out of the burner control unit.

3.6.13

intermittent operation

state of operation whose duration does not exceed 24 h

3.6.14

continuous operation

state of operation whose duration exceeds 24 h

3.7 Diagrams

3.7.1

working diagram

admissible range of application of the burner (pressure in the combustion chamber as a function of fuel flow)

3.7.2

test diagram

test range of the burner during the tests (pressure in the combustion chamber as a function of fuel flow)

4 Classification of oil burners

4.1 General

Oil burners are classified according to their

- type of atomization,
- method of control, and
- means of ignition.

4.2 Types of atomization

4.2.1 Mechanical atomization by pressurization of the combustion liquid

Atomization of the fuel is obtained by means of an atomizing nozzle, through pressure release.

4.2.2 Atomization by auxiliary fluid

Atomization is obtained by the fuel flow meeting a flow of air, steam, other gas or any other fluid.

This type of burner particularly includes

- emulsion burners, in which there is prior mixing of the fuel with the atomizing fluid, and
- rotary cup burners, in which atomization of the fuel is obtained when the fuel leaves the edge of a rotating cup and meets an auxiliary fluid.

Burners having other means of atomization are allowed if they comply with all other requirements and test conditions of this International Standard.

4.3 Automatic oil burner control methods

4.3.1 On-off control (single-stage burner)

This controls whether the oil burner is either in operation at constant mass flow rate or is switched off.

4.3.2 Multi-stage control (two- and multi-stage burner)

This type of control provides several firing stages (steps) for operation. Oil burners with only two firing rates are included in this category.

4.3.3 Modulating control (modulating burner)

This type of control provides infinite variation of the mass flow rate between the lower and the upper limits.

4.4 Means of ignition

4.4.1 Automatic electric ignition

4.4.1.1 General

These are systems in which the ignition of the fuel is brought about by means of electrical energy.

4.4.1.2 Ignition by controlled spark

In this system, fuel is released when the presence of the ignition spark has been proven.

4.4.1.3 Ignition by non-controlled spark

In this system, fuel may be released when the ignition spark is not controlled.

4.4.2 Automatic ignition with liquid or gaseous fuels

4.4.2.1 General

These are systems in which an ignition burner, using a liquid or gaseous fuel, ignites the main fuel. The operation of the ignition burner may be either permanent or intermittent. Permanent ignition burners may be started manually, whereas intermittent ignition burners start automatically.

4.4.2.2 Ignition by controlled ignition burner

In this system, the main fuel supply may only be released when the controlled flame of the ignition burner has been proven.

4.4.2.3 Ignition by non-controlled ignition burner

In this system, the main fuel supply may be released when the ignition burner flame is not controlled.

5 Constructional and operational requirement

5.1 Construction and operation

5.1.1 General design

5.1.1.1 Materials

The quality and thickness of the materials used in the construction of the burner shall be selected so that the constructional and performance characteristics of the system do not deteriorate during operation. In particular, all burner components shall withstand the mechanical, chemical and thermal loads that may be encountered during operation. Under normal conditions of use, maintenance and adjustment, the burner components shall

not show any changes that could affect their normal functioning. The influence of higher heat-transfer media temperature shall also be considered.

If the burner housing contains any metal parts not made of corrosion-resistant material, these shall be suitably protected with an effective anti-corrosion coating.

Asbestos or asbestos-containing materials shall not be used.

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

The pipework material shall be in accordance with ISO 3183, ISO 9329-1, ISO 9330-1 or ISO 1129, as applicable.

In Japan and Korea, the specific requirements respectively given in normative Annexes J and L apply.

5.1.1.2 Design

The effective lifetime of a burner is primarily controlled by its operation and maintenance.

The design of the burner shall be based on its intended lifetime as declared by the manufacturer. The intended lifetime of the equipment into which the burner is to be installed shall also be taken into account.

NOTE 1 The lifetime of components can differ from that of the burner.

The construction and design of the oil burner shall be such that the fuel oil used burns safely over the specified input range and pressure range specified by the manufacturer and the requirements given in Clause 6 are met.

NOTE 2 The burner head can be lengthened as long as the performance of the burner is not affected in an unsafe manner. The geometry of the mixing device and its position in the flame tube can remain unchanged.

Oil burners that can only operate by means of permanent ignition are not permitted.

5.1.1.3 Mounting

The burner shall be designed such that it can be effectively mounted on the appliance.

The burner shall be mounted on the appliance such that no ejection of high temperature gas or flame can occur, and such that back radiation and high refractory temperatures do not adversely affect the stability and lifetime of the burner parts inside the combustion chamber.

The burner components shall be arranged and secured such that their correct operating position and — above all — the correct position of the burner orifices cannot change during operation. The correct operating position shall be maintained when accessories are removed and refitted.

Parts of the burner that are set or adjusted during manufacture and which are not intended to be manipulated by the user or installer shall be sealed.

5.1.1.4 Accessibility for maintenance and use

Components requiring regular maintenance shall be so arranged or designed that they are easily detachable. They shall be designed or marked such that reasonable interpretation of the manufacturer's instructions would provide for proper reinstallation.

Constructional parts accessible during use and maintenance shall be free from sharp edges and corners that might cause damage or personal injury. Burners that can be withdrawn or swivelled out of position without the use of tools shall be interlocked (e.g. by means of limit switches) so that they cannot be operated in the withdrawn or swivelled position.

The interlock device shall be fail-safe in design and, if a limit switch, shall conform with IEC 60204-1 or IEC 60947-5-1, depending on the design.

If the burner is installed according to the manufacturer's instructions, the surface temperatures of accessible burner parts not intended to be touched shall not exceed the ambient temperature by more than 60 K.

If, for technical reasons, these temperature limits cannot be respected, adequate warnings shall be provided.

5.1.2 Equipment

5.1.2.1 Motors, fans and pumps

Guards, grilles and shields shall be used to protect high-temperature or moving parts such that they cannot be touched accidentally. If this protection is not possible, warning signs shall be used.

Removal of such guards, grilles and shields shall be possible only with the use of tools.

The degree of protection provided shall be at least IP 20, according to IEC 60529.

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 tools.

Motors, fans and pumps shall be mounted such as to minimize noise and vibration. Lubrication points, if provided, shall be readily accessible.

5.1.2.2 Electrical safety

5.1.2.2.1 Electrical safety of devices

Controls in accordance with the electrical requirements of IEC 60730-2-5 and ISO 23550 are considered as fulfilling the electrical requirement of this International Standard, and thus 5.1.2.2.2 is not applicable to such controls.

5.1.2.2.2 Electrical safety of the burner

5.1.2.2.2.1 General

The leakage current and electrical strength tests of the complete burner need not be performed if the components and sub-assemblies have been separately tested and the interconnection is carried out in accordance with the manufacturer's instructions.

If the measurements of the leakage current as required in IEC 60335-1:2001, 13.2 are not possible because the protective impedance circuits or radio interference filters cannot be disconnected, then the limit specified for leakage current shall be calculated taking into account the current through those circuits.

The electrical safety of

- a) the burner,
- b) those of its control devices not in accordance with IEC 60730-2-5 and ISO 23550, and
- c) the interface between control devices which do fulfil the requirements of IEC 60730 and ISO 23550

shall be in accordance with IEC 60335-2-102, modified by the additions and replacements given in 5.1.2.2.2.2.

5.1.2.2.2 Modifications, additions and replacements

a) Moisture resistance

The requirements of IEC 60335-1:2001, Clause 15, apply.

IEC 60335-2-102:2004, 15.2, does not apply.

b) Leakage current and electric strength

The following replaces IEC 60335-2-102:2004, 16.2:

For oil burners, the limit is 10 mA.

The following replaces IEC 60335-2-102:2004, 16.3:

Compliance of spark ignition circuits shall be checked by inspection. In case of doubt, spark ignition circuits or crucial parts shall be submitted to an endurance test performed under the following conditions:

- i) the maximum duration of switch-on given by the manufacturer (complete switch-on duration shall correspond with the realistic time of use);
- ii) the relation between on/off cycles as declared by the manufacturer;
- iii) the maximum rated voltage;
- iv) the maximum ambient temperature of all parts under test.

During this test no breakdown of other circuits or — if the limits specified in IEC 60335-2-102:2004, 8.101, are exceeded — accessible surfaces shall occur. Breakdown of conductive parts which are connected to earth is allowed if this does not result in a critical failure of a circuit(s) with safety-related functions.

NOTE In case of doubt, compliance can normally be achieved by increasing the clearance at any part of the spark ignition circuit likely to cause an unacceptable breakdown.

c) Abnormal operation

In addition to the provisions of IEC 60335-2-102:2004, 19.11.2, the following failure mode applies:

Short-circuit and mechanical break-down of relay contacts in protective electronic circuits: these failure modes need not be considered if components conform with footnote g) of IEC 60730-2-5:2004, Table H.27.1.

The following replaces the last paragraph of IEC 60335-1:2001, 19.11.2:

In each case, the test is ended if:

- i) for risks of electrical origin, interruption of the supply occurs within the appliance;
- ii) for risks concerning the fuel, shut-down occurs.

The following is additional to the provisions of IEC 60335-2-102:2004, 19.11.3:

Tests are not to be repeated for protective electronic circuits conforming with the relevant control standard according to 5.1.2.2.1.

The following replaces IEC 60335-2-102:2004, 19.13:

During the tests described in 19.11.4, the appliance shall either continue to operate normally or reach a safe situation for risks concerning the fuel safety shut-down or non-volatile lock-out.

d) Components

The following is additional to IEC 60335-2-102:2004, 24.1.1:

Relays and optocouplers which ensure electrical isolation between live parts and accessible metal parts shall conform with IEC 61810-1 and IEC 60747-5-2.

e) IEC 60335-2-102:2004, Annex Q

The following is additional to the provisions of the annex:

NOTE Repeat testing of a protective electronic circuit is not required where the system has already been certified to conform with published International Standards where compliance requires that the fault behaviour of the fail-safe system is assessed on a second fault analysis basis.

5.1.2.3 Adjustable air damper

Any adjustable air damper or similar device for controlling the airflow shall be adjustable only by means of a tool. The adjusting positions of the air damper shall be visible (e.g. after removal of a cap).

If the burner is provided with a manual means of adjusting the combustion airflow, this means shall be designed so that, after adjustment according to the manufacturer's instructions, it is capable of being set and sealed.

5.1.2.4 Installation of automatic burner control unit

The automatic burner control unit shall be in accordance with IEC 60730-2-5 and, in the installed condition (e.g. in the burner housing/control panel), shall have at least an IP 40 degree of protection as specified in IEC 60529.

In Japan and Korea, the specific requirements respectively given in normative Annexes J and L apply.

5.1.2.5 Rubber hoses and hose assemblies

Rubber hoses and hose assemblies that have a corrosion-proof metal braiding and which meet the requirements of ISO 6806 are permitted.

In Japan and Korea, the specific requirements respectively given in normative Annexes J and L apply.

Rubber hoses and hose assemblies shall withstand the maximum fuel oil temperature.

5.1.2.6 Connections

Inlet connections with pressure-tight joints made on the threads, connections within the burner with pressure-tight joints made on the threads that are not loosened for maintenance, and connections for parts that are not frequently dismantled and refitted shall be designed in accordance with ISO 7-1.

Connections which have to be loosened for maintenance purposes shall be designed in accordance with ISO 228-1. Flange connections shall conform with ISO 7005-1, ISO 7005-2 and ISO 7005-3.

In Japan, Korea and the USA, the specific requirements respectively given in normative Annexes J, L and M apply.

5.1.2.7 Safety shut-off devices and oil pressure switches

In the USA, the specific requirements given in normative Annex M apply.

5.1.2.7.1 Safety shut-off devices

Safety shut-off devices shall be in accordance with ISO 23553-1.

5.1.2.7.2 Burners with a flow rate less than or equal to 30 kg/h

A safety shut-off device shall be provided between the pump and nozzle as shown in Figures F.1 to F.4. It is permissible that the safety shut-off device be integrated with the oil-pump.

In addition, the following applies.

- a) Single-stage burners shall be provided with one safety shut-off device in accordance with ISO 23553-1.
- b) Two-stage or multi-stage burners shall be fitted with one safety shut-off device for each nozzle. See Figure F.2.
- c) Burners with a spill-back nozzle shall be fitted with a safety shut-off device conforming to ISO 23553-1 in both the feed line and return line. A nozzle shut-off valve may be fitted in lieu of the safety shut-off device fitted in the feed line and return line on condition that the nozzle shut-off valve is tested and approved as a safety shut-off device in accordance with ISO 23553-1. See Figures F.3 and F.4.
- d) In the case of a burner with a nozzle head it may be necessary to have oil circulation up to the nozzle head, e.g. for pre-heating purposes. Since there is only a nozzle shut-off device in service, it shall be ensured by a second independent measure that an unsafe fuel discharge is prevented. In the case of a nozzle shut-off device in accordance with ISO 23553-1 a second measure is not necessary. It shall be ensured that the nozzle shut-off device cannot be opened by the return pressure.

5.1.2.7.3 Burners with a flow rate greater than 30 kg/h

Two series-connected safety shut-off devices shall be provided in the flow line of oil burners with a flow rate > 30 kg/h. See Figure F.5.

One of the devices shall be of the fast-closing type. The second device may also be used as a final controlling element for the combustion chamber input. Its closing time shall not exceed 5 s.

The following also applies:

- a) For burners with a spill-back nozzle, two safety shut-off devices shall be provided in the return line and a pressure monitoring device shall be provided between the power regulator and the safety shut-off device (see Figures F.6 and F.7). A nozzle shut-off valve may replace a safety shut-off device fitted in either the flow line or the return line provided it has been tested and certified as a safety shut-off device in accordance with ISO 23553-1.

Except where a step-regulated burner has a full-load stage, the safety shut-off devices shall be interlocked so that when the flow is open the return is not closed. This can be done, for example by

- making a mechanical connection between the safety shut-off devices in the flow and return (e.g. by means of an actuator), or
- by electric or pneumatic interlocking of the safety shut-off devices in the flow and return lines.

It shall be ensured that no excessive pressure builds up between the two shut-off devices.

- b) In the case of a burner with a nozzle head, it may be necessary to enable oil circulation up to the nozzle head, e.g. for pre-heating purposes. Since there is only a nozzle shut-off device in service, it shall be ensured by a second independent measure, so that an unsafe fuel discharge is prevented. In case of a nozzle shut-off device in accordance with ISO 23553-1, a second measure is not necessary. It shall be ensured that the nozzle shut-off valve cannot be opened by the return pressure.

5.1.2.8 Fuel pre-heating

5.1.2.8.1 General

Burners using higher-boiling petroleum in accordance with ISO 8217-based first raffinates shall be provided with the following.

5.1.2.8.2 Heat sources

Any heat source able to be cut off immediately if required and whose rating can be automatically controlled shall be able to be used for oil pre-heating. Open flames shall not be permitted.

5.1.2.8.3 Pre-heating temperature

In the unpressurized condition, the fuel oil temperature shall not attain the fuel oil flash point and shall in no case exceed 90 °C.

In pressurized-type pre-heaters, the maximum temperature shall not exceed a temperature 5 K below the boiling temperature of water in the pressurized oil.

5.1.2.8.4 Control of pre-heating temperature

Each fuel oil pre-heating system shall be automatically controlled. A temperature indicator shall be fitted downstream of the pre-heating system.

Shut-off devices (e.g. thermal limiters) shall prevent a temperature rise above 220 °C of the pre-heating system's surface within unpressurized fuel oil vessels, if not wetted by fuel oil.

5.1.2.8.5 Pressurized pre-heaters

Pressurized pre-heaters shall be designed for 1,5 times the permissible operating pressure.

In Europe, the specific requirements given in normative Annex I apply.

If the pre-heater is used in a closed system, an overpressure protection shall be provided.

Functioning of the necessary overpressure protection shall be ensured by a suitable temperature.

5.1.2.9 Ignition device

The ignition device shall ensure safe ignition of the ignition and/or main burner under the specified conditions of operation.

5.1.2.10 Flame detector device

5.1.2.10.1 General

The flame detector device shall be in accordance with IEC 60730-2-5.

The flame extinction safety time shall be not more than

- 1 s, or
- alternatively, 2 s, provided a flame detector device self-check test is performed at the same time as flame failure.

The flame detector shall be subjected to a safe start check by which, if a flame presence is detected at any time during the pre-purge, the device shall initiate a safety shut-down followed by non-volatile lock-out. The safe start check may be disabled during the 5 s preceding an attempt at ignition.

The flame detector device shall be suitable for the particular thermal rating and mode of operation of the burner (intermittent or permanent operation). When installed on the burner it shall be at least in accordance with IEC 60529, protective category IP 40, and with IP 54 for installations in open air.

In Japan and the USA, the specific requirements respectively given in normative Annexes J and M apply.

5.1.2.10.2 Flame detector device with sensor for the visible range of light

When using flame detector devices equipped with sensors for the visible range of light, the following applies.

- a) If the illumination intensity of the burner flame is $< 0,5$ lx at the flame detector device during operation, sensors for visible light are not allowed to be used for flame supervision purposes.
- b) If the illumination intensity of the burner flame is < 3 lx at the flame detector during operation, the burner with the mounted flame detector device shall conform with the following:
 - when the burner is searched by an illumination intensity of 20 000 lx at 2 856 K colour temperature, the flame detector device shall not show any spurious light signals during the test.

In Japan, the specific requirements given in normative Annex J apply.

5.1.2.10.3 System requirements

Where the ignition burner (if fitted) and the main burner are each provided with their own flame monitor, the ignition burner flame shall not influence the detection of the main flame. The main fuel oil supply shall be opened only after the ignition means is switched off and the ignition burner flame has been established and detected.

For systems where the ignition burner remains in use during main-burner operation, separate flame sensors shall be fitted for monitoring the ignition and main flames. The main flame sensor shall be positioned so that it cannot in any circumstance detect the ignition burner flame.

For systems where the ignition burner is extinguished during main burner operation, a single sensor will suffice. The ignition burner flame shall not influence the detection of the main flame.

5.1.2.11 Air-proving device

If a burner, depending on its design, requires an air-proving device (see 5.1.3.2), such a device shall be fitted as proves adequate airflow during the pre-purge, ignition and operation of the burner.

Airflow failure at any time during the ignition or operation of the burner shall cause a non-volatile lock-out.

Airflow failure during pre-purge shall at least result in a safety shut-down.

For burners with a heat input up to and including 120 kW, a safety shut-down followed by a single recycling attempt is permitted. If the recycling attempt fails then non-volatile lock-out shall occur.

Proof of adequate airflow to the burner shall be achieved by one or another of the following:

- a) pressure sensing;
- b) flow sensing;
- c) any other system which provides a safety level comparable to a pressure sensing-device as specified in a) above.

Fan rotation, an air damper interlock or air damper actuator interlock alone is not sufficient.

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

This check is not necessary if failure of the air-proving device leads to a safe condition.

The air-proving device shall be adjusted such that, if there is insufficient air supply at the highest or lowest burner operating stage, its operation ensures that no critical operating mode will be reached.

Where the burner is fitted with automatic fuel/air ratio control in which an airflow device provides the lead signal, continuous monitoring of the airflow by the air-proving device during the operation of the burner is not necessary. In the event of the failure of the air lead signal, the safety shut-off device shall be closed.

NOTE For multi-stage and modulating burners only one air-proving device is necessary to control the airflow.

An air-proving device may be omitted if the burners are fitted with all of the following:

- a) a device for checking the actual fan speed if no safety shut-down or blocking occurs;
- b) a device for checking the state of the adjustable air damper during pre-purge, if no oil opening occurs;
- c) a device for a positive coupling between motor/fan;
- d) a device for fuel release via fuel/air ratio control;
- e) a device which shall close the oil valve in the event of air reference signal failure.

If a separate combustion air fan is used, proof of adequate airflow is in principle the same as for a burner conforming to the requirements of this International Standard, with the exception that the positioning of the safety devices can be dependent on the installation on site. The air-proving device shall be located in a position ensuring that sufficient combustion air supply is detected.

The test method for the air-proving device shall be effective and take into account the design of the burner upon which it is installed (see Annex H).

5.1.2.12 Fuel/air ratio control device

Each burner shall be provided with an airflow adjustment device.

For two-stage or multi-stage burners, the combustion air and fuel oil flow rates shall be controlled in tandem by a sequential switching system. The air and fuel adjustment devices shall be interconnected (e.g. by mechanical, pneumatic, electric or electronic means) such that the relationship between combustion air and fuel is fixed in a repeatable way at any operating point of the burner.

On multi-stage or modulating burners where the airflow and fuel flow are not altered simultaneously, there shall be either

- a) air lead on increasing firing rate and fuel lead on reducing firing rate, or
- b) sufficient excess air to prevent fuel-rich firing.

The combined control or the sequential switching shall be effected in such a manner that even in the case of a fault the system will tend towards higher excess air or proceed to a safety shut-down.

Where an electronically operated fuel/air ratio device is fitted, it shall be in accordance with ISO 23552-1.

Where a combustion quality control system influencing the ratio between the oil and air supply is used, it shall be in accordance with ISO 23552-1.

NOTE These requirements apply to burners used for both continuous and intermittent operation with electronic fuel/air ratio control.

Setting of adjustment devices shall not change easily if the adjustment devices are properly fastened.

In Japan, the specific requirements given in normative Annex J apply.

5.1.2.13 Automatic burner control unit

The automatic burner control unit shall be in accordance with IEC 60730-2-5 and shall be suitable for the individual output stages of the burner and for the mode of burner operation (intermittent or permanent).

5.1.2.14 Pressure test points

Test points or pressure-measuring devices shall be provided to enable the fuel suction pressure, fuel adjustment pressure and the air pressure to be checked.

5.1.2.15 Interfacing with oil appliances

See Annex N for an example of the application, interfacing and wiring of a burner. This interfacing can facilitate the assembly of burners and boilers/oil appliances on site.

5.1.3 Operating requirements

5.1.3.1 Shut-down

If an on/off control, switch or limiter operates, the fuel oil supply shall be automatically cut off immediately.

5.1.3.2 Protection of the oil and air supply

The oil supply shall not be released without the atomizing process being ensured [e.g. failure of atomizing medium, oil pressure too low, return pressure too high (burners with spill-back nozzle), speed too low] or if the combustion air is not available. If the atomizing medium or combustion air supply fails during operation, the oil supply shall be automatically cut off immediately. In the case of oil pressure atomizers, if no spring-loaded fast closing devices are available in the oil-pump, oil pressure switches shall be used.

Where there are no oil- or air-supply monitoring devices or spring-loaded fast closing devices in the pump, the above requirements are considered to have been met if there is a motor-fan-pump assembly, in the case of a single shaft motor output, or a fan-motor-oil-pump assembly, in the case of a double-ended shaft motor output. In the latter case, there shall be a positive coupling between motor and fan.