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Udstyr til industrielle termiske procesanlæg – Del 2: Sikkerhedskrav til fyrings- og brændstofsystemer

Industrial thermoprocessing equipment – Safety requirements for combustion and fuel handling systems

DANSK STANDARD
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English Version

Industrial thermoprocessing equipment - Safety requirements for combustion and fuel handling systems

Equipements thermiques industriels - Partie 2: Prescriptions de sécurité concernant la combustion et la manutention des combustibles

Industrielle Thermoprozessanlagen - Teil 2: Sicherheitsanforderungen an Feuerungen und Brennstoffführungssysteme

This European Standard was approved by CEN on 11 March 2010.

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Foreword

This document (EN 746-2:2010) has been prepared by Technical Committee CEN/TC 186 “Industrial Thermoprocessing Equipment”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by November 2010, and conflicting national standards shall be withdrawn at the latest by May 2011.

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

This document supersedes EN 746-2:1997.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this document.

Following a request from CEN/TC 186, CEN has agreed to defer the date of withdrawal of EN 746-2:1997 for a transitional period of 12 months.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

This European Standard is a Type C standard as defined in EN ISO 12100-1.

The machinery concerned and the extent to which hazards, hazardous situations and events are covered, is indicated in the scope of this document.

When provisions of this type C standard are different from those which are stated in type A or B standards, the provisions of this type C standard take precedence over the provisions of the other standards, for machines that have been designed and built according to the provisions of this type C standard.

This Part of EN 746 assumes that the equipment is not creating any potentially explosive atmosphere and is located in a normally ventilated area.

This European Standard forms one part of a series of safety standards covering Industrial Thermoprocessing Equipment (IThE). The full list of these standards is given below:

EN 746, *Industrial thermoprocessing equipment*

Part 1: Common safety requirements for industrial thermoprocessing equipment

Part 2: Safety requirements for combustion and fuel handling systems

Part 3: Safety requirements for the generation and use of atmosphere gases

Part 4: Particular safety requirements for hot dip galvanising thermoprocessing equipment

Part 5: Particular safety requirements for salt bath thermoprocessing equipment

Part 6: Particular safety requirements for material melting, re-melting and liquid phase maintaining thermoprocessing equipment

Part 7: Particular safety requirements for vacuum thermoprocessing equipment

Part 8: Particular safety requirements for quenching equipment

Compliance with European product standards e.g. EN 267, EN 12952-8, EN 12953-7 or EN 676 is not sufficient to ensure the minimum safety requirement for industrial thermoprocessing equipment. This part 2 of EN 746 shall always have priority for IThE.

An IThE generally consists of the following components:

— processing chamber (e.g. steel construction with lining);

— heating system;

— protective system;

— control and instrumentation system/operator-control level.

It is assumed that (IThE) will only be operated and maintained by trained personnel.

1 Scope

This part of EN 746 together with EN 746-1 specifies safety requirements for single and multiple burners that are part of Industrial Thermoprocessing Equipment. (In this standard referred to as IThE).

This document deals with significant hazards, hazardous situations and events relevant to combustion and fuel handling systems that are part of IThE as listed in Clause 4, when used as intended and under the conditions foreseen by the manufacturer.

This European Standard covers:

— fuel pipework downstream of and including the manual isolating valve;

— burner(s), burner system and ignition device;

— safety related control system (protective system).

This European Standard applies to any oxidation with air or other gases containing free oxygen of gaseous, liquid and solid fuels or any combustion of them to release thermal energy.

For thermal or catalytic post combustion and waste incineration, this European Standard applies only to auxiliary burners designed to start-up and/or support the process.

The pressure hazard of the piping and components covered by this standard is within the limits of maximum pressure/size relationship as described in normative Annex E.

This European Standard also gives the necessary requirements for the information for use.

This European Standard does not cover hazards from heating generated by electricity.

This European Standard does not deal with the hazards created by the release of flammable substances from the products processed in the IThE.

NOTE EN 1539, *Dryers and ovens, in which flammable substances are released — Safety requirements*

This European Standard is not applicable to combustion and fuel handling systems

— of welding and soldering machines;

— up-stream of the IThE manual isolating valve.

This European Standard is not applicable to electricity cabling and power cabling upstream of the IThE control panel/protective system.

Noise can be a significant hazard for combustion and fuel handling systems. It is not dealt with in this standard.

This European Standard is not applicable to combustion and fuel handling systems as part of IThE which is manufactured before the date of its publication as EN.

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.

EN 88-1:2007, *Pressure regulators and associated safety devices for gas appliances — Part 1: Pressure regulators for inlet pressures up to and including 500 mbar*

EN 88-2:2007, *Pressure regulators and associated safety devices for gas appliances — Part 2: Pressure regulators for inlet pressures above 500 mbar up to and including 5 bar*

EN 125:1991, *Flame supervision devices for gas burning appliances — Thermo-electric flame supervision devices*

EN 161:2007, *Automatic shut-off valves for gas burners and gas appliances*

EN 230:2005, *Automatic burner control systems for oil burners*

EN 264:1991, *Safety shut-off devices for combustion plants using liquid fuels — Safety requirements and testing*

EN 298:2003, *Automatic gas burner control systems for gas burners and gas burning appliances with or without fans*

EN 331:1998, *Manually operated ball valves and closed bottom taper plug valves for gas installations for buildings*

EN 334:2005, *Gas pressure regulators for inlet pressures up to 100 bar*

EN 751-1:1996, *Sealing materials for metallic threaded joints in contact with 1st, 2nd and 3rd family gases and hot water — Part 1: Anaerobic jointing compounds*

EN 751-2:1996, *Sealing materials for metallic threaded joints in contact with 1st, 2nd and 3rd family gases and hot water — Part 2: Non-hardening jointing compounds*

EN 1057:2006, *Copper and copper alloys — Seamless, round copper tubes for water and gas in sanitary and heating applications*

EN 1643:2000, *Valve proving systems for automatic shut-off valves for gas burners and gas appliances*

EN 1854:2006, *Pressure sensing devices for gas burners and gas burning appliances*

EN 10241:2000, *Steel threaded pipe fittings*

EN 10242:1995, *Threaded pipe fittings in malleable cast iron*

EN 12067-1:1998, *Gas/air ratio controls for gas burners and gas burning appliances — Part 1: Pneumatic types*

EN 12067-2:2004, *Gas/air ratio controls for gas burners and gas burning appliances — Part 2: Electronic types*

EN 12078:1998, *Zero governors for gas burners and gas burning appliances*

EN 14382:2005, *Safety devices for gas pressure regulating stations and installations — Gas safety shut-off devices for inlet pressure up to 100 bar*

EN 60204-1:2006, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements (IEC 60204-1:2005, modified)*

EN 60664 -1:2007, *Insulation coordination for equipment within low-voltage systems — Part 1: Principles, requirements and tests (IEC 60664-1:2007)*

EN 60947-4-1:2001, *Low-voltage switchgear and controlgear — Part 4-1: Contactors and motor-starters; Electromechanical contactors and motor-starters (IEC 60947-4-1:2000)*

EN 61140:2002, *Protection against electric shock - Common aspects for installation and equipment (IEC 61140:2001)*

EN 61558-1:2005, *Safety of power transformers, power supplies, reactors and similar products — Part 1: General requirements and tests (IEC 61558-1:2005)*

EN 61810-1:2008, *Electromechanical elementary relays — Part 1: General requirements (IEC 61810-1:2008)*

EN 62061:2005, *Safety of machinery — Functional safety of safety-related electrical, electronic and programmable electronic control systems (IEC 62061:2005)*

EN ISO 5817:2007, *Welding — Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) — Quality levels for imperfections (ISO 5817:2003, corrected version:2005, including Technical Corrigendum 1:2006)*

EN ISO 8434-1:2007, *Metallic tube connections for fluid power and general use — Part 1: 24 degree cone connectors (ISO 8434-1:2007)*

EN ISO 8434-4:2000, *Metallic tube connections for fluid power and general use — Part 4: 24° cone connectors with O-ring weld-on nipples (ISO 8434-4:1995)*

EN ISO 12100-1, *Safety of machinery — Basic concepts, general principles for design — Part 1: Basic terminology, methodology (ISO 12100-1:2003)*

EN ISO 12100-2, *Safety of machinery — Basic concepts, general principles for design — Part 2: Technical principles and specifications (ISO 12100-2:2003)*

EN ISO 13849-1:2008, *Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design (ISO 13849-1:2006)*

EN ISO 19879:2005, *Metallic tube connections for fluid power and general use — Part 5: Test methods for hydraulic fluid power connections (ISO 19879:2005)*

ISO 7-1:1994, *Pipe threads where pressure-tight joints are made on the threads — Part 1: Dimensions, tolerances and designation*

ISO 228-1:2000, *Pipe threads where pressure-tight joints are not made on the threads — Part 1: Dimensions, tolerances and designation*

ISO 6976:1995, *Natural gas — Calculation of caloric values, density, relative density and Wobbe index from composition*

ISO 7005-1:1992, *Metallic flanges —Part 1: Steel flanges*

ISO 7005-2:1988, *Metallic flanges — Part 2: Cast iron flanges*

ISO 7005-3:1988, *Metallic flanges — Part 3: Copper alloy and composite flanges*

ISO 8434-2:1994, *Metallic tube fittings for fluid power and general use — Part 2: 37 degree flared connectors*

ISO 8434-3:2005, *Metallic tube connections for fluid power and general use — Part 3: O-ring face seal fittings*

3 Terms and definitions

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

NOTE 1 A classification of plant, fuels and burners is given in informative Annex A.

NOTE 2 An alphabetic listing of technical terms in German, French and English, as well as their cross-references where applicable is given in informative Annex B.

3.1
automatic burner control system
protective 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 can be in one or more housings (see also 3.66). It is a protective system.

3.2
air pressure detector
device for sensing the existence of air pressure

3.3
air/fuel ratio
ratio between the mass flow of combustion air and the mass flow of the fuel

3.4
burner
combustion system under the control of individual automatic shut-off valves

3.5
burner, alternating pilot
pilot burner that is extinguished at the end of the main burner ignition period and is re-ignited immediately when the main burner is shut down for control purposes

3.6
burners, cross-ignited
group of burners designed and arranged such that, by means of their proximity and relative position, ignition of all burners can be ensured if one burner is ignited

3.7
burner, forced draught
burner in which the combustion air is supplied by mechanical means, usually of a fan or blower

3.8
burner, grate
solid fuel combustion system where the burning fuel is supported by a metallic grate

3.9
burner, induced draught
burner in which the combustion air is supplied by providing suction in the combustion chamber by mechanical means, usually a fan

3.10
burner input rate
highest quantity of fuel energy used by a burner in unit time corresponding to the volumetric or mass flow rates, the calorific value used being the net calorific value

3.11
burner, manual
burner whereby all the operating sequences are performed by an operator

3.12
burner, natural draught
burner in which the combustion air is entrained at atmospheric pressure, by the buoyancy of a chimney or the fuel velocity

3.13
burner, open firing
burner not requiring an enclosed combustion chamber

EXAMPLE Torches, work station burners, equipment-integrated burners, and other burners firing in the open.

3.14
burner, permanent pilot
pilot burner that is intended to be left on permanently

3.15
burner, pilot
independently controlled burner designed to ignite the main burner

3.16
burner, portable
burner designed to be capable of being transported to fire in different locations

3.17
burner, radiant tube
burner that heats up the IThE indirectly by means of firing into a radiant tube protruding into the IThE process chamber whereby the combustion remains wholly separated from the IThE process chamber

3.18
burner, work station
burner used at a particular work station and not requiring an enclosed combustion chamber

3.19
by-pass
passage conveying fuel from the upstream side to the downstream side of a pipework component so as to be independent of the action of the pipework component

3.20
calorific value
quantity of heat produced by the combustion of unit volume or mass of fuel at a constant pressure of 1 013 mbar

NOTE A distinction is made between the gross calorific value (where the water produced by combustion is assumed to be condensed) and the net calorific value.

3.21
combustion air
ambient air, or mixture of ambient air with other gases such as water vapour, carbon dioxide, ... that is used as oxygen supply for combustion process

3.22
combustion chamber
part of the IThE in which the combustion takes place

3.23
condensate drain
pipe designed to collect and drain condensates from a low point in the gas circuit and to drain it from a low point

3.24
control system
system which responds to input signals from the process and/or the operator and generates output signals which cause the process control to operate in the required way

3.25
EMC
immunity of the IThE to Electro Magnetic disturbances

3.26
enriched air
air with an oxygen concentration higher than 23 % (volume) obtained either by the addition of oxygen or the reduction of nitrogen content

3.27
explosion/pressure relief
device (e.g. a flange) containing a disc which is designed to yield safely to an unsafe increase of internal pressure

3.28
fault tolerance time
fault tolerance time is the time between the occurrence of an unsafe condition (caused by the process itself or due to equipment failure) and the point when the process changes into critical operation, which result in an hazardous event

3.29
filter/strainer, strainer/filter
device that enables foreign elements which could otherwise cause failures in the system, to be collected

3.30
flame response time
FRT
period of time that starts with the loss of sensed flame and ends with the de-energising of the terminals for the automatic shut-off valve

3.31
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 a relay for signal transmission.

3.32
flame sensor
actual flame-sensing element, the output signal value of which is used as the input for flame detector amplifier

3.33
flame trap or flame arrestor
device fitted to the pipe conveying gas or a gas-air mixture and whose intended function is to prevent the transmission of flame

3.34
flash back
flame propagation from the burner in upstream direction inside the pipework

3.35
fluids
gases, liquids and vapours in pure phase as well as mixtures thereof

NOTE A fluid contains a suspension of solids.

3.36
fluids group 1
fluids defined as explosive, extremely flammable, highly flammable, flammable (where the maximum allowable temperature is above flashpoint), very toxic, toxic, and/or oxidizing

3.37
fluids group 2
all other fluids not referred to as group 1 fluids

3.38
functional safety
capability of a safety system or other means to reduce risk, to execute the actions required for achieving or maintaining a safe state for the process and its related equipment

3.39
gas flow detector
device for sensing the presence of an adequate gas flow

3.40
gas pressure detector
device for sensing the presence of gas pressure

3.41
gas pressure regulator
device which maintains the downstream pressure constant to within fixed limits, independent of variations, within a given range, of the upstream pressure and/or flow rate

3.42
graded fuel
solid fuel in the form of lumps which are classified according to size

3.43
high temperature equipment
IThE operating at a temperature above 750 °C measured at the combustion chamber walls and/or the processing chamber walls

3.44
ignition
starting up chemical reaction of combustion of a fuel/combustion air mixture by application of a much smaller energy source

3.45
initial boiling point
temperature of a liquid fuel that is measured at the instant that the first drop of condensate falls from the lower end of the condenser tube in a boiling point test

3.46
lighting torch
hand-held burner which is used to ignite another burner

3.47
liquefied petroleum gas
LPG
commercial butane or commercial propane or any mixtures there of

3.48
lock-out, non volatile
safety shut-down by the protective system itself, such that a restart can only be accomplished by a manual reset

3.49
lower flammability limit
LFL
lowest concentration of fuel in air at which the air/fuel mixture is flammable

3.50
low temperature equipment
IThE operating at a temperature measured below 750 °C at any part of the combustion chamber walls and/or the processing chamber walls

3.51
main flame
flame, other than the ignition flame, on the main burner

3.52
manual reset
action after a lock-out of a safety related device (e.g. automatic burner control) carried out manually by the supervising operator

3.53
multiple burner equipment
IThE with several burners with a common air and gas pipework firing in a common combustion chamber

3.54
nominal size
DN
numerical designation of size which is common to all components in a pipework other than components indicated by outside diameter or by thread size

NOTE It is a convenient round number for reference purposes and is only loosely related to manufacturing dimensions. The nominal size is designated by DN followed by a number.

3.55
operating temperature
temperature, or range of temperatures, at which the IThE is designed to operate

3.56
operator supervision
circumstance by which an operator has continuous control and surveillance of the plant and is located in a position where he can shut the IThE down in the event of an emergency

3.57
pipework
assembly of piping (e.g. vale(s), orifice(s), ...) by means of which fuel and combustion air convey from the point(s) of supply to the burner(s)

3.58
piping
components intended for the transport of fluids, when connected together for integration into a pressure system

NOTE Piping includes in particular a pipe or system of pipes, tubing, fittings, expansion joints, hoses, or other pressure-bearing components as appropriate. Heat exchangers consisting of pipes for the purpose of cooling or heating air are considered as piping.

3.59
PLC
Programmable Logic Control
electronic device designed for control of the logical sequence of events

3.60
pre-purge
forced introduction of air or inert gas into the combustion chamber and flue passages, in order to displace any remaining fuel/air mixture and/or products of combustion, and which takes place between the start signal and the energising of the ignition device

3.61
pressure
pressure relative to atmospheric pressure, i.e. gauge pressure

NOTE As a consequence vacuum is designated by a negative value.

3.62
pressure accessories
devices with an operational function and having pressure-bearing housings

3.63
pressure equipment
vessels, piping, safety accessories and pressure accessories

NOTE Where applicable, pressure equipment includes elements attached to pressurized parts, such as flanges, nozzles, couplings, supports, lifting lugs, etc.

3.64
pressure, maximum allowable
PS
maximum pressure for which the equipment is designed, as specified by the manufacturer

NOTE It is defined at a location specified by the manufacturer. This is the location of connection of protective and/or limiting devices or the top of equipment or if not appropriate any point specified.

3.65
processing chamber
part of the equipment in which the workpiece(s) being processed is/are contained

3.66
protective system
equipment, units and safety related circuits whose main purpose is the protection of personnel, property and the environment

NOTE The protective system includes all the components required to carry out the safety function, for example sensors which monitor safety related parameters (e.g. flame monitoring), interruption device for the flow of fuel, ventilation of the body of the furnace and protection of the heated system (e.g. monitoring the temperature level). Typically a protective system consists of sensors, logic solving protective equipment and actuating elements. If this is achieved by multi-channel systems, then all channels and monitoring devices used for safety purposes are included within the protective system.

3.67
pulse firing
burner combustion system where the firing rate is controlled by the number and/or duration of burners firing at fixed heat input rates, e.g. high/low or on/off

3.68
pulverised fuel
solid fuel which has been grounded to a powder

3.69
purge point
plugged tapping at the extremities of a fuel pipework to facilitate purging

3.70
re-cycling
process by which, after a safety shut-down, a full start-up sequence is automatically repeated

3.71
remote reset
manual reset after a lock-out carried out from a location different from the safety related device

NOTE The connection between the place of reset and the safety related device on the IThE can be by electrical or electronic circuit. It complies with the single fault criterion.

3.72
safety accessories
devices designed to protect pressure equipment against the allowable limits being exceeded.

NOTE Such devices include:

— devices for direct pressure limitation, such as safety valves, bursting disc safety devices, buckling rods, controlled safety pressure relief systems (CSPRS), and

— limiting devices, which either activate the means for correction or provide for shutdown or shutdown and lockout, such as pressure switches or temperature switches or fluid level switches and 'safety related measurement control and regulation (SRMCR)' devices.

3.73
safe discharge area
zone which is safeguarded against the risk of combustion of discharged flammable gasses

3.74
safety shut-down
process which is effected immediately following the response of a safety device or the detection of a fault in the automatic burner control system and which puts the burner out of operation by immediately closing to the fuel shut-off valves and the ignition device

3.75
safety time
interval between a fuel valve being energised and another fuel valve being de-energised if the flame detector signals the absence of a flame

3.75.1
first safety time
interval between the pilot fuel valve, the start fuel valve or main fuel valve, as applicable, being energised and the pilot fuel valve, start fuel valve or main fuel valve, as applicable, being de-energised if the flame detector signals the absence of a flame

3.75.2
second safety time
interval between the main fuel valve being energised and the main fuel valve being de-energised if the flame detector signals the absence of a flame[1)]

3.76
self-checking automatic burner control system
automatic burner control system designed so that the functioning of its safety-related parts are checked at suitable intervals

1) Definition used only if there is a first safety time applicable to either a pilot or start gas flame.

3.77
single burner equipment
IThE with one burner with a common air and gas pipework

3.78
spark restoration
process by which, following loss of flame signal, the ignition device will be switched on again automatically without total interruption of the fuel supply

3.79
start fuel
fuel supplied to the pilot or to the main burner at low rate prior to the start-up of the burner

3.80
start fuel flow rate
flue flow rate during the start-up of the burner(s)

3.81
stoichiometric fuel rate
fuel rate at which, if reacted completely with the combustion air rate the fuel would just consume all the oxygen in the airstart fuel flow rate

3.82
system leak tightness check
way of controlling the leak tightness of a system by applying pressure to that system manually or automatically whereby the pressure shall not drop significantly within a given time frame

3.83
temperature, maximum/minimum allowable
TS
maximum/minimum temperatures for which the equipment is designed

3.84
test pressure
pressure to which pipework is submitted to a check for soundness

3.85
thermo-processing equipment
equipment in which material or workpiece is submitted to thermal energy

3.86
torch
manually controlled gas- or oil-fired open-flame tool or any mobile burner unit firing in the open and intended for use together with IThE

3.87
total closing time
interval between the occurrence of an unsafe condition and the automatic shut-off valves being in fully closed position

3.88
valve, automatic shut-off
valve which opens when energised and closes automatically when de-energised

3.89
valve, manual isolating
manually operated valve which is upstream of all other fuel controls to that IThE and by means of which the fuel supply to the IThE can be shut off

3.90
valve, manual shut-off
manually operated valve by means of which the fuel supply to an individual burner or to a group of burners can be shut off

3.91
valve, non-return
device to prevent the back flow of air, fuel, oxygen etc.

3.92
valve, pressure relief
valve or regulator designed to relieve excessive pressure

3.93
valve proving system
system to check the effective closure of automatic shut-off valves by checking leak tightness

NOTE It consists of a programming unit, a measuring device, valves and other functional assemblies.

3.94
Wobbe index
calorific value of a gas, on a volumetric basis, at specified reference conditions, divided by the root square of its relative density, at the same specified metering reference conditions

NOTE The Wobbe index is gross or net depending on whether the calorific value used is the gross or net calorific value.

3.95
zone
self-contained space within a IThE which is operating under the same conditions/parameters (e.g. temperature, pressure)

4 List of hazards

1 Cl.	2 Hazards	3 Location	4 Relevant clauses of Part 1	5 Relevant (sub)clause(s) of this European Standard
	Hazards, hazardous situation and hazardous events			
1	**Mechanical Hazards**			
1.1	High pressure fluid injection or ejection hazard	pipework	5.2.7	5.2.1.1, 5.2.2.4, 5.3.1.6 5.6.10
2	**Electrical Hazards**			
2.1	Electrical contact direct or indirect with live parts	control system, power supply to the machine and connectors	5.3.2	5.2.6.1, 5.2.6.4, 5.3.6.1, 5.4.6, 5.7.2, 5.7.3, 5.7.4
2.2	Electrostatic phenomena		5.3.3	5.7.2, 5.4.1.3
3.	**Thermal hazards,** resulting in:			
3.1	Burns and other injuries by a possible contact of persons with objects or materials with an extreme high temperature, by flames or explosions and also by the radiation of heat sources.	Burners Environment of the IThE	5.4.1, 5.4.4	
3.2	Damage to health by hot working environment	Environment of the IThE	5.4.5, 6.4.15	
4	**Hazards caused by interruption of energy supply**			
4.1	malfunction or break up of components	Burner and accessories		5.2.2.3, 5.3.2.3, 5.4.3.2, 5.7.3
4.2	malfunction or break down of **control system**	Control system		5.7.3
4.3	unexpected start-up	Control system		5.2.5.3, 5.7.3
5	**Hazards caused by (temporary) missing and/or incorrectly positioned safety related measures/means**			
5.1	Specific hazard of maintenance and adjusting	burners, fans, piping, duct, control system		Clause 5
6	**Hazards generated by materials and substances processed or used by the machinery**			
6.1	Hazards from contact with or inhalation of harmful fluids, gases, mists, fumes, and dusts.	Exhaust gases evacuating system Combustion chamber		5.2.2.5, 5.2.2.6, 5.2.2.3 5.3.3, 5.4.4
6.2	Fire or explosion hazard	burners, fans, piping, duct, control system Combustion chamber	5.4.3.1, 5.4.3.2	5.2.1.7, 5.2.1.9, 5.2.1.10, 5.2.1.11, 5.2.2.3, 5.2.3.2, 5.2.4.1, 5.2.4.2, 5.2.5.2, 5.2.5.3, 5.2.6.1, 5.2.6.2, 5.2.6.3, 5.3.1.9, 5.3.1.3, 5.3.1.6, 5.4.1.2, 5.4.1.4, 5.4.1.5, 5.4.1.6, 5.5.2, 5.5.3, 5.5.5, 5.5.10 5.6, 6.2.3
7	**Hazards generated by neglecting ergonomic principles in machinery design,** as e. g. hazards from:			
7.1	Hazard of mismatch of design, location or identification of manual controls	Pipework Control system	5.12.2	5.2.2.1, 5.3.2.1, 5.4.3.1,

5 Safety requirements, measures and verification means

5.1 General

The safety goals of this European Standard shall include:

— choice of materials such that the construction and operation of the system are not detrimentally affected. In particular, all the components of the fuel pipework shall be capable of withstanding the mechanical, chemical and thermal loads to which they can be subjected during normal operation;

— reliable and correct time for ignition of the fuel/air-mixture at the burner(s);

— prevention of unintentional release of unburned fuels;

— shut-off fuel-supply in case of relevant fault;

— protection of pipeline by precluding the propagation of flame in reverse flow;

— prevent firing when the exhaust of combustion products is not ensured;

— prevent firing when the process conditions are not in the safe state.

Electrical circuits shall be designed in accordance with subclause 5.7 of EN 60204-1:2006.

The combustion and fuel handling for IThE shall comply with the safety requirements and/or protective measures of Clause 5.

Machinery shall comply with the safety requirements and/or protective measures of this clause. In addition, the machine shall be designed according to the principles of EN ISO 12100 for relevant but not significant hazards, which are not dealt with by this document.

NOTE For guidance in connection with risk reduction by design, see clause 4 of EN ISO 12100-2:2003, and for safeguarding measures see clause 5 of EN ISO 12100-2:2003.

5.2 Gaseous fuels

5.2.1 Gas pipework

5.2.1.1 General

The pipework design shall take into account the composition and properties (e.g. specific gravity) of the fuel gas and the need for venting, purging and cleaning.

The pipework material shall comply with the relevant standards.

For steel pipes, compliance with EN 10208-1 and EN 10208-2, EN 13480-2:2002 (Table A.3), or EN 10255 is considered appropriate. For copper pipes compliance with EN 1057 is considered appropriate. Copper Soldering connections shall not be used for gas carrying parts where the temperature is likely to exceed 100 °C.

Threaded pipe fittings shall comply with EN 10241 or EN 10242.

Metal is the preferred material for pipes and components but where appropriate and the same safety levels can be achieved then other materials can be utilized. Such materials and conditions of service shall be specified in the instructions for use.

Oscillations which may cause damage to pipework, components, safety systems shall be prevented (by firm anchoring and/or, use of flexible couplings).

5.2.1.2 Connections

Gas pipework connections shall be metallic and shall be of the threaded, compression, flanged, or welded types. Threaded connections shall be used only for the following pressure/diameter combinations:

— pressures up to 100 mbar, and diameters up to DN 80;

— pressures up to 2 bar, and diameters up to DN 50;

— pressures up to 5 bar, and diameters up to DN 25;

— pressures up to 10 bar, and diameters up to DN 15

For other combinations of pressures and diameters connections shall be by means of welded flanges or welded joints. The number of connections shall be kept to a minimum.

Where the equipment has a threaded connection, this thread shall comply with ISO 228-1 or ISO 7-1 as appropriate. In the case of threads according to ISO 228-1 the tightness shall be ensured by a ring gasket. Sealants for threads according to ISO 7-1 shall comply with EN 751, Part 1 or Part 2 as appropriate. Hemp shall not be used in threaded connections unless re-inforced with a suitable sealant.

Other threaded connections shall only be used providing they ensure tight connections and are suitably identified.

The design of pipework shall be such as to avoid tensile loading of the joints.

Compression fittings shall comply with EN ISO 8434-1 or EN ISO 19879. They shall only be used for pressures up to 5 bar and diameters up to 42 mm.

Any pipe passing through an unventilated space shall not have a connection except welded joints.

Flanges shall comply with ISO 7005, Parts 1 and 2 as appropriate.

Arc welding shall comply with EN ISO 5817, quality Level C.

5.2.1.3 Unconnected pipework

Any unconnected pipework shall be plugged, capped or blank flanged by means of metallic parts.

5.2.1.4 Galvanic cells

The formation of galvanic cells shall be avoided by suitable choice of materials.

5.2.1.5 Flexible tubing and couplings

Flexible tubing shall comply with the general requirements of 5.2.1.1, together with the following:

— shall be as short as possible;

— shall be suitable for the maximum and minimum working temperatures;

— shall be suitable for a pressure 1,5 times the working operating pressure (with a minimum of 150 mbar), at the maximum and minimum working temperatures;

— shall have a directly accessible, upstream shut-off valve;

— shall be mounted in such a way as to avoid distortion, whiplash and damage;

— shall have end fittings as integral parts of the tubing;

— shall be constructed from suitable material both metallic and/or non metallic selected for the application duty and not be easily damaged.

Couplings for removable equipment shall ensure a gastight connection with the equipment connected and disconnected.

5.2.1.6 Marking

The pipework shall be identified as gas pipework.

NOTE Identification of gas pipework is dealt with by national regulations.

5.2.1.7 Soundness

The gas pipework shall be tight and shall be designed to withstand the internal pressure.

The external leakage rate shall not give rise to a dangerous condition, flammable and/or toxic, in the foreseen circumstances of the equipment installation. The frequency of testing to determine the external leakage shall be specified in the instruction handbook.

NOTE It is generally agreed that an external leak rate of ~1dm3(n)/h will not give rise to a dangerous condition in typical ventilated industrial installations. The actual leak rate will depend upon the volume, number of connections, test gas, number of valves and component parts contained.

The external leak rate test method shall take into account the volume, number of connections, test gas, number of valves and component parts contained and temperature. Methods of testing shall include spray bubble leak identification and/or pressure decay test.

5.2.1.8 Condensate drains

In cases where condensates can create a hazard, means shall be provided at the lowest points of the equipment for draining any condensate. When moist gases are being used, condensate drains of a suitable type shall be installed. Any condensate drains, siphons, etc. shall be in a position such that they can be easily checked. Flammable condensates shall be collected by an appropriate means (e.g. piped into a container).

Valves in condensate drains shall be suitably plugged, capped or blank flanged by metallic parts.

5.2.1.9 Purge points

Means shall be provided to facilitate purging of the gas system during commissioning and maintenance to prevent the build up of flammable substances.

5.2.1.10 Blow-off and breather pipes or conduits

Where blow-off or breather pipes or conduits are fitted on regulators or relief valves or vent valves, adequate means shall be provided to facilitate the venting of gas from the system to a safe discharge area.

In case breathers or blow-off pipes are gathered, the cross section of the collector shall be suitable to evacuate simultaneously total flow rates of the exhaust sources.

5.2.1.11 Pressure relief devices and flame arrestors on pipework

For equipment designed for situations in which flash-backs can occur, flame arrestors and/or pressure relief devices shall be fitted.

Pressure relief devices shall be designed to yield at a pressure below the design pressure of the pipework and shall be positioned such that the discharge flow and the pressure relief device does not constitute a risk to the equipment, personnel or third parties.

A flash-back at least shall trigger an alarm. The required measures after a flash-back shall be described in the instruction for use.

5.2.1.12 Pressure oscillations

The gas pipework shall be designed so as to avoid the possibility of gas velocities and pressure fluctuations causing oscillations which could cause damage to pipework, components or safety systems (e.g. by designing the correct sizing of pipe, using pressure regulator).

5.2.1.13 Equipment supplied with different fuel gases

Where a burner is intended for use with more than one gaseous fuel, means shall be provided to ensure that the supply pipework of the gas not being fired is positively isolated.

5.2.1.14 By-pass

By-passes shall not be fitted in parallel with any item of safety equipment.

This requirement shall not apply to valve proving systems (EN 1643) nor to system leak tightness checks on automatic shut-off valves.

5.2.1.15 Isolation of required safety devices

Required safety devices (e.g. pressure switches, relief valves, ...) shall not be isolated from the equipment they protect during start-up or operation of the burner. In case isolating valves can not be avoided and are mounted between these required devices and the main lines, these isolating valves shall be locked in the open position during operation of the equipment by adequate means (e.g. manual lock, ...). Operation with the isolation valves not in the fully open position shall not be possible.

5.2.2 Required safety devices

5.2.2.1 Manual isolating valve

A manually operated isolation valve shall be fitted upstream of the first control device in the gas circuit. Manual isolation valves shall be so designed or positioned as to prevent inadvertent operation but shall be easily accessible and capable of rapid operation when required.

If technically applicable, only manual isolating valves complying with EN 331 shall be fitted. For valves outside the scope of EN 331, the safety requirements detailed in EN 331 shall be met at an equivalent level.

They shall be so designed that the "OPEN" and "CLOSED" positions are readily distinguishable (e.g. a 90° turn valve if applicable and available).

5.2.2.2 Filter/strainer

Special care shall be taken to prevent the ingress of particles, either from the pipework or from the gas, which would be detrimental to the operation of the equipment by the incorporation of a suitable filter or strainer immediately downstream of the first manual isolating valve of the IThE. Additional filters/strainers may be required (e.g. immediately upstream of the automatic shut-off valve).The filter and/or the strainer shall be positioned in such a way that periodic servicing remains easy.

In the event of the installation of a by-pass to the filter and/or the strainer, an identical filtering device shall be installed on the by-pass line.

Filter and/or the strainer shall be checked at intervals specified in the instruction handbook.

5.2.2.3 Automatic shut-off valves

5.2.2.3.1 General

Automatic shut-off valves shall be in accordance with the following subclauses of EN 161:2007:

— for general requirements: subclause 7.1

— for leak tightness: subclauses 7.2 and 7.3,

— for durability: subclause 7.8,

— for the closing function: subclause 7.9,

— for the closing force: subclause 7.10,

— for the closing time: subclause 7.12

— for the sealing force: subclause 7.13.

The automatic shut-off valve shall endure the intended cyclings in the IThE.

Valves construction and materials shall be suitable for the used gas composition.

Automatic shut-off valve shall be capable of withstanding back pressure and differential pressure under all process circumstances.

Low cycling applications intended to operate continuously for periods longer than 1 year shall have a redundant safety shut-off system at least comparable with the flow sheet given in Figure C.5 that allows testing the effective closure of the valves at least once a year.

High cycling applications (e.g. over 10 000 cycles/year, e.g. pulse firing, …) shall use only valves that are specified capable of an increased number of cycles. The instruction handbook shall specify the need to check valves for correct operation, the procedure to be adopted and the intervals at which this should be carried out.

5.2.2.3.2 Single burner equipment

The gas supply to the burner shall be under the control of two class A automatic shut-off valves of EN 161 in series in the gas pipework.

For natural draught burner with a controlled capacities below 70 kW there shall be at least two class B valves of EN 161.

A thermo-electric flame supervision device complying with EN 125 is acceptable for natural draught burners operating in open air with controlled capacities below 70 kW and for natural draft burners operating in combustion chamber with controlled capacities below 2,5 kW.

The automatic shut-off valves shall not open or shall shut off the fuel to the burner when the limit of any safety condition is reached. The following conditions shall be taken into account:

— minimum and maximum gas flow;

— minimum and maximum gas pressure;

— minimum and maximum air flow;

— minimum and maximum air pressure;

— failure of power supply and/or other utilities (e.g. compressed air, steam);

— failure of heat transfer fluid;

— fume extraction malfunction;

— maximum operation temperature of IThE;

— minimum and maximum combustion chamber pressure;

— flame failure;

— failure of system leak tightness check and/or valve proving system;

— incorrect air/gas ratio as referred in 5.2.3.3.

In these cases the automatic shut-off valves shall be de-energised by a protective system.

This function shall meet the requirements of the protective system according to 5.7.2 and 5.7.3.

NOTE In addition there may be processes and/or machine conditions that can cause a risk if the burner continues to fire. However these conditions are not covered by this standard.

It shall only be possible to manually reset the lock-out (see 3.48) of a closed automatic shut-off valve.

For typical examples of piping and components see informative Annex C.

5.2.2.3.3 Multiple burner equipment

The gas supply to each burner or group of burners shall be under the control of two class A automatic shut-off valves of EN 161 in series in the gas pipework.

For natural draught burner with a controlled capacities below 70 kW there shall be at least two class B valves of EN 161.

A thermo-electric flame supervision device complying with EN 125 is acceptable for natural draught burners operating in open air with controlled capacities below 70 kW and for natural draft burners operating in combustion chamber with controlled capacities below 2,5 kW.

For multiple burner installations, the individual burner shut-off valve shall be considered as one of the automatic shut-off valves specified above provided it is at least of the same class. For typical examples of piping see informative Annex C.

The automatic shut-off valve(s) shall not open or shall shut off the fuel to the entire IThE or independent zone when the limit of any safety condition is reached. The following condition shall be taken into account:

— minimum and maximum gas flow;

— minimum and maximum gas pressure;

— minimum and maximum air flow;

— minimum and maximum air pressure;

— failure of power supply and/or other utilities (e.g. compressed air, steam);

— failure of heat transfer fluid;

— fume extraction malfunction;

— maximum operation temperature of IThE;

— minimum and maximum combustion chamber pressure;

— flame failure;

— failure of system tightness check and/or valve proving system;

— incorrect air/gas ratio as referred in 5.2.3.3.

In these cases the relevant automatic shut-off valves shall be de-energised by a protective system.

This function shall meet the requirements of the protective system according to 5.7.2 and 5.7.3.

NOTE In addition there may be processes and/or machine conditions that cause a risk if the burner continues to fire. However these conditions are not covered by this standard.

It shall only be possible to manually reset the lock-out (see 3.48) of a closed automatic shut-off valve.

Flame failure or process control shut-down shall cause the closing of two automatic shut-off valves piped in series except in the following cases where single individual burner shut-off valve is sufficient:

— in case of high temperature equipment;

— in case of low temperature equipment providing the following conditions complied with:

  — a system leak tightness test to ensure that the individual burner automatic shut-off valves are closed is conducted at each start up of the IThE or other specific test period of the burner group and this shall not be less than once per week; and

  — dilution of gas leakage (at full burner capacity) of one valve is under 25 % of LFL, achieved by fresh air or flue gas considering all modes of operation (maximum power and part load of the heating system as well as variation of the LFL with furnace temperature).

For typical examples of piping and components see informative Annex C.

5.2.2.3.4 Valve proving system

Automatic shut-off valves controlling capacities greater than 1 200 kW shall be equipped with a valve proving system. If this is applicable, then the valve proving system shall comply with EN 1643 or give an equivalent level of safety.

The signal of a leaking valve from the valve proving system shall stop the current start-up when the test takes place during start up or prevent the next start-up when the test takes place after shut down.

This function shall meet the requirements of a protective system according to 5.7.2 and 5.7.3.

5.2.2.4 Gas pressure regulator

A gas pressure regulator shall be incorporated where this is necessary for control of the pressure and the flow rate.

Gas pressure regulators, when fitted, shall comply, with EN 88 or with EN 334 as appropriate.

If the outlet side of the gas pressure regulator and/or the following line section with equipment up to the burner is/are not designed for the maximum supply pressure (inlet upstream pressure to the gas pressure regulator under fault conditions) the following measures shall be applied shutting off the gas supply before an excessively high pressure occurs:

— an over pressure cut off device shall be applied upstream of the gas pressure regulator. This device shall comply with EN 14382;

— the over pressure cut off device shall be designed via an overpressure switch according EN 1854 combined with a safety shut-off valve of EN 161;

— if an over pressure cut-off device is installed a small capacity relief valve shall always be applied downstream of the gas pressure regulator to vent small leakages of the high pressure cut-off.

Pressure adjustment on the gas pressure regulator shall only be possible with a special tool provided for the task.

5.2.2.5 Air and gas flow and pressure detectors

5.2.2.5.1 Air

Equipment fitted with forced or induced draught burner(s) shall be fitted with devices 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 and, in the case of no operator supervision, shall cause a lockout.

This function shall meet the requirements of the protective system according to 5.7.2 and 5.7.3.

The air-proving device shall be checked in the 'no flow' state prior to start-up (e.g. by stopping the combustion air supply or by interrupting the air signal to the device(s) in such a way as to simulate stopping the combustion air supply). Failure to prove the device in the "no flow" condition shall prevent start-up.

Air flow shall be monitored:

— by pressure detectors or

— by flow detectors.

It has to be shown that any of these devices provide satisfactory and reliable proof of the flow for all operating conditions.

This requirement shall not apply to portable gas burners, work station burners and equipment-integrated burners with open flame, supervised continuously by trained operators, and having a maximum burner input rating below 70 kW.

Air pressure detectors shall comply with EN 1854.

5.2.2.5.2 Gas

5.2.2.5.2.1 Low gas protection

Low gas pressure protection to prevent insufficient gas flow shall be fitted.

The low gas pressure protection device has to provide satisfactory and reliable proof of the flow for all operation conditions.

The system shall prevent start-up or cause safety shut-down or, in the case of no operator supervision, lock-out (see 3.48) in the event of pressure falling below a pre-determined value.

This function shall meet the requirement of the protective system according to 5.7.2 and 5.7.3.

Gas pressure detectors shall comply with EN 1854.

5.2.2.5.2.2 High gas protection

High gas pressure protection to prevent excessive gas flow shall be fitted in all circumstances except when:

— the equipment supply pressure does not exceed 100 mbar; and

— the pressure drop across the gas pressure regulator is less than 30 % of the normal operating minimum outlet pressure; and

— regulator failure does not result in an unsafe start-gas rate being obtained; and

— the equipment capacity is below 600 kW.

Where high gas pressure protection is required, the system shall prevent start-up or cause safety shut-down or, in the case of no operator supervision, lock-out (see 3.52) in the event of a pre-determined pressure being exceeded.

This functions shall meet the requirement of the protective system according to 5.7.2 and 5.7.3.

Gas pressure detectors shall comply with EN 1854.

5.2.2.6 Flue gas venting

Flue gases shall be vented in a safe way.

IThE with a closed combustion chamber or combustion chamber with at least three surrounding walls shall be equipped with a flue system. The cross sectional area of the flue system shall be calculated according to volume, pressure and temperature of the flue gases (products of combustion, excess air and process emissions).

For IThE's equipped with natural draught burners the flue system shall be fitted with an appropriate draught break, above the height of the operator, or control damper (typical example of a draft break see informative Annex C, Figure C.6).

If the flue gases are extracted by a fan or the draught is controlled by a damper, the system shall be fitted with a safety device to effect a safety shut-down of the burner(s) or a switching over to a backup duct system in the event of a failure in the flue venting. This function shall meet the requirement of the protective system according to 5.7.2 and 5.7.3.

For all IThE equipment burners supplied without a flue system the combustion products shall be directed away from the workplace. The instructions for use shall refer to the need for sufficient venting to ensure the correct air quality for the operator.

NOTE 1 EN 525 gives useful information on maintaining the air quality in workshops.

NOTE 2 Local regulations may apply.

5.2.2.7 Ignition system

Where the gas for the pilot burner is taken from upstream of the gas pressure regulator to the main burner(s), the pilot burner shall be equipped with an appropriate gas pressure regulator complying with 5.2.2.4.

For safety requirements pilot burner(s) shall be treated as main burners and 5.2.2.1, 5.2.2.2, 5.2.2.3, 5.2.2.4 and 5.2.2.5 shall apply.

Any direct ignition device or combination of the ignition device and the pilot burner in automatic installations shall form an integral part of the main burner system.

In the case of installations for controlled manual operation, the ignition assembly shall be capable of being mounted on the main burner in one way only and in such a way that it occupies a fixed position with respect to the burner to be ignited.

The construction and location of a pilot burner shall be such that, under all operating conditions, the ignition flame remains stable and of such a shape that the main flame is ignited.

The ignition device shall be reliable and of sufficient capacity, so that immediate, low noise and smooth ignition is obtained.

Where use is made of a portable pilot burner or ignition device:

— the pilot burner or ignition device shall be capable of being fitted in one way only. If necessary the correct position shall be monitored;

— the connections for fuel, air and ignition energy shall be so designed that a reliable link-up is obtained, and errors of fitting of connections are avoided.

5.2.2.8 Individual manual shut-off valves for burners

For burners which are independently ignited, each individual burner shall be fitted with a manual shut-off valve.

The manual shut-off valve shall comply with EN 331. For valves outside the scope of EN 331, the safety requirements detailed in EN 331 shall be met at an equivalent level.

However if the installation of such a manual valve affects the mixing characteristics of mixing devices (e.g. venturi mixers), then the shut-off valve shall be installed upstream of any such device.

For multiple burners in which cross-ignition from burner to burner occurs by design the complete group of burners shall be fitted with at least one manual shut-off valve.

5.2.3 Combustion air and pre-purging the combustion chamber and flue passages

5.2.3.1 Combustion air system

The pipework to be designed shall take into account the properties of combustion air.

All manual control devices (registers, valves, etc.) for the air shall be set in their pre-determined positions and protected against inadvertent movement.

The location of the combustion air intake shall be such as to prevent entry of exhaust products, unless provided for by the design (e.g. for reduction of emission of nitrogen oxides (NO_X)).

The ventilation of IThE shall be such as to allow an adequate supply of process air and combustion air to reach the burner(s) under all conditions.

NOTE Attention should be paid to sufficient air supply to the IThE. For many application it is recommended to install an air inlet filter with filter monitoring to achieve reliable operation of the installation.

The combustion air system shall be designed in a manner that prevents the back-flow of furnace atmosphere through combustion equipment.

The air circuit shall be designed so as to avoid oscillations that may lead to material defects.

5.2.3.2 Pre-purging of the combustion chamber

Except where specified below, start up or re-start after a lock-out (see 3.48) shall not be initiated until adequate steps have been taken to ensure that no combustible mixture is present in the combustion/processing chamber, connected spaces and flue products evacuation circuit (heat exchangers, dust extractors). This condition shall be achieved by means of a period of pre-purging immediately prior to ignition or within a time to be specified in the instruction handbook.

The pre-purge time shall be such as to ensure that the concentration of any combustible products in any part of the combustion chamber/connected spaces and flue duct is below 25 % of the LFL of the fuel gas; this being calculated with the combustion chamber/connected spaces and the flue duct assumed as being initially filled up with flammable gases.

In general, five complete air changes of the combustion chamber/connected spaces and flue duct will suffice. The air flow rate used for a pre-purge shall be at least 25 % of the maximum combustion air flow rate. In the case of natural draught, the condition to achieve the above requirements shall be defined in the instruction handbook.

Inert or non flammable gases shall be used instead of air if required by the equipment or process. Other methods of ensuring that the combustion chamber and connected spaces do not contain flammable gases can be utilized providing that the equivalent level of safety is achieved.

The pre-purge time and purge procedure and or methodology shall be specified in the instruction handbook.

The system for ensuring correct pre-purge time and the airflow shall meet the requirements of a protective system according to 5.7.2 and 5.7.3.

In the following cases the pre-purge shall be omitted:

a) in applications where the presence of free oxygen can be a risk (e.g. flammable atmosphere) or shall affect the equipment (e.g. graphite crucible) or the product quality; additional precautions shall be taken to prevent gas leakage across the automatic shut-off valves by using two class A valves of EN 161 and a valve proving system;

b) when the combustion chamber is proved to be at a temperature above 750 °C (as defined for high temperature equipment);

c) when re-cycling a burner after shutdown for control purposes, pre-purging is not required in the following different cases:

   — where the burner is fitted with an independently supervised permanent or alternating pilot;

   — where the burner is fitted with two class A valves of EN 161, that close simultaneously and are equipped with a valve proving system. The valve proving system is not required for pulse fired burners;

   — with pulse fired burners if the burner shut-off valve is certified by the supplier to be suitable for the increased number of cycles typical of pulse firing;

   — in multiple burner systems when one or more burners remain alight provided that not more than one burner is extinguished due to flame failure;

   — when the combustion chamber is proved to be at a temperature above 750 °C (as defined for high temperature equipment) at any point where a flammable mixture coming from the burner(s) will ignite without delay;

d) in the case where one burner of a group of radiant tube burners has been locked-out maximum of one re-start is permitted before lock-out (see 3.48) after a flame failure, if:

— each burner has an automatic burner control system; and

— the ignitable fuel-air-mixture inside the exhaust system is below 25 % of the LFL or the radiant tube, the burner and the connection to the exhaust are designed for the maximum pressure increase that is possible during ignition; and

— the gas supply to each radiant tube burner is equipped with automatic shut-off valve class A of EN 161.

5.2.3.3 Air/gas fuel ratio

The air mass flow rate shall always be in a ratio with the gas mass flow in order to ensure safe ignition and that throughout the operating range, a stable and safe combustion is maintained at each individual burner. The ratio needs not be the same value at all operational conditions.

The design of the air/gas ratio control has to consider process conditions as well as fuel and combustion air properties. Defect or malfunction should effect that the system will tend towards higher excess air or proceed to lockout if the air/gas ratio results in an unsafe condition.

Pneumatic gas/air ratio controls shall comply with EN 12067-1 or EN 12078 if applicable.

Electronic gas/air ratio controls shall comply with EN 12067-2 if applicable.

To ensure their reliability, air/gas ratio controllers shall be used in conditions (temperature, pressure, flow rate) for which they have been designed. These conditions and instructions for maintenance shall be specified in the instruction handbook.

In case other methods/technologies are used for the ratio control and depending on the combustion air and fuel gas properties, additional protective measures shall be required (e.g. in case of frequency control of the combustion air blower, preheated combustion air, variable Wobbe index of the gas). The air/gas ratio control function shall meet the requirement of the protective system according to 5.7.2 and 5.7.3.

NOTE The combination of any ratio control (pneumatic or other) in combination with a flame supervision system that detects all possible incorrect ratios is generally considered to be sufficient protection.

5.2.4 Supply of pre-mixed fuel gas/air

5.2.4.1 Mixture pipework

The mixture pipework volume shall be as small as possible. The system shall be designed so as to provide a sufficiently high mixture flow velocity such that flame propagation upstream cannot occur, or shall be fitted with a flame trap/arrestor or pressure relief devices.

Alternatively, the system shall be fitted with a sensor which causes lock-out in the event of the flow velocity falling below a pre-determined limit or a temperature sensor which causes lock-out in the event of flash-back (see 3.48).

These devices are not required for burners where the manufacturer can demonstrate that flash-back cannot occur in any circumstances (e.g. pilot burners with their own mixing devices).

5.2.4.2 Air and gas supply to the mixture circuit

The presence of fuel gas/air mixture in the pipework supplying either fuel gas or air to the mixing device, whether due to reverse flow of the mixture, ingress to either feed or to internal leakage, shall be prevented.

If a non-return valve is used for this purpose and if it is not resistant to flashback, then an additional high gas pressure switch located downstream of this non-return valve shall be incorporated to shut off the flow of fuel gas to the equipment by means of the relevant automatic shut-off valves specified in 5.2.2.3 in the event of a flame flashback.

A flash-back shall trigger an alarm. The required measures after a flash-back shall be described in the instruction for use.

5.2.5 Burners

5.2.5.1 Main burners

All burners shall be suitable for the working conditions and shall provide operating safety for:

— the fuels used (type, pressure, etc.);

— the operating conditions (pressure, temperature, atmosphere, etc.);

— the nominal input rate and range of regulation (maximum and minimum capacity);

— ease of visual monitoring (sight glasses, sight holes, etc.).

5.2.5.2 Radiant tube burner system

Radiant tubes burner system shall be suitable and allow safe operation.

Radiant tube burner systems shall be designed in accordance with the requirements for a protective system in accordance with 5.7.2 and 5.7.3.

They shall:

— be constructed of suitable materials for the thermal input rate, temperature and furnace atmosphere;

— minimise the probability of combustion products having contact with the furnace atmosphere;

— shall be equipped with an automatic burner control system according to 5.2.6. At temperatures above 750 °C no automatic burner control system is needed if a safe ignition of the air/gas mixture can take place. The temperature limit of 750 °C shall be detected at the coldest point;

— if additional burners are required to operate the IThE processes above 750 °C and an automatic burner control systems is not required then they shall be isolated from the supply by automatic shut-off valves that are controlled in accordance with the requirements of a protective system (according to 5.7.2 and 5.7.3) that will not permit fuel to flow until the temperature at the ignition point within the radiant tube is above 750 °C.

Because the ignition point is inside the radiant tube and the temperature inside the tube may well be much lower than in the chamber in which the radiant tube is placed this temperature difference shall be taken into consideration when designing.

5.2.5.3 Start-up and ignition

5.2.5.3.1 Start-up

Start-up of the fuel supply and burner(s) shall be possible only when:

a) the installed air and fuel gas proving devices (e.g. air flow, gas pressure, system leak tightness check) have been checked to ensure that they are in the correct operating condition for start-up;

b) all relevant interlocks (e.g. burner(s) position, valve(s) position, flue damper(s)) have been proved to be in the correct position.

5.2.5.3.2 Start fuel flow rate

The energy released during the start-up of the burner(s) shall be limited so that the maximum pressure rise from ignition shall not cause any damage to the IThE (see Table 3).

The start fuel flow rate shall be controlled by a protective system according to 5.7.2 and 5.7.3.

Where the burner is ignited manually (e.g. by means of a lighting torch) and has a burner input rate in excess of 70 kW, it shall be equipped with a means of limiting the start-up gas.

5.2.5.3.3 Ignition

The ignition process shall be initiated immediately or within a time to be specified in the instruction handbook after the conclusion of the pre-purging stage.

Where the main burner is ignited by means of a pilot burner, the gas supply to the main burner shall be shut off during the pre-purge and ignition of the pilot burner. The automatic shut-off valve(s) of the main burner shall open only when the pilot burner flame has been proved.

NOTE Where air enriched with oxygen or oxygen alone is the oxidising agent for the combustion of a gas, (commonly called oxy/fuel firing), then the ignition procedures and times for such systems may require specific additional design attention to ensure the equivalent levels of safety.

5.2.5.3.4 Safety time

5.2.5.3.4.1 General

The safety time and total closing time shall not vary by more than 20 % when the electrical supply voltage is varied between 85 % and 110 % of the nominal value.

5.2.5.3.4.2 Maximum safety times for natural draught burners

The safety time and total closing time for natural draught burners shall not exceed the values given in Tables 1 and 2.

Table 1 — Maximum safety times for natural draught burners operating in open air

Burner input rate kW	Safety time s	Total closing time s
1) Thermoelectric flame supervision device (EN 125)		
up to and including 70	60	45
2) Flame supervision device other than thermoelectric (EN 298)		
up to and including 70 above 70 up to and including 360 above 360 *[a]	10 10 5	10 3 3
*[a] Ignition at a rate of 33 % of the burner input rating with a maximum of 350 kW.		

Table 2 — Maximum safety times for natural draught burners operating in combustion chamber

Burner input rate kW	Safety time s	Total closing time s
1) Thermoelectric flame supervision device (EN 125)		
up to and including 2,5	60	45
2) Flame supervision device other than thermoelectric (EN 298)		
up to and including 70	10	10
above 70 up to and including 360	10	3
above 360 *[a]	5	3
*[a] Ignition at a rate of 33 % of the burner input rating with a maximum of 350 kW.		

5.2.5.3.4.3 Maximum safety times for forced and induced draught burners

The maximum start gas rate and the corresponding safety time for forced and induced draught burners shall not exceed the values given in Table 3.

The total closing time shall not exceed 3 s.

Burner start-up shall be achieved in accordance with one of the following methods:

— direct ignition of the main burner at full rate (see Table 3, Column 2); or

— direct ignition of the main burner at reduced rate e.g. by using slow opening valve; (see Table 3, Column 3); or

— direct ignition of the main burner at reduced rate with by-pass start gas supply to a separate gas inlet of the burner or two step safety valve; (see Table 3, Column 4); or

— ignition of the main burner by means of an independent pilot burner; (see Table 3, Column 5).

For methods of burner start-up see Annex D.

Higher start gas rates than those specified in Table 3 may be achieved at the end of the safety time provided that it is proved that the total amount of energy released in the combustion chamber during the safety time is not greater than the energy release calculated by multiplying the values of maximum start gas heat input and safety time given by Table 3.

Table 3 — Maximum safety times for forced and induced draught burners

<table>
<tr><td>1</td><td>2</td><td>3</td><td colspan="2">4</td><td colspan="2">5</td></tr>
<tr><td rowspan="2">\</td><td rowspan="2">Direct main burner ignition at full rate</td><td rowspan="2">Direct main burner ignition at reduced rate with slow opening valves</td><td colspan="2" rowspan="2">Direct main burner ignition at reduced rate with by-pass start gas supply</td><td colspan="2">Main burner ignition with independent pilot burner</td></tr>
<tr><td>Pilot burner ignition ($Q_{ST} \le 0{,}1 * Q_{F\,max}$)</td><td>Main burner ignition</td></tr>
<tr><td>Rate $Q_{F\,max}$</td><td>Safety time t_s</td><td>Safety time t_s</td><td>Rate Q_{ST}</td><td>Safety time t_s</td><td>First safety time t_{s1}</td><td>Second safety time t_{s2}</td></tr>
<tr><td>kW</td><td>s</td><td>s</td><td>kW</td><td>s</td><td>s</td><td>s</td></tr>
<tr><td>≤ 70</td><td>5</td><td>5</td><td>≤ 70</td><td>5</td><td>5</td><td>5</td></tr>
<tr><td rowspan="2">> 70
≤ 120</td><td rowspan="2">3</td><td rowspan="2">3</td><td>≤ 70</td><td>5</td><td rowspan="2">5</td><td rowspan="2">3</td></tr>
<tr><td>> 70
≤ 120</td><td>3</td></tr>
<tr><td rowspan="3">> 120
≤ 360</td><td rowspan="3">not allowed except as described below</td><td rowspan="3">3</td><td>≤ 70</td><td>5</td><td rowspan="3">5</td><td rowspan="3">3
with slow opening valves
or
$t_s * Q_s < 150$ (max. $t_s = 3$ s)</td></tr>
<tr><td>> 70
≤ 120</td><td>3</td></tr>
<tr><td>> 120
≤ 360</td><td>not allowed</td></tr>
<tr><td rowspan="2">> 360</td><td rowspan="2">not allowed</td><td rowspan="2">not allowed</td><td colspan="2" rowspan="2">Q_{ST} = 120 kW or $t_s * Q_s < 100$ (max. $t_s = 3$ s)</td><td>5 ($Q_{ST} \le 70$KW)</td><td rowspan="2">Q_{ST} = 180 kW or $t_s * Q_s < 150$ (max. $t_s = 3$ s)</td></tr>
<tr><td>3 ($Q_{ST} > 70$KW)</td></tr>
<tr><td colspan="7">$Q_{F\,max}$ = maximum main burner input rate in kilowatts
Q_{ST} = start input rate in kilowatts
Q_s = maximum start input rate expressed as a percentage of $Q_{F\,max}$ ($Q_s = Q_{ST} / Q_{F\,max}$)
t_s = safety time in seconds</td></tr>
</table>

Only if required for process reasons or special cases of equipment construction and if the above mentioned ignition safety times cannot be used the function and values of the ignition safety time shall differ from those given in Table 3 provided the safety of the IThE is not endangered. In this case, the ignition safety times shall not exceed the values:

$$t_s < P_v / (B_v \times 1{,}7 \times Q_s)$$ 2)

where

t_s is the safety time in s;

B_v is the combustion chamber full load (MW/m^3), with a minimum of 0,015 MW/m^3;

Q_s is the maximum start gas heat input expressed as a percentage of $Q_{F\,max}$: ($0 < Q_S < 100$);

P_v is the allowable combustion chamber pressure (mbar) minus combustion chamber back pressure during ignition (mbar).

Where for process reasons, burners with a nominal input exceeding 120 kW are ignited directly at full rate or burners with a nominal input exceeding 360 kW are ignited directly, at reduced rate using slow opening valves

2) This formula is typical for natural gas, LPG and comparable fuels (e.g. not for fuels containing high amounts of hydrogen) firing with cold combustion air with 21 % Oxygen content.

the combustion chamber/process chamber, flue ways and pipework shall be designed to take account of the maximum pressure rise.

In any case, the safety time and total closing time shall not exceed 10 s. In the case of long cross-ignited burners, an extension of the safety time of 1,5 s/m of burner length, with a maximum of 10 s is acceptable providing the flame is monitored at the end of the burner remote from the source of ignition and safe ignition always takes place.

5.2.5.3.5 Flame failure

5.2.5.3.5.1 Flame failure on start-up

In the event that flame failure occurs during the safety time, the burner shall go to lock-out (see 3.48).

However, re-cycling is acceptable providing equipment safety is not compromised. The number of re-cycles shall not exceed 2. The control of the re-cycle(s) shall be designed in accordance with the requirements for a protective system according to 5.7.2 and 5.7.3. If there is no flame signal at the end of these re-cycles, the failing burner shall go to lock-out (see 3.48). The conditions of and the time period between recycle and the number of re-cycles shall be specified in the instruction handbook.

For pulse firing burners, flame failure of a single burner shall cause safety shut-down instead of lock-out. Three consecutive flame failures shall cause lock-out. The total number of burners subject to this provision shall be limited to comply with 5.2.5.3.1 (see 3.48). The number of burners shall be specified in the instruction handbook.

5.2.5.3.5.2 Flame failure during operation

In the event of flame failure during operation the burner shall go to lock-out (see 3.48).

However, in certain cases, safety shut-down is acceptable providing equipment safety is not compromised. Not more than one re-cycle shall be permitted, the conditions for which shall be specified in the instruction handbook. If there is not a flame signal at the end of this re-cycle, the failing burner shall go to lock-out (see 3.48)

The IThE shall be designed such that a recycle of a single burner system requires a complete recycle including pre-purge.

5.2.5.4 Burner capacity control

In any combustion system, the turndown ratio shall be such that the burner(s) is/are fully stable at all firing conditions.

5.2.5.5 Permanent pilots

Where used in the case of main burners supplied with gas or combustible vapours with uncertain combustion characteristics, e.g. varying calorific value, permanent pilots shall be independently supplied with a clean fuel gas of constant quality and be fitted with automatic burner control systems.

5.2.6 Automatic burner control systems

5.2.6.1 General

The main flame and, if applicable, the pilot burner flame, shall be supervised by means of an automatic burner control system. Exceptions are only permitted when equipment safety is not compromised (e.g. see 5.2.6.2 and 5.2.6.3).

Automatic burner control systems shall comply with EN 298 or EN 125, if technically applicable. If necessary for process reasons, the characteristics of the system shall differ from the requirements specified in EN 298 or EN 125 providing the levels of safety and reliability are not reduced.

For systems where the pilot burner remains in use during main burner operation, separate flame detector device to supervise the pilot and main flames shall be fitted. The main flame detector device shall be so positioned that it cannot in any circumstances detect the pilot flame. In the case that the pilot burner ignites under all circumstances the main flame, it is sufficient to supervise only the pilot flame providing the flow rate of that pilot burner is checked by a protective System according to 5.7.2 and 5.7.3 (e.g. minimum gas pressure switch).

Where the pilot burner and the main burner are each provided with their own flame detector device the ignition flame shall not influence the response of the main flame sensor.

For systems where the pilot flame is extinguished during main burner operation a single flame detector device may suffice.

Where fitted, flame sensors shall be unresponsive to unintended radiation.

Where a burner is required to fire continuously for periods in excess of 24 h, the automatic burner control system shall be designed for permanent operation.

The detection of a flame when there should not be a flame or a defect of the automatic burner control system or the protective system (according to 5.7.2 and 5.7.3) shall result into lock-out (see 3.48).

Where manual checking of the automatic burner control system is carried out, the instruction handbook shall specify the procedures to be followed in the event of a malfunction.

5.2.6.2 Low temperature equipment

Low temperature equipment fitted with a single burner shall be equipped with an automatic burner control system in accordance with 5.2.6.1.

For low temperature multiple burner equipment, each burner shall be equipped with an automatic burner control system.

Only one of the burners need be equipped with an automatic burner control system operating continuously provided that the burners guarantee stable combustion throughout the range of regulation, are on the same air/gas ratio control system and are arranged adjacent and in such a way that, if one of them is extinguished, it is re-ignited quickly and smoothly by the flame from the next burner. This procedure shall not apply to burners controlled by "on/off" systems.

5.2.6.3 High temperature equipment

Flame supervision, either by means of a automatic burner control system or by the operator, shall be provided during the start-up period when the processing chamber wall temperature is below 750 °C.

Any automatic burner control system shall comply with the requirements of 5.2.6.1.

Automatic burner control systems shall not be substituted by operator supervision unless the operator is capable of taking immediate corrective actions during the heat-up phase. The supervision procedure shall be specified in the instruction handbook.

If the design and construction of the IThE is such that, in the event of flame failure, the temperature of the processing chamber walls is likely to fall below 750 °C within 1 h, then an acoustical and visual alarm shall be fitted. The required measures after a flash-back shall be described in the instruction for use.

If automatic switchover is used, a temperature not less than 750 °C shall be used for the switching point. This function shall be designed in accordance with the requirements for protective systems according to 5.7.2 and 5.7.3.

NOTE For radiant tube burner systems additional information is given in 5.2.5.2.

5.2.6.4 Automatic burner control systems for burners operating in the open air

Each burner firing in the open air with a rated heat input greater than 70 kW shall be fitted with an automatic burner control system complying, if technically applicable, with EN 298 or EN 125.

Where the burner heat input rating is 70 kW or less, the flame may be supervised by the operator, provided that the flame is visible from his workplace.

If the flame cannot be observed continuously from the workplace, an automatic burner control system complying, if technically applicable, with EN 298 or EN 125 shall be provided.

Where an installation is equipped with several burners other than ON/OFF burners, no automatic burner control system is required if the burners are arranged in a configuration in which the flame of an operating burner will reliably crosslight another burner in the event of flame extinction. However, in this case at least one burner shall be equipped with spark restoration or a supervised permanent pilot designed so that a failure of the permanent pilot or the spark restoration system leads to safety shut-down of all the burners.

If required for, and allowed by, production operations, the flame supervision function shall be integrated into a control other than a standard automatic burner control system, if such a control is capable of triggering an automatic shut-down. Any such device shall be designed to generate an alarm in the event of a safety shut-down. The required measures after a flash-back shall be described in the instruction for use.

If necessary for process reasons (e.g. load damaged due to lock-out (see 3.48)), and where the single burner capacity is below 100 kW, the lock-out function integrated into a multiple burner installation may be replaced by an acoustic and a visual alarm providing the operator can react in a time to be specified in instruction for use.

5.3 Liquid fuels

5.3.1 Liquid fuel pipework

5.3.1.1 General

The pipework design shall take into account the composition and properties of the liquid fuel and the need for venting, purging and cleaning.

The pipework material shall comply with the relevant standards.

NOTE For steel pipes e.g. EN 10208-1 and EN 10208-2, EN 10216-1, EN 10217-1 or EN 10220 as appropriate and for copper pipes with EN 1057 allowing connections according to 5.3.1.2.

Metal is the preferred material for pipes and components but where appropriate and when the same safety levels can be achieved then other materials can be utilized. Such materials and conditions of service shall be specified in the instructions for use.

Oscillations which could cause damage to the pipework, components, safety systems shall be prevented (e.g. by firm anchoring, use of flexible coupling).

Where excessive pressure can occur in the pipework due to thermal expansion of the liquid fuel, means of pressure relief shall be provided.

5.3.1.2 Connections

Liquid fuel pipework connections shall be of the threaded, compression, flanged or welded types. Other types of connections, such as couplings for removable equipment, shall ensure a liquid tight connection with the equipment connected and disconnected. Threaded connections shall be used only for the following combinations:

— pressures up to 10 bar;

— temperatures up to 130°C;

— diameters up to DN 25.

Threaded connections shall be used for higher pressures and temperatures where the connection is specifically designed to operate under those conditions without creating a risk. In this case the connection ratings for pressure and temperature will be specified in the manual.

Compression connections shall be used comply to EN ISO 8434-1, ISO 8434-2, ISO 8434-3, EN ISO 8434-4 and EN ISO 19879 only for the following combinations:

— pressures up to 40 bar;

— diameters up to DN 32.

For other combinations of pressures and diameters connections shall be by means of welded flanges or welded joints. The number of connections shall be kept to a minimum.

Where the equipment has a threaded connection, this thread shall comply with ISO 228-1 or ISO 7-1 as appropriate. In the case of parallel threads care shall be taken to ensure an adequate seal.

Other threaded connections shall be used providing they ensure tight connections and are suitably identified.

The design of pipework shall be such as to avoid tensile loading of the joints.

Sealants used shall comply with EN 751, Part 1 or Part 2, as appropriate.

Hemp shall not be used in threaded connections unless re-inforced with a suitable sealant.

Solder with a melting point below 450 °C and adhesives shall not be used.

Any pipe passing through an unventilated space shall not have a connection except welded joints.

Flanges shall comply with ISO 7005, Parts 1, 2 and 3, as appropriate.

Arc welding shall comply with EN ISO 5817, quality level C.

Special requirements for **liquefied petroleum gas** in the liquid phase shall be considered.

5.3.1.3 Unconnected pipework

Any unconnected live pipework shall be plugged, capped or blank flanged by means of metallic parts.

5.3.1.4 Flexible tubing

Flexible tubing shall comply with the general requirements of 5.3.1.1, together with the following:

— shall be as short as possible;

— shall be suitable for the maximum and minimum operating temperatures;

— shall be suitable for a pressure 1,5 times the maximum operating pressure (with a minimum of 1 bar), at the maximum and minimum operating temperatures;

— shall have a directly accessible, upstream manual shut-off valve;

— shall be mounted in such a way as to avoid distortion, whiplash and damage;

— shall have end fittings as integral parts of the tubing;

— shall be constructed from suitable material both metallic and/or non metallic selected for the application duty and not be easily damaged.

5.3.1.5 Marking

The pipework shall be identified with respect to the liquid fuel being carried.

5.3.1.6 Soundness

The liquid fuel pipework shall be leak tested for tightness and ability to withstand the internal pressure.

After assembly, the liquid fuel circuit shall be submitted to its test pressure and tested for tightness. The test pressure shall be not less than 1,5 times the maximum working pressure at any point.

Suitable methods for checking the leak tightness are e.g. visible leak, pressure decay monitoring, etc. Instructions concerning the methods and frequency of testing shall be specified in the instruction handbook (see 7.3).

In addition to the pressure test on the pipework, all the pressure relief valves shall be tested to ensure their operation at the correct pressure.

The external leakage rate shall not give rise to a dangerous condition, flammable and/or toxic, in the foreseen circumstances of the equipment installation. The frequency of testing to determine the external leakage shall be specifed in the instruction handbook.

5.3.1.7 Fuel pipe heating

Where the liquid fuel pipe needs to be heated and insulated to maintain the required temperature, safeguards shall be provided to prevent the temperature and/or pressure of the fuel exceeding the maximum design values.

The trace heating system shall include all equipment, such as regulating and shut-off mechanisms. In the case of vapour or liquid heating, the heating system shall be provided with suitable condensate outlets and shut-off valves.

5.3.1.8 By-passes

By-passes shall not be fitted in parallel with any automatic shut-off valve except where the by-pass is a stand-by system equipped with a automatic shut-off valve of the same class as that being by-passed.

5.3.1.9 Purge points

Means shall be provided to purge gases safely from the liquid fuel system. The venting of the purge gases shall take into account, in particular:

— risk of combustion;

— avoidance of recirculation into the combustion chamber;

— avoidance of introduction into drains and pits;

— specific gravity of the gas.

5.3.1.10 Equipment supplied with different liquid fuels

Where a burner is intended for use on more than one liquid fuel, means shall be provided to ensure that the supply pipe of the fuel not being fired is positively isolated (e.g. by physical blank or disconnection).

5.3.2 Required safety devices

5.3.2.1 Manual isolating valve

A manually operated isolation valve shall be fitted upstream of the first control device in the liquid fuel circuit. Manual isolation valves shall be so designed or positioned as to prevent inadvertent operation but shall be easily accessible and capable of rapid operation when required.

They shall be so designed that the "OPEN" and "CLOSED" positions are readily distinguishable (e.g. a 90° turn valve if applicable and available).

5.3.2.2 Filter/strainer

Special care shall be taken to prevent the ingress of particles, either from the pipework or from the liquid fuel, which would be detrimental to the operation of the equipment by the incorporation of a suitable filter or strainer immediately downstream of the first manual isolating valve of the IThE. Additional filters/strainers shall be required (e.g. immediately upstream of the automatic shut-off valve). The filter and/or the strainer shall be positioned in such a way that periodic servicing can be carried out easily.

In the event of the installation of a by-pass to the filter and/or the strainer, an identical filtering device shall be installed on the by-pass line.

Filter and/or the strainer shall be checked at intervals specified in the instruction handbook.

5.3.2.3 Automatic shut-off valves

The liquid fuel distribution circuit shall be under the control of automatic shut-off valves. Automatic shut-off valves shall comply with EN 264.

In the event of damage, failure of the electricity supply or actuating fluid, the automatic shut-off valves shall shut off the fuel supply to the burner(s).

Automatic shut-off valve shall be capable of withstanding backpressure and differential pressure under all process circumstances.

Low cycling applications intended to operate continuously for periods longer than 1 year shall have a redundant safety shut-off system that allows testing the effective closure of the valves at least once a year.

High cycling applications (e.g. over 10 000 cycles/year, e.g. pulse firing, …) shall use only valves that are specified capable of an increased number of cycles. The valves shall be checked at intervals specified in the instruction handbook.

Where the initial boiling point of the liquid fuel is less than 200 °C or the viscosity at 20 °C is less than 6 mm^2/s and where the burner input rating is greater than 1 200 kW, two automatic shut-off valves shall be installed in series.

Single shut-off valve controlling more than 1 200 kW shall be fitted with a proof of closure device to create an alarm. The required measures after a flash-back shall be described in the instruction for use. in event of failure to close. Where proof of closure is not possible two automatic shut-off valves shall be installed in series.

Where the automatic shut-off valves are closed and lock-out (see 3.48) has occurred, they shall be only manual reset.

The automatic shut-off valves shall not open or shall shut off the fuel to the burner when the limit of any safety condition is reached. The following conditions shall be taken into account:

— minimum and maximum liquid fuel flow;

— minimum and maximum liquid fuel pressure;

— liquid fuel temperature outside a safe operating range;

— minimum and maximum air flow;

— atomizing fluid pressure outside a safe operating range;

— failure of power supply and/or other utilities (e.g. compressed air, steam);

— failure of heat transfer fluid;

— fume extraction malfunction;

— maximum operation temperature of IThE;

— flame failure.

In these cases the automatic shut-off valves shall be de-energised by a protective system according to 5.7.2 and 5.7.3.

NOTE There may be processes and/or machine conditions that can cause a risk if the burner continues to fire. However these conditions are not covered by this standard.

5.3.2.4 Pressure relief valve

Where required, the fuel circuit shall be fitted with calibrated pressure relief valves.

5.3.2.5 Liquid fuel pressure regulator

A liquid fuel pressure regulator shall be incorporated where this is necessary for control of the flow rate.

5.3.2.6 Pressure regulation of auxiliary fluids

For auxiliary fluids (compressed air, steam, ...), automatically operated pressure regulators shall be installed where this is necessary for control of the burner system.

5.3.2.7 Combustion air, liquid fuel, atomizing and control fluid flow and pressure detectors

5.3.2.7.1 Combustion Air

Equipment fitted with forced or induced draught burner(s) shall be fitted with devices 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 and, in the case of no operator supervision, shall cause a lock-out.

This function shall meet the requirements of the protective system according to 5.7.2 and 5.7.3.

The air-proving device shall be checked in the 'no flow' state prior to start-up (e.g. by stopping the combustion air supply or by interrupting the air signal to the device(s) in such a way as to simulate stopping the combustion air supply). Failure to prove the device in the "no flow" condition shall prevent start-up.

Air flow shall be monitored:

— by pressure detectors; or

— by a flow detectors.

It has to be shown that any of these devices provide satisfactory and reliable proof of the flow for all operating conditions.

Air pressure detectors shall comply with EN 1854.

5.3.2.7.2 Liquid fuel

5.3.2.7.2.1 Liquid fuel pressure

High and Low fuel pressure detectors shall be fitted in the case of all Low Temperature applications where operation within preset pressure limits is essential in ensuring the correct flow and atomising conditions. Deviation outside of these limits shall prevent start-up or cause safety shut-down.

This function shall meet the requirements of a protective system according to 5.7.2 and 5.7.3.

5.3.2.7.2.2 Liquid fuel temperature

High and Low fuel temperature detectors shall be fitted in the case of all Low Temperature applications where operation within preset pressure limits is essential in ensuring the correct flow and atomising conditions. Deviation outside of these limits shall prevent start-up or cause safety shut-down.

This function shall meet the requirements of a protective system according to 5.7.2 and 5.7.3.

5.3.2.8 Individual manual shut-off valves for multiple burners

For multiple burners which are independently ignited, each individual burner shall be fitted with a manual shut-off valve.

If fitted, the operation of the manual shut-off valve(s) shall not adversely affect the safety of the system e.g. the atomizing fluid valve shall be proven open prior to the introduction of liquid fuel.

5.3.2.9 Automatic shut-off valves for multiple burners

Where individual burners are equipped with automatic shut-off valves, such valves shall comply with EN 264, if technically applicable, and their operation shall not adversely affect the safe operation of the remaining burners.

Where 5.3.2.3 requires two automatic shut-off valves it is permissible for an individual burner to be shut down by a single automatic shut-off valve in the event of flame failure or for process reasons (e.g. thermal input) providing it is a high temperature application.

5.3.2.10 Flue gas venting

Flue gases shall be vented in a safe way.

IThE with a closed combustion chamber or combustion chamber with at least three surrounding walls shall be equipped with a flue system. The cross sectional area of the flue system has to be calculated according to the volume, the pressure and the temperature of the flue gases (products of combustion, excess air and process emissions).

If the flue gases are extracted by a fan or the draught is controlled by a damper, the system shall be fitted with a safety device to effect a safety shut-down of the burner(s) or a switching over to a backup duct system in the event of a failure in the flue venting. This function shall be part of the protective system according to 5.7.2 and 5.7.3.

For all IThE equipment burners supplied without a flue system, to remove the combustion products from the workplace, then the instructions for use will refer to the need for sufficient venting to ensure the correct air quality for the operator e.g. EN 525:2009, Table 2, air quality standard minimums, local codes could apply.

5.3.2.11 Ignition system

For safety requirements pilot burner(s) shall be treated as main burners and 5.3.2.1, 5.3.2.2, 5.3.2.3 and 5.3.2.4 shall apply.

Any direct ignition device or combination of the ignition device and the pilot burner in automatic installations shall form an integral part of the main burner system.

In the case of installations for controlled manual operation, the ignition assembly shall be capable of being mounted on the main burner in one way only and in such a way that it occupies a fixed position with respect to the burner to be ignited.

The construction and location of any pilot burner shall be such that, under all operating conditions, the ignition flame remains stable and of such a shape that the main flame is ignited.

The ignition device shall be reliable and of sufficient capacity, so that immediate, low noise and smooth ignition is obtained.

Where use is made of a portable pilot burner or ignition device:

— the pilot burner or ignition device shall be capable of being fitted in one way only. If necessary the correct position shall be monitored;

— the connections for fuel, air, ignition energy shall be so designed that a reliable link-up is obtained, with confusion of connections being impossible.

If the fuel used for the pilot burner is gaseous, then the requirements of the relevant subclauses of 5.2 shall apply.

5.3.3 Combustion air and pre-purging the combustion chamber and the flue passages

5.3.3.1 Combustion air system

The pipework to be designed shall take into account the properties of combustion air.

All manual control devices (registers, valves, etc.) for the air shall be set in their pre-determined positions and protected against inadvertent movement.

The location of the combustion air intake shall be such as to prevent entry of exhaust products unless provided for by the design (e.g. for reduction of emission of nitrogen oxides (NO_X)).

The combustion air system shall be designed in a manner that prevents the back-flow of furnace atmosphere and/or flue gases through combustion equipment.

The air circuit shall be designed so as to avoid oscillations that are potentially dangerous.

NOTE The ventilation of the building and IThE shall be such as to allow an adequate supply of process air and combustion air to reach the burner(s)/ IThE under all conditions.

5.3.3.2 Pre-purging of the combustion chamber

Except where specified below, start up or restart after a lock-out (see 3.52) shall not be initiated until adequate steps have been taken to ensure that no combustible mixture is present in the combustion/processing chamber, connected spaces and flue products evacuation circuit (heat exchangers, dust extractors). This condition shall be achieved by means of a period of pre-purging immediately prior to ignition or within a time to be specified in the instruction handbook.

The pre-purge time shall be such as to ensure that the concentration of any combustible products in any part of the combustion chamber/processing chamber and flue duct is below 25 % of the Lower Flammable Limit of the liquid fuel; this being calculated with the combustion chamber/processing chamber and the flue duct assumed as being initially 100 % filled with flammable gases.

In general, five complete air changes of the combustion chamber/processing chamber and flue duct will suffice. The air flow rate used for a pre-purge shall be at least 25 % of the maximum combustion air flow rate. In the case of natural draught, the condition to achieve the above requirements shall be defined in the instruction handbook.

Inert or non flammable gases shall be used instead of air if required by the equipment or process. Other methods of ensuring that the combustion chamber and connected spaces do not contain flammable gases can be utilized providing that the equivalent level of safety is achieved.

The pre-purge time and purge procedure and or methodology shall be specified in the instruction handbook.

The pre-purge time and the airflow requirement during a pre-purge shall be controlled by a protective system according to 5.7.2 and 5.7.3.

Restart after a lock-out condition shall commence with a pre-purge (see 3.48).

In the following cases the pre-purge shall be omitted:

a) in applications where the presence of free oxygen could be hazardous (e.g. flammable atmosphere) or shall affect the equipment (e.g. graphite crucible) or the product quality; in this case additional precautions shall be taken to prevent combustible products from remaining in the combustion chamber e.g. by purging with inert gas;

b) when the combustion chamber is proved to be at a temperature above 750 °C (as defined for high temperature equipment);

c) when re-cycling a burner after shutdown for control purposes, pre-purging is not required on re-cycling:

   1) where the burner is fitted with an independently supervised permanent or alternating pilot; or

   2) where the burner is fitted with two automatic shut-off valves complying with EN 264 closing simultaneously or one automatic shut-off valve equipped with a proof of closure device; or

   3) with pulse fired burners if the burner shut-off valve is certified by the supplier to be suitable for the increased number of cycles typical of pulse firing; or

   4) in multiple burner systems when one or more burners remain alight in the same zone, even in the case of flame failure of one single burner; or

   5) when the combustion chamber is proved to be at a temperature above 750 °C (as defined for high temperature equipment) at any point where a flammable mixture coming from the burner(s) will ignite without delay;

d) where one burner of a group of radiant tube burners has locked-out, a maximum of one re-start shall be permitted before lock-out after a flame failure (see 3.48), if:

1) each burner has an automatic burner control system; and

2) the exhaust system dilutes the ignitable fuel-air-mixture inside the exhaust system below 25 % of the LFL or the radiant tube, the burner and the connection to the exhaust are designed for the maximum pressure increase that is possible during ignition; and

3) the liquid fuel supply to each radiant tube burner is equipped with an automatic shut-off valve complying with EN 264.

5.3.3.3 Air/liquid fuel ratio

The air mass flow rate shall always be in a ratio with the liquid fuel mass flow sufficient to ensure a safe ignition and that, throughout the operating range, a stable and safe combustion is maintained at each individual burner. The ratio needs not be the same value at all operational conditions.

The air/fuel ratio control function shall meet the requirement of the protective system according to 5.7.2 and 5.7.3.

NOTE The combination of any air/fuel ratio control (pneumatic or other) in combination with a flame supervision system that detects all possible incorrect ratios is sufficient.

5.3.4 Liquid fuel atomisation

Burners for liquid fuels shall be equipped where applicable with fuel atomizing systems to permit their correct combustion.

Measures shall be taken to prevent the liquid fuel from entering the atomizing fluid pipe and vice versa. If the atomizing fluid is a combustible gas, then the requirements of the relevant subclauses of 5.2 shall apply.

5.3.5 Burners

5.3.5.1 Main burners

All burners shall be suitable for the working conditions and shall provide operating safety for:

— the fuels used (type, pressure, etc.);

— the operating conditions (pressure, temperature, atmosphere, etc.);

— the nominal input rate and range of regulation (maximum and minimum capacity);

— ease of visual monitoring (sight glasses, sight holes, etc.).

5.3.5.2 Start-up and ignition

5.3.5.2.1 Start-up

Start-up of the fuel supply and burner(s) shall be permitted only when:

a) the installed air and liquid fuel proving devices (e.g. air flow, fuel pressure, atomizing fluid pressure when required) have been checked to ensure that they are in the correct operating condition for start-up;

b) all relevant interlocks (e.g. burner(s) position, valve(s) position, flue damper(s)) have been proved to be in the correct position.

5.3.5.2.2 Start fuel flow rate

The energy released during the start-up of the burners(s) shall be limited and the maximum pressure rise from a delayed ignition shall not cause any damage to the IThE (see Table 4).

The start fuel flow rate shall be controlled by a protective system according to 5.7.2 and 5.7.3.

5.3.5.2.3 Ignition

The ignition process shall be initiated immediately or within the time to be specified in the instruction handbook after the conclusion of the pre-purging stage.

Where the main burner is ignited by means of a pilot burner, the liquid fuel supply to the main burner shall be shut off during ignition of the pilot burner. The burner input rating shall be such that the maximum pressure in the combustion chamber/process chamber and in the flue ways does not create a hazard and hazardous situations in the pipework are prevented. The automatic valve(s) of the main burner shall be opened only when the pilot burner flame has been proved.

Where air enriched with oxygen or oxygen alone is the oxidising agent for the combustion of a fuel, (commonly called oxy/fuel firing), then the ignition procedures and times for such systems requires specific additional design attention to ensure the equivalent levels of safety.

5.3.5.2.4 Safety times

5.3.5.2.4.1 General

The safety ignition time and total closing time shall not vary by more then 20 % when the electrical supply voltage is varied between 85 % and 110 % of the nominal value or of the voltage range stated by the manufacturer.

5.3.5.2.4.2 Maximum safety times

The ignition and total closing times shall not exceed the values given in Table 4.

Table 4 — Maximum safety times

1	2	3	4
Heat input	Direct main burner ignition at full rate	Direct main burner ignition at reduced rate Q_s	reduced rate Q_s by pilot burner
$Q_{F\,max}$ in kW	t_{smax} in sec	t_{smax} in sec Q_{smax} in %	t_{smax} in sec Q_{smax} in %
< 300	t_{smax}=10	t_{smax}=10	t_{smax}=10
> 300 < 1 000	t_{smax}=5	t_{smax}=5	t_{smax}=5
> 1 000 < 5 000	not allowed	$Q_s \leq$ 100 kW $Q_{smax} \leq$ 70 % t_{smax}=5	$Q_s \leq$ 1 000 kW t_{smax}=5
> 5 000	not allowed	$Q_{smax} \leq$ 35 % t_{smax}=5	$Q_{smax} \leq$ 50 % t_{smax}=5
Q_s = start heat input expressed as a percentage of $Q_{F\,max}$ $Q_{s\,max}$ = maximum start heat input expressed as a percentage of $Q_{F\,max}$ $Q_{F\,max}$ = maximum heat input in kilowatts $t_{s\,max}$ = maximum safety time in seconds			

NOTE For liquid fuels, the ignition safety time commences with the release of the fuel into the combustion chamber.

5.3.5.2.5 Flame failure

5.3.5.2.5.1 Flame failure on start-up

In the event of failure occurs during the safety time, the burner shall go to lock-out (see 3.48).

However, in certain cases, re-cycling is acceptable providing equipment safety is not compromised. The conditions and the time delay between recycle and the number of re-cycles, which shall not exceed 2 and shall be specified in the instruction handbook. Re-cycle(s) shall be controlled by a protective system according to 5.7.2 and 5.7.3. If there is no flame signal at the end of these re-cycles the burner shall go to lock-out (see 3.48).

For pulse firing burners, failure of a single burner to ignite shall cause safety shut-down instead of lock-out. Three consecutive flame failures shall cause lock-out (see 3.48). The total number of burners subject to this provision shall be limited to comply with 5.3.5.3. The number of burners shall be specified in the instruction handbook.

5.3.5.2.5.2 Flame failure during operation

In the event of flame failure during operation the burner shall go to lock-out (see 3.48).

However, in certain cases, safety shut-down is acceptable providing equipment safety is not compromised. Not more than one re-cycle shall be permitted, the condition for which shall be specified in the instruction handbook. If there is no flame signal at the end of this re-cycle, the failing burner shall go to lock-out (see 3.48).

A recycle on a single burner system requires a complete recycle including pre-purge.

5.3.5.3 Burner capacity control

In any combustion system, the turndown ratio shall be such that the burner(s) is/are fully stable at all firing conditions.

5.3.5.4 Permanent pilots

Where used, a permanent pilot(s) shall be supplied with a clean fuel of constant quality and be fitted with automatic burner control systems. This automatic burner control systems shall be the automatic burner control systems of the ignited main burner, when the safety of the equipment is not compromised.

5.3.6 Automatic burner control systems

5.3.6.1 General

The main flame and, if applicable, the pilot burner flame shall be supervised by means of an automatic burner control system. Exceptions are only permitted when equipment safety is not compromised (e.g. see 5.3.6.2 and 5.3.6.3)

For systems where the pilot burner remains in use during main burner operation, separate flame detector devices to supervise the pilot and main flames shall be fitted. The main flame detector device shall be so positioned that it cannot in any circumstances detect the pilot flame. When the pilot burner ignites under all circumstances the main flame, it is sufficient to supervise only the pilot flame providing the flow rate of that pilot burner is checked by a protective System according to 5.7.2 and 5.7.3 (e.g. minimum gas pressure switch).

Where the pilot burner and the main burner are each provided with their own flame detector device the ignition flame shall not influence the response of the main flame sensor.

For systems where the pilot flame is extinguished during main burner operation a single flame detector device shall suffice.

Where fitted, flame detector device shall be unresponsive to unintended radiation.

Automatic burner control device shall comply with EN 230 if technically applicable. If necessary for process reasons, the characteristics of the system may differ from the requirements specified in EN 230 providing the levels of safety and reliability are not reduced.

Where a burner is required to fire continuously for periods in excess of 24 h, the automatic burner control system shall be designed for permanent operation.

The detection of a flame when there should not be a flame or a defect of the automatic burner control system or the protective system (according to 5.7.2 and 5.7.3) shall result into lock-out (see 3.48).

Where manual checking of the automatic burner control system is carried out, the instruction handbook shall specify the procedures to be followed in the event of a malfunction developing.

5.3.6.2 Low temperature equipment

Low temperature equipment fitted with a single burner shall be equipped with an automatic burner control system in accordance with 5.3.6.1.

For low temperature multiple burner equipment, each burner shall be equipped with an automatic burner control system.

Only one of the burners may be equipped with a automatic burner control system operating continuously provided that the burners guarantee stable combustion throughout the range of regulation, are on the same air/gas ratio control system and are arranged adjacent and in such a way that, if one of them is extinguished, it is re-ignited quickly and smoothly by the flame from the next burner. This procedure shall not apply to burners controlled by "on/off" systems.

5.3.6.3 High temperature equipment

Flame supervision, either by means of an automatic burner control system or by the operator, shall be provided during the start-up period when the processing chamber wall temperature is below 750 °C.

All automatic burner control system shall comply with the requirements of 5.3.6.1.

Automatic burner control systems shall not be substituted by operator supervision unless the operator is capable of taking immediate corrective actions during the heat-up phase. The supervision required shall be specified in the instruction handbook.

If the design and construction of the IThE is such that, in the event of flame failure, the temperature of the processing chamber walls is likely to fall below 750 °C within 1 h, then an acoustic and visual alarm shall be fitted. The required measures after a flash-back shall be described in the instruction for use.

If automatic switchover is used, a temperature not less than 750 °C shall be used for the switching point. This function shall be designed in accordance with the requirements for protective systems according to 5.7.2 and 5.7.3.

5.4 Solid fuels

5.4.1 Pulverised solid fuel pipework

5.4.1.1 General

The pipework design shall take into account the composition and properties of the solid fuel and the need for venting, purging and cleaning. The creation of static electricity shall be avoided.

Potentially dangerous oscillations in the pipework shall be prevented (e.g. by firm anchoring, use of flexible coupling).

The pipework shall be dust-tight.

The pipework shall be constructed in a way that no improper deposits shall occur due to its appropriate design and its adequate flow rate. These requirements are principally fulfilled if the velocity in the conveyor line amounts to minimum 18 m/s. Depending on the material to be conveyed, higher speeds shall be required.

The pipework shall be designed to be pressure-impulse-resistant which is usually met by piping of the minimum pressure category PN 10.

5.4.1.2 Unconnected pipework

Any unconnected live pipework shall be plugged, capped or blank flanged by metallic parts.

5.4.1.3 Electrical continuity

Electrical continuity shall be ensured for all pipework.

The pipework shall be earthed to prevent build-up of static charge.

The formation of galvanic cells shall be avoided.

5.4.1.4 Flexible tubing

Flexible tubing shall comply with the general requirements of 5.4.1.1, together with the following:.

— shall be as short as possible;

— shall be suitable for the maximum and minimum operating temperatures;

— shall be suitable for the maximum operating pressure, at the maximum and minimum operating temperatures;

— shall have a directly accessible, upstream isolating shut-off device;

— shall be mounted in such a way as to avoid distortion, whiplash and damage;

— shall have end fittings as integral parts of the tubing;

— shall be constructed from suitable material both metallic and/or non metallic selected for the application duty and not be easily damaged;

— shall be such that the creation of static electricity is avoided.

5.4.1.5 Marking

The pipework shall be identified as solid fuel pipework.

5.4.1.6 Soundness

The solid fuel pipework shall be dust tight and shall be designed to withstand the internal pressure.

After assembly, the solid fuel circuit shall be submitted to its test pressure and tested for dust tightness. The test pressure shall be 6 times the maximum working pressure at any point.

The testing procedure and the frequency of soundness testing shall be specified in the instruction handbook.

The external leakage rate shall not give rise to a dangerous condition, flammable and/or toxic, in the foreseen circumstances of the equipment installation.

The frequency to determine the external leakage shall specify in the instruction handbook.

5.4.1.7 Pressure relief devices and flame arrestors on pipework

For equipment designed for situations in which flash-backs can occur, flame arrestors and/or pressure relief devices shall be fitted.

To prevent a smouldering fire taking place in a fuel system during start-up, operation or especially during and after shut-down, measures (e.g. an extinction system, flame resistant stairwell feeders) shall be provided.

Pressure relief devices shall be designed to yield at a pressure below the test pressure of the circuit and shall be positioned such that the discharge flow and the pressure relief device does not constitute a risk to the equipment, personnel or third parties.

5.4.1.8 Pressure oscillations

The solid fuel system shall be designed so as to avoid the possibility of solid fuel velocities and pressure fluctuations causing oscillations which could cause damage to pipework, components, safety systems in the system (e.g. by providing the correct sizing of pipe, using a pressure regulator(s), etc.).

5.4.2 Graded fuel pipework (applicable to grate burners and fluidised beds)

Graded fuel pipework shall be adapted to the working conditions and shall guarantee stable, safe operation for the following:

— fuel supply (type, particle size distribution, pressure, prevention of dust leakage, prevention of ignition due to friction or overheating, etc.);

— combustion chamber conditions (pressure, temperature, atmosphere, etc.);

— nominal input rate and range of regulation (maximum and minimum capacity);

— ease of visual monitoring (sight glasses, sight holes).

In the case of solid fuels with high volatile content (e.g. brown coal ...) provision shall be made for the fitting of explosion relief devices in the fuel handling system.

These explosion relief devices shall be positioned such that the discharge flow does not constitute a hazard to the equipment, personnel or third parties.

5.4.3 Required devices (for pulverised fuels and fluidised beds)

5.4.3.1 Manual isolating device

A manually operated isolation device shall be fitted so as to permit the solid fuel supply to be shut off in the event of an emergency.

5.4.3.2 Automatic shut-off devices

The automatic shut-off devices shall shut off the solid fuel supply to the IThE or independent zone when a hazardous situations occurs e.g. :

— insufficient solid fuel supply (in the case of a supply from a metering hopper equipped with low level switches, the automatic shut-off devices shall be replaced by an audible or visible warning signal);

— minimal air flow and/or air pressure;

— failure of power supply and/or other utilities (compressed air, steam, transport air, etc.);

— failure of heat transfer fluid;

— fume extraction malfunction;

— excessive equipment temperature;

— combustion chamber temperature dropping below the safe ignition temperature of the fuel being fired. This temperature will be specified in the instruction handbook.

In these cases the automatic shut-off devices shall be de-energised by a protective system according to 5.7.2 and 5.7.3.

NOTE There may be processes and/or machine conditions that can cause a risk if the burner continues to fire. However these conditions are not covered by this standard.

In the case of a stoppage upon activation of the automatic shut-off device(s), any integral storage or fine crushing system shall reduce its output or cease production.

Where automatic shut-off devices are closed and lock-out has occurred, they shall be only manually reset (see 3.48).

Automatic restart after power failure shall be permitted under special circumstances. These special circumstances shall be defined in the instruction handbook.

5.4.3.3 Air flow and pressure detectors

Equipment fitted with forced or induced draught burner(s) shall be fitted with a 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 and, in the case of no operator supervision, shall cause lock-out (see 3.48).

5.4.3.4 Ignition system

Pilot burners fired by gaseous or liquid fuels shall comply with the safety requirements specified in 5.2 and 5.3.

5.4.4 Combustion air and pre-purging of the combustion chamber and flue passages

5.4.4.1 Combustion air system

All manual control devices (registers, valves, etc.) for the air shall be set in their pre-determined positions and protected against inadvertent movement.

The location of the combustion air intake shall be such as to prevent entry of flue products unless provided for by the design (e.g. for reduction of emission of nitrogen oxides (NO_X)).

The combustion air system shall be designed in a manner that prevents the back-flow of furnace atmosphere and/or flue gases through combustion equipment.

The air circuit shall be designed so as to avoid oscillations that are potentially dangerous.

NOTE The ventilation of the building and IThE shall be such as to allow an adequate supply of process air and combustion air to reach the burner(s)/ IThE under all conditions.

5.4.4.2 Pre-purging of the combustion chamber

Start-up shall not be initiated until adequate measures (e.g. pre-purging, venting, etc.) have been taken to ensure that no combustible mixture is present in the combustion/working chamber, connected spaces and flue products evacuation circuit (heat exchangers, dust extractors etc.).

The pre-purge time and the airflow requirement during this shall be controlled by a protective system according to 5.7.2 and 5.7.3.

These measures shall be specified in the instruction handbook.

5.4.4.3 Air/solid fuel ratio

The air mass flow rate shall always be in a ratio with the solid fuel feed rate in order to ensure that, throughout the operating range, a stable and safe combustion is maintained at each individual burner. The ratio needs not be the same value at all operational conditions.

The air/fuel ratio control function shall meet the requirement of the protective system according to 5.7.2 and 5.7.3.

NOTE The combination of any air/fuel ratio control (pneumatic or other) in combination with a flame supervision system that detects all possible incorrect ratios is sufficient.

5.4.5 Burners

5.4.5.1 Main burners

All burners shall be suitable for the working conditions and shall provide operating safety for:

— the solid fuels used (type, particle size distribution, etc.);

— the operating conditions (pressure, temperature, atmosphere, etc.);

— the nominal input rate and range of regulation (maximum and minimum capacity);

— ease of visual monitoring (sight glasses, sight holes, etc.).

5.4.5.2 Start-up and ignition

5.4.5.2.1 Start-up

Start-up of fuel supply and the burner(s) shall be permitted only when:

a) the installed air and solid fuel proving devices (e. g. air flow, solid fuel pressure) have been checked to ensure that they are in the correct operating condition for start-up;

b) all relevant interlocks (e.g. burner(s) position, valve(s) position, flue damper(s)) have been proved to be in the correct position.

The start-up sequence shall ensure that there is no flame present before proceeding further.

5.4.5.2.2 Ignition of the pilot burner

Ignition of the pilot burner, if any, shall comply with the requirements specified in 5.4.3.4.

5.4.5.2.3 Ignition of the main combustion system

The procedure and the conditions for the safe ignition of the main combustion system shall be specified in the instruction handbook and, where appropriate, shall be incorporated into the automatic start-up sequence for pulverised fuel burners.

Where a pilot burner is used for the ignition of a pulverised fuel burner, it shall be proved stable before the introduction of the pulverised fuel.

Where air enriched with oxygen or oxygen alone is the oxidising agent for the combustion of a gas, (commonly called oxy/fuel firing), then the ignition procedures and times for such systems requires specific additional design attention to ensure the equivalent levels of safety.

5.4.5.2.4 Safety times (pulverised fuel)

The ignition and total closing times shall be such that no hazardous situation occurs.

The ignition safety time shall be specified in the instruction handbook.

The extinction safety time shall not exceed 5 s except where the type of solid fuel or the design of the firing system dictates a longer time. In such cases, the extinction safety time shall be specified in the instruction handbook.

5.4.5.2.5 Flame failure (pulverised fuel)

In the event of flame failure, either during start-up or operation, the burner(s) shall go to lock-out (see 3.48).

Manual intervention shall be necessary before any attempt is made to re-ignite the flame.

5.4.5.3 Burner capacity control (pulverised fuel)

In any combustion system, the turndown ratio shall be such that the burner(s) is/are fully stable at all firing conditions and no flash back condition can occur.

5.4.5.4 Permanent pilot (pulverised fuel)

Where the main burner is supplied with solid fuel with uncertain combustion characteristics, (e.g. anthracite, petroleum coke etc.), in a particular application a permanent pilot shall be used. This pilot shall be supplied with a fuel of constant quality.

5.4.6 Automatic burner control systems (pulverised fuel)

5.4.6.1 General

The main flame and, if applicable, the pilot burner flame shall be supervised by means of a automatic burner control system. Exceptions are only permitted when equipment safety is not compromised (e.g. see 5.4.6.2 and 5.4.6.3).

For systems where the pilot burner remains in use during main burner operation, separate flame detector device to supervise the pilot and main flames shall be fitted. The main flame sensor shall be so positioned that it cannot in any circumstances detect the pilot flame. In case that the pilot burner ignites under all circumstances the main flame, it is sufficient to supervise only the pilot flame providing the flow rate of that pilot burner is checked by a protective system according to 5.7.2 and 5.7.3 (e.g. minimum gas pressure switch).

Where the pilot burner and the main burner are each provided with their own flame detector device the ignition flame shall not influence the response of the main flame sensor.

Where fitted, flame sensors shall be unresponsive to unintended radiation.

Where a burner is required to fire continuously for periods in excess of 24 h, the automatic burner control system shall be designed for permanent operation.

The detection of a flame when there should not be a flame or a defect of the automatic burner control system or the protective system according to 5.7.2 and 5.7.3 shall result into lock-out (see 3.48).

Where manual checking of the automatic burner control system required, the instruction handbook shall specify the procedures to be followed in the event of a malfunction developing.

5.4.6.2 Low temperature equipment

Low temperature equipment shall be fitted with an automatic burner control system with the requirements of 5.4.6.1.

Only one of the burners shall be equipped with an automatic burner control system operating continuously provided that the burners guarantee stable combustion throughout the range of regulation, are on the same air/gas ratio control system and are arranged adjacent and in such a way that, if one of them is extinguished, it is re-ignited quickly and smoothly by the flame from the next burner. This procedure shall not apply to burners controlled by "on/off" systems.

5.4.6.3 High temperature equipment

Flame supervision, either by means of a automatic burner control system or by the operator, shall be provided during the start-up period when the processing chamber wall temperature is below 750 °C.

All automatic burner control system shall comply with the requirements of 5.4.6.1.

Automatic burner control systems shall not be substituted by operator supervision unless the operator is capable of taking immediate corrective actions during the heat-up phase. The length of this heat-up phase and the supervision procedure shall be specified in the instruction handbook.

5.5 Multiple fuels

5.5.1 General

Equipment heated with multiple fuels can be fitted with burners supplied with two or more types of fuel, i.e. gaseous, vapour, liquid or solid, operating either simultaneously or separately.

5.5.2 Fuel circuit

Each type of fuel shall be distributed to the burner(s) by means of an independent system. This system shall be constructed in accordance with the requirements of 5.2, 5.3 and 5.4 as appropriate.

In particular, each burner shall be fitted with automatic shut-off valves for each type of fuel. In addition, the flame supervision system shall be chosen in such that it complies with the specifications appropriate to the types of fuel used.

Means shall be provided to ensure that the supply pipework of each individual fuel can be positively isolated from the other fuels whether or not non-return valves are fitted.

5.5.3 Combustion air supplies

It is acceptable to use a common combustion air system for all fuels.

5.5.4 Operation of the safety devices

Where malfunctions occur that affect only one type of fuel, the individual safety shut-off device relating to that fuel shall close.

Where a fuel supports the combustion of other fuels, the safety device of the assisted fuel shall also operate as intended.

Simultaneous closure of the safety shut-off devices installed for each type of fuel shall be ensured under all other circumstances given in 5.2.2.3, 5.3.2.3 and 5.4.3.2.

5.5.5 Air/fuel ratio

For each individual or combination fuel, the requirements specified in 5.2.3.3, 5.3.3.3 and 5.4.4.3 shall apply.

The air/fuel ratio control function shall meet the requirement of the protective system according to 5.7.2 and 5.7.3.

NOTE The combination of any air/fuel ratio control (pneumatic or other) in combination with a flame supervision system that detects all possible incorrect ratios is sufficient.

5.6 Oxygen or oxygen-enriched combustion air

5.6.1 General

The application of oxygen or oxygen-enriched combustion air needs particular consideration. Oxygen or oxygen-enriched air shall be shall be released only when essential and in a safe area. The hazards related to the use and handling of oxygen shall be specified in the instruction handbook.

5.6.2 Suitability for oxygen service

Due to the high ignition hazard of flammable material in contact with oxygen, all components coming into contact with oxygen, shall be prepared, cleaned and sufficiently free of flammable substances (e.g. dust, grease, particulates) prior to start-up. They shall be suitable for oxygen service.

NOTE EN 12300 provides information on cleanliness for oxygen systems.

5.6.3 Sealing materials for oxygen pipework

Sealing materials shall be suitable for application at the particular pressure levels, installation methods and operating temperatures and shall meet the safety requirements.

Suitable metallic sealing materials for oxygen pipework are those indicated in Table 5, Column 2.

5.6.4 Pipework

The design and material of pipework and their equipment and connections shall be suitable for oxygen and the intended pressures and temperatures.

Generally, for pipework right angle impingement of gaseous oxygen onto the pipe walls shall be avoided.

5.6.5 Pipes velocities

Velocities for temperature between –10 °C and + 200 °C shall not exceed:

a) for carbon and stainless steels piping

   — pressure below 12 bar 30 m/s (impinging or non-impinging flow);

   — pressure above 12 bar: 8 m/s (impinging or non impinging flow);

b) for Copper, Nickel, and Copper/nickel alloys piping

   — pressures up to 65 bar no velocity limit.

For piping after pressure reducing or control valves the pipe shall be straight for a minimum distance of 8 pipe diameters and fabricated from:

   — stainless steel (wall thickness shall be > 3 mm), copper, Nickel, Cu/Ni alloys ;for pressures below 12 bar;

   — copper, nickel or Cu/Ni alloys for pressures above 12 bar.

For operating temperatures exceeding 200 °C and below –10 °C, these materials and conditions shall not apply. In this case the limits of use are to be specified in the Instruction Handbook.

Filter(s) shall be fitted at the inlet of the oxygen pipe systems to prevent ingress of particulates (e.g. rust). The filter(s) shall be equipped with pressure drop indication.

5.6.6 Fittings

The design and material of fittings for gaseous oxygen such as safety shut-off valves, control devices and non return valves shall be suitable for oxygen at the intended pressures and temperatures.

Suitable materials for housings and built-in parts of fittings and their sealing materials are those indicated in Table 5.

Fittings for gaseous oxygen at an operating temperature exceeding 200 °C and below –10 °C shall be made of materials which are suitable for these conditions.

5.6.7 Blow off and venting lines

Oxygen line shall be vented to an area where the release of oxygen will not create a hazard.

5.6.8 Manual torches

Hoses, flexible pipes and connections shall be gas-tight.

Hoses and flexible pipes associated with manually operated torches shall be lockable in position by means of fittings within the solidly laid piping. They shall be easily accessible.

Manual torches shall be equipped with a flash back arrestor (EN 730-1 or equivalent) and a lockable manual shut-off valve upstream of the hose.

5.6.9 Safety devices against gas backflow

Oxygen pipework shall be equipped with a non return valve (EN 730-2 or equivalent) suitable for the operating pressure.

5.6.10 Safety devices against oxygen backflow in mixture with other substances

If oxygen is mixed with other substances (e.g. gas, air) it shall be ensured that back-flow cannot occur.

5.6.11 Material requirements

Materials in contact with oxygen shall be suitable for the intended operating pressures and temperatures. The installation method has to be selected to ensure that it will be safe in oxygen service.

NOTE Regarding the selection and compatibility of materials and gases (including oxygen) see also EN 1797.

The materials indicated in Table 5 (depending on the mounting location and the pressure) are suitable for use with oxygen or oxygen enriched combustion air.

Table 5 — Materials requirements

	Column 1	**Column 2**
1	pressure range [bar]	materials for housings, built-in components and seals
2	exceeding 40	copper, copper alloys with a mass proportion of at least 55 %, nickel, nickel-wrought alloys with copper high-alloy Cr-Ni-steels with a mass proportion of Cr and Ni of a total of at least 22 % high-alloy Cr-Si-steels with a mass proportion of Cr of at least 22%
3	0 up to 40	copper, copper alloys with a mass proportion of copper of at least 55 % high-alloy Cr-Ni-steels with a mass proportion of Cr and Ni of a total of at least 22% high-alloy Cr-Si-steels with a mass proportion of Cr of at least 22 %
4	0 up to 16	gray cast iron, at least quality class GG 25, cast iron with nodular graphite, at least quality class GGG 40
5	0 up to 10	metallic materials (except Titanium, Zirconium and their alloys)

Besides the metals indicated in Table 5, Column 2, lead and tin shall be used as metallic sealing materials for all pressure ranges.

For gaseous oxygen at an operating temperature exceeding 200 °C and below –10 °C materials which are suitable for these conditions shall be used.

5.7 Design requirements for electrical and electronic equipment for control system and protective system

5.7.1 General

Electrical equipment shall comply with EN 60204-1 and withstand the hazards identified in the risk assessment required at the design stage.

Electrical equipment shall be protected against damage. In particular it shall be robust to withstand damage during continuous operation.

NOTE For the characteristics of electrical components information from electrical component suppliers can be useful.

Figure 1 is provided as an aid to understanding the relationship between the various elements of thermoprocess equipment and their ancillary equipment, the heated systems, the control system and the protective system(s).

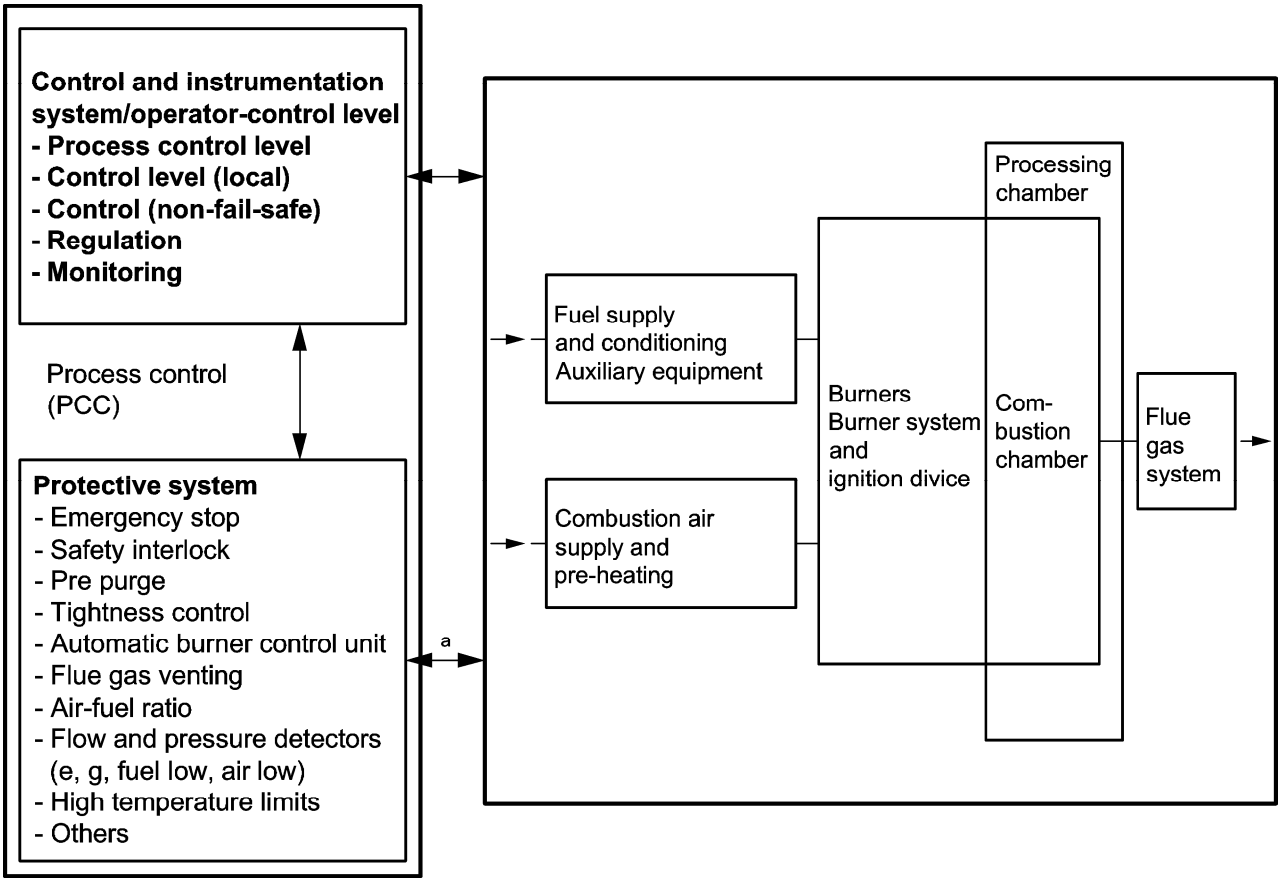


Figure 1 — Block diagram of control/protective and heated system

Techniques for avoiding (preventing the introduction of) systematic faults during design and development and design features (e.g. self checking, redundancy) in the safety devices for controlling both random and systematic faults during operation shall be applied.

5.7.2 Requirements for protective systems

The protective system is a collection of equipment, units and safety related circuits whose main purpose is the protection of personnel, property and the environment. The protective system includes all the components required to carry out the safety function, such as sensors which monitor safety related parameters (e.g. flame monitoring), interruption device for the flow of fuel, ventilation of the body of the furnace and protection of the heated system (e.g. monitoring the temperature level). Typically a protective system consists of sensors, logic solving protective equipment and actuating elements. If this is achieved by multi-channel systems, then all channels and monitoring devices used for safety purposes are included within the protective system.

The protective system contains all components which are required for functional safety.

For the purpose of this document, safety related part of a control system means the system which implements safety functions from the initial device, e.g. actuator, position detector or sensor up to and including the power/energy disconnection system.

Functional requirements (e.g. total closing time,) specified in 5.2 to 5.6 shall be applied.

Protective systems shall fulfil one of the following conditions:

a) hardwired system in which all components comply with the relevant product standards as specified in 5.2 to 5.6;

   — sublause 9.4.1 of EN 60204-1 is not applicable for this type of protective system;

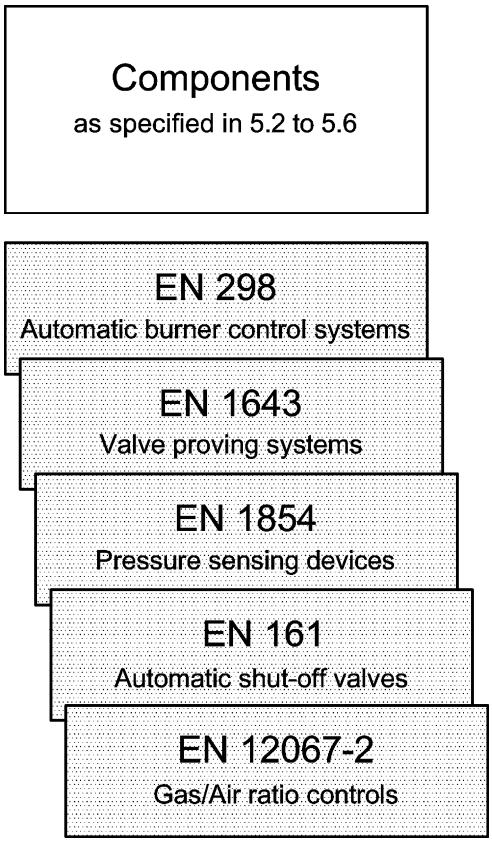


Figure 2 a — Example for requirements of 5.7.2 a

b) hardwired system with a combination of components complying with the relevant product standards as specified in 5.2 to 5.6 and of components complying with defined SIL/PL level in accordance with EN 62061 and EN ISO 13849-1 respectively;

   — guarding functions (e.g. gas pressure, temperature) performed by components for which no relevant product standards are existing shall comply with at least SIL 2/PL d;

   — functions which will lead to immediate hazard in case of failure (e.g. flame detector device, ratio monitoring) performed by components for which no relevant product standards are existing shall comply with at least SIL 3/PL e;

   — the hard-wiring shall comply with part a.

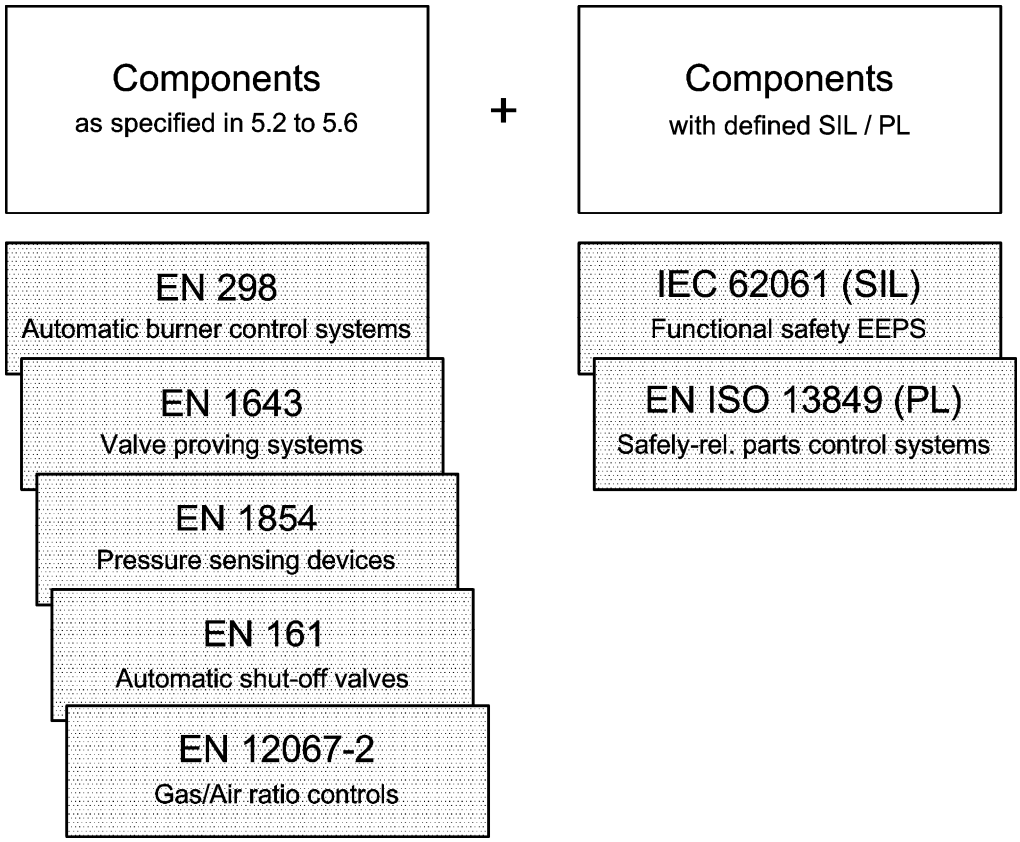


Figure 2 b — Example for requirements of 5.7.2 b

c) PLC based system with a combination of components compling with the relevant product standards as specified in 5.2 to 5.6 and of components complying with defined SIL/PL;

— guarding functions (e.g. gas pressure, temperature) performed by components for which no relevant product standards are existing shall comply with at least SIL 2/PL d;

— functions which will lead to immediate hazard in case of failure (e.g. flame supervision, ratio control) performed by components for which no relevant product standards are existing shall comply with at least SIL 3/PL e;

— software for safety functions should be separate from other functions (e.g. control functions). The software for safety functions shall be designed in accordance with the requirements of EN ISO 13849 or EN 62061.

— a PLC used for safety functions shall comply with EN ISO 13849-1 or EN 62061;

— the hard-wiring shall comply with part a.

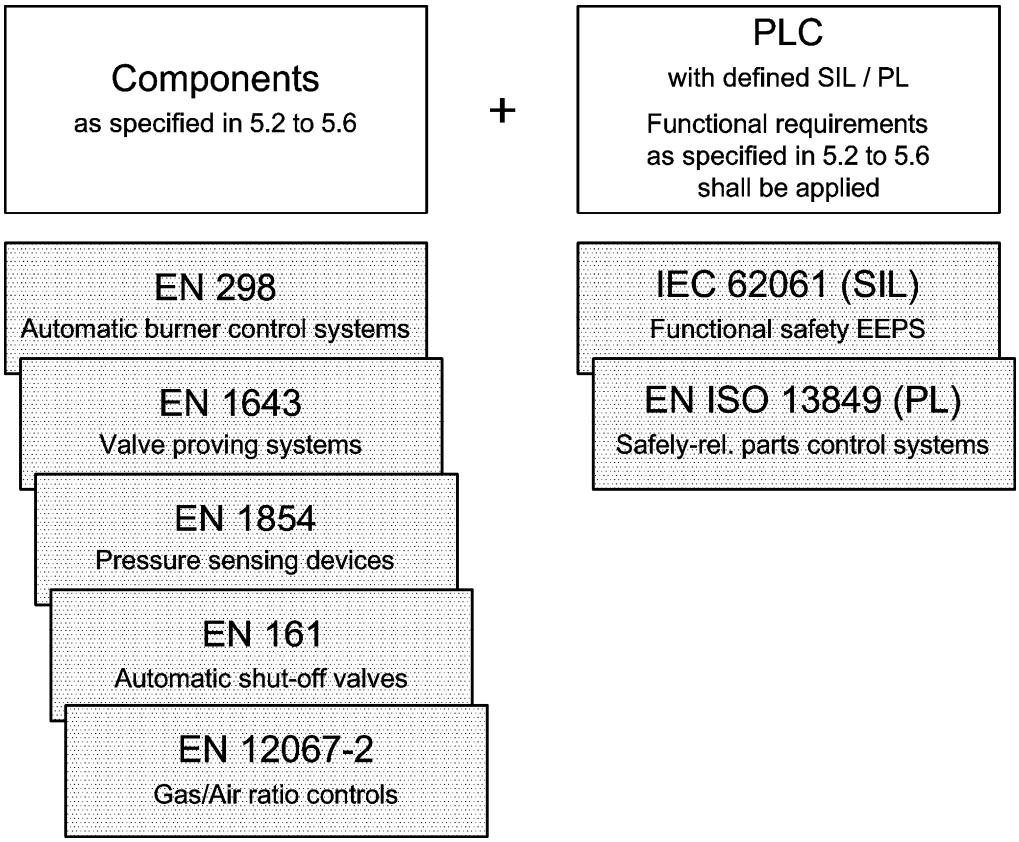


Figure 2 c — Example for requirements of 5.7.2 c

d) PLC based system in which all components comply with defined SIL 3/ PL e and with a defined SIL 3/ PL. e of hard and software;

— in this case EN 13849-1 and EN 62061 shall be applied for the protective system in general.

Any changes of hardware and software shall be documented and maintained on site.

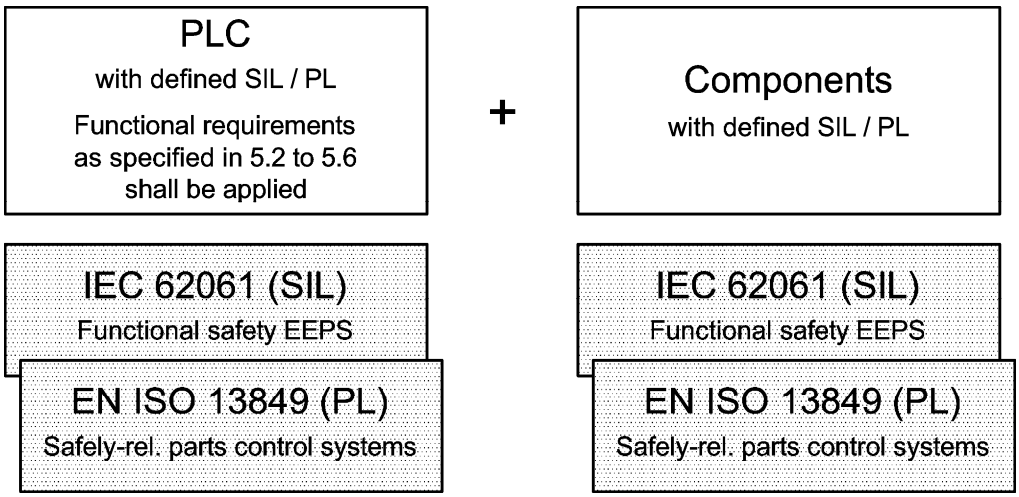


Figure 2 d — Example for requirements of 5.7.2 d

5.7.3 Fault assessment for a hardwired protective system

5.7.3.1 General requirements

If failures or disturbances in the protective system can cause a hazardous situation or damage to the machine or product, suitable measures shall be taken to reduce the probability of occurrence of such failures or disturbances. The necessary measures and the extent to which they are implemented – either individually or in combination – depend on the level of risk associated with the application in question.

The electrical control circuits shall have an appropriate level of safety-related capacity as defined in the risk assessment of the thermoprocess equipment.

The hardwired part of the protective system shall be designed in such way that one single fault in a contactor or relay leads to the activation of the safety circuit.

Signals coming from the safety circuit shall only be doubled or made further use of when free from interference, e.g. with a safety relay.

Measures to reduce these risks include, but are not restricted to:

— protective devices on the thermoprocess equipment (e.g. interlocking guards, releasing devices);

— protective interlocking of the electrical circuit;

— use of proven circuit techniques and components (see EN 60204, subclause 9.4.2.1);

— provision of partial or complete redundancy (see EN 60204, subclause 9.4.2.2) or diversity (see EN 60204, subclause 9.4.2.3);

— provision for functional tests (see EN 60204, subclause 9.4.2.4).

The hardwired system shall fulfil the following conditions:

a) the system description shall be readily comprehensible and logically structured, and it shall clearly depict the safety philosophy and the safety functions;

b) required function, reaction in the event of a fault, interfaces (software, hardware) and the permissible environmental influences of a functional unit within the system shall be unambiguously specified;

c) components shall be used which are:

   1) proven in operation;

   2) approved and authorised in the works of the manufacturer of the safety device concerned.

5.7.3.2 Fault assessment for the hardwired section of a protective system

For the design of the protective system, the fault analysis following the procedure in the fault chart Figure 3 depending on the technology to be employed.

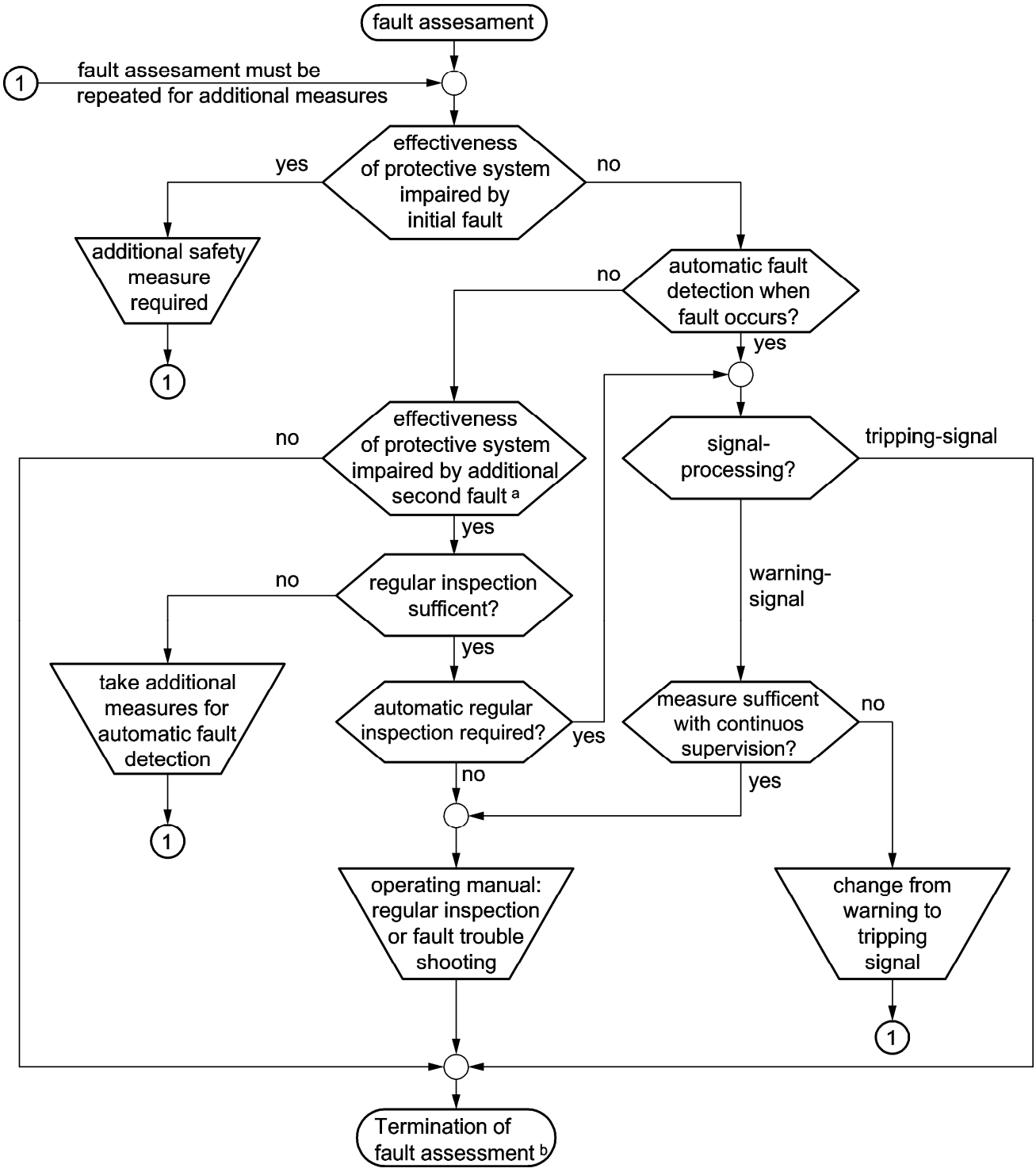


Figure 3 — Fault assessment for the hardwired section of a protective system

The protective system shall be designed such that:

— faults which could impair the effectiveness of the protective system cannot occur (by fault-avoidance techniques); or

— in the event of internal faults or the occurrence of external influences in or at the safety device;

  — its effectiveness remains unaffected; or

— the plant remains in a safe condition, or it is brought to a safe condition (by fault control techniques).

The simultaneous occurrence of two independent faults in different components need not be taken into account. The addition of a second fault to an undetected initial fault shall, however, be taken into account, where it affects the fault tolerance time, in accordance with Figure 3.

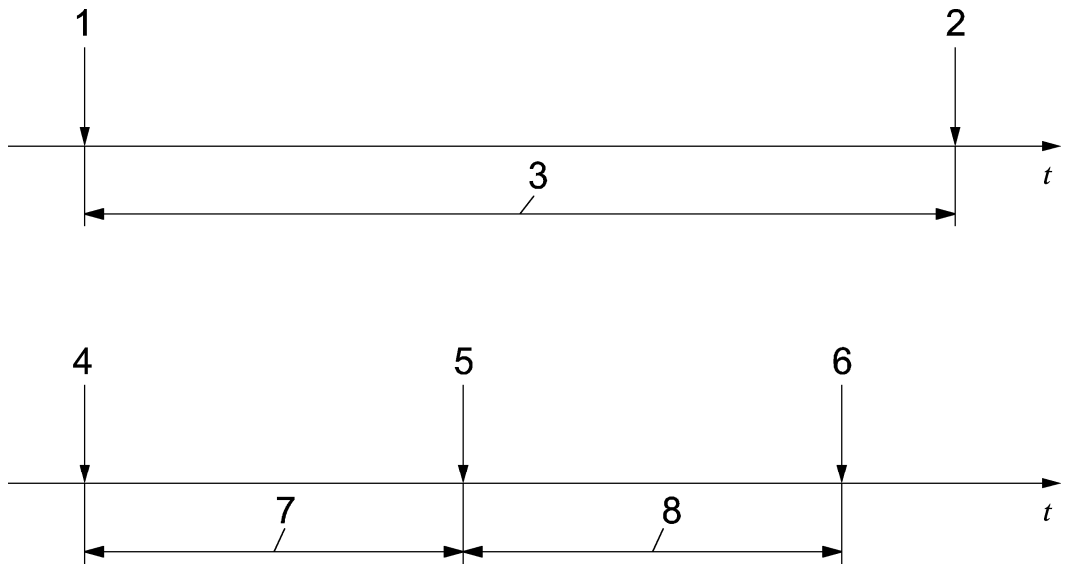
The reaction to a fault which negatively affects the effectiveness of the protective system shall be as described in the following:

— a single channel protective system shall trip into a safe state;

— a multiple channel protective system can trip into a degraded mode. The time limit for the degraded mode of operation depends on the requirements of the plant (operation with or without supervision) and the result of the calculation of the second fault occurrence time according to the probability of failure on demand;

— for the safety related inputs and outputs of the protective system the tripping of the affected parts could be sufficient.

The sum of safety time and the closing time of the shut-off valve or the final element shall be less than the fault tolerance time of the relevant process function.



Key

1 occurrence of unsafe operating conditions
2 process changes into critical operation, which results in an hazardous event
3 fault tolerance time
4 e.g. flame interrupt
5 initiate closure of the shut-off valve or the final element
6 e.g. fuel valve closed
7 safety time
8 closing time

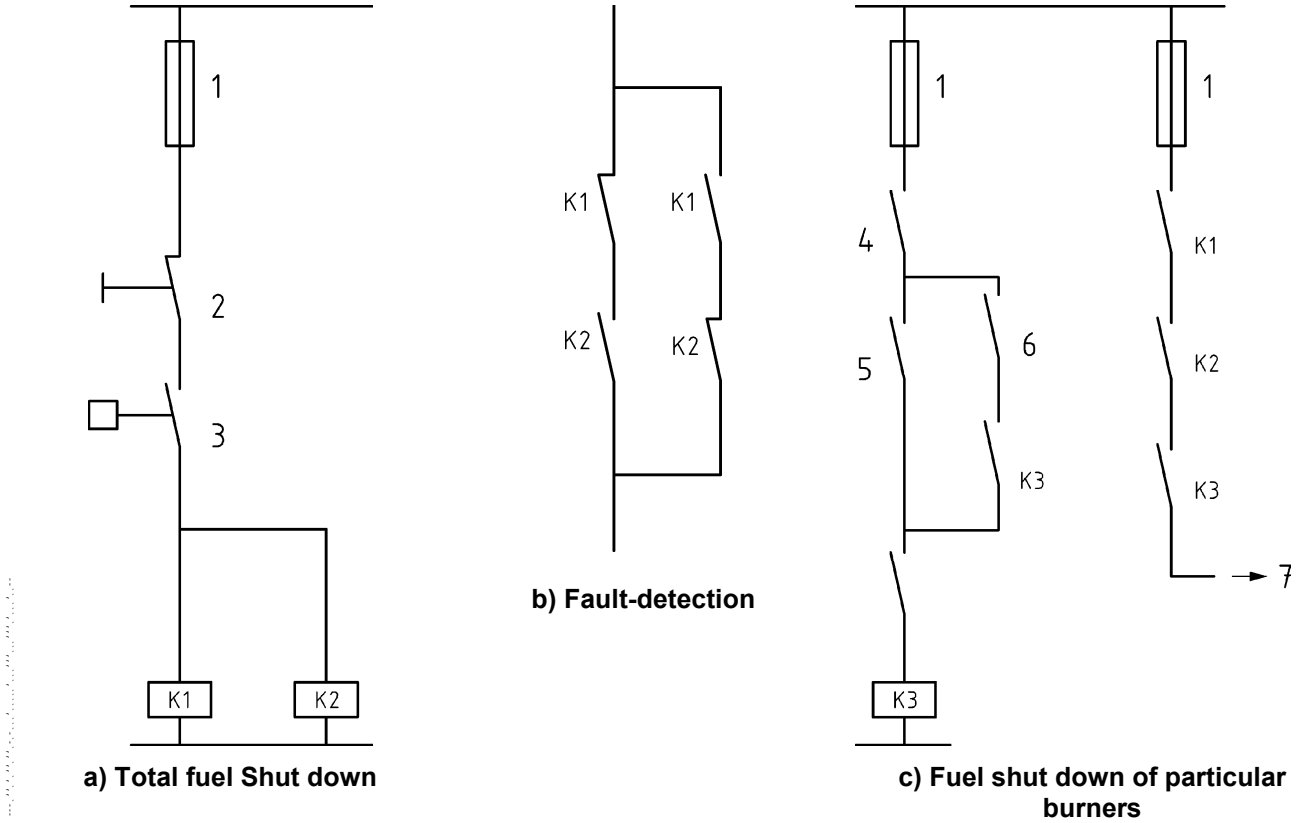
Figure 4 — Consideration of fault tolerance time and safety time for IThE

5.7.3.3 Hardwired section of protective system

The hard-wired section of protective system shall be so constructed that fault assessment according to Figure 3 results in termination. This stipulation applies for safety integrity levels 1, 2 and 3.

Fault assessment for the protective equipment according Figure 3 shall consider failure of auxiliary power and break of connecting lines. If plant components affected by such failures achieve a safe status (e.g. closed-circuit operation in binary circuits) a single-channel design of the relevant parts shall be sufficient apart from the following measures.

If this cannot be assumed (e.g. open-circuit operation of binary circuits) a second independent trip channel shall be provided in order to achieve the effectiveness of the protective system (including all pneumatic, hydraulic and mechanical actuating elements) for this function.



Key

1	overcurrent protection
2	emergency stop device
3	protective limiter (type approved)
4	enable
5	ignition safety time
6	burner monitoring
7	fuel valve
K 1	relay 1
K 2	relay 2
K 3	relay 3

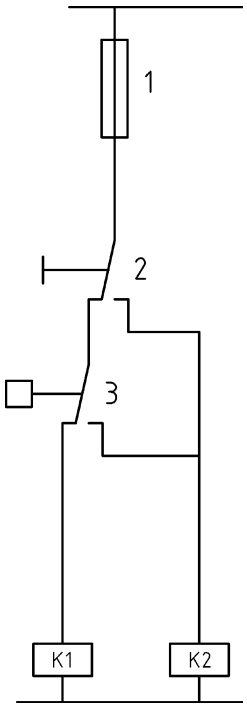
Figure 5 — Examples for wiring of fuel shut-down with hardware diversity of the disconnecting devices

In the case of non-solid state circuits, at least two monitored disconnecting devices, i.e. contactor or relay, shall be provided to obtain safety shutdown of the entire fuel supply to the furnace (see Figure 5 and Figure 6).

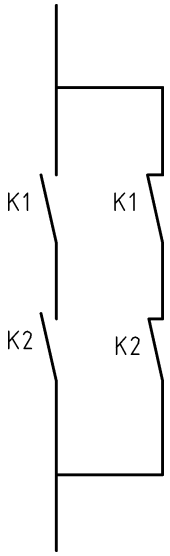
For furnaces which operate continuously where regular inspections at sufficiently short intervals in accordance with Figure 3 shall not be performed, disconnecting devices (relays) with diverse functionality or hardware diversity shall be provided to shut down the entire fuel supply.

Reed relays shall not be used for any safety related functions, unless remanence is covered by continuous testing.

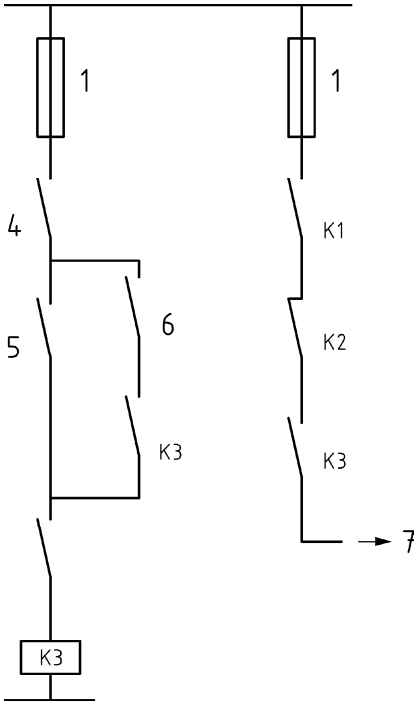
NOTE Diverse functionality is for instance achieved by closed-circuit arrangement and open-circuit arrangement for instance Figure 6. Hardware diversity is achieved by different types of construction of electro-mechanical switching devices, e.g. if switching devices of different construction or design are used (Figure 5).



a) Total fuel shut down



b) Fault-detection



c) Fuel shut down of particular burners

Key

1	overcurrent protection
2	emergency stop device
3	protective limiter (type approved)
4	enable
5	ignition safety time
6	burner monitoring
7	fuel valve
K 1	relay 1
K 2	relay 2
K 3	relay 3

Figure 6 — Example for wiring of fuel shut-down with diverse functionality of the disconnecting devices

"Non-opening of contact elements due to permanent welding" fault in the case of contactors, relays or auxiliary power switches can be excluded if they are protected against the effects of short circuits by an appropriate overcurrent protective or a current limiting device. In rating of the overcurrent protective device, the nominal current of the overcurrent protective device stated by the switching device manufacturer shall be mulitplied by a safety factor of 0,6. The overcurrent protective device shall permit to interrupt the maximum level of short-circuit current occurring. Fault exclusion is also permissible if the prospective short-circuit current is less than the nominal current for the contact element concerned. Where contact elements are connected in series, the contact element with the lowest overcurrent strength shall be the deciding factor.

5.7.3.4 Fault exclusions

5.7.3.4.1 General

With fault assessment according to Figure 3 it is assumed that certain faults do not occur. Such assumption are justified by describing the failure mechanism as well as by stating the conditions relating design, construction, environment etc. for the conductors, components and equipment.

5.7.3.4.2 Conductor-to-conductor short circuit

"Conductor-to-conductor short circuit" fault

a) if the clearances between live parts are designed according to overvoltage category III and pollution degree 3 and the creepage distances are designed according to pollution degree 3 but at least for the nominal voltage 63 V as specified in EN 60664-1;

b) if components are encapsulated so that they are moisture resistant or if they are hermetically sealed and they withstand a test as specified in this standard;

c) if printed conductors (tracks) are varnished so that they are resistant to ageing in accordance with the distances between the printed conductors are equivalent to at least the values specified in EN 60664-1, Table 4 for pollution degree 1 but at least for a nominal voltage of 32 V (minimum creepage distance 0,14 mm).

5.7.3.4.3 Mechanical failure of switching devices

"Mechanical failure of switching devices" if they are still operative after at least 250 000 switching cycles under conditions similar to operating conditions. Contactors and relays shall additionally have a mechanical endurance of 3×10^6 switching cycles. This fault exclusion is not applicable for reed contacts. The fault exclusion also is not applicable for applications requiring safety integrity level 3 associated with continuous operation (see 5.7.3.3).

NOTE The term "conditions similar to operating conditions" covers chemical and climatic as well as electrical and mechanical stresses.

5.7.3.4.4 Faults in components for safe isolation

Faults in components which are provided for safe isolation of electrical circuits (e.g. power circuits and telecommunications circuits) in accordance with EN 61140.

a) Inter-winding short circuits in transformers (e.g. primary-secondary): transformers shall comply with the electrical and mechanical requirements of EN 61558. In deviation from EN 61558, for transformers with working voltages up to 200 V insulation between windings and insulation against the core shall be designed for a test voltage of 2 kVrms. Transformers shall as a minimum be conditionally short-circuit proof. Shifting of windings, turns and connection lines shall be prevented, e.g. by vacuum impregnation or encapsulation.

b) Transient voltages of switching devices, like relays, contactors or auxiliary contacts between the contacts and between coil and contact. The insulation between the contacts or between coil and contact shall be designed for nominal voltages UB up to 200 V for a test voltage of 2 kVrms at nominal voltages 200 V

<UB <500 V for a test voltage of 3,75 kVrms. By special design features (e.g. caps, ribs, encapsulation, banding) at contacts and coils, safe isolation shall be guaranteed also in the event of faults, for example spring breakage.

5.7.3.5 Switching devices

Contacts of contactors and relays shall be forcibly guided.

Contactors shall conform to EN 60947-4-1 and relays shall conform to EN 61810-1. Alternatively, safety switching devices conforming to EN 62061 are permissible.

5.7.4 Electrical power failure

Loss of electrical power to the IThE shall result in lock-out (see 3.48). Any restart shall only be initiated by manual intervention. The start-up and ignition sequence shall apply (5.2.5.3 or 5.3. or 5.4).

An automatic restart by the protective system after electrical power failure shall only be initiated if all below conditions are meet:

— the power supply to the protective system is not interrupted (e.g. an uninterruptable power supply is used for the protective system);

— the IThE is in normal operating mode, not in the heating up or cooling down, or not in any starting or stopping sequence;

— all conditions that are required for safety operation of the IThE were fulfilled immediately before the power cut occurred (e.g. all doors were closed);

— the frequency of the power cuts is small enough to guarantee the IThE is functioning normally (e.g. temperatures are close to setpoint).

If all above conditions are met:

— a lock-out shall not be generated immediately;

— the protective system shall neglect power cuts shorter than 1 s;

— all power cuts longer than 1 s shall result in the protective system to act as if it shuts down the IThE (no lock-out is initiated): de-energise all equipment that is not energised during stop of the IThE (e.g. blowers, valves) and keep all protective equipment energised (e.g. guards, switches); and

— if the power cut is of a duration that does not result in a dangerous situation if restarted automatically (e.g. due to increased heat release after the restart), the protective system can initiate an automatic restart as for a controlled stop. The maximum allowable power cut duration to allow automatic restart shall be specified in the instruction manual;

— in all other cases, the protective system shall go to lock out. Only manual restart is possible.

Any hazardous situation during the power cut shall always result in lock out by the protective system.

In case of re-supply of energy after interruption, any uncontrolled re-start shall be avoided, see EN 1037.

5.7.5 Reset

On components performing a safety function, reset after lock-out shall be triggered manually after remedying the fault (see 2.52).

When the manual reset is initiated without visible sight on the appliance, the actual status and relevant information of the process under control shall be visible to the user before, during and after the reset action and a safe operation is ensured.

Methods for reset are:

a) manually operating a button or a handle which is a part of the locked safety device;

b) manually operating a button which is direct connected (hardwired) to the specified inputs of the locked safety device;

c) manually operating a button with signal processing and transmission via protective system to the locked safety device;

d) manually operating a button with signal processing and transmission via an electronic which does not fulfil the requirements of a protective system (e.g. normal PLC). In this case the maximum number of resets within a defined time span shall be limited in a way which meets the requirements of a protective system.

A reset done automatically (e.g. in a loop of the PLC system) is not permitted.

In case of method b) c) and d) the maximum number of resets shall be specified the in instruction handbook and shall be limited in the control system.

Reset of burners firing into the open air shall only be done according a).

NOTE The number of lock-outs which are reset at the same time should be limited (see 3.48).

A remote reset after a fault lock-out (see 3.48), e.g. from the control room, is permitted if the safety of the installation is not impaired under the following conditions:

e) by manually operating a button, permanently wired to the safety equipment; can be considered as equivalent to local reset;

resets shall be logged;

f) by manually operating a button and signal forwarding via a protective system; can be considered as equivalent to local reset;

resets shall be logged;

g) by manual operating a button if a single-channel PLC is used, additional safety measures are necessary, e.g. redundancy, in order to ensure a level of safety equivalent to a) and b).

resets shall be logged.

The number of allowed resets shall be described in the instruction handbook.

The requirements of 5.2.5.3.5, 5.3.5.3.5 and 5.4.5.2.5 in respect of flame failure on start-up and during operation shall be complied with for resetting the individual burner, i.e. gas valves shall not open an uncontrolled number of times.

All safety functions shall be tested at least once during commissioning.

6 Verification of the safety requirements and/or measures

Table 6 shall be used as a check list for manufactures to prepare their own specific table of methods used to verify that the safety requirements and measures described in Clause 5 are compiled with and contains references to the respective clauses of this European Standard.

Table 6 — Verification of the safety requirements and/or measures

Clause	Safety requirements and/or measures	Visual inspection Note 1	Functional test Note 2	Measuring Note 3	Examination of drawings / Calculations Note 4
5.1	General				
5.2	Gaseous fuels				
5.2.1	Gas pipework				
5.2.1.1	General	X			X
5.2.1.2	Connections	X			X
5.2.1.3	Unconnected pipework	X			X
5.2.1.4	Galvanic Cells	X			X
5.2.1.5	Flexible tubing and couplings	X			X
5.2.1.6	Marking	X			
5.2.1.7	Soundness	X			X
5.2.1.8	Condensate drains	X			X
5.2.1.9	Purge points	X			
5.2.1.10	Blow-off and breather pipes or conduits	X	X		X
5.2.1.11	Pressure relief devices and flame arrestors on pipework	X	X		X
5.2.1.12	Pressure oscillations	X			
5.2.1.13	Equipment supplied with different fuel gases	X			X
5.2.1.14	By-pass	X			X
5.2.1.15	Isolation of required safety devices	X			X
5.2.2	Required safety devices				
5.2.2.1	Manual isolating valve	V	X		X
5.2.2.2	Filter/strainer	X	X		X
5.2.2.3	Automatic shut-off valves				
5.2.2.3.1	General	X			X
5.2.2.3.2	Single Burner equipment	X	X		X
5.2.2.3.3	Multiple Burner equipment	X	X		X
5.2.2.3.4	Valve Proving System	X	X		X
5.2.2.4	Gas pressure regulator	X	X		X
5.2.2.5	Air and gas flow and pressure detectors				
5.2.2.5.1	Air	X			X
5.2.2.5.2.	Gas				

Table 6 *(continued)*

Clause	Safety requirements and/or measures	Visual inspection Note 1	Functional test Note 2	Measuring Note 3	Examination of drawings / Calculations Note 4
5.2.2.5.2.1	Low gas protection	X			X
5.2.2.5.2.2	High gas protection	X			X
5.2.2.6	Flue gas venting	X			X
5.2.2.7	Ignition system	X			X
5.2.2.8	Individual manual shut-off valves for burners	X	X		X
5.2.3	Combustion air and pre-purging the combustion chamber and flue passages				
5.2.3.1	Combustion air system	X			X
5.2.3.2	Pre-purging of the combustion chamber	X	X		X
5.2.3.3	Air/gas fuel ratio	X			
5.2.4	Supply of pre-mixed fuel gas/air				
5.2.4.1	Mixture pipework	X			X
5.2.4.2	Air and gas supply to the mixture circuit	X	X		X
5.2.5	Burners				
5.2.5.1	Main burners	X			X
5.2.5.2	Radiant Tube burner system	X		X	X
5.2.5.3	Start-up and ignition				
5.2.5.3.1	Start-up	X			X
5.2.5.3.2	Start fuel flow rate	X	X		X
5.2.5.3.3	Ignition	X	X		X
5.2.5.3.4	Safety time				
5.2.5.3.4.1	General	X	X		X
5.2.5.3.4.2	Maximum safety times for natural draught burners	X	X		X
5.2.5.3.4.3	Maximum safety times for forced and induced draught burners	X	X		X
5.2.5.3.5	Flame Failure				
5.2.5.3.5.1	Flame failure on start-up	X	X		X
5.2.5.3.5.2	Flame failure during operation	X			
5.2.5.4	Burner capacity control	X			X
5.2.5.5	Permanent pilots	X			X
5.2.6	Automatic burner control systems				
5.2.6.1	General	X			X
5.2.6.2	Low temperature equipment	X			X
5.2.6.3	High temperature equipment	X			X
5.2.6.4	Automatic burner control systems for burners operating in the open air	X			X
5.3	Liquid fuels				

Table 6 *(continued)*

Clause	Safety requirements and/or measures	Visual inspection Note 1	Functional test Note 2	Measuring Note 3	Examination of drawings / Calculations Note 4
5.3.1	Liquid fuel pipeword				
5.3.1.1	General	X			X
5.3.1.2	Connections	X			X
5.3.1.3	Unconnected pipework	X			X
5.3.1.4	Flexible tubing	X			X
5.3.1.5	Marking	X			X
5.3.1.6	Sounding	X			X
5.3.1.7	Fuel pipe heating	X			X
5.3.1.8	By-passes	X			X
5.3.1.9	Purge points	X			
5.3.1.10	Equipment supplied with different liquid fuels	X			X
5.3.2	Obligatory devices				
5.3.2.1	Manual isolating valve	X			X
5.3.2.2	Filter/strainer	X	X		X
5.3.2.3	Automatic shut-off valves	X	X		X
5.3.2.4	Pressure relief valve	X			X
5.3.2.5	Liquid fuel pressure regulator	X			X
5.3.2.6	Pressure regulation of auxiliary fluids	X			X
5.3.2.7	Combustion air, liquid fuel, atomizing and control fluid flow and pressure detectors	X			X
5.3.2.8	Individual manual shut-off valves for multiple burners	X			X
5.3.2.9	Automatic shut-off valves for multiple burners	X			X
5.3.2.10	Flue gas venting	X			X
5.3.2.11	Ignition system	X			X
5.3.3	Combustion air and pre-purging the combustion chamber and the flue passages				
5.3.3.1	Combustion air system	X			X
5.3.3.2	Pre-purging of the combustion chamber	X	X		X
5.3.3.3	Air/liquid fuel ratio	X			
5.3.4	Liquid fuel atomisation	X	X		
5.3.5	Burners				
5.3.5.1	Main burners				
5.3.5.2	Start-up and ignition				
5.3.5.2.1	Start-up	X			
5.3.5.2.2	Start fuel flow rate	X	X		X
5.3.5.2.3	Ignition	X	X		X
5.3.5.2.4	Safety times				

Table 6 *(continued)*

Clause	Safety requirements and/or measures	Visual inspection Note 1	Functional test Note 2	Measuring Note 3	Examination of drawings / Calculations Note 4
5.3.5.2.4.1	General	X	X	X	X
5.3.5.2.4.2	Maximum safety times	X	X	X	X
5.3.5.2.5	Flame Failure				
5.3.5.2.5.1	Flame failure on start-up	X			X
5.3.5.2.5.2	Flame failure during operation	X			X
5.3.5.3	Burner capacity control	X			X
5.3.5.4	Permanent pilots	X			X
5.3.6	Automatic burner control systems				
5.3.6.1	General	X			X
5.3.6.2	Low temperature equipment	X			X
5.3.6.3	High temperature equipment	X			X
5.4	Solid fuels				
5.4.1	Pulverised solid fuel distribution system				
5.4.1.1	General	X			X
5.4.1.2	Unconnected pipework	X			X
5.4.1.3	Electrical continuity	X	X		X
5.4.1.4	Flexible tubing	X			
5.4.1.5	Marking	X			
5.4.1.6	Soundness	X	X		
5.4.1.7	Pressure relief devices and flame arrestors on pipework	X			X
5.4.1.8	Pressure oscillations	X			
5.4.2	Graded fuel supply systems (Applicable to grate burners and fluidised beds)	X			X
5.4.3	Required devices (for pulverised fuels and fluidised beds)				
5.4.3.1	Manual isolating device	X			X
5.4.3.2	Automatic shut-off devices	X			X
5.4.3.3	Air flow and pressure detectors	X			X
5.4.3.4	Ignition system				
5.4.4	Combustion air and pre-purging of the combustion chamber and flue passages				
5.4.4.1	Combustion air system	X			X
5.4.4.2	Pre-purging of the combustion chamber	X	X		X
5.4.4.3	Air/solid fuel ratio	X	X		
5.4.5	Burners				
5.4.5.1	Main burners				
5.4.5.2	Start-up and ignition				
5.4.5.2.1	Start-up	X			

Table 6 *(continued)*

Clause	Safety requirements and/or measures	Visual inspection Note 1	Functional test Note 2	Measuring Note 3	Examination of drawings / Calculations Note 4
5.4.5.2.2	Ignition of the pilot burner	X			X
5.4.5.2.3	Ignition of the main combustion system	X			X
5.4.5.2.4	Safety times (pulverised fuel)	X	X		X
5.4.5.2.5	Flame failure (pulverised fuel)	X	X		X
5.4.5.3	Burner capacity control (pulverised fuel)	X	X		X
5.4.5.4	Permanent pilot (pulverised fuel)	X			
5.4.6	Automatic burner control systems (pulverised fuel)				
5.4.6.1	General	X			
5.4.6.2	Low temperature equipment	X			
5.4.6.3	High temperature equipment	X			
5.5	Multiple fuels				
5.5.1	General	X			
5.5.2	Fuel circuit	X			
5.5.3	Combustion air supplies	X			
5.5.4	Operation of the safety devices	X			
5.5.5	Air/fuel ratio	X			
5.6	Oxygen or oyigen-enriched combustion air				
5.6.1	General				
5.6.2	Suitability for oxygen service	X			X
5.6.3	Sealing materials for oxygen pipework	X			X
5.6.4	Pipework	X			X
5.6.5	Pipes velocities	X			X
5.6.6	Fittings	X			X
5.6.7	Blow off and venting lines	X			
5.6.8	Manual torches	X			X
5.6.9	Safety devices against gas backflow	X			X
5.6.10	Safety devices against oxygen backflow in mixture with other substances	X			X
5.6.11	Material requirements	X			X
5.7	Design requirements for electrical and electronic equipment for Control System and Protective System				
5.7.1	General	X			X
5.7.2	Requirements for protective systems	X			X
5.7.3	Fault assessment for a hardwired protective system				
5.7.3.1	General requirements	X			X
5.7.3.2	Fault assessment for the hardwired section of a protective system	X			X
5.7.3.3	Hardwired section of protective system	X			X

Table 6 *(continued)*

Clause	Safety requirements and/or measures	Visual inspection Note 1	Functional test Note 2	Measuring Note 3	Examination of drawings / Calculations Note 4
5.7.3.4	Fault exclusions				
5.7.3.4.2	Conductor-to-conductor short circuit	X			X
5.7.3.4.3	Mechanical failure of switching devices	V			X
5.7.3.4.4	Faults in components for safe isolation	X			X
5.7.3.5	Switching devices	X	X		X
5.7.4	Electrical power failure	X	X		X
5.7.5	Reset	X	X		X

NOTE 1 Visual inspection is carried out for testing the required characteristics and properties by visual study of the delivered equipment and components.

NOTE 2 The functional test will show whether the parts in question function in such a way as to satisfy the requirements.

NOTE 3 Verification by means of measuring instruments is used to check whether the requirements are fulfilled within the specific limits (e.g. the safety distances between the guard and the inrunning nip acc. to EN 294).

NOTE 4 Drawings and calculations are used to check whether the design characteristics of the components used the specific requirements.

7 Information for Use

7.1 General

The manufacture shall deliver for of the combustion and fuel handling system of the IThE an instruction handbook.

An instruction handbook shall be provided by the manufacturer in respect of the combustion and fuel handling system. The format and content shall comply with clause 5 of EN ISO 12100.

The information for use shall be written in the user's language and shall contain one copy in the original language chosen by the manufacturer. Both documents shall be written in a EU language.

The information for use shall contain details for commissioning, start-up and use together with information for general maintenance of the dryer and its intended use defined by the manufacturer.

7.2 Marking

The minimum information marked on the equipment covered by the scope of this part of EN 746 shall be:

— name and address of the manufacturer;

— year of construction; …….. modified on…….year of modification;

— designation of series or type;

— serial number, if any;

— nominal fuel rating of the equipment (minimum-maximum);

— fuel type(s);

— calorific value;

— supply air, supply fuel, utilities, pressures and temperatures.

The pipework shall be identified by:

— colour

and/or

— sign.

7.3 Instruction handbook

7.3.1 General

For the part: combustion and fuel handling system the instruction handbook shall at least contain the following details:

— exact description of the combustion and fuel handling system of the IThE and of the safety equipment;

— instructions for use and requirements for the training of personnel;

— complete range of application of the combustion and fuel handling system of the IThE (tolerable range of application, if necessary);

— schematic description of the safety functions;

Moreover, the following aspects are to be treated by the instruction handbook:

— operation of combustion and fuel handling system of the IThE only by competent personnel according to the conditions of use defined by the manufacturer;

— information on correct work place of operator.

This handbook shall deal with start-up, operation, and normal and emergency shut-down.

7.3.2 Description of equipment

The instruction handbook shall contain the following information:

— a description of the combustion and fuel handling system, including as built schematic diagrams of pipework and electrical wiring;

— a list of all safety and control equipment parts with their settings and an indication of the relevant standards;

— a list of equipment settings/adjustments as made during final commissioning;

— a description of any deviations from the requirements of relevant standards in the construction and/or function of parts of the combustion and fuel handling system;

— the requirements for handling the waste products of combustion from the IThE.

All the information given on the marking plate(s) shall be repeated together with information relevant to combustion and fuel handling.

7.3.3 Inspection procedures

The instruction handbook shall contain details of inspection intervals and periodic checking procedures for:

— leak tightness test of the complete system (as per 5.2.1.7, 5.3.1.6 and 5.4.1.6);

— leak tightness of all pipework; periodic checking of leak tightness should be carried out at intervals to be determined by consideration of the operating conditions, fuel type and material of construction;

— leak tightness of the IThE and the flue ducts in cases where pressurized combustion is used;

— leak tightness check of the valves;

— leak tightness check of the filter/filter and/or the strainer;

— all safety equipment, especially automatic burner control systems, warning devices and safety shut-off valves;

— combustion quality (e.g. temperatures and/or combustion products analysis), if applicable;

— safety functions in order to ensure that these functions are not impaired by concealed faults or errors.

A documentation form shall be included in which the date, the results and the person who carried out the checks are recorded together with the date of the next inspection.

7.3.4 Commissioning, start-up and operating procedures

The instruction handbook shall provide details of the procedure for commissioning, start up, including preliminary checks (e.g. cleaning of pipework), description of conditions and a list of manually and automatically operated system checks, e.g. opening equipment doors, if applicable.

Attention shall be drawn to the necessity of ensuring that the pipework is free of debris, welding slag, etc. after initial commissioning, before the equipment is put into service, after maintenance or long periods of shutdown.

The instruction handbook shall provide information on special allowances or requirements for:

— pre-purge, e.g. deviation of pre-purge times from standardized conditions in justified cases or waiting time between ignition attempts in the case of natural draught burners;

— the exhausting of combustion products;

— the conditions for automatic restart, if applicable;

— the conditions for, and the number of permitted recycles;

— any special conditions for combustion of solid fuel concerning:

  — the safety limits of ignition temperature of the fuel;

  — safety times;

  — supervision procedure of the heat-up phase;

  — any other process relevant limits.

7.3.5 Shut-down procedures

The instruction handbook shall provide information on any special requirements necessary before fuel shut-off, e.g. evacuation or combustion of flammable atmospheres, and after fuel shut-off, e.g. continuous venting to avoid overheating or blocking of flue dampers in the open position, together with a description of measures to be taken in the event of a safety shut-down.

The instruction handbook shall set down any special requirements for lock-out and/or emergency shut-down and any special measures for subsequent restart (see 3.48).

An information sheet containing the information required by this clause shall be provided for display at the equipment control panel.

7.3.6 Maintenance procedures

The instruction handbook shall contain details of the maintenance intervals and procedures for all parts that require maintenance, replacement and/or repair of items of safety equipment.

It shall specify the suitable cleaning methods and agents for the cleaning of oxygen systems.

Documentation forms with dates of last and next maintenance and the addresses and telephone and fax numbers of maintenance and repair services shall be provided.

7.3.7 Documentation

Provision shall be made for recording revisions to the instruction handbook in the event of modification of the equipment (e.g. by repair, modernisation or replacement of parts, change of operating conditions).

Annex A
(informative)

Typical Examples of IThE, Fuels and Burners

A.1 List – Machines concerned, descriptions, functions

A.1.1 List of IThE

The classifications below are given as typical examples only and should not be considered as limitations to this standard where all industrial Thermoprocessing equipment is covered.

A.1.1.1 In Metallurgical industrial thermoprocessing equipment

A.1.1.1.1 Thermal production

— Roasting;

— calcining, reducing, firing;

— sintering, agglomeration;

— non-ferrous metal refining;

— melting out metals.

A.1.1.1.2 Melting, pouring

— Melting (steel/iron, non-ferrous metals);

— holding (liquid phase);

— pouring;

— re-melting.

A.1.1.1.3 Heating

— Heating, preheating, cooling, holding;

— drying;

— sand drying and core making;

— re-claiming used foundry sands.

A.1.1.1.4 Heat treatment

— Annealing;

— hardening;

— tempering;

— quenching;

— sintering, pressure sintering.

A.1.1.1.5 Surface treatment

— Carburising;

— carbo-nitriding;

— nitriding;

— nitro-carburizing;

— oxidizing.

A.1.1.1.6 Coating

— Metallic coating;

— hot dip galvanizing;

— non-metallic coating;

— varnish drying;

— vapour deposition.

A.1.1.1.7 Joining

— Brazing, soldering;

— welding.

A.1.1.1.8 Surface pre-treatment

— Cleaning, degreasing;

— delacquering.

A.1.1.2 In Glass industrial thermoprocessing

— Melting;

— cooling;

— decorating;

— heat Treatment.

A.1.1.3 In Ceramic industrial thermoprocessing

— De-waxing;

— drying;

— heating;

— annealing;

— sintering;

— firing;

— decorating.

A.1.1.4 In cement, lime and gypsum industrial thermoprocessing

— Calcining;

— firing;

— heating;

— cooling.

A.1.1.5 In chemical/petrochemical industrial thermoprocessing

— Calcining;

— distillation;

— drying;

— endothermic/exothermic gas production;

— gasifying;

— impregnating;

— liquefying;

— polymerization;

— pyrolysing;

— reaction;

— reforming, cracking;

— sintering;

— smelting;

— vulcanising, curing.

A.1.1.6 In waste incineration industrial thermoprocessing

— Incineration of domestic refuse, sewage sludge, refuse derived fuel, industrial and special waste (such as toxic);

— pyrolysing;

— gasifying.

A.1.1.7 In other industries

— Drying paper, printing;

— drying granular products;

— drying textiles;

— drying wood;

— industrial food processing.

A.2 Classification of fuels

The classifications below are given as typical examples only and should not be considered as limitations to this standard where all gaseous, liquid and solid fuels apply.

A.2.1 Gaseous fuels

Gases likely to be used are classified following ISO 6976 into three families in accordance with their Wobbe index.

— 1st family (manufactured gases: e.g. town gas);

— 2nd family (natural gases);

— 3rd family (liquefied petroleum gases);

— other gaseous fuels.

A.2.2 Liquid fuels

Liquid petroleum fuels likely to be used can be classified into different categories in accordance with the value of their viscosity:

— gas-oil fuel-oils;

— light fuel-oils;

— medium fuel-oils;

— heavy fuel-oils;

— very heavy fuel-oils;

— other liquid fuels.

A.2.3 Solid fuels

Solid fuels likely to be used are classified into two categories in accordance with their particle size:

— pulverised fuel;

— graded fuel;

— other solid fuels.

A.3 Classification of burners

The classifications below are given as typical examples only and should not be considered as limitations to this standard where all types of burners used in industrial thermo-processing equipment apply.

A.3.1 Gaseous fuels

— Natural draught;

— forced or induced draught.

A.3.2 Liquid fuels

— Natural draught;

— forced or induced draught.

A.3.3 Solid fuels

— Pulverised fuel burners;

— fluidized beds;

— grate burners.

Annex B
(informative)

Technical terms

Trilingual index

Table B.1 — English – German – French

Ref.	Definition – No.	English	German	French
1		air flow protection max. as needed (FSL)	Luftströmung Luft max. wie benötigt	protection contre le manque de débit d'air
2		air flow detector	Luftströmungswächter	détecteur de débit d'air
3		air/gas ratio	Luft-/Gasregler	rapport air/gaz
4		air/gas ratio control	Luft-/Gasregler/ Verhältnisregler	régulateur de rapport air/gaz
5	3.2	air pressure detector	Luftdruckwächter	détecteur de pression d'air
6	3.3	air/fuel ratio	Luft/Brennstoff-Verhältnis	rapport air/combustible
7	3.5	alternating pilot burner	Zündbrenner mit Abschaltung	brûleur d'allumage à fonctionnement semi-permanent alterné
8	3.1	automatic burner control system	Flammenüberwachungseinrichtung	système automatique de commande de brûleur
9		automatic burner	Automatischer Brenner	brûleur automatique
10	3.88	automatic shut-off valve	Sicherheitsabsperrventil	robinet automatique de sectionnement
11	3.4	burner	Brenner	brûleur
12	3.10	burner input rate	Brennerleistung	débit calorifique du brûleur
13		burner manual shut-off valve	Brenner handbetätigtes Absperrventil	robinet manuel de sectionnement de brûleur
14		burner automatic shut-off valve connected to automatic burner control	Brenner Sicherheitsabsperrventil verbunden mit dem Gasfeuerungsautomaten	vanne d'arrêt de sécurité de brûleur relié au boîtier/dispositif de surveillance de flamme
15	3.19	by-pass	Bypass	bipasse
16	3.20	calorific value	Wärmewert	pouvoir calorifique
17	3.21	combustion air	Verbrennungsluft	air de combustion
18	3.22	combustion chamber	Brennkammer/Feuerraum	chambre de combustion
19	3.23	condensate drain	Kondensatablauf	purge de condensat
20	3.24	control system	Steuerungssystem	système de commande

Table B.1 *(continued)*

Ref.	Definition – No.	English	German	French
21	3.6	cross-ignited burners	Überzündende Brenner	brûleurs à interallumage
22	3.25	EMC	EMC	CEM
23	3.26	enriched air	Angereicherte Luft	air enrichi
24	3.27	explosion/pressure relief	Explosions-/Druckentlastungs-einrichtung/Berstscheibe	dispositif de décharge d'explosion et de pression
25		extinction safety time	Sicherheitszeit "Betrieb"	temps de sécurité à l'extinction
26	3.28	fault tolerance time	Fehlertoleranzzeit	temps de tolérance aux pannés
27	3.29	filter/strainer; strainer/filter	Filter/Sieb; Schmutzfänger	filtre/tamis; tamis/filtre
28	3.31	flame detector device	Flammenwächter	équipement de détection de flamme
29		flame failure	Flammenausfall	défaut de flamme
30	3.30	flame response time (FRT)	Sicherheitszeit im Betrieb	temps de réponse à l'extinction (FR)
31	3.32	flame sensor	Flammenfühler	détecteur de flamme
32	3.33	flame trap or flame arrestor	Flammensperre	arrête-flamme
33	3.34	flash back	Flammenrückschlag	retour de flamme
34	3.7	forced draught burner	Gebläsebrenner	brûleur à air soufflé
35	3.35	fluids	Flüssigkeiten	fluides
36	3.36	fluids group 1	Flüssigkeiten Gruppe 1	fluides du groupe 1
37	3.37	fluids group 2	Flüssigkeiten Gruppe 2	fluides du groupe 2
38	3.38	functional safety	Funktionssicherheit	sécurité fonctionnelle
39		gas flow adjustment for burner	Gasmengeneinstellung des Brenners	robinet d'ajustement de débit gaz pour brûleur
40	3.39	gas flow detector	Gasströmungswächter	détecteur de débit de gaz
41		gas manifold	Gasverteiler	collecteur de gaz (nourrice)
42	3.40	gas pressure detector	Gasdruckwächter	détecteur de pression de gaz
43	3.41	gas pressure regulator	Gasdruckregler	régulateur/détendeur de pression
44		governor (pressure regulator)	Druckregler	régulateur de pression
45	3.42	graded fuel	Klassierter Brennstoff	combustible classé
46	3.8	grate burner	Rostfeuerung	brûleur à grille
47		high gas pressure protection max.	Gasüberdrucksicherung Gas max.	Protection contre les surpressions gaz
48	3.43	high temperature equipment	Hochtemperaturanlage	équipement à haute température

Table B.1 *(continued)*

Ref.	Definition – No.	English	German	French
49	3.44	ignition	Zündung	allumage
50		ignition safety time	Sicherheitszeit "Anlauf"	temps de sécurité à l'allumage
51	3.9	induced draught burner	Brenner mit mechanischer Abgasabführung	brûleur à air induit
52	3.45	initial boiling point	Siedebeginn	point d'ébullition initial
53		isolating flange (blanking plate)	Blindflansch	bride d'isolement
54		leak tightness device	Dichtheitskontrolleinrichtung	dispositif de contrôle d'étanchéité
55		light back	Rückschlagen	retour de flamme
56	3.46	lighting torch	Zündlanze	torche d'allumage
57	3.47	liquefied petroleum gas (LPG)	Flüssiggas	gaz de pétrole liquéfié (GPL)
58	3.48	lock-out, non volatile	Störabschaltung	mise en position de sécurité
59	3.49	lower flammability limit (LFL)	Untere Zündgrenze	limite inférieure d'inflammabilité
60	3.50	low temperature equipment	Niedertemperaturanlage	installation basse température
61		low air pressure protection min.	Luftmangelsicherung Luft min.	protection contre le manque de pression d'air
62		low gas pressure protection min.	Gasmangelsicherung Gas min.	protection contre le manque de pression de gaz
63	3.51	main flame	Hauptflamme	flamme principale
64		main flame establishment period	Entstehungszeit der Hauptflamme	période d'établissement de la flamme principale
65		main fuel supply	Hauptbrennstoffzufuhr	alimentation principale en combustible
66	3.11	manual burner	Handbedienter Brenner	brûleur manuel
67	3.89	manual isolating valve	Handbetätigtes Hauptabsperrventil	robinet de barrage à commande manuelle
68	3.52	manual reset	Manuelle Quittierung/Entstörung	réarmement manuel
69	3.90	manual shut-off valve	Handbetätigtes Absperrventil	robinet d'isolement à commande manuelle
70		mixing machine	Mischmaschine	machine à mélange
71	3.53	multiple burner equipment	Brennergruppe	équipement à brûleurs multiples
72	3.12	natural draught burner	Brenner ohne Gebläse	brûleur atmosphérique
73	3.91	non-return valve	Rückschlagventil	vanne anti-retour
74	3.54	nominal size (DN)	Nennweite (DN)	diamètre nominal (DN)
75	3.13	open firing burner	Freibrennender Brenner	brûleur à flamme nue

Table B.1 *(continued)*

Ref.	Definition – No.	English	German	French
76	3.55	operating temperature	Arbeitstemperatur	température de service
77	3.56	operator supervision	Überwachen durch Bedienungspersonal	surveillance par opérateur
78		overpressure cut off device with manual reset	Sicherheitsabsperrventil für Gasversorgungsdruck mit manueller Rückstellung	dispositif de coupure haute pression avec réarmement manuel
79	3.15	pilot burner	Zündbrenner	brûleur d'allumage
80	3.14	permanent pilot burner	Zündbrenner mit Dauerbetrieb	brûleur d'allumage permanent
81		pilot flame	Zündflamme	flamme d'allumage
82	3.57	pipework	Leitungssystem	tuyauterie
83	3.58	piping	Verrohrung	canalisation
84	3.59	PLC (Programmable logical control)	SPS (Speicher-programmierbare Steuerung)	API (Automate Programmable Industriel)
85	3.16	portable burner	Ortsbeweglicher Brenner	brûleur portatif
86	3.60	pre-purge	Vorspülen	prébalayage
87	3.61	pressure	Druck	pression
88	3.62	pressure accessories	Druckführende Teile	accessoires de pression
89	3.63	pressure equipment	Druckgeräte	équipement de pression
90	3.64	pressure, maximum allowable (PS)	Maximaler zulässiger Betriebsdruck	pression, maximale autorisée (PS)
91	3.92	pressure relief valve	Druckentlastungsventil	soupape de décharge à pression (déverseur)
92	3.65	processing chamber	Nutzraum	laboratoire
93		proof of closure switch	Schließkontrollschalter	témoin de fermeture
94	3.66	protective system	Schutzsystem	système de protection
95	3.67	pulse firing	Getaktete Feuerung	combustion séquentielle
96	3.68	pulverised fuel	Brennstoffstaub	combustible solide pulvérisé
97		purge	Spülung	purge
98	3.69	purge point	Spülstutzen	point de purge
99		relief valve	Abblaseventil	Soupape de décharge
100	3.17	radiant tubes burner	Strahlheizrohrbrenner	brûleur pour tubes radiants
101	3.70	re-cycling	Wiederanlauf	redémarrage
102	3.71	remote reset	Ferngesteuertes Zurücksetzen	ré-armement à distance
103	3.72	safe accessories	Sicherheitsausrüstung	accessoires de sécurité
104	3.73	safe discharge area	Bereich für sichere Abführung	zone d'évacuation sûre
105	3.74	safety shut-down	Sicherheitsabschaltung	mise en position d'arrêt

Table B.1 *(continued)*

Ref.	Definition – No.	English	German	French
106		safety shut-off system	Sicherheitsabsperrsystem	système d'arrêt de sécurité
107	3.75	safety time	Sicherheitszeit	temps de sécurité
108	3.76	self-checking automatic burner control system	Selbstüberprüfte Flammenüber-wachungseinrichtung	système automatique de commande de brûleur auto-vérifiant
109	3.77	single burner equipment	Einzelbrennersystem	brûleur individuel
110	3.78	spark restoration	Wiederzündung	reprise d'étincelle
111	3.79	start fuel	Anfahrbrennstoff	combustible de démarrage
112		start fuel flame	Anfahrflamme	flamme du combustible de démarrage
113		start fuel flame establishment	Entstehen der Anfahrflamme	établissement de la flamme du combustible de démarrage
114	3.80	start fuel flow rate	Anfahrbrennstoffmenge	débit de combustible de démarrage
115		start fuel supply	Startwärmebelastung	alimentation en combustible de démarrage
116	3.81	stoichiometric fuel rate	Stöchiometrische Brennstoffmenge	régime stoechiométrique
117		strainer/filter; filter/strainer	Schmutzfänger; Filter/Sieb	tamis/filtre; filtre/tamis
118	3.82	system leak tightness check	Systemdichtheitsprüfung	système de contrôle d'étanchéité
119	3.83	temperature, maximum / minimum allowable (TS)	Maximaler / minimaler zulässige Temepratur	température, maximale / minimale admise (TS)
120	3.84	test pressure	Prüfdruck	pression d'essai
121	3.85	thermo-processing equipment	Thermoprozessanlage	équipement thermique
122	3.86	torch	Brennerlanze	chalumeau
123	3.87	total closing time	Gesamt-Schließzeit	temps total de fermeture
124	3.93	valve proving system	Ventilüberwachungssystem	contrôleur d'étanchéité
125	3.94	Wobbe index	Wobbe-Index	indice de Wobbe
126	3.18	work station burner	Maschinenbrenner, Tischbrenner	brûleur de poste de travail
127	3.95	zone	Zone	zone
128		zone isolating valve	Zonen-handbetätigtes-Absperrventil	robinet de barrage de zone
109		zone automatic shut-off valve	Zonen- Sicherheitsabsperrventil	vanne d'arrêt de sécurité de zone

Table B.2 — German – English – French

Ref.	Definition – No.	German	English	French
99		Abblaseventil	relief valve	soupape de décharge
111	3.79	Anfahrbrennstoff	start fuel	combustible de démarrage
114	3.80	Anfahrbrennstoffmenge	start fuel flow rate	débit de combustible de démarrage
112		Anfahrflamme	start fuel flame	flamme du combustible de démarrage
23	3.26	Angereicherte Luft	enriched air	air enrichi
76	3.55	Arbeitstemperatur	operating temperature	température de service
9		Automatischer Brenner	automatic burner	brûleur automatique
104	3.73	Bereich für sichere Abführung	safe discharge area	zone d'évacuation sure
53		Blindflansch	isolating flange (blanking plate)	bride d'isolement
11	3.4	Brenner	burner	brûleur
13		Brenner handbetätigtes Absperrventil	burner manual shut-off valve	robinet manuel de sectionnement de brûleur
51	3.9	Brenner mit mechanischer Abgasabführung	induced draught burner	brûleur à air induit
71	3.12	Brenner ohne Gebläse	natural draught burner	brûleur atmosphérique
14		Brenner Sicherheits-absperrventil verbunden mit dem Gasfeuerungsautomaten	burner automatic shut-off valve connected to automatic burner control	vanne d'arrêt de sécurité de brûleur relié au boîtier/dispositif de surveillance de flamme
70	3.53	Brennergruppe	multiple burner equipment	équipement à brûleurs multiples
122	3.86	Brennerlanze	torch	chalumeau
12	3.10	Brennerleistung	burner input rate	débit calorifique du brûleur
18	3.22	Brennkammer/Feuerraum	combustion chamber	chambre de combustion
96	3.68	Brennstoffstaub	pulverized fuel	combustible solide pulvérisé
15	3.19	Bypass	by-pass	bipasse
54		Dichtheitskontrolleinrichtung	leak tightness device	dispositif de contrôle d'étanchéité
87	3.61	Druck	pressure	Pression
91	3.92	Druckentlastungsventil	pressure relief valve	soupape de décharge à pression (déverseur)
88	3.62	Druckführende Teile	pressure accessories	accessoires de pression
89	3.63	Druckgeräte	pressure equipment	équipement de pression
44		Druckregler	governor (pressure regulator)	régulateur de pression
109	3.77	Einzelbrennersystem	single burner equipment	brûleur individual systeme
22	3.25	EMC	EMC	CEM

Table B.2 *(continued)*

Ref.	Definition – No.	German	English	French
113		Entstehen der Anfahrflamme	start fuel flame establishment	établissement de la flamme du combustible de démarrage
63		Entstehungszeit der Hauptflamme	main flame establishment period	période d'établissement de la flamme principale
24	3.27	Explosions-/Druckentlastungs-einrichtung/Berstscheibe	explosion/pressure relief	dispositif de décharge d'explosion et de pression
26		Fehlertoleranzzeit	fault tolerance time	temps de tolérance aux pannés
102	3.71	Ferngesteuertes Zurücksetzen	remote reset	ré-armement à distance
27	3.29	Filter/Sieb; Schmutzfänger	filter/strainer; strainer/filter	filtre/tamis; tamis/filter
29		Flammenausfall	flame failure	défaut de flame
31	3.32	Flammenfühler	flame sensor	détecteur de flame
33	3.34	Flammenrückschlag	flash back	retour de flame
32	3.33	Flammensperre	flame trap or flame arrestor	arrête-flamme
8	3.1	Flammenüberwachungs-einrichtung	automatic burner control system	système automatique de commande de brûleur
28	3.31	Flammenwächter	flame detector device	équipement de détection de flamme
57	3.47	Flüssiggas	liquefied petroleum gas (LPG)	gaz de pétrole liquéfié (GPL)
35	3.35	Flüssigkeiten	fluids	fluides
36	3.36	Flüssigkeiten Gruppe 1	fluids group 1	fluides du groupe 1
37	3.37	Flüssigkeiten Gruppe 2	fluids group 2	fluides du groupe 2
75	3.13	Freibrennender Brenner	open firing burner	brûleur à flamme nue
38	3.38	Funktionssicherheit	functional safety	sécurité fonctionnelle
43	3.41	Gasdruckregler	gas pressure regulator	Régulateur/détendeur de pression
42	3.40	Gasdruckwächter	gas pressure detector	détecteur de pression de gaz
61		Gasmangelsicherung Gas min.	low gas pressure protection min.	Protection contre le manque de pression de gaz
39		Gasmengeneinstellung des Brenners	gas flow adjustment for burner	Robinet d'ajustement de débit gaz pour brûleur
40	3.39	Gasströmungswächter	gas flow detector	détecteur de débit de gaz
47		Gasüberdrucksicherung	high gas pressure protection max.	protection contre les surpressions gaz
41		Gasverteiler	gas manifold	collecteur de gaz (nourrice)
34	3.7	Gebläsebrenner	forced draught burner	brûleur à air soufflé
123	3.87	Gesamt-Schließzeit	total closing time	temps total de fermeture
95	3.67	Getaktete Feuerung	pulse firing	combustion séquentielle

Table B.2 *(continued)*

Ref.	Definition – No.	German	English	French
65	3.11	Handbedienter Brenner	manual burner	brûleur manuel
59	3.90	Handbetätigtes Absperrventil	manual shut-off valve	robinet d'isolement à commande manuelle
66	3.89	Handbetätigtes Hauptabsperrventil	manual isolating valve	robinet de barrage à commande manuelle
64		Hauptbrennstoffzufuhr	main fuel supply	alimentation principale en combustible
62	3.51	Hauptflamme	main flame	flamme principale
48	3.43	Hochtemperaturanlage	high temperature equipment	équipement à haute temperature
45	3.42	Klassierter Brennstoff	graded fuel	combustible classé
19	3.23	Kondensatablauf	condensate drain	purge de condensat
82	3.57	Leitungssystem	pipework	Tuyauterie
6	3.3	Luft/Brennstoff-Verhältnis	air/fuel ratio	rapport air/combustible
3		Luft-/Gasregler	air/gas ratio	rapport air/gaz
4		Luft-/Gasregler/ Verhältnisregler	air/gas ratio control	Régulateur de rapport air/gaz
5	3.2	Luftdruckwächter	air pressure detector	détecteur de pression d'air
60		Luftmangelsicherung Luft min.	low air pressure protection min.	Protection contre le manque de pression d'air
1		Luftströmung Luft max. wie benötigt	air flow protection max. as needed (FSL)	Protection contre le manque de débit d'air
2		Luftströmungswächter	air flow detector	détecteur de débit d'air
67	3.52	Manuelle Qittierung/Entstörung	manual reset	réarmement manuel
126	3.18	Maschinenbrenner, Tischbrenner	work station burner	brûleur de poste de travail
119	3.83	Maximaler / minimaler zulässige Temepratur	temperature, maximum / minimum allowable (TS)	température, maximale/minimale admise (TS)
90	3.64	Maximaler zulässiger Betriebsdruck	pressure, maximum allowable (PS)	pression, maximale autorisée (PS)
69		Mischmaschine	mixing machine	machine à mélange
73	3.54	Nennweite (DN)	nominal size (DN)	diamètre nominal (DN)
59	3.50	Niedertemperaturanlage	low temperature equipment	installation basse température
92	3.65	Nutzraum	processing chamber	Laboratoire
85	3.16	Ortsbeweglicher Brenner	portable burner	brûleur portative
120	3.84	Prüfdruck	test pressure	pression d'essai
46	3.8	Rostfeuerung	grate burner	brûleur à grille
55		Rückschlagen	light back	retour de flame

Table B.2 *(continued)*

Ref.	Definition – No.	German	English	French
72	3.91	Rückschlagventil	non-return valve	vanne anti-retour
93		Schließkontrollschalter	proof of closure switch	témoin de fermeture
117		Schmutzfänger; Filter/Sieb	strainer/filter; filter/strainer	tamis/filtre; filtre/tamis
94	3.66	Schutzsystem	protective system	système de protection
108	3.76	Selbstüberprüfte Flammenüber-wachungseinrichtung	self-checking automatic burner control system	système automatique de commande de brûleur auto-vérifiant
105	3.74	Sicherheitsabschaltung	safety shut-down	mise en position d'arrêt
106		Sicherheitsabsperrsystem	safety shut-off system	système d'arrêt de sécurité
10	3.88	Sicherheitsabsperrventil	automatic shut-off valve	robinet automatique de sectionnement
78		Sicherheitsabsperrventil für Gasversorgungsdruck mit manueller Rückstellung	overpressure cut off device	dispositif de coupure haute pression avec réarmement manuel
103	3.72	Sicherheitsausrüstung	safety accessories	accessoires de sécurité
107	3.75	Sicherheitszeit	safety time	temps de sécurité
50		Sicherheitszeit "Anlauf"	ignition safety time	temps de sécurité à l'allumage
25		Sicherheitszeit "Betrieb"	extinction safety time	temps de sécurité à l'extinction
30	3.30	Sicherheitszeit im Betrieb	flame response time (FRT)	temps de réponse à l'extinction (FR)
52	3.45	Siedebeginn	initial boiling point	point d'ébullition initial
84	3.59	SPS (Speicherprogrammierbare Steuerung)	PLC (Programmable logical control)	API (Automate Programmable Industriel)
98	3.69	Spülstutzen	purge point	point de purge
97		Spülung	purge	purge
114		Startwärmebelastung	start fuel supply	alimentation en combustible de démarrage
20	3.24	Steuerungssystem	control system	système de commande
116	3.81	Stöchiometrische Brennstoffmenge	stoichiometric fuel rate	régime stoechiométrique
74	3.48	Störabschaltung	lock-out, non volatile	mise en position de sécurité
60		Störabschaltung	non volatile lock-out	mise en position de sécurité
100	3.17	Strahlheizrohrbrenner	radiant tubes burner	brûleur pour tubes radiants
118	3.82	Systemdichtheitsprüfung	system leak tightness check	système de contrôle d'étanchéité
121	3.85	Thermoprozessanlage	thermo-processing equipment	équipement thermique

Table B.2 *(continued)*

Ref.	Definition – No.	German	English	French
77	3.56	Überwachen durch Bedienungs-personal	operator supervision	surveillance par opérateur
21	3.6	Überzündende Brenner	cross-ignited burners	brûleurs à interallumage
58	3.49	Untere Zündgrenze	lower flammability limit (LFL)	limite inférieure d'inflammabilité
124	3.93	Ventilüberwachungssystem	valve proving system	contrôleur d'étanchéité
17	3.21	Verbrennungsluft	combustion air	air de combustion
83	3.58	Verrohrung	piping	canalisation
86	3.60	Vorspülen	pre-purge	Prébalayage
16	3.20	Wärmewert	calorific value	pouvoir calorifique
101	3.70	Wiederanlauf	re-cycling	Redémarrage
110	3.78	Wiederzündung	spark restoration	reprise d'étincelle
125	3.94	Wobbe-Index	Wobbe index	indice de Wobbe
127	3.95	Zone	zone	zone
129		Zonen- Sicherheitsabsperrventil	zone automatic shut-off valve	vanne d'arrêt de sécurité de zone
128		Zonen-handbetätigtes-Absperrventil	zone isolating valve	robinet de barrage de zone
79	3.15	Zündbrenner	pilot burner	brûleur d'allumage
7	3.5	Zündbrenner mit Abschaltung	alternating pilot burner	brûleur d'allumage à fonctionnement semi-permanent alterné
80	3.14	Zündbrenner mit Dauerbetrieb	permanent pilot burner	brûleur d'allumage permanent
81		Zündflamme	pilot flame	flamme d'allumage
56	3.46	Zündlanze	lighting torch	torche d'allumage
49	3.44	Zündung	ignition	allumage

Table B.3 — French – English – German

Ref.	Definition – No.	French	English	German
17	3.21	air de combustion	combustion air	Verbrennungsluft
23	3.26	air enrichi	enriched air	Angereicherte Luft
115		alimentation en combustible de démarrage	start fuel supply	Startwärmebelastung
64		alimentation principale en combustible	main fuel supply	Hauptbrennstoffzufuhr
49	3.44	allumage	ignition	Zündung
84	3.59	API (Automate Programmable Industriel)	PLC (Programmable logical control)	SPS (Speicher-programmierbare Steuerung)
32	3.33	arrête-flamme	flame trap or flame arrestor	Flammensperre
88	3.62	accessoires de pression	pressure accessories	Druckführende Teile
103	3.72	accessoires de sécurité	safe accessories	Sicherheitsausrüstung
15	3.19	bipasse	by-pass	Bypass
53		bride d'isolement	isolating flange (blanking plate)	Blindflansch
11	3.4	brûleur	burner	Brenner
51	3.9	brûleur à air induit	induced draught burner	Brenner mit mechanischer Abgasabführung
34	3.7	brûleur à air soufflé	forced draught burner	Gebläsebrenner
75	3.13	brûleur à flamme nue	open firing burner	Freibrennender Brenner
46	3.8	brûleur à grille	grate burner	Rostfeuerung
21	3.6	brûleurs à interallumage	cross-ignited burners	überzündende Brenner
72	3.12	brûleur atmosphérique	natural draught burner	Brenner ohne Gebläse
9		brûleur automatique	automatic burner	Automatischer Brenner
50		brûleur d'allumage	pilot burner	Zündbrenner
79	3.15	brûleur d'allumage	pilot burner	Zündbrenner
7	3.5	brûleur d'allumage à fonctionnement semi-permanent alterné	alternating pilot burner	Zündbrenner mit Abschaltung
80	3.14	brûleur d'allumage permanent	permanent pilot burner	Zündbrenner mit Dauerbetrieb
126	3.18	brûleur de poste de travail	work station burner	Maschinenbrenner, Tischbrenner
109	3.77	brûleur individual systeme	single burner equipment	Einzelbrennersystem
65	3.11	brûleur manuel	manual burner	Handbedienter Brenner
85	3.16	brûleur portatif	portable burner	Ortsbeweglicher Brenner
100	3.17	brûleur pour tubes radiants	radiant tubes burner	Strahlheizrohrbrenner
21	3.6	brûleurs à interallumage	cross-ignited burners	Überzündende Brenner

Table B.3 *(continued)*

Ref.	Definition – No.	French	English	German
83	3.58	canalisation	piping	Verrohrung
22	3.25	CEM	EMC	EMC
122	3.86	chalumeau	torch	Brennerlanze
18	3.22	chambre de combustion	combustion chamber	Brennkammer/Feuerraum
41		collecteur de gaz (nourrice)	gas manifold	Gasverteiler
45	3.42	combustible classé	graded fuel	Klassierter Brennstoff
111	3.79	combustible de démarrage	start fuel	Anfahrbrennstoff
97	3.68	combustible solide pulvérisé	pulverised fuel	Brennstoffstaub
95	3.67	combustion séquentielle	pulse firing	Getaktete Feuerung
124	3.93	contrôleur d'étanchéité	valve proving system	Ventilüberwachungssystem
12	3.10	débit calorifique du brûleur	burner input rate	Brennerleistung
114	3.80	débit de combustible de démarrage	start fuel flow rate	Anfahrbrennstoffmenge
29		défaut de flamme	flame failure	Flammenausfall
2		détecteur de débit d'air	air flow detector	Luftströmungswächter
40	3.39	détecteur de débit de gaz	gas flow detector	Gasströmungswächter
31	3.32	détecteur de flamme	flame sensor	Flammenfühler
5	3.2	détecteur de pression d'air	air pressure detector	Luftdruckwächter
42	3.40	détecteur de pression de gaz	gas pressure detector	Gasdruckwächter
73	3.54	diamètre nominal (DN)	nominal size (DN)	Nennweite (DN)
54		dispositif de contrôle d'étanchéité	leak tightness device	Dichtheitskontrolleinrichtung
78		dispositif de coupure haute pression avec réarmement manuel	overpressure cut off device	Sicherheitsabsperrventil für Gasversorgungsdruck mit manueller Rückstellung
24	3.27	dispositif de décharge d'explosion et de pression	explosion/pressure relief	Explosions-/Druckentlastungs-einrichtung/Berstscheibe
70	3.53	équipement à brûleurs multiples	multiple burner equipment	Brennergruppe
48	3.43	équipement à haute température	high temperature equipment	Hochtemperaturanlage
121	3.85	équipement thermique	thermo-processing equipment	Thermoprozessanlage
28	3.31	équipement de détection de flamme	flame detector device	Flammenwächter
89	3.63	équipement de pression	pressure equipment	Druckgeräte
113		établissement de la flamme du combustible de démarrage	start fuel flame establishment	Entstehen der Anfahrflamme

Table B.3 *(continued)*

Ref.	Definition – No.	French	English	German
27	3.29	filtre/tamis; tamis/filtre	filter/strainer; strainer/filter	Filter/Sieb; Schmutzfänger
81		flamme d'allumage	pilot flame	Zündflamme
112		flamme du combustible de démarrage	start fuel flame	Anfahrflamme
62	3.51	flamme principale	main flame	Hauptflamme
35	3.35	fluides	fluids	Flüssigkeiten
36	3.36	fluides du groupe 1	fluids group 1	Flüssigkeiten Gruppe 1
37	3.37	fluides du groupe 2	fluids group 2	Flüssigkeiten Gruppe 2
57	3.47	gaz de pétrole liquéfié (GPL)	liquefied petroleum gas (LPG)	Flüssiggas
125	3.94	indice de Wobbe	Wobbe index	Wobbe-Index
59	3.50	installation basse température	low temperature equipment	Niedertemperaturanlage
92	3.65	laboratoire	processing chamber	Nutzraum
58	3.49	limite inférieure d'inflammabilité	lower flammability limit (LFL)	Untere Zündgrenze
69		machine à mélange	mixing machine	Mischmaschine
105	3.74	mise en position d'arrêt	safety shut-down	Sicherheitsabschaltung
60	3.48	mise en position de sécurité	lock-out, non volatile	Störabschaltung
63		période d'établissement de la flamme principale	main flame establishment period	Entstehungszeit der Hauptflamme
98	3.69	point de purge	purge point	Spülstutzen
52	3.45	point d'ébullition initial	initial boiling point	Siedebeginn
16	3.20	pouvoir calorifique	calorific value	Wärmewert
86	3.60	prébalayage	pre-purge	Vorspülen
87	3.61	pression	pressure	Druck
120	3.84	pression d'essai	test pressure	Prüfdruck
90	3.64	pression, maximale autorisée (PS)	pressure, maximum allowable (PS)	Maximaler zulässiger Betriebsdruck
1		protection contre le manque de débit d'air	air flow protection	Luftströmung
60		protection contre le manque de pression d'air	low air pressure protection min.	Luftmangelsicherung
61		Protection contre le manque de pression de gaz	low gas pressure protection min.	Gasmangelsicherung Gas min.
47		protection contre les surpressions gaz	high gas pressure protection max.	Gasüberdrucksicherung
97		purge	purge	Spülung
19	3.23	purge de condensat	condensate drain	Kondensatablauf

Table B.3 *(continued)*

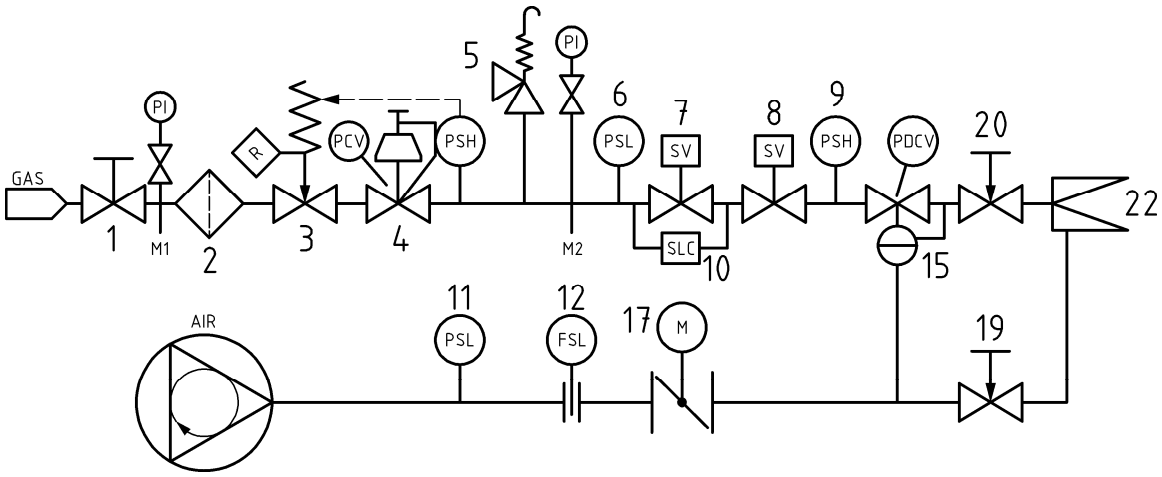
Ref.	Definition – No.	French	English	German
6	3.3	rapport air/combustible	air/fuel ratio	Luft/Brennstoff-Verhältnis
3		rapport air/gaz	air/gas ratio	Luft-/Gasregler
102	3.71	ré-armement à distance	remote reset	Ferngesteuertes Zurücksetzen
101	3.70	redémarrage	re-cycling	Wiederanlauf
116	3.81	régime stoechiométrique	stoichiometric fuel rate	Stöchiometrische Brennstoffmenge
44		Régulateur/détendeur de pression	gas pressure regulator	Gasdruckregler
4		Régulateur de rapport air/gaz	air/gas ratio control	Luft-/Gasregler/ Verhältnisregler
44		régulateur de pression	governor (pressure regulator)	Druckregler
43	3.41	régulateur/détendeur de pression	gas pressure regulator	Gasdruckregler
110	3.78	reprise d'étincelle	spark restoration	Wiederzündung
33	3.34	retour de flamme	flash back	Flammenrückschlag
55		retour de flamme	light back	Rückschlagen
10	3.88	robinet automatique de sectionnement	automatic shut-off valve	Sicherheitsabsperrventil
39		robinet d'ajustement de débit gaz pour brûleur	gas flow adjustment for burner	Gasmengeneinstellung des Brenners
67	3.89	robinet de barrage à commande manuelle	manual isolating valve	Handbetätigtes Hauptabsperrventil
128		robinet de barrage de zone	zone isolating valve	Zonen-handbetätigtes-Absperrventil
68	3.90	robinet d'isolement à commande manuelle	manual shut-off valve	Handbetätigtes Absperrventil
13		robinet manuel de sectionnement de brûleur	burner manual shut-off valve	Brenner handbetätigtes Absperrventil
38	3.38	sécurité fonctionnelle	functional safety	Funktionssicherheit
99		soupape de décharge	relief valve	Abblaseventil
91	3.92	soupape de décharge à pression (déverseur)	pressure relief valve	Druckentlastungsventil
77	3.56	surveillance par opérateur	operator supervision	Überwachen durch Bedienungs-personal
20	3.24	système de commande	control system	Steuerungssystem
8	3.1	système automatique de commande de brûleur	automatic burner control system	Flammenüberwachungs-einrichtung
108	3.76	système automatique de commande de brûleur auto-vérifiant	self-checking automatic burner control system	Selbstüberprüfte Flammenüber-wachungseinrichtung

Table B.3 *(continued)*

Ref.	Definition – No.	French	English	German
106		système d'arrêt de sécurité	safety shut-off system	Sicherheitsabsperrsystem
118	3.82	système de contrôle d'étanchéité	system leak tightness check	Systemdichtheitsprüfung
94	3.66	système de protection	protective system	Schutzsystem
67	3.52	réarmement manuel	manual reset	Manuelle Qittierung/Entstörung
117		tamis/filtre; filtre/tamis	strainer/filter; filter/strainer	Schmutzfänger; Filter/Sieb
93		témoin de fermeture	proof of closure switch	Schließkontrollschalter
119	3.83	température, maximale / minimale admise (TS)	temperature, maximum / minimum allowable (TS)	Maximaler / minimaler zulässige Temepratur
76	3.55	température de service	operating temperature	Arbeitstemperatur
30	3.30	temps de réponse à l'extinction (FR)	flame response time (FRT)	Sicherheitszeit im Betrieb
107	3.75	temps de sécurité	safety time	Sicherheitszeit
50		temps de sécurité à l'allumage	ignition safety time	Sicherheitszeit "Anlauf"
25		temps de sécurité à l'extinction	extinction safety time	Sicherheitszeit "Betrieb"
26		temps de tolérance aux pannés	fault tolerance time	Fehlertoleranzzeit
123	3.87	temps total de fermeture	total closing time	Gesamt-Schließzeit
56	3.46	torche d'allumage	lighting torch	Zündlanze
82	3.57	tuyauterie	pipework	Leitungssystem
72	3.91	vanne anti-retour	non-return valve	Rückschlagventil
14		vanne d'arrêt de sécurité de brûleur relié au boîtier/dispositif de surveillance de flamme	burner automatic shut-off valve connected to automatic burner control	Brenner Sicherheitsabsperrventil verbunden mit dem Gasfeuerungsautomaten
111		vanne d'arrêt de sécurité de zone	zone automatic shut-off valve	Zonen- Sicherheitsabsperrventil
127	3.95	zone	zone	Zone
104	3.73	zone d'évacuation sûre	safe discharge area	Bereich für sichere Abführung

Annex C
(informative)

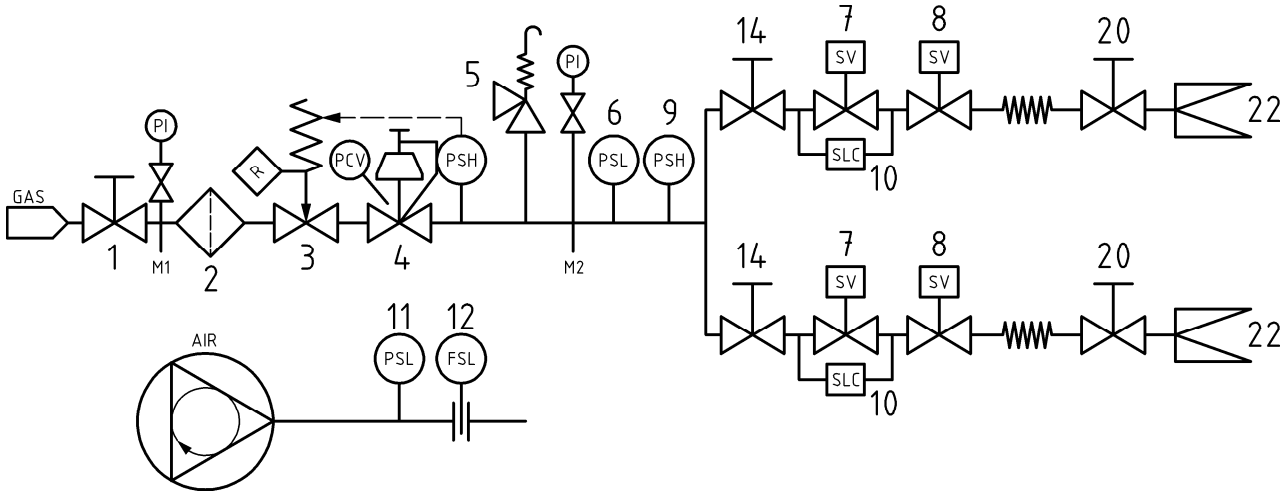
Typical examples of piping and components



Key

1	manual isolating valve
2	filter/strainer
3	overpressure cut off device with manual reset (R)
4	gas pressure regulator (PSV)
5	relief valve
6	low gas pressure protection (PSL)
7	1st automatic shut-off valve (SV)
8	2nd automatic shut-off valve (SV)
9	high gas pressure protection (PSH)
10	system leak tightness check/ valve proving system (SLC)
11	low air pressure protection (PSL)
12	air flow protection as needed (FSL)
15	air/gas ratio control (PDCV)
17	air flow control valve with motor (M)
19	air flow adjustment valve for burner
20	gas flow adjustment valve for burner
22	burner
M	control motor
M1	measuring point for inlet pressure (pressure indicator PI)
M2	measuring point for governor/regulator outlet pressure (pressure indicator PI)
PI	pressure indicator
PCV	pressure control valve
PDCV	pressure difference control valve
PSH	pressure switch high
R	manual reset

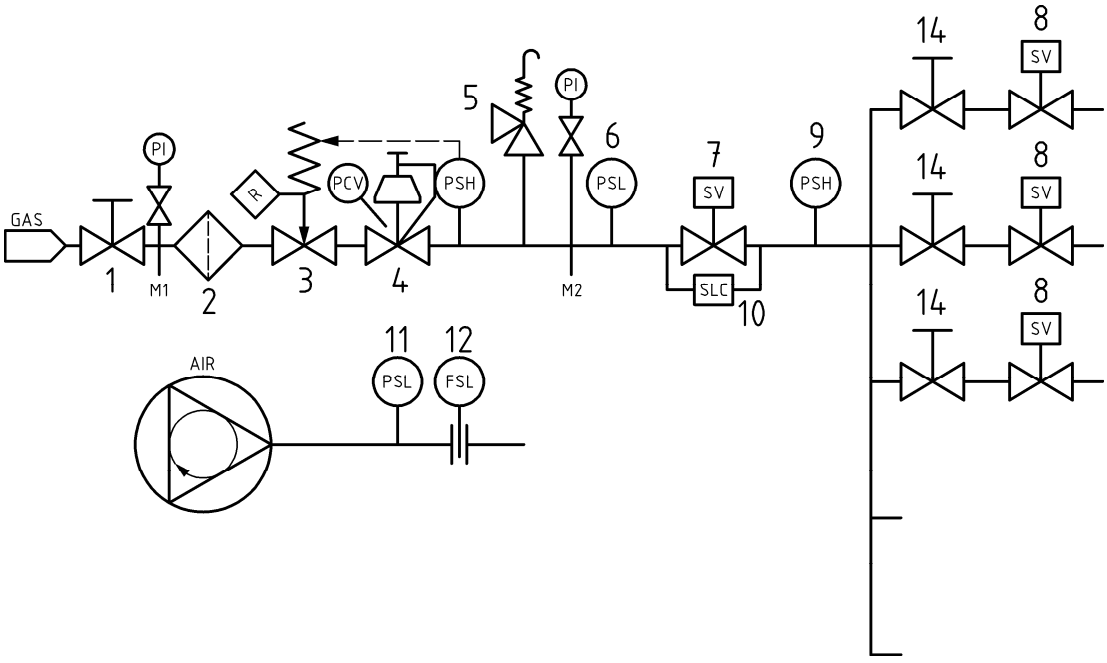
Figure C.1 — Single burner equipment



Key

1	manual isolating valve
2	filter/strainer
3	overpressure cut off device with manual reset (R)
4	gas pressure regulator (PSV)
5	relief valve
6	low gas pressure protection (PSL)
7	1st automatic shut-off valve (SV)
8	2nd automatic shut-off valve (SV)
9	high gas pressure protection (PSH)
10	system leak tightness check/ valve proving system (SLC)
11	low air pressure protection (PSL)
12	air flow protection as needed (FSL)
14	burner manual shut-off valve
15	air/gas ratio control
20	gas flow adjustment valve for burner
22	burner
M1	measuring point for inlet pressure (pressure indicator PI)
M2	measuring point for governor/regulator outlet pressure (pressure indicator PI)

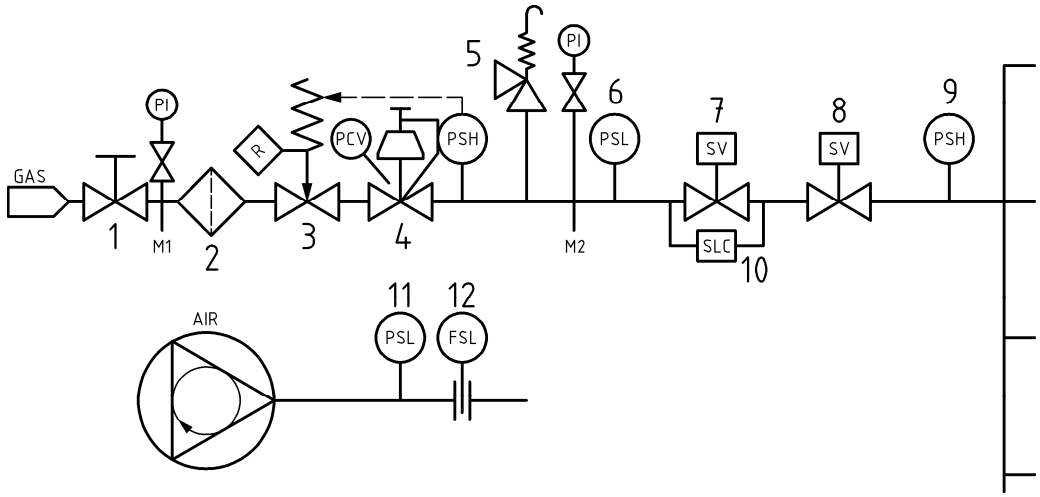
Figure C.2a — Multiple burner equipment – Central pipework – Example a two burners system



Key

1	manual isolating valve
2	filter/strainer
3	overpressure cut off device with manual reset (R)
4	gas pressure regulator (PSV)
5	relief valve
6	low gas pressure protection (PSL)
7	1st automatic shut-off valve (SV)
8	2nd automatic shut-off valve (SV)
9	high gas pressure protection (PSH)
10	system leak tightness check/ valve proving system (SLC)
11	low air pressure protection (PSL)
12	air flow protection as needed (FSL)
14	burner manual shut-off valve
M1	measuring point for inlet pressure (pressure indicator PI)
M2	measuring point for governor/regulator outlet pressure (pressure indicator PI)

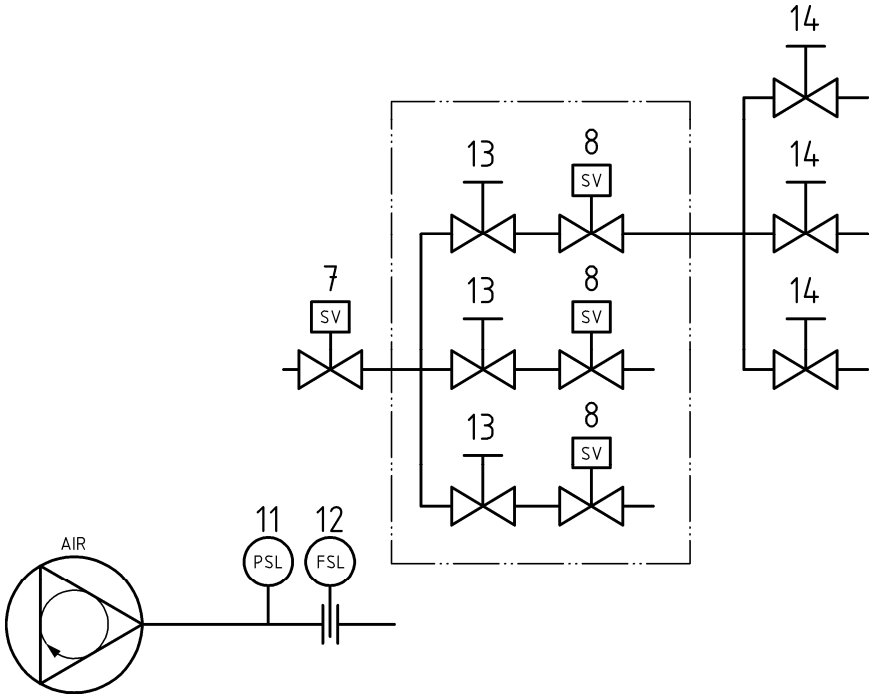
Figure C.2b — Multiple burner equipment – Central pipework – Example b



Key

1	manual isolating valve
2	filter/strainer
3	overpressure cut off device with manual reset (R)
4	gas pressure regulator (PSV)
5	relief valve
6	low gas pressure protection (PSL)
7	1st automatic shut-off valve (SV)
8	2nd automatic shut-off valve (SV)
9	high gas pressure protection (PSH)
10	system leak tightness check/ valve proving system (SLC)
11	low air pressure protection (PSL)
12	air flow protection as needed (FSL)
M1	measuring point for inlet pressure (pressure indicator PI)
M2	measuring point for governor/regulator outlet pressure (pressure indicator PI)

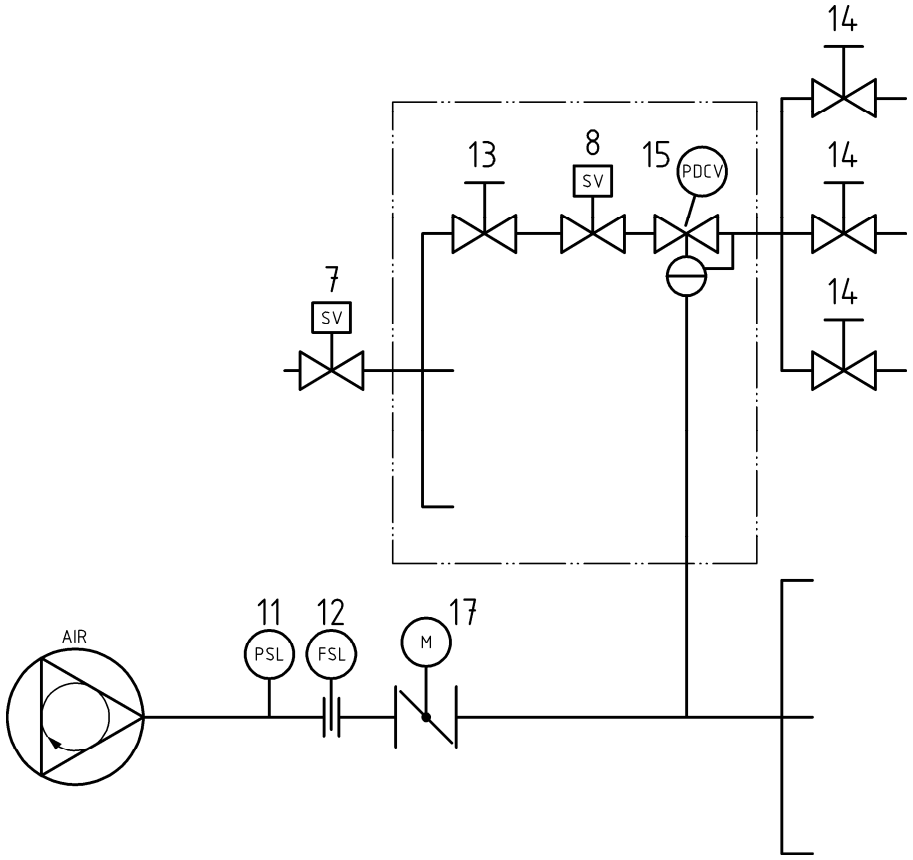
Figure C.2c — Multiple burner equipment – Central pipework – Example c



Key

7	1st automatic shut-off valve (SV)
8	2nd automatic shut-off valve (SV)
11	low air pressure protection (PSL)
12	air flow protection as needed (FSL)
13	zone isolating valve
14	burner manual shut-off valve

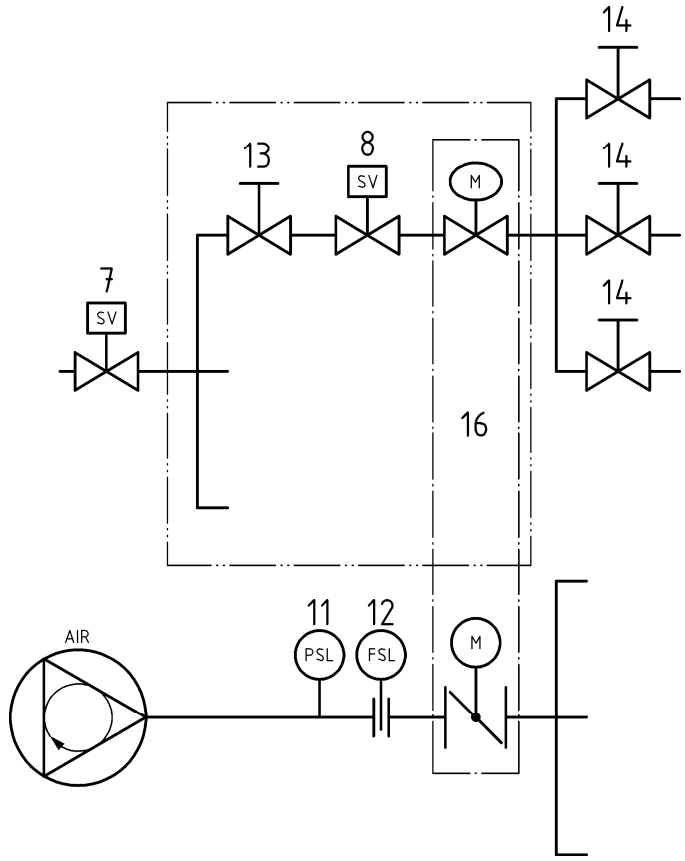
Figure C.3a — Multiple burner equipment – Zone pipework – Example a



Key

7	1st automatic shut-off valve (SV)
8	2nd automatic shut-off valve (SV)
11	low air pressure protection (PSL)
12	air flow protection as needed (FSL)
13	zone isolating valve
14	burner manual shut-off valve
15	air/gas ratio control (PDCV)
17	air flow control valve with motor (M)

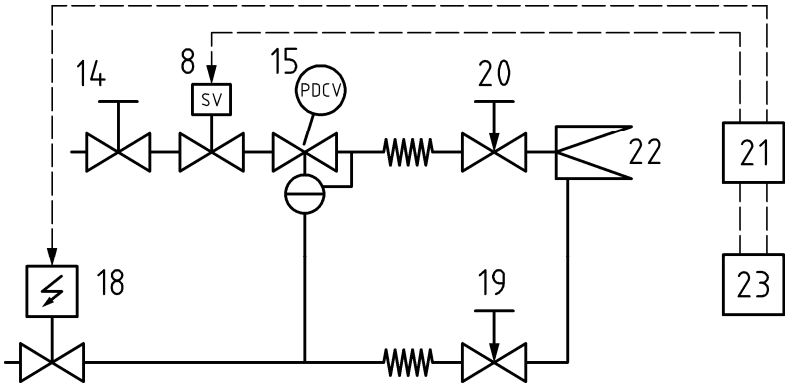
Figure C.3b — Multiple burner equipment – Zone pipework – Example b



Key

7	1st automatic shut-off valve (SV)
8	2nd automatic shut-off valve (SV)
11	low air pressure protection (PSL)
12	air flow protection as needed (FSL)
13	zone isolating valve
14	burner manual shut-off valve
16	electronic air/gas ratio control with motor (M)

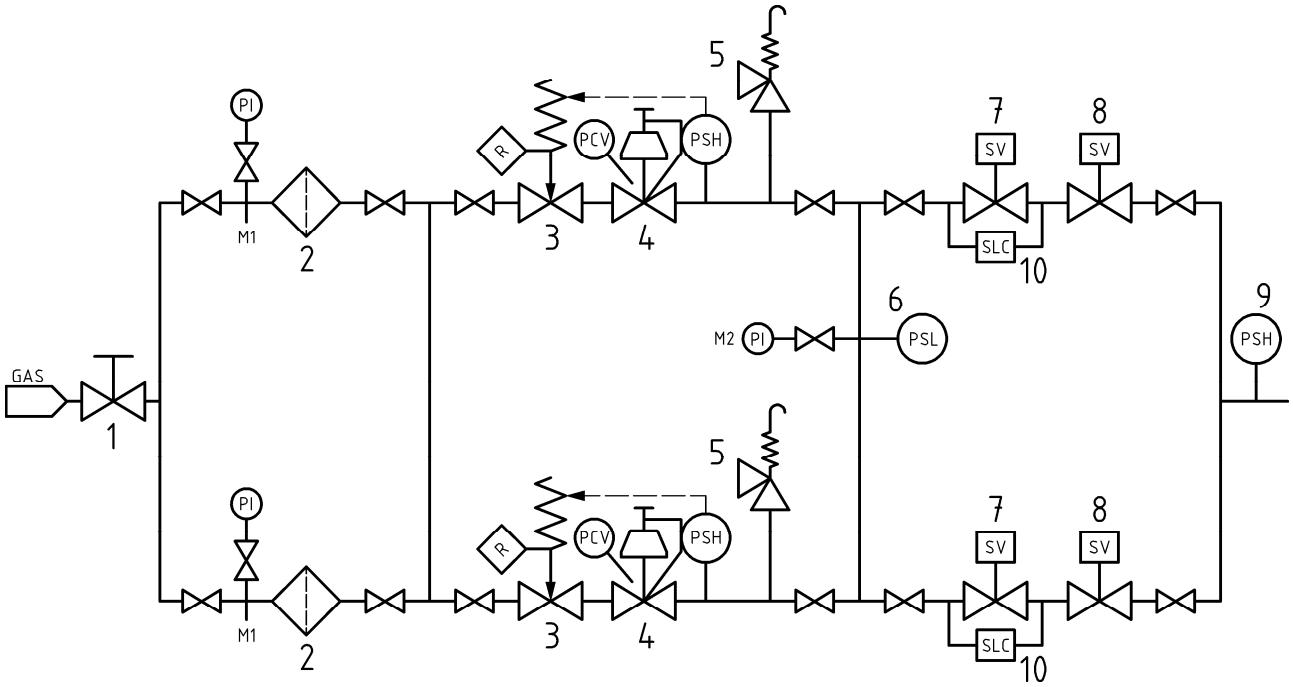
Figure C.3c — Multiple burner equipment – Zone pipework – Example c



Key

8	2nd automatic shut-off valve (SV)
14	burner manual shut-off valve
15	air/gas ratio control (PDCV)
18	air flow valve for burner
19	air flow adjustment valve for burner
20	gas flow adjustment valve for burner
21	automatic burner control system
22	burner
23	PLC programmable logical control

Figure C.4 — Multiple burner equipment (burner pipework)



Key

1	manual isolating valve
2	filter/strainer
3	overpressure cut off device with manual reset (R)
4	gas pressure regulator (PSV)
5	relief valve
6	low gas pressure protection (PSL)
7	1st automatic shut-off valve (SV)
8	2nd automatic shut-off valve (SV)
9	high gas pressure protection (PSH)
10	system leak tightness check/ valve proving system (SLC)
M1	measuring point for inlet pressure (pressure indicator PI)
M2	measuring point for governor/regulator outlet pressure (pressure indicator PI)

Figure C.5 — Central pipework for low cycling applications

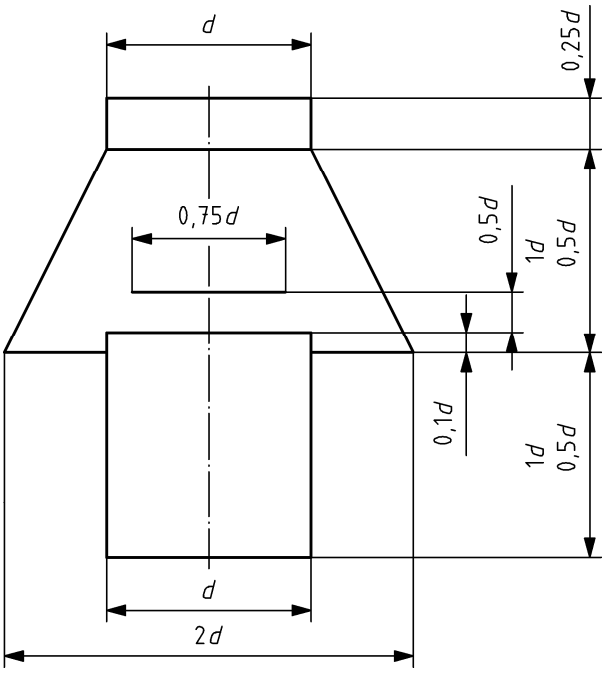
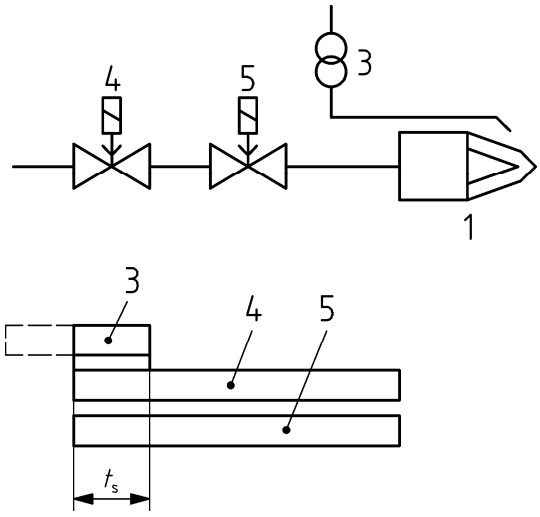


Figure C.6 — Draft breaks

Annex D
(informative)

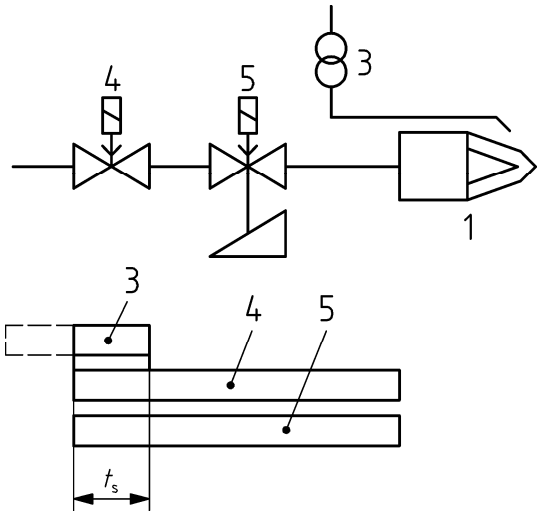
Methods for burner start-up



Key

1	burner
3	ignition
4	1st shut-off valve
5	2nd shut-off valve
t_S	safety time

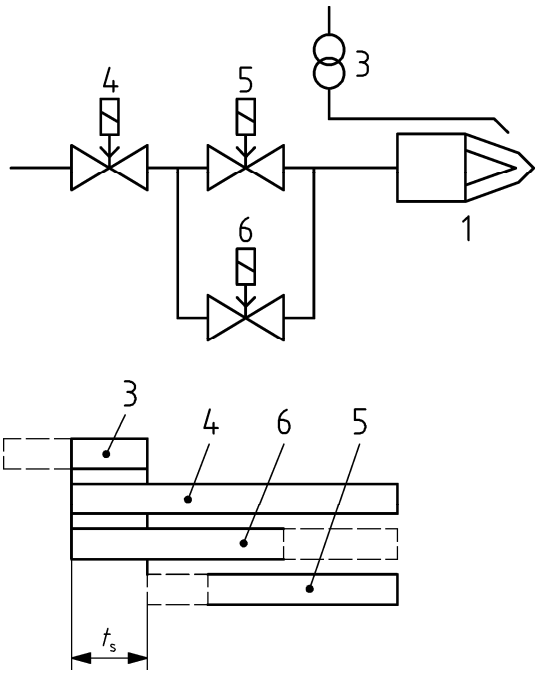
Figure D.1 — Direct main burner ignition at full rate (see Table 3, Column 2, $Q_{F\ max} \leq 120$ kW)

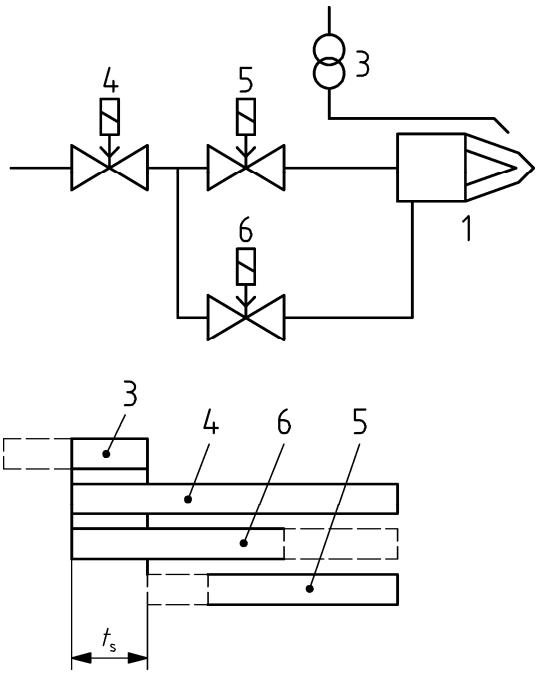


Key

1	burner
3	ignition
4	1st shut-off valve
5	2nd shut-off valve
t_S	safety time

Figure D.2 — Direct main burner ignition at reduced ratewith slow opening valve (see Table 3, Column 3, $Q_{F\ max} \leq 360$ kW)

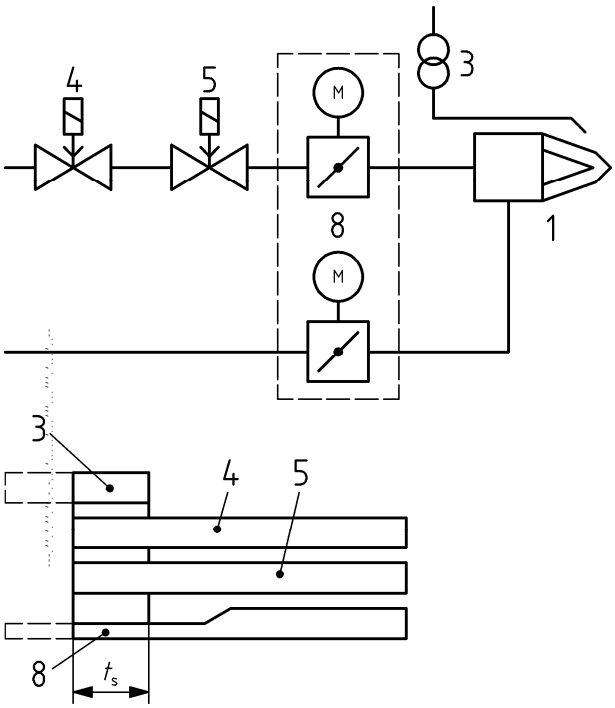


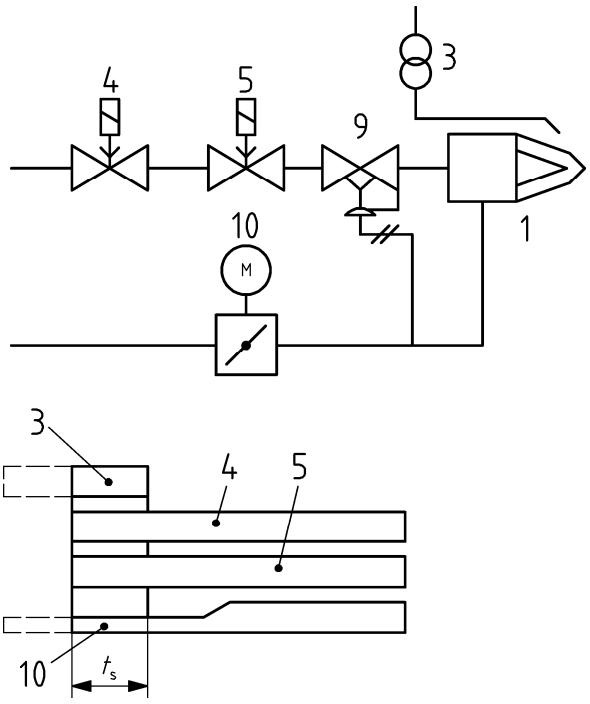


Key	
1	burner
3	ignition
4	1st shut-off valve
5	2nd shut-off valve
6	by-pass shut-off valve
t_S	safety time

Key	
1	burner
3	ignition
4	1st shut-off valve
5	2nd shut-off valve
6	by-pass shut-off valve
t_S	safety time

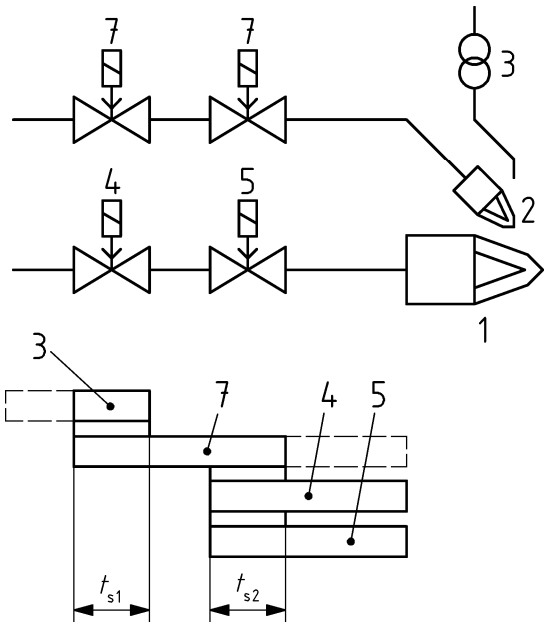
Figures D.3 and D.4 — Direct main burner ignition at reduced rate with by-pass start gas supply (see Table 3, Column 4)

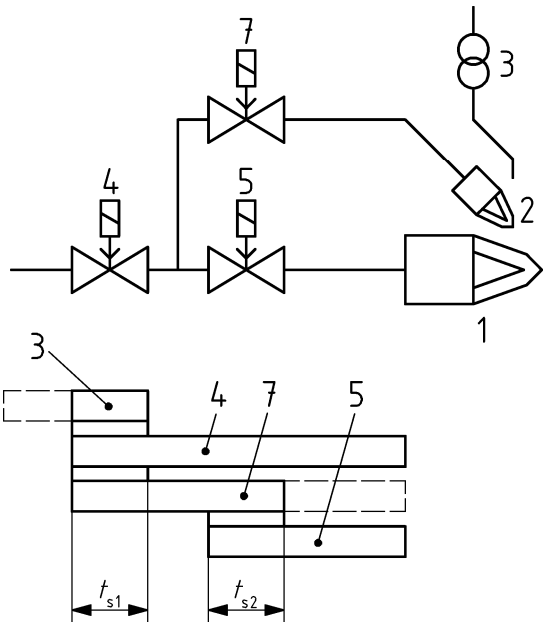




Key		Key	
1	burner	1	burner
3	ignition	3	ignition
4	1st shut-off valve	4	1st shut-off valve
5	2nd shut-off valve	5	2nd shut-off valve
8	electronic air/gas ratio control with motor (M)	9	air/gas ratio control (PDCV)
		10	air flow control valve with motor (M)
t_S	safety time	t_S	safety time

Figures D.5 and D.6 — Direct main burner ignition at reduced rate with limited start gas input (see Table 3, Column 4)

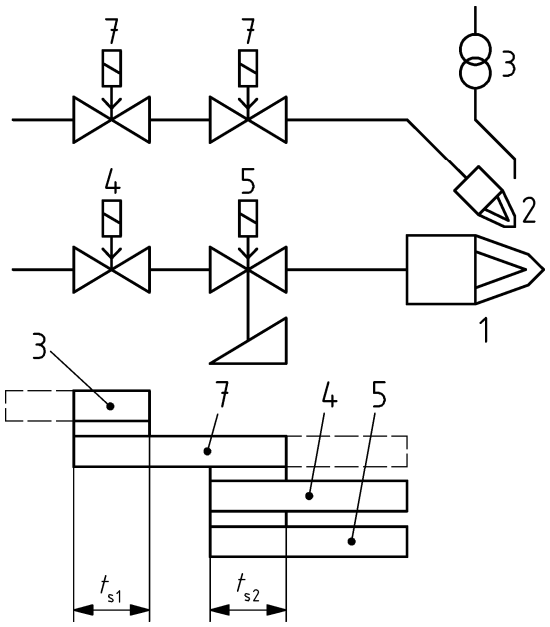


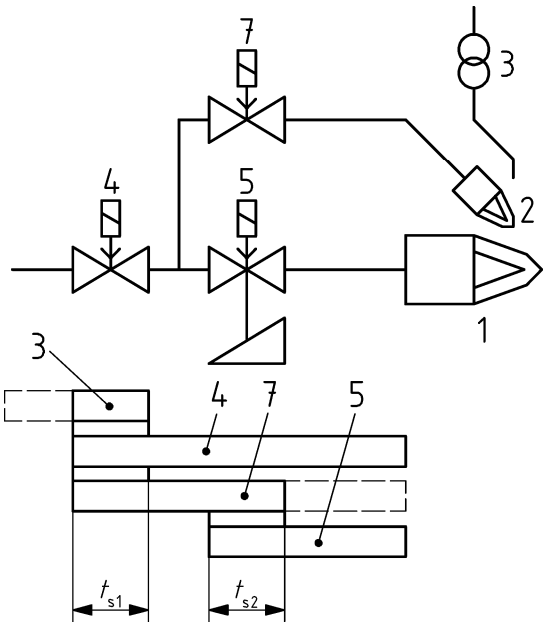


Key	
1	burner
2	pilot burner
3	ignition
4	1st shut-off valve
5	2nd shut-off valve
7	pilot burner shut-off valve
t_{S1}	safety time 1
t_{S2}	safety time 2

Key	
1	burner
2	pilot burner
3	ignition
4	1st shut-off valve
4	2nd shut-off valve
7	pilot burner shut-off valve
t_{S1}	safety time 1
t_{S2}	safety time 2

Figures D.7 and D.8 — Main burner ignition with independent pilot burner (see Table 3, Column 5, $Q_{F\,max} \leq 120$ kW)

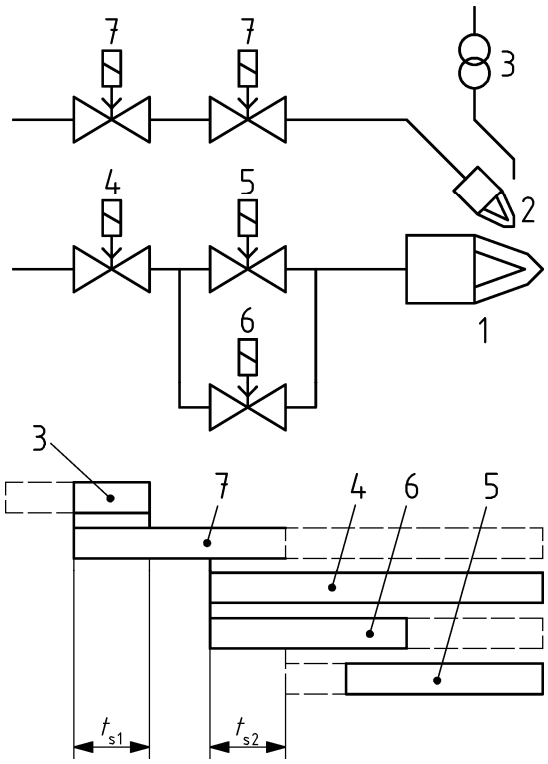


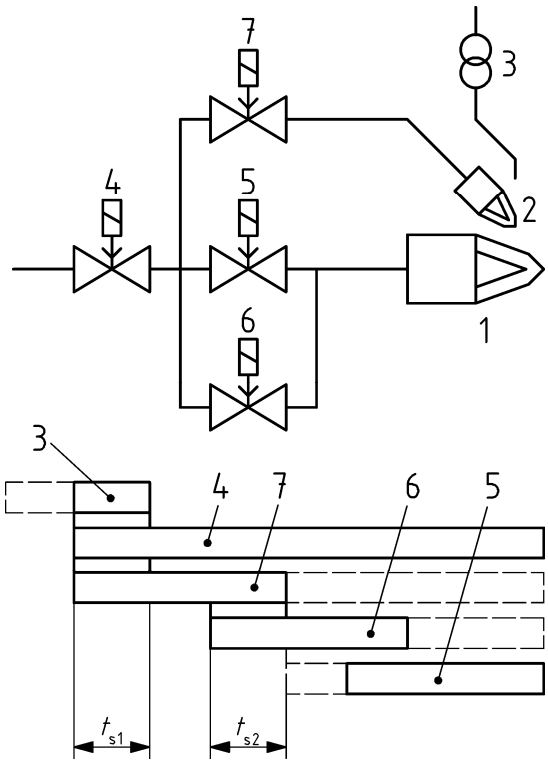


Key	
1	burner
2	pilot burner
3	ignition
4	1st shut-off valve
5	2nd shut-off valve
7	pilot burner shut-off valve
t_{S1}	safety time 1
t_{S2}	safety time 2

Key	
1	burner
2	pilot burner
3	ignition
4	1st shut-off valve
5	2nd shut-off valve
7	pilot burner shut-off valve
t_{S1}	safety time 1
t_{S2}	safety time 2

Figures D.9 and D.10 — Main burner ignition with independent pilot burner (see Table 3, Column 5, $Q_{F\ max} \leq 360$ kW)

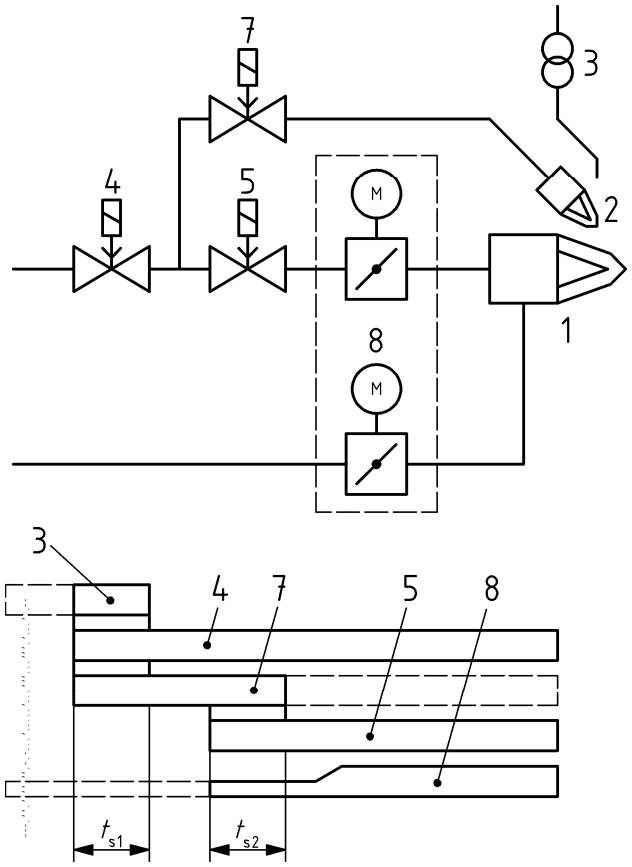


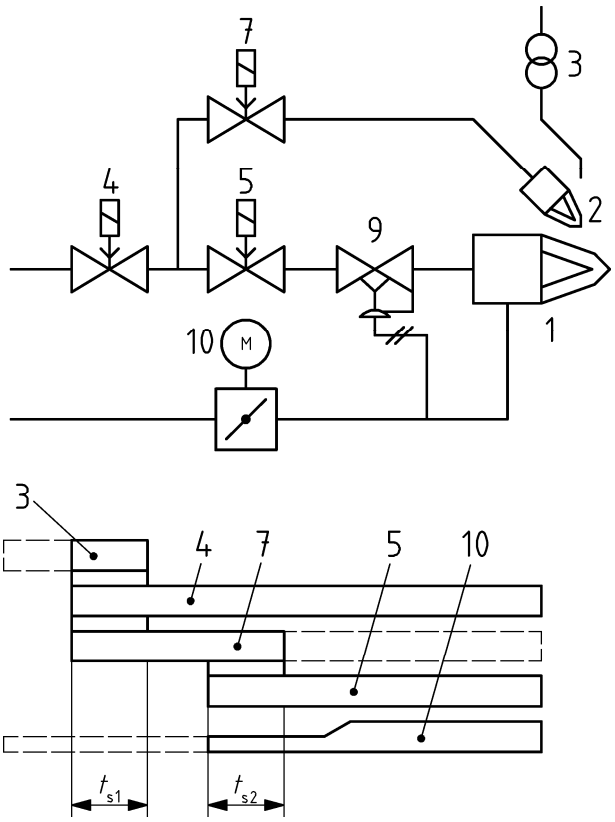


Key	
1	burner
2	pilot burner
3	ignition
4	1st shut-off valve
5	2nd shut-off valve
6	by-pass shut-off valve
7	pilot burner shut-off valve
t_{S1}	safety time 1
t_{S2}	safety time 2

Key	
1	burner
2	pilot burner
3	ignition
4	1st shut-off valve
5	2nd shut-off valve
6	by-pass shut-off valve
7	pilot burner shut-off valve
t_{S1}	safety time 1
t_{S2}	safety time 2

Figures D.11 and D.12 — Main burner ignition with independent pilot burner (see Table 3, Column 5)





Key		**Key**	
1	burner	1	burner
2	pilot burner	2	pilot burner
3	ignition	3	ignition
4	1st shut-off valve	4	1st shut-off valve
5	2nd shut-off valve	5	2nd shut-off valve
7	pilot burner shut-off valve	7	pilot burner shut-off valve
8	electronic air/gas ratio control with motors (M)	9	air/gas ratio control (PDCV)
		10	air flow control valve with motor (M)
t_{S1}	safety time 1	t_{S1}	safety time 1
t_{S2}	safety time 2	t_{S2}	safety time 2

Figures D.13 and D.14 — Main burner ignition with independent pilot burner (see Table 3, Column 5)

Annex E
(normative)

Maximum allowable pressure

This European Standard covers the pressure hazard of piping forming an integral part of Combustion and fuel handling systems of Industrial Thermoprocessing Equipment intended to be subjected to a maximum allowable pressure of not more than 0,5 bar.

This European Standard covers the pressure hazard of piping forming an integral part of Combustion and fuel handling systems of Industrial Thermoprocessing Equipment intended to be subjected to a maximum allowable pressure of more than 0,5 bar containing:

a) gases, liquefied gases, gases dissolved under pressure, vapours and also those liquids whose vapour pressure at the maximum allowable temperature is greater than 0,5 bar above normal atmospheric pressure, (1 013 mbar) at the following limits:

— for Group 1 (see Note 1):

  — DN 25 and included;

  — DN X PS = 1000 for DN 25 up to 100 and included (see Figure E.1);

— for Group 2 (see Note 2):

  — DN 100 and included;

  — DN X PS = 3500 for DN greater than 100 (see Figure E.2).

b) liquids having a vapour pressure at the maximum allowable temperature of not more than 0,5 bar above normal atmospheric pressure (1 013 mbar) at the following limits:

— for Group 1 (see Note 1):

  — DN 25 and included;

  — DN X PS = 2000 for DN 25 up to 200 and included;

  — PS = 10 bar for DN greater than 200 (see Figure E.3);

— for Group 2 (see Note 2):

  — DN 200 and included;

  — PS = 500 bar for DN greater than 200 (see Figure E.4).

This document is not applicable to piping forming an integral part of Combustion and fuel handling systems of Industrial Thermoprocessing Equipment intended to contain unstable gases.

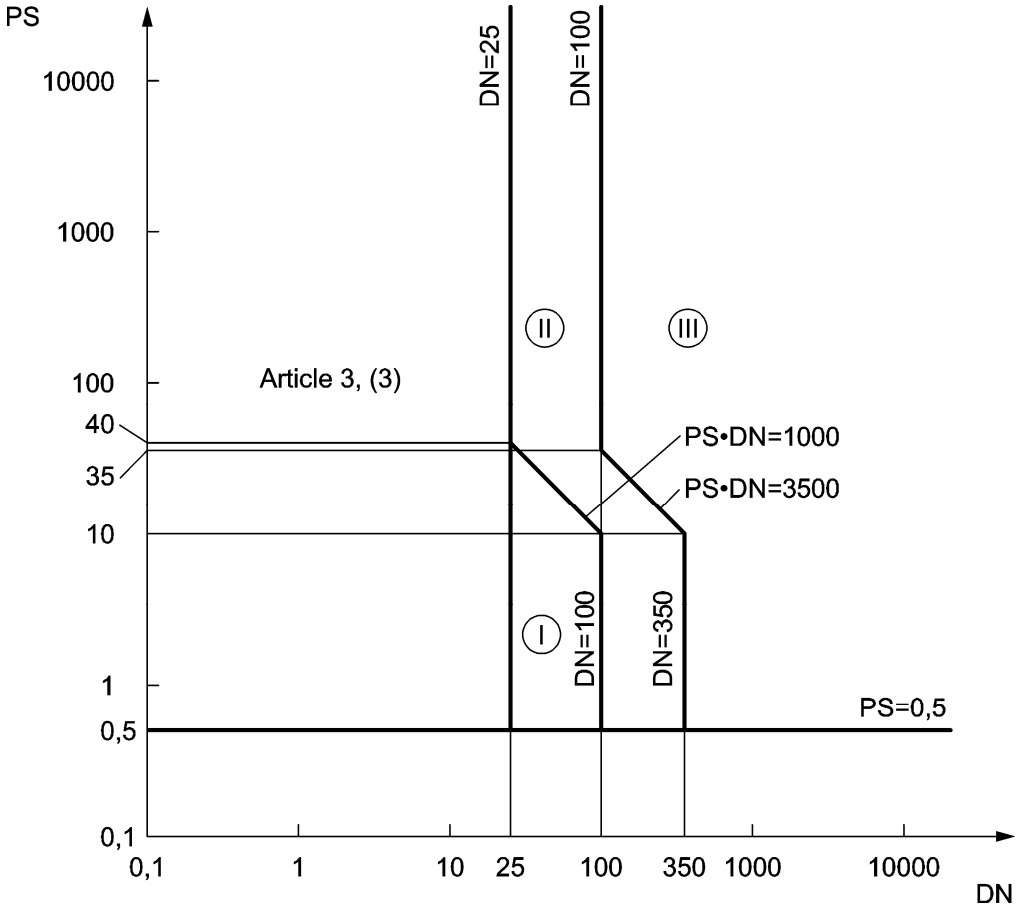


Figure E.1 — Piping referred to clause a) group 1 of Annex E

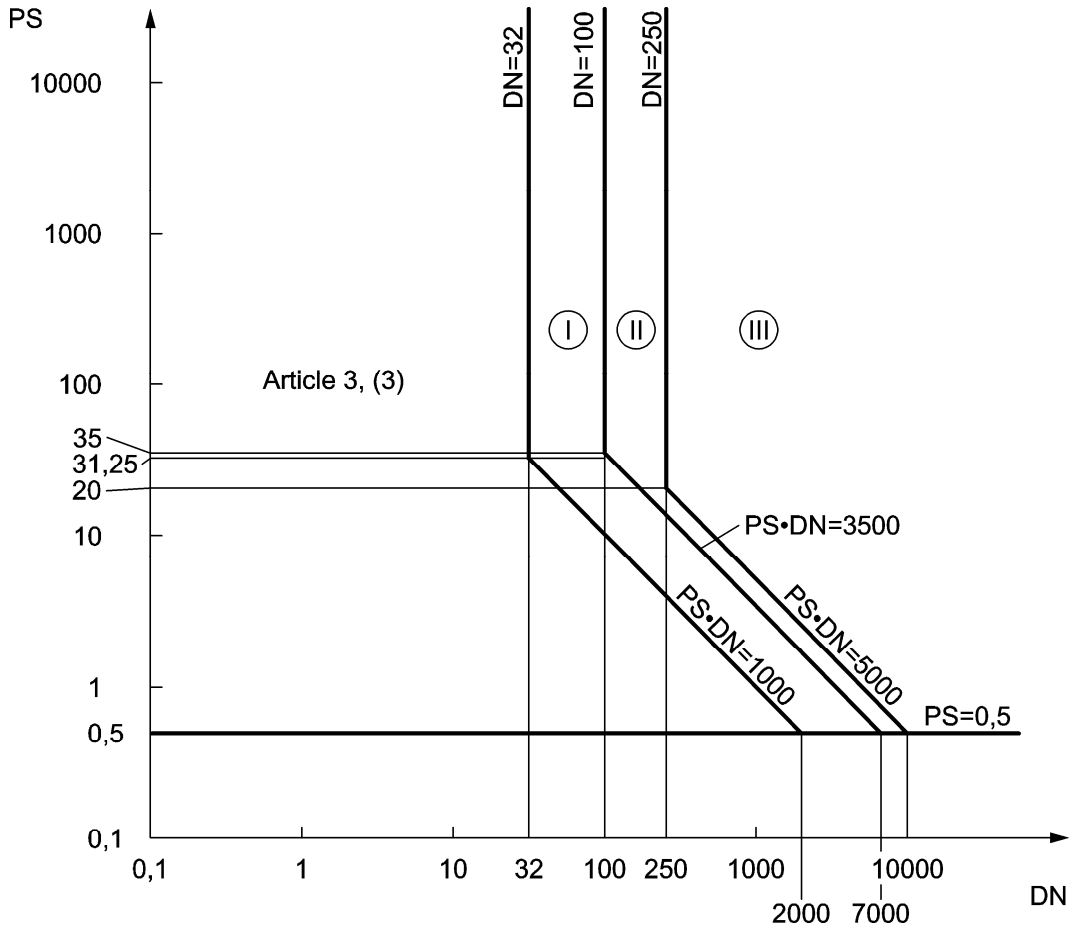


Figure E.2 — Piping referred to clause a) group 2 of Annex E

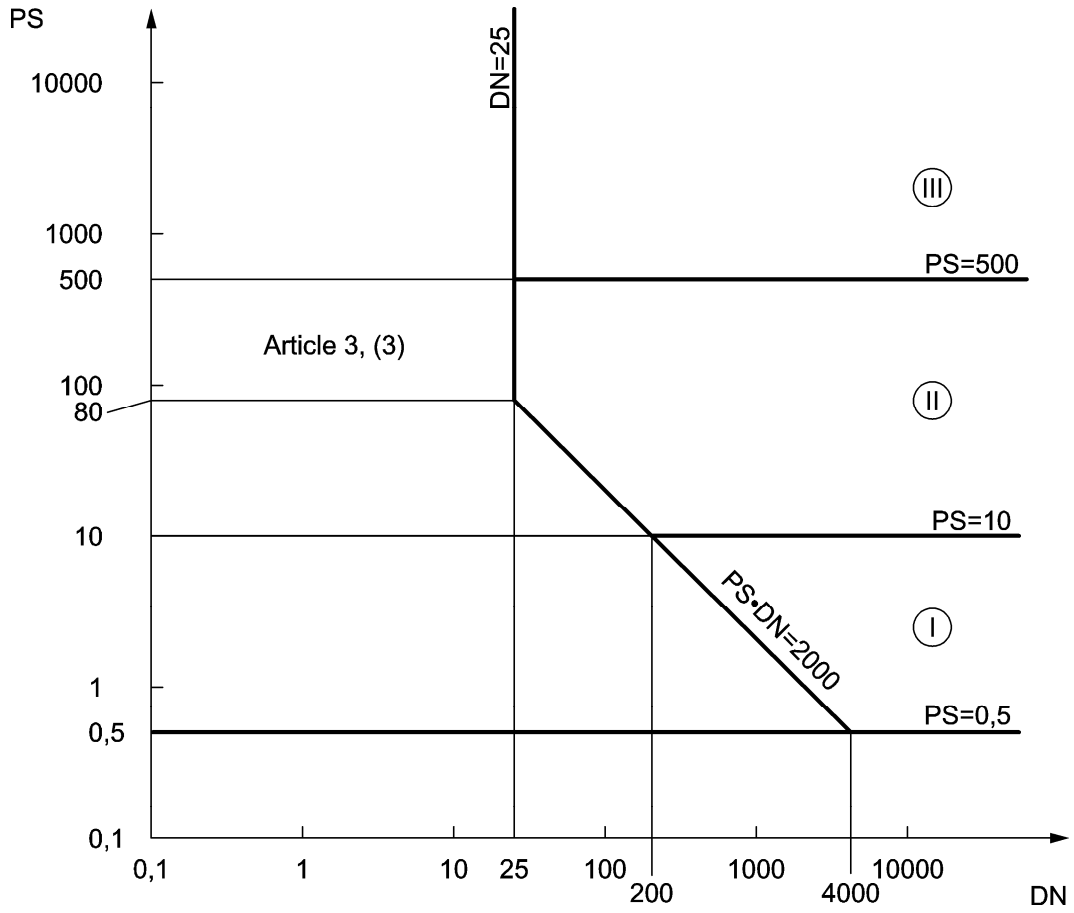


Figure E.3 — Piping referred to clause b) group 1 of Annex E

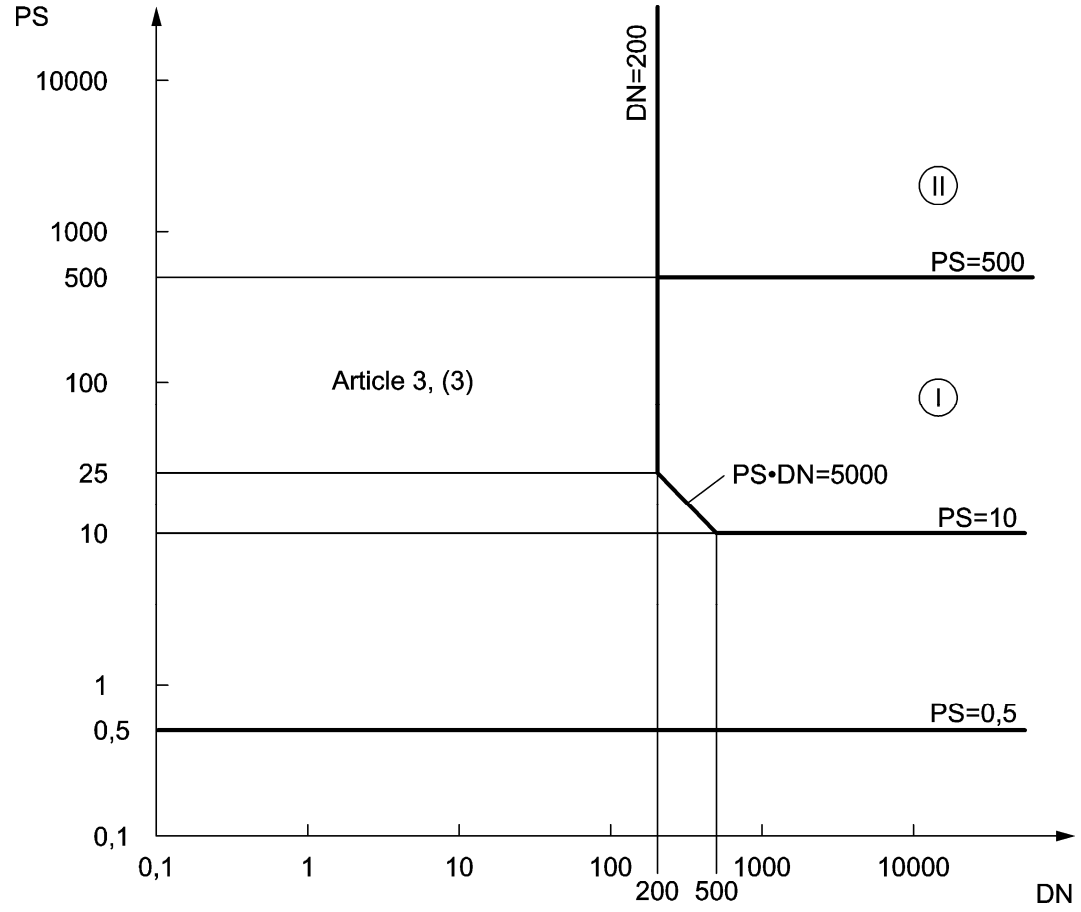


Figure E.4 — Piping referred to clause b) group 2 of Annex E

NOTE 1 Group 1 comprises fluids defined according to Council directive 67/548/EEC) as:

- explosive;
- extremely flammable;
- highly flammable;
- flammable (where the maximum allowable temperature is above flashpoint);
- very toxic;
- toxic;
- oxidizing.

NOTE 2 Group 2 comprises all other fluids not referred to in Note 1.

Annex ZA
(informative)

Relationship between this European Standard and the Essential Requirements of EU Directive 2006/42/EC

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association to provide one means of conforming to Essential Requirements of the New Approach Directive for Machinery 2006/42/EC.

Once this standard is cited in the Official Journal of the European Union under that Directive and has been implemented as a national standard in at least one Member State, compliance with the normative clauses of this standard confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding Essential Requirements of that Directive and associated EFTA regulations, except Essential Requirements 1.5.8 and 1.7.4.2 u).

WARNING — Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard.

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