

# Industrial thermoprocessing equipment

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

The European Standard EN 746-3 : 1997 has the status of a  
British Standard

ICS 25.180.01

## Committees responsible for this British Standard

The preparation of this British Standard was entrusted by Technical Committee MCE/3, Safeguarding of machinery, to Subcommittee MCE/3/8, Thermoprocessing equipment — Safety, upon which the following bodies were represented:

British Combustion Equipment Manufacturers' Association  
British Gas  
British Industrial Furnace Constructors' Association  
British National Committee for Electroheat  
British Non-Ferrous Metals Federation  
British Vermiculite Association  
Health and Safety Executive  
Institute of Materials  
Institution of Gas Engineers

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# National foreword

This Part of BS EN 746 has been prepared by Subcommittee MCE/3/8 and is the English language version of EN 746-3 : 1997 *Industrial thermoprocessing equipment — Part 3 : Safety requirements for the generation and use of atmosphere gases* published by the European Committee for Standardization (CEN).

EN 746-3 was produced as a result of international discussions in which the United Kingdom took an active part.

## Cross-references

Publication referred to	Corresponding British Standard
EN 88	BS EN 88 : 1991 <i>Pressure governors for gas appliances for inlet pressures up to 200 mbar</i>
EN 161	BS EN 161 : 1991 <i>Automatic shut-off valves for gas burners and gas appliances</i>
	BS EN 292 <i>Safety of machinery. Basic concepts, general principles for design</i>
EN 292-1 : 1991	BS EN 292-1 : 1991 <i>Basic terminology, methodology</i>
EN 292-2 : 1991	BS EN 292-2 : 1991 <i>Technical principles and specifications</i>
EN 298	BS EN 298 : 1994 <i>Automatic gas burner control systems for gas burners and gas burning appliances with or without fans</i>
	BS EN 746 <i>Industrial thermoprocessing equipment</i>
EN 746-1	<sup>1)</sup> BS EN 746-1 : 1997 <i>Common safety requirements for industrial thermoprocessing equipment</i>
EN 746-2	BS EN 746-2 : 1997 <i>Safety requirements for combustion and fuel handling systems</i>
	BS EN 60204 <i>Safety of machinery</i>
	<i>Electrical equipment of machines</i>
EN 60204-1	BS EN 60204-1 : 1993 <i>Specification for general requirements</i>
	BS EN 60519 <i>Safety in electroheat installations</i>
EN 60519-1	BS EN 60519-1 : 1993 <i>General requirements</i>
EN 60519-2	BS EN 60519-2 : 1994 <i>Particular requirements for resistance heating equipment</i>
EN 60519-3 (IEC 519-3)	BS EN 60519-3 : 1996 <i>Particular requirements for induction and conduction heating and induction melting installations</i>

**Compliance with a British Standard does not of itself confer immunity from legal obligations.**

## Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the EN title page, pages 2 to 28, an inside back cover and a back cover.

<sup>1)</sup> In preparation.



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Descriptors: Industrial products, heating installation, heat treatment, dangerous machines, safety of machinery, accident prevention, hazards, controlled atmospheres, gases, safety devices, specifications

English version

## Industrial thermoprocessing equipment — Part 3 : Safety requirements for the generation and use of atmosphere gases

Equipements thermiques industriels —  
Partie 3 : Prescriptions de sécurité pour la  
génération et l'utilisation des gaz d'atmosphère

Industrielle Thermoprozeßanlagen —  
Teil 3 : Sicherheitsanforderungen für die Erzeugung  
und Anwendung von Schutz- und Reaktionsgasen

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Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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**CEN**

European Committee for Standardization  
Comité Européen de Normalisation  
Europäisches Komitee für Normung

**Central Secretariat: rue de Stassart 36, B-1050 Brussels**

## Foreword

This European Standard has been prepared by Technical Committee CEN/TC 186, Industrial thermoprocessing — Safety, 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 September 1997, and conflicting national standards shall be withdrawn at the latest by September 1997.

The working group that drafted this part of EN 746 comprised experts from the following countries: France, Germany, Italy, Switzerland and the United Kingdom.

This standard forms one part of safety standards covering industrial thermoprocessing equipment.

The full list of Parts of this standard is given below:

- EN746     *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 liquid phase treatment thermoprocessing equipment;*  
          *Part 7: Particular safety requirements for vacuum thermoprocessing equipment;*  
          *Part 8: Particular safety requirements for quenching equipment.*

This European Standard 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 standard.

An assessment of the foreseeable risks arising from the use of the equipment was carried out when this standard was prepared.

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## Introduction

This standard has been prepared to be a harmonized standard to provide one means of conforming with the essential requirements of the Machinery Directive and associated EFTA Regulations.

The extent to which hazards are covered is indicated in the scope of this standard. In addition, machinery shall comply as appropriate with EN 292 for hazards which are not covered by this standard.

This European Standard is a type C-standard as defined in EN 292.

The equipment dealt with and the extent to which hazards are covered are indicated in the scope of this Part of EN 746.

**Where for clarity an example of a preventative measure is given in the text, this should not be considered as the only possible solution. Any other solution leading to the same risk reduction is permissible if an equivalent level of safety is achieved.**

This Part of EN 746 assumes that the installations are operated and maintained by trained personnel.

## 1 Scope

This Part of EN 746 specifies safety requirements for atmosphere gas systems and their use in industrial thermoprocessing equipment and associated plant, including systems for the production of atmosphere gases by reaction inside the thermoprocessing equipment.

It applies to the supply of atmosphere gases, gaseous and liquid additions to, and their removal from industrial thermoprocessing equipment and associated plant, confined to equipment integrated in the thermoprocessing and associated plant.

This Part of EN 746 also details the anticipated significant hazards associated with atmosphere gas systems and their use in industrial thermoprocessing equipment and specifies the appropriate preventative measures for the reduction or elimination of these hazards.

This Part of EN 746 does not apply to atmosphere process gases, essential safety equipment, start-up, operation and shut-down of thermoprocessing plant for semi-conductor devices for which special additional engineering requirements are necessary.

This Part of EN 746 specifies the requirements to be met to ensure the safety of persons and property during commissioning, start up, operation, shut down and maintenance, as well as in the event of foreseeable faults or malfunctions which can occur in the equipment. It specifies the safety requirements at stages in the life of the equipment, and its design, ordering, construction and use.

This Part of EN 746 applies to equipment which is placed on the market after the date of issue of this standard.

The hazards covered by this Part of EN 746 are listed in clause 4.

A table of typical atmosphere gases is given in annex A.

## 2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 88	<i>Pressure governors for gas appliances for inlet pressures up to 200 mbar;</i>
EN 161	<i>Automatic shut-off valves for gas burners and gas appliances;</i>
EN 292-1:1991	<i>Safety of machinery — Basic concepts, general principles for design — Part 1: Basic terminology, methodology;</i>
EN 292-2:1991	<i>Safety of machinery — Basic concepts, general principles for design — Part 2: Technical principles and specifications;</i>
EN 298	<i>Automatic gas burner control systems for gas burners and gas burning appliances with or without fans;</i>
EN 746-1	<i>Industrial thermoprocessing equipment — Part 1: Common safety requirements for industrial thermoprocessing equipment;</i>
EN 746-2	<i>Industrial thermoprocessing equipment — Part 2: Safety requirements for combustion and fuel handling systems;</i>
EN 60204-1	<i>Safety of machinery — Electrical equipment of machines — Part 1: General requirements (IEC 204-1:1992, modified);</i>
EN 60519-1	<i>Safety in electroheat installations — Part 1: General requirements;</i>
EN 60519-2	<i>Safety in electroheat installations — Part 2: Particular requirements for resistance heating equipment;</i>

- IEC 364-4-41 *Electrical installations of buildings  
Part 4: Protection for safety  
Chapter 41: Protection against  
electrical shock;*
- IEC 364-4-43 *Electrical installations of buildings  
Part 4: Protection for safety  
Chapter 43: Protection against  
overcurrent;*
- IEC 364-4-47 *Electrical installations of buildings  
Part 4: Protection for safety  
Chapter 47: Application of  
protective measures for safety  
Section 470 — General  
Section 471 — Measures of  
protection against electric shock;*
- IEC 364-4-442 *Electrical installations of buildings  
Part 4: Protection for safety  
Chapter 44: Protection against  
overvoltages  
Section 442: Protection of  
low-voltage installations against  
faults between high-voltage systems  
and earth*
- IEC 364-4-443 *Electrical installations of buildings  
Part 4: Protection for safety  
Chapter 44: Protection against  
overvoltages  
Section 443 — Protection against  
overvoltages of atmospheric origin  
or due to switching;*
- IEC 364-4-473 *Electrical installations of buildings  
Part 4: Protection for safety  
Chapter 47: Application of  
protective measures for safety  
Section 473 — Measures of  
protection against overcurrent;*
- IEC 364-4-45 *Electrical installations of buildings  
Part 4: Protection for safety  
Chapter 45: Protection against  
undervoltage;*
- IEC 364-4-46 *Electrical installations of buildings  
Part 4: Protection for safety  
Chapter 46: Isolation and  
switching;*
- IEC 519-3 *Safety in electroheat  
installations — Part 3: Particular  
requirements for induction and  
conduction heating and induction  
melting installations.*

### 3 Definitions

For the purposes of this standard the following definitions apply:

NOTE. An alphabetic listing of the definitions, as well as their cross-references in German, French and English is given in informative annex E.

#### 3.1 industrial thermoprocessing and associated equipment

Any equipment through or into which the atmosphere gases flow.

NOTE. This includes atmosphere gas distribution systems, safety control equipment and the furnace or other enclosures in which atmosphere gases are used.

#### 3.2 safe ignition temperature

The minimum temperature at which spontaneous, safe auto-ignition of flammable gases occurs.

NOTE. The safe ignition temperature has been established at 750 °C.

#### 3.3 purging

The general displacement of one type of atmosphere within a thermal processing plant by another.

#### 3.4 flammable atmosphere gas

Any gas mixture that is capable of forming flammable mixtures with air or oxygen under the conditions of temperature and pressure used in the process.

NOTE 1. Typically any gas mixture containing more than 5 % (V/V) combustibles ( $H_2+CO+CH_4$ ) of which  $CH_4$  is not more than 1 % (V/V), where the remainder of the mixture is non-flammable, is considered to be flammable. Any gas mixture which contains more than 1 % (V/V)  $C_nH_m$  or 2,5 % (V/V)  $NH_3$  where the remainder of the mixture is non-flammable is also considered to be flammable (see annexes A and B).

NOTE 2. A flammable gas which contains 1 % (V/V) or less oxygen cannot in itself form an explosive or flammable mixture.

#### 3.5 non-flammable atmosphere gas

Any gas mixture which is not capable of forming flammable mixtures with air or oxygen under the conditions of temperature and pressure used in the process.

NOTE. Typically any gas mixture containing 5 % (V/V) or less of combustibles ( $H_2+CO+CH_4$ ) of which  $CH_4$  is not more than 1 % of the 5 % (V/V) and the remainder is non-flammable and which will not support combustion.

#### 3.6 inert gas

A non-flammable gas which will not support combustion and does not react to produce a flammable gas.

NOTE 1. An inert gas can safely be used for pre- and post-purging of cold and hot enclosures of thermoprocessing equipment.

NOTE 2. Inert gas can be produced by appropriate adjustment of an exothermic generator. In the event of malfunction such a gas can be flammable and provisions should be taken to ensure that the adjustment is correct.

#### 3.7 toxic atmosphere gas

A gas which, in addition to having asphyxiating properties, also acts as a poison.



### 3.8 fluid

A liquid or a gas.

NOTE. If specific reference is made to 'liquid' or 'gas' this means the physical state of the fluid being considered.

### 3.9 safe level of vacuum

The absolute pressure of an evacuated furnace chamber/enclosure corresponding to safe atmosphere conditions.

NOTE. The safe level of vacuum has been established as a maximum of 45 mbar absolute (1 bar =  $10^5$  Pa).

### 3.10 safety purge volume

The volume of inert purge gas needed to displace either air or a flammable gas from a furnace chamber/enclosure to achieve 1 % (V/V) or less oxygen and/or a non-flammable atmosphere gas (as defined in 3.5) and/or 25 % of the lower flammability limit.

NOTE. Typically this will be a volume equal to five times the volume of the thermoprocessing equipment chamber to be purged, see annex C.

### 3.11 atmosphere gas generating system

Equipment that converts or modifies a mixture of fluids (gaseous or liquid) into a gas which can be utilized as the controlled atmosphere within the thermoprocessing equipment.

### 3.12 automatic re-start

Automatic repetition of the starting up sequence without manual intervention.

### 3.13 flame instability

Undesirable variation in the size, shape and position of a flame.

### 3.14 flame sensor

That part of a flame safeguard or flame monitoring system that is responsive to flame properties and which signals the presence of flame.

### 3.15 sensor output drift

A condition occurring within the flame sensor whereby it responds to flame characteristics outside the safety range for which it was designed.

### 3.16 flame failure

Loss of flame from the normally detected position by any cause other than the action of de-energizing the safety shut-off valves system [EN 746-2].

### 3.17 flame safeguard

A device responsive to flame properties, detecting the presence of a nominated flame and, in the event of ignition failure or subsequent flame failure, causing safety shut-down or lock out.

It consists of a flame sensor, an amplifier and a relay for signal transmission. These parts, with the possible exception of the actual flame sensor, may be assembled in a single housing for use in conjunction with a programming unit [EN 746-2].

### 3.18 flame trap

A device capable of arresting a flame while allowing the passage of gas.

### 3.19 start-up interlock

The safety shut-down condition of the control system such that re-start cannot be accomplished without manual re-set.

### 3.20 multiturn valve

A valve which, in order to operate from the fully closed to the fully open position, requires a number of revolutions of the operating key or handwheel to be completed.

### 3.21 non-return valve

A device to prevent the reversal of flow of air, fuel, oxygen etc. [EN 746-2].

### 3.22 pilot flame

Pilot burner flame that is used to ignite the main flame [EN 746-2].

### 3.23 interrupted pilot

A pilot which is ignited each time the burner is started up and which is extinguished at the end of the main flame establishment period.

### 3.24 pilot shrinkage

Unintended reduction in the length of the pilot flame.

### 3.25 safe start check

A means of providing safety shut-down or start-up interlock on start-up if a fault or flame simulating condition is present.

### 3.26 safe shut-down

The shutting off of all reaction gas and reaction air supplies to the atmosphere generator.

NOTE 1. This can be accomplished either manually or automatically.

NOTE 2. This should not be confused with system of safety shut-down (see 3.27).

### 3.27 system of safety shut-down

A system that provides the automatic shutting off of all gas and ignition energy.

### 3.28 safety shut-off valve system

A system of valves with associated circuits which enables the supply of gas to be admitted or shut off.

### 3.29 slam shut valve

A valve which automatically closes when it is actuated by an increase in the downstream line pressure above a set limit. Manual intervention is required to re-open the valve.

### 3.30 start gas flame

A flame established at the start gas rate either at the main burner or at a separate pilot burner.

#### 4 List of hazards

The anticipated significant hazards are detailed in table 1. For ease of reference this table also indicates the hazardous situations and corresponding preventative measures and should be used in conjunction with Parts 1 and 2 of EN 746 and clauses 5, 6 and 8 of this part of EN 746, as identified in the reference column.

<b>Table 1. List of hazards, hazardous situations and preventative measures</b>					
<b>1</b> Clause	<b>3</b> Hazards	<b>2</b> Reference EN 292-1 : 1991	<b>4</b> Hazardous situation	<b>5</b> Preventative measures	<b>6</b> Reference
<b>1</b>	MECHANICAL				
<b>1.1</b>	General	<b>4.2</b>			EN 746-1
<b>2</b>	ELECTRICAL				
<b>2.1</b>	General	<b>4.3</b>			
<b>2.2</b>	Thermal radiation and other phenomena		* Breakdown/ reduction of electrical insulation * Cable damage/Short circuits: – Fire – Electric shock	* System design * Correct placement of cables * Protection of cables * Fire fighting equipment (suitable for electrical systems)	EN 746-1 <b>5.3.2.18</b> <b>6.5</b>
<b>2.3</b>	External influences on electrical equipment		* Corruption of control circuits, particularly software systems * Failure of safety control: – Fire/Explosion – Toxicity/Asphyxiation	* System design * Protection of hardware * Monitoring systems * First aid: – equipment – training * Fire fighting equipment	EN 746-1 <b>5.3.2.18</b> <b>6.5</b>
<b>3</b>	THERMAL				
<b>3.1</b>	General	<b>4.4</b>			
	Flames, Explosions, Radiation		* Personal injuries such as: – Flash/radiation, burns – Dehydration – Eyesight damage * Deterioration of joints and pipework and/or distortion of structures: – Escaping of flammable or toxic fluids (gases/liquids) * Ejection of parts	* System design *Monitoring/inspection/ maintenance * Operator: – Instruction – Training * Personal protection equipment *First aid: – Equipment – Training * Safety devices in the workshop * Fire fighting equipment	EN 746-1 EN 746-2 <b>5</b> <b>6</b> <b>8.1</b>

<b>Table 1. List of hazards, hazardous situations and preventative measures</b> <i>(continued)</i>					
<b>1</b> Clause	<b>3</b> Hazards	<b>2</b> Reference EN 292-1 : 1991	<b>4</b> Hazardous situation	<b>5</b> Preventative measures	<b>6</b> Reference
<b>4</b>	HAZARDS GENERATED BY MATERIALS AND SUBSTANCES PROCESSED/USED/EXHAUSTED				
<b>4.1</b>	General	<b>4.8</b>			
<b>4.2</b>	* Contact with harmful liquids  * Contact with or inhalation of harmful gases/vapours/fumes		* Personal injuries such as: – Skin effects – Poisoning – Physiological effects – Respiratory/asphyxiating effects	* Regulations for storage/use/disposal * System design * Monitoring/inspection/maintenance * Personal protection equipment * First aid: – Equipment – Training <b>*Consider:</b> – <b>Permit-to-work system</b> – <b>Gas analysing system</b>	EN 746-1 <b>5.3.1</b> <b>5.3.2.1</b> <b>5.3.2.2</b> <b>5.3.2.13</b> <b>5.3.2.14</b> <b>6.7.3</b> <b>6.8.9</b> <b>8.1</b>
<b>4.3</b>	Contact with or inhalation of dusts		* Personal injuries such as: – Skin effects – Respiratory effects – Poisoning – Carcinogenic effects from nickel-bearing dusts	* Regulations for storage/use/disposal * Procedures for assembling, maintenance and dismantling * Provisions for disposal	<b>8.1.6</b> <b>8.1.7</b>
<b>5</b>	FIRE AND EXPLOSION				
<b>5.1</b>	General	<b>4.8</b>			
<b>5.2</b>	Fire hazard		* Property damage and/or personal injury caused by flammable fluids (gases/liquids)	* System: – Design – Safety systems * Fire fighting equipment * Monitoring/inspection/maintenance * Operator: – Instruction – Training * Plant housekeeping procedures * First aid: – Equipment – Training	EN 746-1 EN 746-2 <b>5.3</b> <b>6.8</b> <b>8.1</b>
<b>5.3</b>	Explosion hazard		* Property damage and/or personal injury caused by flammable fluids (gases/liquids)	* System – Design – Safety system * Fire fighting equipment * Monitoring/inspection/maintenance * Operator: – Instruction – Training * Explosion relief devices	<b>5</b> <b>6</b> <b>8.1</b>

<b>Table 1. List of hazards, hazardous situations and preventative measures (continued)</b>					
<b>1</b> Clause	<b>3</b> Hazards	<b>2</b> Reference EN 292-1 : 1991	<b>4</b> Hazardous situation	<b>5</b> Preventative measures	<b>6</b> Reference
<b>6</b> HAZARDS GENERATED BY FAILURE OF SERVICES					
<b>6.1</b>	Failure of energy supply * Electrical supplies * Control fluid supplies * Cooling system supplies		* Failure to normal control * Damage to property and personnel	* System: – Design – Safety systems * Inert gas supply * Failure mode system * Operator: – Instruction – Training * Service/repair management * <b>Consider</b> – <b>Standby energy system</b>	EN 746-1 EN 746-2 <b>5.2.4</b> <b>5.3.2.17</b> <b>5.3.2.18</b> <b>6.3.4.2</b> <b>6.5</b> <b>6.6</b> <b>6.8.1</b> <b>6.8.9</b> <b>8.1</b>
<b>6.2</b>	Failure of atmosphere gas supply		* Formation of explosion gas/air mixtures in industrial thermoprocessing plant	* Automatic inert gas purging * Standby supply of atmosphere gas * Failure mode system * Operator: – Instruction – Training * Service/repair management	<b>5.2.4</b> <b>5.2.5</b> <b>8.1</b>
<b>6.3</b>	Failure of supplies for atmosphere gas generators		* Breakdown of atmosphere gas supply * Generating plant/ failure of normal control	* Safe shut-down procedure * Automatic inert gas purging * Failure mode system * Service/repair management	<b>6.1.5</b> <b>6.1.6</b> <b>6.2</b> <b>6.3</b> <b>6.4</b> <b>8.1</b>
<b>7</b> HAZARDS GENERATED BY FUNCTIONAL DISORDERS, MISSING OR INCORRECTLY POSITIONED/SET SAFETY DEVICES					
<b>7.1</b>	Unexpected escape of fluids		* Unexpected escape of high temperature gases through furnace openings * Flashes of burning gases	* Avoidance of/protection against uncontrolled draught effects * Precautions during maintenance * Protective devices	EN 746-1 <b>5.1</b> <b>5.2.3</b> <b>5.3.2.1</b> <b>5.3.2.12</b> <b>5.3.2.13</b> <b>5.3.2.14</b> <b>5.3.2.15</b> <b>5.3.2.16</b> <b>5.3.2.17</b>
<b>7.2</b>	Failure/disorder of control systems		* Unexpected start-up * Unexpected overrun	* System design * Safety shut-down procedure * Inspection/maintenance * Operator: – Instruction – Training	<b>5</b> <b>6</b> <b>8.1</b>

<b>Table 1. List of hazards, hazardous situations and preventative measures</b> <i>(continued)</i>					
<b>1</b> Clause	<b>3</b> Hazards	<b>2</b> Reference EN 292-1 : 1991	<b>4</b> Hazardous situation	<b>5</b> Preventative measures	<b>6</b> Reference
<b>7.3</b>	Errors of fitting		* Damage to property and/or personal injuries	* System design * Marking/identification of components * Supplier information/ components * Spare parts maintenance management * Instruction for maintenance <b>*Consider:</b> – <b>PERMIT-TO-WORK system</b>	<b>5</b> <b>6</b> <b>8.1</b> <b>8.2</b>
<b>7.4</b>	Loading and unloading means for workpieces being processed		* Personal injuries such as: – Burns – Poisoning * Damage to property caused by: – Overheating – Incorrect purging – Fire	* System design * Sequence logic * Personal protection * Inspection/maintenance * Operator: – Instruction – Training	EN 746-1 <b>5.1</b> <b>5.2.7</b> <b>5.3.2.16</b> <b>8.1</b>
<b>7.5</b>	* Pressure or flow control devices  * Low or high temperature detectors		* Incorrect atmosphere gas production or use, resulting in: – Fire/explosion – Poisoning	* System design * Monitor/inspection/ maintenance * Operator: – Instruction – Training * Explosion relief devices * Fire fighting equipment * First aid: – Equipment – Training <b>* Consider:</b> – <b>Gas analysing system</b>	<b>5.2</b> <b>5.2.6</b> <b>5.3.2.7</b> <b>6.1.1</b> <b>6.8</b>
<b>7.6</b>	Explosion reliefs (if fitted)		* Leakage of atmosphere gas into the workshop, causing: – Fire/explosion – Poisoning/asphyxiation	* Inspection/maintenance * General ventilation of workshop * Operator: – Instruction – Training * Fire fighting equipment <b>* Consider:</b> – <b>PERMIT-TO-WORK system</b>	<b>5.3.2.17</b> <b>8.1</b>

<b>Table 1. List of hazards, hazardous situations and preventative measures</b> <i>(continued)</i>					
<b>1</b> Clause	<b>3</b> Hazards	<b>2</b> Reference EN 292-1 : 1991	<b>4</b> Hazardous situation	<b>5</b> Preventative measures	<b>6</b> Reference
<b>7.7</b>	Flame failure control (main burner(s) and pilot(s))		* Incorrect production or use of atmosphere gas, resulting in: – Unreliable ignition/ explosion – Risk of personal injuries (burns)	* System design * Self checking flame safeguard * Interlocks preventing sequence continuation * Monitoring/inspection/ maintenance * Operator: – Instruction – Training * Safety shut-down procedure * First aid: – Equipment – Training	EN 746-2 <b>5.1.3.3</b> <b>5.3.2.14</b> <b>5.3.2.15</b> <b>5.3.2.16</b> <b>6.8.5</b> <b>6.8.6</b> <b>6.8.9</b> <b>8.1</b>
<b>7.8</b>	Inert purging gas supplies		* Incorrect purge of air or atmosphere gases from thermal processing equipment, resulting in: – Fire/explosion – Personal injuries (burns)	* System design * Monitor/inspection/ maintenance * Operator: – Instruction – Training * Operating manual * First aid: – Equipment – Training  * <b>Consider:</b> – <b>PERMIT-TO-WORK</b> <b>system</b>	<b>5.1</b> <b>5.2.4</b> <b>8.1</b>
<b>7.9</b>	Starting and stopping devices: * Electrical circuits * Fluids (gas/air/ liquids)		* Inability to operate plant correctly causing: – Fire/explosion – Asphyxiation	* System design * Start & stop logic * Inspection/maintenance * Operator: – Instruction – Training * Operating manual  * <b>Consider:</b> – <b>PERMIT-TO-WORK</b> <b>system</b>	<b>5.1</b> <b>5.2.4</b> <b>8.1</b>

<b>Table 1. List of hazards, hazardous situations and preventative measures</b> <i>(continued)</i>					
<b>1</b> Clause	<b>3</b> Hazards	<b>2</b> Reference EN 292-1 : 1991	<b>4</b> Hazardous situation	<b>5</b> Preventative measures	<b>6</b> Reference
<b>7.10</b>	Energy supply disconnecting devices:  * Electrical supplies * Control fluids (gas/air liquids)		* Inability to isolate plant: – electrically – from fluids supply	* System design * Start and stop logic * Inspection/maintenance * Operator: – Instruction – Training * Operating manual  * Remote isolation system  * <b>Consider:</b> – <b>PERMIT-TO-WORK system</b>	EN 746-1 <b>5.2</b> <b>6.2</b> <b>6.3.2</b> <b>6.5</b> <b>8.1</b>
<b>7.11</b>	Emergency stopping devices		* Inability to stop plant operation under emergency conditions	* System design * Start and stop logic * Inspection/maintenance * Operator: – Instruction – Training * Operating manual * Remote isolation system  * <b>Consider:</b> – <b>PERMIT-TO-WORK system</b>	<b>5.2</b> <b>5.3</b> <b>6.8</b> <b>8.1</b>
<b>7.12</b>	Essential equipment/ accessories for safe adjusting and/or maintenance of fluid supplies * Flow measurement * Pressure measurement		* Over or under supply of fluids, due to incorrect settings/ pressure variations resulting in: – Fire/Explosion – Toxicity/Asphyxiation	* System design * Limitation of flow * Separate low flow system * Reliable pressure control * Monitor/inspection/maintenance * Operator: – Instruction – Training * Regular check of settings  * <b>Consider:</b> – <b>PERMIT-TO-WORK system</b>	<b>5.3</b> <b>6.1</b> <b>6.2</b> <b>6.3</b> <b>6.4</b> <b>6.6</b> <b>8.1</b>

Table 1. List of hazards, hazardous situations and preventative measures (continued)					
1 Clause	3 Hazards	2 Reference EN 292-1 : 1991	4 Hazardous situation	5 Preventative measures	6 Reference
7.13	Equipment evacuating gases * Natural/forced draught chimneys * Fume extraction ducts * Vents		* Increased toxicity, asphyxiation, fire, explosion if: – Insufficient evacuation of gases – Flammable deposits, vapours and ignition sources NOTE. Effect can be delayed in time	* System design * No interconnection of vents * Monitoring/inspection/maintenance * Explosion relief devices * Fire fighting equipment  * <b>Consider:</b> – <b>Gas analysing system</b>	<b>5.3.2.13</b> <b>5.3.2.14</b> <b>5.3.2.15</b> <b>5.3.2.16</b> <b>6.7.3</b> <b>6.8.3</b> <b>6.8.4</b> <b>8.1</b>
8	HAZARDS GENERATED BY NOISE				
8.1	General	4.5	Health damaging effects	* System design * Personal protective devices	EN 746-1
9	HAZARD COMBINATIONS				
	General	4.10	Property damage and/or personal injuries caused by uncontrolled voluntary/involuntary action	* System design * Failure mode * Safe shut-down procedures, based on risk analysis * Monitoring/inspection/maintenance * Regular testing of safety systems * Operator: – Instruction – Training	<b>5</b> <b>6</b> <b>8.1</b>

## 5 Safety requirements for the use of atmosphere gases

### 5.1 Purging

The following subclauses detail established process requirements for purging safety controls for atmosphere gas and thermoprocessing equipment that can be used in the design of equipment for atmosphere gases. These techniques can be applied singly or in combination depending on the application.

#### 5.1.1 General

Specific instructions on the procedure for admitting atmosphere gas into, and removing atmosphere gas from, thermoprocessing equipment and enclosures shall be provided by the manufacturer in accordance with the purging method(s) adopted (see also annexes A, B and C).

The effects of doors (operational speed and sequencing) and/or other openings on safe purging shall be taken into account in the selection and use of purging procedures.

#### 5.1.2 Purging during start-up

The following purging methods shall be used, either singly or in combination.

The normal start-up of thermoprocessing equipment or enclosure which uses a flammable atmosphere gas involves replacing the air with the flammable atmosphere gas.

In some cases evacuation or an intermediate purge with inert gas can be necessary.

##### 5.1.2.1 Purge without ignition

If a flammable atmosphere gas is introduced into industrial thermoprocessing equipment or enclosures which operate below 750 °C, then its introduction shall be preceded by an inert gas purge to remove air until the oxygen content is 1 % (V/V) or less.

NOTE 1. If the atmosphere gas supply source can be adjusted to provide a non-flammable atmosphere gas, this gas can be utilized as the purge inert gas.

NOTE 2. The inert gas purge can be omitted provided that the air has been evacuated to a predetermined safe level of vacuum (see 3.9).



#### **5.1.2.2 Purge with spontaneous ignition**

If a flammable atmosphere gas is introduced into a furnace zone where the temperature is maintained at 750 °C or more then, providing that ignition occurs immediately upon the introduction of the flammable atmosphere gas, purging of the furnace chamber may continue until all the air has been consumed and/or displaced by the incoming flammable atmosphere gas.

#### **5.1.2.3 Purge with induced ignition**

If the thermoprocessing equipment zone or enclosure into which the flammable atmosphere gas is introduced is at a temperature below 750 °C, purging without the use of inert gas is only permitted if a reliable source of ignition is provided at the position where the flammable atmosphere gas is introduced.

This method of purging shall not be used when atmosphere gas circulation fans are operating in the zone or enclosure.

#### **5.1.3 Purging during normal shut-down**

The following purging methods shall be used, either singly or in combination.

The normal shut-down of a furnace or enclosure containing a flammable atmosphere gas can involve replacing the flammable atmosphere gas with air.

In some cases evacuation or an intermediate purge with inert gas can be necessary.

##### **5.1.3.1 Purge without ignition**

Prior to shutting off the supply of flammable atmosphere gas to a furnace or enclosure operating below 750 °C an inert gas purge shall be initiated and the flow adjusted to the required value. The flammable atmosphere gas supply valve shall then be closed and the inert gas purge continued until all the flammable atmosphere gas has been displaced. The inert gas can then be replaced by air.

NOTE 1. If the atmosphere gas supply source can be adjusted to provide a non flammable atmosphere gas this gas can be utilized as the inert gas purge (5.1.3.2).

NOTE 2. The inert gas purge volume can be reduced to a backfill requirement, i.e. sufficient to raise the pressure to the prevailing atmospheric value, provided that the flammable atmosphere gas has been evacuated to a predetermined safe level of vacuum (see 3.9)

##### **5.1.3.2 Purge with spontaneous ignition**

If it is required to purge a flammable atmosphere gas from thermoprocessing equipment which is maintained above 750 °C, then providing that the flammable atmosphere gas will burn safely, the flammable atmosphere gas supply valve can be closed, thus allowing the flammable atmosphere gas within the thermoprocessing equipment to be removed by combustion.

NOTE. Where furnace doors are fitted, they should be opened before the flammable atmosphere gas supply valve is closed.

##### **5.1.3.3 Purge with induced ignition**

If it is required to purge flammable atmosphere gas from a furnace or enclosure which is maintained at a temperature below 750 °C purging without the use of inert gas shall be allowed only if a reliable source of ignition is provided at every position where air is admitted and combustion of the flammable atmosphere gas is maintained.

Where furnace or enclosure doors are fitted they shall be opened fully before the flammable atmosphere gas supply valve is closed.

Provided that the flammable atmosphere gas is burning safely the flammable atmosphere gas supply valve may be closed, allowing the flammable atmosphere gas within the thermoprocessing equipment or enclosure to be removed by combustion.

This method of purging shall not be used when furnace atmosphere gas circulation fans are operating in the zone or enclosure.

#### **5.2 Safety control equipment for atmosphere gases**

##### **5.2.1 Manual shut-off valve**

Manual shut-off valves shall be fitted in the atmosphere gas supply and in the gaseous/liquid additions supplies to each furnace or point of use.

##### **5.2.2 Automatic shut-off valve**

If the supply of atmosphere gas or gaseous/liquid additions to the furnace is under the control of an electrically operated automatic shut-off valve (e.g. as described in 5.2.4 and 5.2.6), this valve shall comply with EN 161.

##### **5.2.3 Safety interlocks**

If an automatic shut-off valve is used it shall be provided with safety interlocks (e.g. for temperature, pressure, supplies) to prevent the atmosphere gas, including any gaseous/liquid additions, from being admitted to the furnace if this could give rise to an unsafe condition.

##### **5.2.4 Emergency inert gas supply**

If the atmosphere gas used in the furnace is flammable and if interruption of its supply could cause a hazard, a supply of inert gas of sufficient capacity to effect a safety purge (see 3.10) shall be provided and its availability shall be proved before the atmosphere gas is admitted.

Loss of an adequate supply of inert gas at any time shall be indicated by means of a suitable alarm.

##### **5.2.5 Atmosphere gas supply sensor**

If safety is dependent upon the atmosphere gas flow rate then a device shall be fitted to prove that an adequate supply of that atmosphere gas is available. If, for any reason, the supply of atmosphere gas or of gaseous/liquid fluids for furnace-reacted atmospheres, is not sufficient, an alarm condition shall be indicated.

In the case of a flammable atmosphere gas, closure of the atmosphere gas supply valve shall be preceded by, or be simultaneous with, the admittance of inert gas, or the furnace or enclosure doors shall be opened, where appropriate, to prevent any hazardous situation arising.

#### 5.2.6 *Temperature sensor*

A temperature sensor, interlock and alarm shall be fitted where the safe use of thermoprocessing equipment in which a flammable atmosphere gas is used is dependent upon the operating temperature being maintained above a safe ignition temperature. This system shall prevent the introduction of flammable atmosphere gas before the safe ignition temperature has been reached and shall cause an alarm condition if the temperature subsequently falls below that safe value. If this situation is not corrected within a predetermined time, it shall be followed by:

- admittance of inert gas or the opening of thermoprocessing equipment doors to prevent any hazardous situation arising; and
- closure of the flammable atmosphere gas supply valves(s).

#### 5.2.7 *Processing chamber door interlocks*

Door interlocks (e.g. ignition flame door gas curtain) shall be fitted where the safe use of thermoprocessing equipment in which a flammable atmosphere gas is used is dependent upon the automatic operation of processing chamber doors.

### 5.3 *Thermoprocessing equipment requirements*

#### 5.3.1 *Construction*

The following requirements are in addition to those detailed in EN 746-1.

Atmosphere gases shall only be used in thermoprocessing equipment that has been constructed to avoid the leakage of either flammable or toxic gases into the working environment at any point other than at vents or other exits designed for the purpose.

#### 5.3.2 *Distribution system for atmosphere gases, including fluid (gaseous or liquid) additions*

##### 5.3.2.1 *General*

All pipework, valves and controls shall be designed, installed and marked in accordance with EN 746-2.

All pipework shall be installed and jointed in such a manner as to be gas tight and shall be securely supported. In addition pipework shall be located where mechanical, thermal or corrosion damage cannot occur, or shall be suitably protected.

The system shall be designed to prevent any pipework or control equipment being subjected to pressures in excess of the maximum intended pressure.

##### 5.3.2.2 *Purging*

All distribution pipework and storage vessels for atmosphere gas shall be purged using procedures in accordance with 5.1.2.1 or in such a manner which excludes the simultaneous presence of flammable gas/air mixtures and an ignition source. Each venting point shall be provided with a valve which shall either:

- be fitted with a device to prevent unauthorized operation; or
- be blanked off during normal operation of the plant.

##### 5.3.2.3 *Drainage points*

If drainage points are provided to prevent the accumulation of moisture in pipework they shall either:

- be fitted with a valve incorporating a device designed to prevent unauthorized operation; or
- be sealed during normal operation of the plant.

##### 5.3.2.4 *Flexible pipework*

If flexible gas pipes are necessary they shall be suitable for the duty intended and be of the metal or metal armoured type having flanged or screwed connections. They shall be kept as short as practicable and shall be protected against excessive heat.

##### 5.3.2.5 *Filters*

Filters shall be fitted to protect safety shut-off valves, other controls and pipework, whenever safe operation can be affected.

Special care shall be taken to prevent the ingress of particles, either from the pipework or from the fluid, which would be detrimental to the operation of the equipment.

##### 5.3.2.6 *Manual valve*

All manual isolating valves shall be of the quick opening and closing type (e.g. 90° operation type) with clear indication of, and physical stops at, the open and closed positions. They shall be selected having due regard to any thermal hazard.

Manual isolating valves shall be installed in safe, easily accessible, positions.

Multiturn valves shall only be used for throughput control and in conjunction with flow metering equipment.

##### 5.3.2.7 *Pressure governors*

Pressure governors up to 200 mbar shall comply with EN 88.

Where a pressure governor incorporates a pressure relief the relief vent shall discharge into an area where it does not create hazards e.g. by explosion, ignition, intoxication, asphyxiation. Such vents shall not be manifolded.

NOTE. Where ring mains are used to distribute atmosphere gas to several points of use it can be necessary to fit a pressure governor at each point of use.

##### 5.3.2.8 *Flow rate indicators*

Flow meters and flow control valves shall be provided in atmosphere gas supply lines to the furnace.

#### **5.3.2.9 Non-return valves**

Non-return valves(s) or other devices/systems shall be provided in the atmosphere gas and gaseous or liquid addition supplies to the thermoprocessing equipment. Where atmosphere gas or fluid additions are supplied to thermoprocessing equipment or enclosures that are operating under, or may induce, a vacuum then special consideration shall be given to the selection of any controls which can be subject to vacuum during both normal and abnormal conditions.

#### **5.3.2.10 Boosters/compressors**

Where an atmosphere gas booster/compressor is used, a low pressure cut-off switch shall be fitted in the gas inlet system to the booster/compressor to ensure that depressurization of remote gas systems cannot occur. This low pressure cut-off switch shall cause shut-down of the booster/compressor in the event of reduced pressure and shall prevent automatic re-start on pressure restoration.

A suitable non-return valve shall be fitted between the booster/compressor outlet and the inlet to any storage vessel incorporated in the system.

The atmosphere gas booster/compressor shall be fitted with a device to prevent the pressure from exceeding a pre-determined safe value.

NOTE. This should preferably take the form of a booster/compressor by-pass relief valve that will maintain the downstream pipework at pressure without interruption of the supply of atmosphere gas.

#### **5.3.2.11 Storage vessels**

Vessels used for the storage of atmosphere gas and other fluid additions shall comply with appropriate design codes and standards.

NOTE. CEN/TC 54 is in the process of elaborating a range of standards.

#### **5.3.2.12 Position of inlets for atmosphere gas and fluid additions**

The inlets through which atmosphere gas and fluid additions are admitted to thermoprocessing equipment shall be arranged to ensure that:

- effective purging by the incoming atmosphere can be maintained;
- the ingress of air does not create a hazard;
- where a flammable atmosphere gas is supplied it shall enter at a place which ensures smooth ignition.

NOTE. This position should be where sufficient ignition energy is available and the flow pattern and physical location ensure reliability in all foreseen circumstances.

#### **5.3.2.13 Atmosphere gas discharge vents and exits**

Atmosphere gas discharge vents and exits shall permit continuous discharge of the atmosphere gas without changes of pressure that can cause loss of effective purging.

#### **5.3.2.14 Location of discharge vent pilot burners or igniters**

Where a permanent pilot burner, or an igniter, is used to ignite flammable atmosphere gas discharging from a vent or exit point, it shall be positioned such that smooth ignition of the vented atmosphere gas occurs (see 5.3.2.12).

#### **5.3.2.15 Supervision of the pilot burner at the point of gas discharge**

Permanent pilot burners fitted at all the points of gas discharge shall be provided with a means of flame supervision.

Flammable atmosphere gas and gaseous additions shall not enter until the pilot flame(s) is/are established. Failure of the pilot flame(s) shall cause an alarm condition to be signalled.

#### **5.3.2.16 Thermoprocessing equipment doors and access openings**

If a flammable atmosphere gas is used, a means of smooth ignition shall be provided at each door or access opening to ignite the atmosphere gases issuing from it (see 5.3.2.12).

Any pilot burner shall be provided with a means of flame supervision. Failure of the pilot flame, or other means of ignition, shall cause an alarm condition to be signalled.

The gas supply valve for flame curtains, if these are used, shall not be opened until the means of ignition is established.

#### **5.3.2.17 Explosion relief**

Means shall be provided to protect personnel in the event of an explosion occurring in the thermoprocessing equipment or enclosures. Particular attention shall be given to low temperature (below 750 °C) thermoprocessing equipment.

If the build-up of explosive gas/air mixtures cannot be avoided by operational means (e.g. inert gas purging procedures or the automatic sequence of process steps which ensure safe operating conditions), then a purpose designed explosion relief device shall be fitted which relieves below the maximum pressure the weakest affected structural member (eg.casing, door, etc.) can withstand.

#### **5.3.2.18 Electrical supplies**

The electrical control circuits shall conform to EN 60204-1, EN 60519-1, EN 60519-2, and IEC 519-3, and shall be installed in accordance with IEC 364-4-41, IEC 364-4-43, IEC 364-4-47, IEC 364-4-442, IEC 364-4-443, IEC 364-4-473, IEC 364-4-45 and IEC 364-4-46.

NOTE. Because the use of atmosphere gases can give rise to higher localized temperatures on thermoprocessing equipment due care should be exercised in the selection and placement of cables and controls.

## 6 Safety requirements for atmosphere gas generators

This clause describes the functional requirements for:

- reaction gas supplies;
- fuel gas supplies;
- air supplies;
- mixture supplies;
- electrical supplies;
- cooling water supplies and discharge;
- generated atmosphere gas supplies and distribution

and the related safety equipment.

### 6.1 Reaction gas supplies

#### 6.1.1 Avoidance of excess pressure

The system shall be designed so as to prevent any pipework and control equipment being subjected to pressures in excess of their maximum intended pressure due to malfunction, such as governor failure.

NOTE 1. If higher pressure supplies are involved consideration should be given to the provision of a pressure relief valve to release the gas to a safe place.

NOTE 2. The use of electrical or pressure operated slam shut valves can be an alternative means of protecting the system.

#### 6.1.2 Manual isolating valves

A reaction gas manual isolating valve shall be installed in an easily accessible position in the gas supply.

#### 6.1.3 Non-return valves

If reaction air is supplied under pressure a non-return valve shall be installed in the reaction gas supply to the atmosphere gas generator.

#### 6.1.4 Pressure governors

A pressure governor shall be installed in the reaction gas supply to the atmosphere gas generator. Pressure governors up to 200 mbar shall comply with EN 88.

#### 6.1.5 Low gas pressure protection

Signalling of low gas pressure shall cause an alarm condition followed by safety shut-down and start-up interlock of the reaction system.

#### 6.1.6 Low pressure cut-off device

If a booster is used in the reaction gas supply or a compressor is used in the atmosphere gas outlet, then a low pressure cut-off device shall be fitted in the reaction gas supply upstream of the booster or compressor. This device shall cause shut-down of the booster or compressor in the event of reduced gas pressure and shall prevent automatic re-start on pressure restoration.

### 6.2 Fuel gas supplies

All pipework, valves and controls intended for the supply of fuel gas to the atmosphere generator shall comply with EN 746-2.

If the fuel and reaction gases are supplied from a single main inlet steps shall be taken to ensure that varying flow rates do not adversely affect the control of combustion and reaction.

NOTE. To avoid gas starvation on pilot burners when main burners are turned on, the gas supply to such pilot burners can be taken from upstream of the main governor and separately regulated.

## 6.3 Air supplies

### 6.3.1 General

The ventilation of the building in which the atmosphere gas generator is housed shall be such as to allow a supply of clean fresh air sufficient volume to reach the atmosphere gas generator under all conditions.

### 6.3.2 Reaction air supplies

Reaction air supplies to the atmosphere gas generator shall be filtered.

Where the reaction air is supplied under pressure a suitable device for proving the air supply to the atmosphere gas generator shall be fitted. The air supply shall be proved before opening the reaction gas safety shut-off valve.

Inadequate reaction air supply at any time during the operation of the atmosphere gas generator shall cause an alarm condition followed by system of safety shut-down and start-up interlock of the reaction system.

Automatic restart following restoration of the air supply shall not occur.

A suitable device shall be fitted to enable the reaction air supply to be shut off, after a pre-determined purge period, in the event of any shut-down of the atmosphere gas generator.

### 6.3.3 Combustion air supplies

All pipework, valves and controls intended for the supply of combustion air to the atmosphere generator shall comply with EN 746-2.

NOTE. If the combustion air and the reaction air are supplied from the same source steps should be taken to ensure that varying flow rates do not adversely affect the control of combustion or reaction.

### 6.3.4 Air supplies for other purposes

#### 6.3.4.1 Catalyst regeneration

The design and instructions for use of systems incorporating catalyst regeneration shall ensure that the reaction air cannot be fed into the atmosphere gas distribution pipework of the thermoprocessing equipment or enclosures.

Regeneration of the catalyst of endothermic generators (i.e. burning off of carbon deposits) is usually carried out by passing only air through the retort at a suitable temperature. In order to carry out this procedure it will be necessary to energise the reaction air supply control system with the reaction gas supply control system isolated and locked out.

#### 6.3.4.2 Failure of control instruments.

The equipment shall be designed so that in the event of failure of control instrument(s), no additional risks arise.

#### **6.3.4.3 Failure of control air supplies**

The equipment shall be designed so that in the event of failure of control air, no additional risks arise.

#### **6.4 Mixture supplies**

If a system includes flammable gas/air mixtures the mixture supply pipe shall be kept as short as possible.

If a mechanical gas/air mixing machine or a similar pre-mixing system is used a flame trap or other suitable devices, shall be provided to protect against the effects of light-back in the mixture supply pipe. The flame trap shall be fitted as close as practicable to the atmosphere gas generator retort inlet and the main burner respectively. The length of the mixture supply pipe between the device and the retort or main burner shall not exceed 2 m.

If the gas/air mixture is supplied by a blast injector (inspiring effect) and the injector is more than 2 m from the retort, a protection shall be provided against the effects of light-back in the mixture supply pipe.

The flame trap or other suitable device, shall incorporate a sensor to detect light-back. Detection of light-back shall result in safety shut-down and start-up interlock of the reaction system.

If a mechanical gas/air mixing machine is used there shall be no gas offtake from the gas line between the manual reaction gas isolating valve and the mixing machine inlet.

If a pressure switch is fitted to the mixture supply it shall be of a type which cannot cause ignition of the mixture.

#### **6.5 Electrical supplies**

The electrical control circuits shall conform to EN 60204-1, EN 60519-1, EN 60519-2, and IEC 519-3, and shall be installed in accordance with IEC 364-41, IEC 364-4-43, IEC 364-4-47, IEC 364-4-442, IEC 364-4-443, IEC 364-4-473, IEC 364-4-45 and IEC 364-4-4.

NOTE. The generation of atmosphere gases can give rise to higher localized temperatures on generating equipment and hence due care should be exercised in the selection and placement of cables and controls.

Interruption of the electricity supply at any time during the starting up or operation of the atmosphere gas generator shall result in safety shut-down and start-up interlock.

Automatic re-start following restoration of the electricity supply shall not occur.

The fitting of flame proof equipment on or adjacent to equipment generating or using atmosphere gases is not necessary unless dictated by reasons associated with the location of the equipment.

#### **6.6 Cooling water supplies and discharge**

##### **6.6.1 Cooling water supplies**

Means of proving the minimum cooling water flow shall be provided.

Failure of, or reduction in, the minimum required cooling water flow rate shall cause an alarm condition to be signalled. If the fault is not corrected within a pre-determined time safety shut-down and start-up interlock shall occur.

##### **6.6.2 Cooling water discharge**

For open discharge systems the cooling water shall be discharged into an open drain such that the flow is visible. There shall be no valves or restrictions in the discharge piping to, or the outlet piping from, the drain.

For closed discharge systems the cooling water shall be discharged through individual flow indicators. Relief valves shall be installed to relieve any obstructed discharge lines.

#### **6.7 Atmosphere gas supplies and distribution**

##### **6.7.1 Valves**

The atmosphere gas supply and/or distribution pipe from the atmosphere gas generator shall be fitted with a manual shut-off valve and a manually controlled vent upstream of this shut-off valve.

##### **6.7.2 Condensate traps**

Means shall be provided to ensure that generated atmosphere gas is not discharged from condensate traps other than via suitably designed vents into an area it does not create hazards (e.g. explosion, ignition, intoxication, asphyxiation).

##### **6.7.3 Excess generated atmosphere gases**

Means shall be provided for the safe disposal of excess (unwanted) generated atmosphere gas discharged from the vent (see 6.7.2). Depending upon specific local circumstances and the analysis of the generated atmosphere gas, safe disposal shall be accomplished by either:

- burning off of the generated atmosphere gas and safe disposal of the combustion products. The pilot burner for this purpose shall be suitably protected and an audible alarm given on flame failure; or
- venting to a safe place outside the building.

#### **6.8 System requirements**

##### **6.8.1 Safety shut-off systems**

The reaction gas supply to the atmosphere gas generator shall be controlled by a safety shut-off valve system (see 3.28).

The reaction air supply to the atmosphere gas generator shall be controlled by a shut-off system.

The safety shut-off systems in the reaction air and gas supplies shall be interlocked with reaction gas pressure switches and, if fitted, the reaction air pressure switch, the mixture pressure switch, and cooling water flow sensors.

Electrically operated safety shut-off valves shall comply with EN 161.

### **6.8.2 Retort temperature monitoring (endothermic generators)**

The temperature of the retort in endothermic atmosphere generators shall be monitored. Deviation in temperature outside a pre-set operating range shall signal an alarm condition. If the fault is not corrected within a pre-determined time safety shut-down followed by start-up interlock of the reaction system shall occur.

### **6.8.3 Pressure governors**

If a pressure relief is incorporated in a governor controlling flammable or toxic gases, the pressure relief shall be vented to a safe place outside the building, where it does not create hazards e.g. by explosion, ignition, intoxication, asphyxiation.

NOTE. Consideration should be given to sealing governors and labelling them with the set pressure.

### **6.8.4 Vents**

Any vent from a gas supply pipe, reaction gas control system, gas/air mixture pipe or generated atmosphere gas line shall be adequately sized for the duty intended and shall be under the control of a valve system.

Any vent which is likely to carry a flammable gas/air mixture and which is fitted with a pilot burner shall be equipped with a flame trap.

Any vent from the mixture supply pipe shall be taken from a point downstream of the flame trap or be fitted with a separate flame trap.

All vents shall terminate in a safe place and shall be designed to prevent the ingress of foreign matter.

NOTE. Any vent which is not fitted with a pilot burner should terminate above roof level and be remote from potential sources of ignition, having due regard to the layout of adjacent buildings.

Vents shall not be manifolded.

### **6.8.5 Flame detection**

The atmosphere gas generator burner(s) shall be fitted with a flame monitoring system for the flame complying with EN 298.

The flame monitoring system shall incorporate a start-up interlock which engages if a fault or flame simulating condition is present.

In flame failure conditions the control system shall cause safety shut-down and start-up interlock. A re-start cycle shall only be attempted after manual reset.

During and after the process of safety shut-down and start-up interlock, there shall be no ignition attempt or opening of fuel valves.

If a burner is fired continuously for periods greater than one day, the flame monitoring system shall be of the periodic self-checking type. A burner which is not fitted with a self-checking flame sensor shall have the operation of the sensor checked at least daily.

NOTE. This requirement is specifically intended for the reaction gas burner which is typically designed to operate over a much wider flammable range than a heating system burner and frequently near the upper flammability limit for long periods of time.

The flame sensor shall only detect the pilot flame if that flame is in a position to give smooth and reliable main flame ignition. Protection against pilot flame shrinkage, sensor output drift or maladjustment, fuel pressure reduction and flame instability, shall be incorporated.

Any flame monitoring system shall be inherently safe.

### **6.8.6 Pre-purge**

Pre-purges shall provide at least five volume changes of the atmosphere gas generator and, if necessary, ancillary or associated plant, see annex C.

NOTE. The pre-purge should be carried out at the full combustion air rate.

### **6.8.7 Burner ignition**

#### **6.8.7.1 General**

A means of ignition of the main burner shall be provided.

Ignition shall be accomplished by either:

- a properly located and fixed interrupted pilot; or
- a properly located and removable interrupted pilot; or
- direct ignition of the main flame at the minimum practicable rate.

In all cases ignition shall comply with EN 746-2.

#### **6.8.7.2 Removable ignition burner**

It shall not be possible to operate a removable pilot burner independently of the lighting up sequence.

### **6.8.8 Shut-down purge**

If the atmosphere gas being produced is flammable or toxic, then it shall be purged from the atmosphere gas generator prior to any maintenance work.

### **6.8.9 Safety shut-off systems.**

The gas supply to each burner or group of burners shall be under the control of a suitable safety shut-off valve system.

The safety shut-off valve system(s) shall be interlocked with the flame sensor, gas pressure switches, and, if fitted, air pressure switch, mixture pressure switch, and cooling water flow sensors.

Electrically operated safety shut-off valves shall comply with EN 161.

## 7 Verification of the safety requirements and/or measures

Verification of the safety requirements and measures detailed in clauses 5 and 6 can be effected by inspection and/or testing of the function of the equipment.

## 8 Information for use

### 8.1 Instruction handbook

#### 8.1.1 General

Operating instructions shall be provided by the manufacturer. The instructions shall deal with start-up, operation, and normal and emergency shut-down. The format and content shall comply with clause 5 of EN 292-2:1991 and shall refer specifically to 8.1.2 to 8.1.6 of this part of EN 746.

#### 8.1.2 Description of equipment

The instruction handbook shall contain the following information:

- a description of the gas generation and/or atmosphere supply system, including 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 gas generation and/or atmosphere supply;
- requirements for necessary venting systems.

All the information given on the marking plate(s) shall be repeated together with information relevant to combustion and fuel handling.

#### 8.1.3 Inspection procedures

The instruction handbook shall contain details of inspection intervals and checking procedures for:

- a) 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. In any case, this interval shall not exceed five years;
- b) all safety equipment, especially flame safeguards, warning devices and safety shut-off valves.

Documentation (e.g. logbook) 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.

#### 8.1.4 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.

It should be ensured that pipework is free from debris, welding slag, etc. before the equipment is put into service after initial commissioning, maintenance or long periods of shut-down.

The instruction handbook shall provide information on:

- special allowances or requirements for purging procedure;
- the exhausting of combustion products and gas excess atmosphere;
- the conditions for automatic re-start, if applicable.

#### 8.1.5 Shut-down procedures

The instruction handbook shall provide information on any special requirements necessary before shut-off, e.g. purging procedure.

The instruction handbook shall set down any special requirements for safety shut-down and/or start-up interlock and any special measures for subsequent re-start.

#### 8.1.6 Maintenance arrangements

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.

Documentation (e.g. logbook) with dates of last and next maintenance and the addresses and telephone and fax numbers of maintenance and repair services shall be provided.

The manufacturer shall issue complete and clear instructions for the maintenance of atmosphere generation systems.

The manufacturer shall draw the attention of the user to the following good practices:

- a) An established maintenance programme is an essential safety aid which determines that the equipment is in working order.  
The final responsibility for adequate operational checks rests with the user of the thermoprocessing equipment.
- b) The user's maintenance programme should include the recommended procedures which are applicable to atmosphere generation systems.
- c) Maintenance of safety devices, including checking of the correct settings, should be undertaken only by authorized personnel familiar with the safety concept and proper functioning of the equipment.

### **8.1.7 Additional information**

The manufacturer shall draw the user's attention to the following :

- a) The selection of alert and competent personnel shall be required. It is recognized that their knowledge and training is essential for safe operation and safe maintenance.
- b) All personnel shall be thoroughly instructed and trained by experienced persons authorized by the user of the thermoprocessing equipment. Scheduled retraining is necessary at regular intervals.
- c) Personnel should have access to operating instructions and other necessary means of information at all times.
- d) Personnel, who, in the course of maintenance and repair work inside thermoprocessing equipment should be trained that:
  - the space they are entering has been adequately purged; and
  - does not contain toxic or asphyxiating gases.They should have knowledge of working procedures in confined spaces. They should be trained in the use of personal protection equipment and rescue procedures.
- e) Abbreviated instructions setting out all necessary measures for safe operation should be provided in durable form at a suitable location within the plant. These instructions should be concise in nature and should not be considered as a substitute for the instruction handbook.

The following minimum information shall be given:

- list of requirements of utilities.

### **8.1.8 Documentation**

Provision shall be made for the recording of revisions to the instruction handbook in the event of modification of the equipment (e.g. by repair, modernization or replacement of parts, change of operating conditions).

### **8.2 Marking**

Marking shall be in accordance with EN 746-1.



**Annex A (informative)**  
**Typical atmosphere gases**

Atmosphere gases	Typical gas composition					Density kg/m <sup>3</sup>	Weight (Relative to air)		Hazards		
	% (V/V)						lighter	heavier	explosion	toxicity	Asphyx- iation
	CO <sub>2</sub>	CO	H <sub>2</sub>	N <sub>2</sub>	H <sub>2</sub> O						
<b>Elementary gases:</b>											
1. Helium (He)	—	—	—	—	—	0,179	☑	—	—	—	☑
2. Argon (Ar)	—	—	—	—	—	1,784	—	☑	—	—	☑
3. Nitrogen (N <sub>2</sub> )	—	—	—	100	—	1,251	☑ <sup>6)</sup>	—	—	—	☑
4. Hydrogen (H <sub>2</sub> )	—	—	100	—	—	0,090	☑	—	☑	—	☑
<b>Exothermic atmospheres:<sup>3)</sup></b>											
5. CCHN-type <sup>1)</sup> ('lean')	12-18	0,5-2,5	0,5-2,5	87-85	5)	1,131 <sup>8)</sup>	☑ <sup>6)</sup>	—	— <sup>2)</sup>	☑	☑
	('rich')	8-4	5-12	5-18	82-66	5)	1,161 <sup>8)</sup>	☑	—	☑	☑
6. CHN-type <sup>1)</sup> ('lean')	—	0,5-2,5	0,5-2,5	99-95	—	1,234 <sup>8)</sup>	☑ <sup>6)</sup>	—	— <sup>2)</sup>	☑	☑
	('rich')	—	5-12	5-18	90-70	—	1,117 <sup>8)</sup>	☑	—	☑	☑
7. HN-type <sup>1)</sup> ('lean')	—	—	1-5	99-95	—	1,216 <sup>8)</sup>	☑ <sup>6)</sup>	—	— <sup>2)</sup>	—	☑
	('rich')	—	—	10-30	90-70	—	1,0198	☑	—	☑	—
<b>Endothermic atmospheres:</b>											
8. ENDO-Gas	Traces	20-23	31-40	40-46	Traces	0,834 <sup>8)</sup>	☑	—	☑	☑	☑
9. Ammonia (dissociated)	—	—	75	25	—	0,380	☑	—	☑	—	☑
10. Methanol (dissociated)	Traces	33	67	—	Traces	0,868	☑	—	☑	☑	☑
<b>Other atmosphere gases:</b>											
11. Water vapour (H <sub>2</sub> O)	—	—	—	—	100	0,805 <sup>7)</sup>	☑	—	—	—	☑
12. Carbon dioxide (CO <sub>2</sub> )	100	—	—	—	—	1,977	—	☑	—	—	☑
13. Ammonia (NH <sub>3</sub> )	—	—	—	—	—	0,771	☑	—	☑	☑	☑
14. Hydrocarbons											
Methane (CH <sub>4</sub> )	—	—	—	—	—	0,717	☑	—	☑	—	☑
Propane (C <sub>3</sub> H <sub>8</sub> )	—	—	—	—	—	2,019	—	☑	☑	—	☑

<sup>1)</sup> Code-letters indicate typical constituents:

- (C) → CO  
(CC) → CO + CO<sub>2</sub>  
(H) → H<sub>2</sub>  
(N) → N<sub>2</sub>

<sup>2)</sup> Provided that (CO + H<sub>2</sub> + max 1 % (V/V) CH<sub>4</sub>) ≤ 5 % (V/V)

<sup>3)</sup> Atmosphere gases classified under 5 to 10 can also be produced by mixing of component gases.

<sup>4)</sup> The percentage of combustibles in a furnace chamber can be higher due to the addition of hydrocarbons or the vapourization of oily residues of insufficiently cleaned workpieces.

<sup>5)</sup> The amount of water vapour may be varied to make the atmosphere gas suitable for specific processes.

<sup>6)</sup> Difference in density relative to air is only slight. Equal density should be assumed in terms of safety considerations.

<sup>7)</sup> Gaseous state not existing under physical 'Standard Conditions' (0 °C/1013 mbar = 1,013 × 10<sup>5</sup> Pa).

<sup>8)</sup> Density value refers to mean composition.

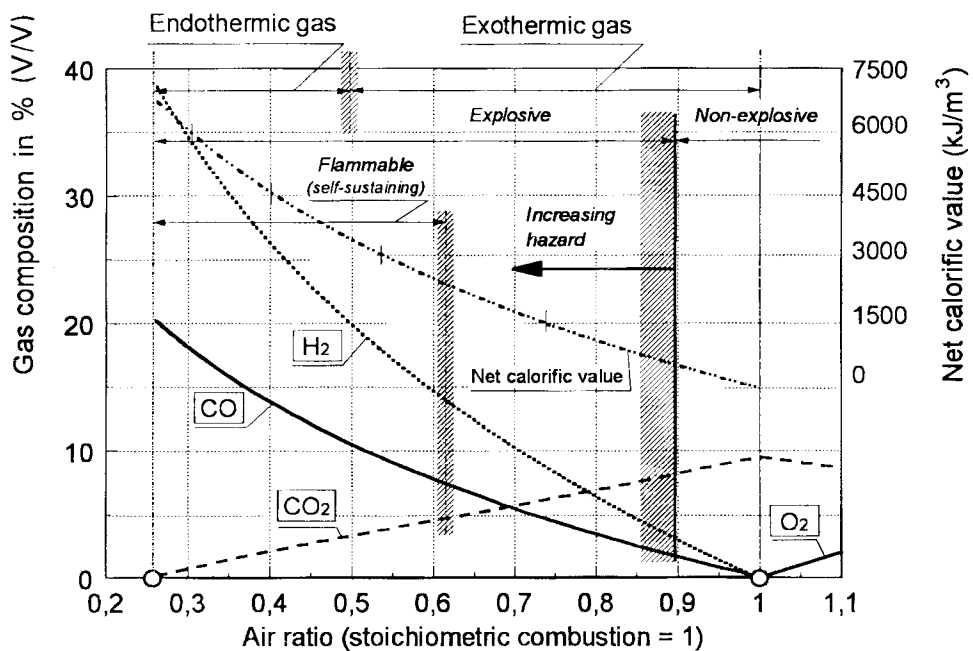
**Annex B (informative)**

**Explosion hazards of gas mixtures containing combustibles**

Figure 1 shows typical gas compositions as a result of the sub-stoichiometric combustion of fuel gases (propane, natural gas, etc.) as it is supplied for the generation of various types of controlled gas atmospheres. The aim of this figure is to add to an understanding of the defined safety threshold values (in terms of critical gas constituents) on which the strategies to avoid the risk of explosion are based.

The dividing line between flammable and self-sustaining combustible is variable. It depends not only on the composition of the gas and its ignition temperature but also on external conditions such as the dissipation of heat at the point of combustion, the temperature and the exit velocity of the gas.

It should be noted that flammable gases which are not sustaining combustion in accordance with this definition can be capable of forming explosive mixtures. A gas which fails to combust under test cannot automatically be assumed to be harmless.



**Figure B.1 Typical gas composition/Partial combustion of a fuel gas with air**

## Annex C (informative)

### Inert gas purging

Figure C.1 illustrates the relationship between the reduction of oxygen (starting with 20,9 % (V/V) in accordance with oxygen in air) as a function of the inert purge gas volume (related to the volume of the chamber/enclosure) during a typical purging procedure at ambient temperature using an inert gas (non-reactive with oxygen, preferably Nitrogen N<sub>2</sub>).

The threshold value of 1 % (V/V) oxygen (as specified in 3.4) theoretically requires a purging gas volume which is equal to 3-times the volume of the chamber/enclosure on condition that complete mixing occurs. The established value of safety purge volume (5-times the chamber volume, ref. 3.10) includes a safety margin, thus taking account of practical operation conditions which can deviate somewhat from ideal conditions. Short circuits of the gas flow and so-called 'dead spots' (parts of the enclosure not fully included in the flow pattern) must be avoided. Gas inlets/outlets should be adequately positioned and where fitted gas circulation should be activated. Particular attention should be paid to the adequate supply of purge gas. It is important that both throughput volume of gas and the duration of the purging procedure are being monitored. Analytical monitoring of a critical gas constituent (e.g. oxygen content) can be required in specialized cases.

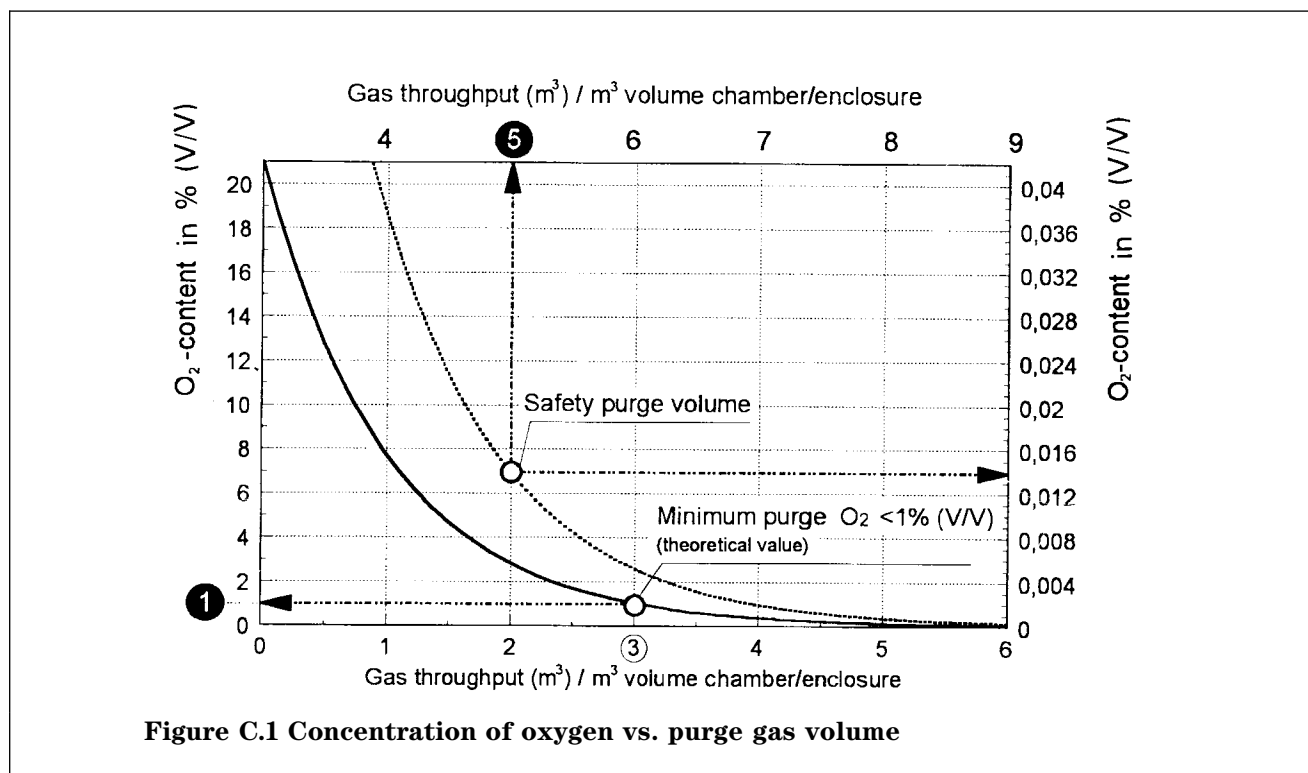


Figure C.1 Concentration of oxygen vs. purge gas volume

**Annex D (informative)**

**Bibliography**

Country	Document title
(B)	<p><b>A.G.B/3 GT 1/Fascicule V:</b> (Fours sous atmosphère contrôlée) (Furnaces under protective atmosphere)</p>
(CH)	<p><b>Schweizerische Unfallversicherungsanstalt/Unfallverhütung:</b> Richtlinien zur Verhütung von Unfällen und Vergiftungen bei der thermischen Behandlung von Metallen (Règles pour la prévention des accidents et intoxications lors du traitement thermique des métaux) (Guidelines for the prevention of accidents and poisoning during thermal treatment of metals)</p>
(D)	<p><b>AWT-Fachausschuss 8:</b> Sicherheitstechnische Empfehlungen für den Betrieb von Industrieöfen mit Schutzgasatmosphären (Industrial furnaces with controlled atmospheres)</p> <p><b>VDI Richtlinie 2046:</b> Sicherheitstechnische Richtlinie für den Betrieb von Industrieöfen mit Schutz- und Reaktionsgasatmosphären (Safety code for operation of industrial furnaces with protective and reaction gases)</p>
(F)	<p><b>APAVE T 127-7.65:</b> 'Recommendations for safe use of gases in industrial furnaces.' Recommandations en vue de l'emploi des gaz combustibles riches dans les fours industriels.</p>
(I)	<p><b>UNI 7728:</b> 'Forni industriali - Diretiva per la sicurezza' (Industrial furnaces - safety rules)</p>
(UK)	<p><b>IM/9 Code of practice/Part 1:</b> 'Exothermic atmosphere gas generators'. <b>IM/9 Code of practice/Part 2:</b> 'Endothermic atmosphere gas generators'. <b>IM/9 Code of practice/Part 3:</b> 'Use of generated atmosphere gas in associated plant'.</p>

## Annex E (informative)

### Used definitions

#### Trilingual index

#### E.1 English — German — French

Ref.	English	German	French
3.11	atmosphere gas generating system	Schutz- und Reaktionsgaserzeugungssystem	générateur de gaz d'atmosphère
3.12	automatic re-start	Automatisches Wiederanfahren	redémarrage automatique
3.16	flame failure	Flammenausfall	défaut de flamme
3.13	flame instability	Flammeninstabilität	instabilité de flamme
3.17	flame safeguard	Flammenüberwachungseinrichtung	dispositif de surveillance de flamme
3.14	flame sensor	Flammenfühler	détecteur de flamme
3.18	flame trap	Flammensperre	dispositif anti-retour de flamme
3.4	flammable atmosphere gas	Brennbares Schutz- und Reaktionsgas	gaz d'atmosphère inflammable
3.8	fluid	Fluid	fluide
3.1	industrial thermoprocessing and associated equipment	Industrielle Thermoprozeßanlagen und damit verbundene Einrichtungen	équipement thermique industriel et annexes
3.6	inert gas	Inertgas	gaz inerte
3.23	interrupted pilot	Zündbrenner, mit unterbrochener Betriebsweise	brûleur d'allumage intermittent
3.20	multiturn valve	Ventil mit Mehrfachumdrehung	vanne multitours
3.5	non-flammable atmosphere gas	Nichtbrennbares Schutz- und Reaktionsgas	gaz d'atmosphère non inflammable
3.21	non-return valve	Rückschlagventil	vanne anti-retour
3.22	pilot flame	Zündflamme	flamme d'allumage
3.24	pilot shrinkage	Flammenreduzierung	brûleur d'allumage en bas régime
3.3	purging	Spülen	purge
3.2	safe ignition temperature	Sicherheitstemperatur	température d'allumage en toute sécurité
3.9	safe level of vacuum	Sicherheitsvakuum	niveau suffisant de vide assurant la sécurité
3.26	safe shut-down	Sichere Abschaltung	arrêt de sécurité
3.25	safe start check	Sicherheitsstartkontrolle	contrôle de sécurité au démarrage
3.10	safety purge volume	Sicherheits-Spülvolumen	volume de purge assurant la sécurité
3.28	safety shut-off valve system	Sicherheitsabschalt-Ventilsystem	système de vannes d'arrêt d'urgence
3.15	sensor output drift	Signaldrift	dérive du détecteur
3.29	slam shut valve	Schnellschlußventil	vanne à fermeture rapide par pression
3.30	start gas flame	Startflamme	flamme de démarrage
3.19	Start-up interlock	Startverriegelung	dispositif de verrouillage au démarrage
3.27	system of safety shut-down	Sicherheitsabschaltsysteme	système d'arrêt de sécurité
3.7	toxic atmosphere gas	Giftiges Schutz- und Reaktionsgas	gaz d'atmosphère toxique

E.2 German — English — French

Ref.	German	English	French
3.12	Automatisches Wiederanfahren	automatic re-start	redémarrage automatique
3.4	Brennbares Schutz- und Reaktionsgas	flammable atmosphere gas	gaz d'atmosphère inflammable
3.16	Flammenausfall	flame failure	défaut de flamme
3.14	Flammenfühler	flame sensor	détecteur de flamme
3.13	Flammeninstabilität	flame instability	instabilité de flamme
3.24	Flammenreduzierung	pilot shrinkage	brûleur d'allumage en bas régime
3.18	Flammensperre	flame trap	dispositif anti-retour de flamme
3.17	Flammenüberwachungseinrichtung	flame safeguard	dispositif de surveillance de flamme
3.8	Fluid	fluid	fluide
3.7	Giftiges Schutz- und Reaktionsgas	toxic atmosphere gas	gaz d'atmosphère toxique
3.1	Industrielle Thermoprozeßanlagen und damit verbundene Einrichtungen	industrial thermoprocessing and associated equipment	équipement thermique industriel et annexes
3.6	Inertgas	inert gas	gaz inerte
3.5	Nichtbrennbares Schutz- und Reaktionsgas	non-flammable atmosphere gas	gaz d'atmosphère non inflammable
3.21	Rückschlagventil	non-return valve	vanne anti-retour
3.29	Schnellschlußventil	slam shut valve	vanne à fermeture rapide par pression
3.11	Schutz- und Reaktionsgaserzeugungssystem	atmosphere gas generating system	générateur de gaz d'atmosphère
3.26	Sichere Abschaltung	safe shut-down	arrêt de sécurité
3.27	Sicherheitsabschaltssysteme	system of safety shut-down	système d'arrêt de sécurité
3.28	Sicherheitsabschalt-Ventilsystem	safety shut-off valve system	système de vannes d'arrêt d'urgence
3.10	Sicherheits-Spülvolumen	safety purge volume	volume de purge assurant la sécurité
3.25	Sicherheitsstartkontrolle	safe start check	contrôle de sécurité au démarrage
3.2	Sicherheitstemperatur	safe ignition temperature	température d'allumage en toute sécurité
3.9	Sicherheitsvakuum	safe level of vacuum	niveau suffisant de vide assurant la sécurité
3.15	Signaldrift	sensor output drift	dérive du détecteur
3.3	Spülen	purging	purge
3.30	Startflamme	start gas flame	flamme de démarrage
3.19	Startverriegelung	Start-up interlock	dispositif de verrouillage au démarrage
3.20	Ventil mit Mehrfachumdrehung	multiturn valve	vanne multitours
3.23	Zündbrenner, mit unterbrochener Betriebsweise	interrupted pilot	brûleur d'allumage intermittent
3.22	Zündflamme	pilot flame	flamme d'allumage

**E.3 French — English — German**

Ref.	French	English	German
3.26	arrêt de sécurité	safe shut-down	Sichere Abschaltung
3.24	brûleur d'allumage en bas régime	pilot shrinkage	Flammenreduzierung
3.23	brûleur d'allumage intermittent	interrupted pilot	Zündbrenner, mit unterbrochener Betriebsweise
3.21	vanne anti-retour	non-return valve	Rückschlagventil
3.25	contrôle de sécurité au démarrage	safe start check	Sicherheitsstartkontrolle
3.16	défaut de flamme	flame failure	Flammenausfall
3.15	dérive du détecteur	sensor output drift	Signal drift
3.14	détecteur de flamme	flame sensor	Flammenfühler
3.18	dispositif anti-retour de flamme	flame trap	Flammensperre
3.17	dispositif de surveillance de flamme	flame safeguard	Flammenüberwachungseinrichtung
3.19	dispositif de verrouillage au démarrage	Start-up interlock	Startverriegelung
3.1	équipement thermique industriel et annexes	industrial thermoprocessing and associated equipment	Industrielle Thermoprozeßanlagen und damit verbundene Einrichtungen
3.22	flamme d'allumage	pilot flame	Zündflamme
3.30	flamme de démarrage	start gas flame	Startflamme
3.8	fluide	fluid	Fluid
3.4	gaz d'atmosphère inflammable	flammable atmosphere gas	Brennbares Schutz- und Reaktionsgas
3.5	gaz d'atmosphère non inflammable	non-flammable atmosphere gas	Nichtbrennbares Schutz- und Reaktionsgas
3.7	gaz d'atmosphère toxique	toxic atmosphere gas	Giftiges Schutz- und Reaktionsgas
3.6	gaz inerte	inert gas	Inertgas
3.11	générateur de gaz d'atmosphère	atmosphere gas generating system	Schutz- und Reaktionsgaserzeugungssystem
3.13	instabilité de flamme	flame instability	Flammeninstabilität
3.9	niveau suffisant de vide assurant la sécurité	safe level of vacuum	Sicherheitsvakuum
3.3	purge	purging	Spülen
3.12	redémarrage automatique	automatic re-start	Automatisches Wiederanfahren
3.27	système d'arrêt de sécurité	system of safety shut-down	Sicherheitsabschaltssysteme
3.28	système de vannes d'arrêt d'urgence	safety shut-off valve system	Sicherheitsabschalt-Ventilsystem
3.2	température d'allumage en toute sécurité	safe ignition temperature	Sicherheitstemperatur
3.29	vanne à fermeture rapide par pression	slam shut valve	Schnellschlußventil
3.20	vanne multitours	multiturn valve	Ventil mit Mehrfachumdrehung
3.10	volume de purge assurant la sécurité	safety purge volume	Sicherheits-Spülvolumen

**Annex ZA (informative) Clauses of this European Standard addressing essential requirements or other provisions of EU Directives**

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association and supports essential requirements of following EU Directives:

Machinery Directive	89/392/EEC,
its amendments	91/368/EEC, 93/44/EEC and 93/68/EEC
Low Voltage Directive	73/23/EEC

**WARNING:** Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard.

Compliance with the clauses of this standard provides one means of conforming with the specific essential requirements of the Directive concerned and associated EFTA regulations.



## List of references

See national foreword.

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