BRITISH STANDARD

BS EN
746-1 : 1997

Industrial thermoprocessing equipment

Part 1. Common safety requirements for industrial thermoprocessing equipment

The European Standard EN 746-1 : 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

This British Standard, having been prepared under the direction of the Engineering Sector Board, was published under the authority of the Standards Board and comes into effect on
15 November 1997

Amendments issued since publication

Amd. No.	Date	Text affected

The following BSI references relate to the work on this standard:
Committee reference MCE/3/8
Draft for comment 92/76827 DC

ISBN 0 580 28354 2

National foreword

This Part of BS EN 746 has been prepared by Subcommittee MCE/3/8 and is the English language version of EN 746-1 : 1997 *Industrial thermoprocessing equipment — Part 1: Common safety requirements for industrial thermoprocessing equipment* published by the European Committee for Standardization (CEN).

EN 746-1 was produced as a result of international discussions in which the United Kingdom took an active part.

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 32, an inside back cover and a back cover.

blank

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 746-1

June 1997

ICS 25.180.01

Descriptors: Industrial products, industrial furnaces, dangerous machines, safety of machinery, safety requirements, accident prevention, hazards, safety measures, specifications, utilization, information

English version

Industrial thermoprocessing equipment — Part 1: Common safety requirements for industrial thermoprocessing equipment

Equipements thermiques industriels — Partie 1: Prescriptions générales de sécurité pour les équipements thermiques industriels

Industrielle Thermoprozeßanlagen — Teil 1: Allgemeine Sicherheitsanforderungen an industrielle Thermoprozeßanlagen

This European Standard was approved by CEN on 1997-02-15. CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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.

CEN members are the national standards bodies of Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CEN

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

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

Ref. No. EN 746-1 : 1997 E

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, Sweden, United Kingdom.

This standard forms one Part of safety standards covering Industrial Thermoprocessing Equipment.

The full list of Parts of EN 746 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, remelting and liquid phase maintaining 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.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Contents

0 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.

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

1.1 This part of EN 746 specifies common safety requirements for industrial thermoprocessing equipment (for example industrial furnaces and industrial heating equipment), which meets the definition for machinery given in EN 292-1 : 1991.

It details the anticipated significant hazards associated with industrial thermoprocessing equipment and specifies the appropriate preventative measures for reduction or elimination of these hazards.

This standard gives general principles and common requirements for the reduction of risks for equipments covered by the scope.

The common requirements apply to all of the subsequent parts of this EN 746 dealing with specific equipment unless an exception is stated in the relevant Part. The general principles (subclauses are pointed out) will be used to establish the specific technical measures in the subsequent Part(s) dealing with safety requirements for particular equipment.

NOTE. For similar equipment not covered by the particular Parts of this standard, EN 746-1 can be used to assist in the reduction of risk for the hazards identified in clause **4** (List of hazards).

1.2 This Part of EN 746 is applicable to industrial thermoprocessing equipments for use in fields such as:

- metallurgical and metal working plant;
- glass making plant;
- ceramic manufacturing plant;
- cement, lime and gypsum manufacturing plant;
- chemical plant;
- waste incineration equipment;

and heated by:

- gaseous fuels;
- liquid fuels;
- solid fuels;
- mixed fuels;
- electricity.

The thermoprocessing equipment covered by this Part of EN 746 is further specified in clause **3**.

A more detailed list of thermoprocessing equipment within these categories is given in annex A.

In the remainder of this standard the expression 'equipment' will be used.

This Part of EN 746 is not applicable to blast furnaces, converters (in steel plants), boilers, welding machines or food processing equipment.

1.3 This Part of EN 746 specifies the requirements to be met by the manufacturer to ensure the safety of persons and property during commissioning, start-up, operation, shut-down, maintenance periods and dismantling, 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, use and disposal.

It specifies safety requirements for:

- protection against:
  - mechanical hazards, movement of machinery and material, ejection of parts or material or liquids and gases, implosion, structural failure;
  - electrical hazards;
  - thermal hazards: explosion, fire, scalds, contact with hot parts, gases and flames;
  - noise and vibration;
  - thermal, optical and ionising and non-ionising radiation;
  - harmful by-products and hazardous substances, poisoning, biological and micro-biological contamination, pollution and environmental discomfort;
  - other hazards such as listed in clause **4**;
- maintenance, provision for indicators, and inspection.

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

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.

2.1 Basic Standards

EN 292-1 : 1991	*Safety of machinery — Basic concepts, general principles for design — Part 1: Basic terminology, methodology*
EN 292-2 : 1991	*Safety of machinery — Basic concepts, general principles for design — Part 2: Technical principles and specifications*
EN 60204-1	*Safety of machinery — Electrical equipment of machines — Part 1: General requirements* (IEC 204-1 : 1992, modified)
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*

2.2 Group Safety Standards

EN 294	*Safety of machinery — Safety distances to prevent danger zones being reached by the upper limbs*
EN 349	*Safety of machinery — Minimum gaps to avoid crushing of parts of the human body*
EN 418	*Safety of machinery — Emergency stop equipment, functional aspects — Principles for design*
EN 457	*Safety of machinery — Auditory danger signals — General requirements, design and testing* (ISO 7731 : 1986 modified)
EN 547-1	*Safety of machinery — Human body measurements — Part 1: Principles for determining the dimensions required for openings for whole body access into machinery*
EN 547-2	*Safety of machinery — Human body measurements — Part 2: Principles for determining the dimensions required for access openings*
EN 563	*Safety of machinery — Temperatures of touchable surfaces — Ergonomics data to establish temperature limit values for hot surfaces*
EN 614-1	*Safety of machinery — Ergonomic design principles — Part 1: Terminology and general principles*
EN 626-1	*Safety of machinery — Reduction of risks to health from hazardous substances emitted by machinery — Part 1: Principles and specifications for machinery manufacturers*

EN 811	*Safety of machinery — Safety distances to prevent danger zones being reached by the lower limbs*
EN 842	*Safety of machinery — Visual danger signals — General requirements, design and testing*
prEN 953	*Safety of machinery — General requirements for the design and construction of guards (fixed, movable)*
EN 954-1	*Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design*
EN 981	*Safety of machinery — System of auditory and visual danger and information signals*
EN 982	*Safety of machinery — Safety requirements for fluid power systems and their components — Hydraulics*
EN 983	*Safety of machinery — Safety requirements for fluid power systems and their components — Pneumatics*
EN 1037	*Safety of machinery — Prevention of unexpected start-up*
EN 1088	*Safety of machinery — Interlocking devices associated with guards — Principles for design and selection*
prEN 1127-1	*Safety of machinery — Fire and explosions — Part 1: Explosion prevention and protection*
prEN 1299	*Vibration isolation of machines — Information for the application of source isolation*
EN ISO 11690-2	*Acoustics — Recommended practice for the design of low-noise workplaces containing machinery — Part 2: Noise control measures* (ISO 11690-2 : 1996)
EN 60825-1	*Safety of laser products — Part 1: Equipment classification, requirements and users guide* (IEC 825-1 : 1993)
EN 61310-1	*Safety of machinery — Indication, marking and actuation — Part 1: Requirements for visual, auditory and tactile signals* (IEC 1310-1 : 1995)
EN 61310-2	*Safety of machinery — Indication, marking and actuation — Part 2: Requirements for marking* (IEC 1310-2 : 1995)
IEC 405	*Nuclear instruments: constructional requirements to afford personal protection against ionizing radiations*
IEC 417	*Graphical symbols for use on equipment — Index, survey and compilation of the single sheets*
ISO 7000	*Graphical symbols for use on equipment — Index and synopsis*
ISO 7243	*Hot environments — Estimation of the heat stress on working man, based on the WBGT-index (wet bulb globe temperature)*
ISO 7933	*Hot environments — Analytical determination and interpretation of thermal stress using calculation of required sweat rate*

2.3 Product Safety Standards

EN 746-2 : 1997	*Industrial thermoprocessing equipment — Part 2: Safety requirements for combustion and fuel handling systems*
EN 746-3	*Industrial thermoprocessing equipment — Part 3: Safety requirements for the generation and use of atmosphere gases*
prEN 746-4	*Industrial thermoprocessing equipment — Part 4: Particular safety requirements for hot dip galvanising equipment*
prEN 746-5	*Industrial thermoprocessing equipment — Part 5: Particular safety requirements for salt bath thermoprocessing equipment*
prEN 746-6	*Industrial thermoprocessing equipment — Part 6: Particular safety requirements for liquid phase treatment equipment*
prEN 746-7	*Industrial thermoprocessing equipment — Part 7: Particular safety requirements for vacuum thermoprocessing equipment*

prEN 746-8	*Industrial thermoprocessing equipment — Part 8: Particular safety requirements for quenching equipment*
prEN 1547	*Industrial thermoprocessing equipment — Noise test code for industrial thermoprocessing equipment including its ancillary handling equipment*
EN 60519-1	*Safety in electroheat installations — Part 1: General requirements*
EN 60519-2	*Safety in electroheat installations — Part 2: Particular requirements for resistance heating equipment*
IEC 519-3	*Safety in electroheat installations — Part 3: Particular requirements for induction and conduction heating and induction melting installations*
IEC 519-4	*Safety in electroheat installations — Part 4: Particular requirements for arc furnace installations*
IEC 519-5	*Safety in electroheat installations — Part 5: Specifications for safety in plasma installations*
IEC 519-6	*Safety in electroheat installations — Part 6: Specifications for safety in industrial microwave heating equipment*
IEC 519-7	*Safety in electroheat installations — Part 7: Particular requirements for installations with electron guns*
IEC 519-8	*Safety in electroheat installations — Part 8: Particular requirements for electro-slag remelting furnaces*
IEC 519-9	*Safety in electroheat installations — Part 9: Particular requirements for high-frequency dielectric heating 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 are given in informative annex D.

3.1 metallurgical and metal working plant

Plant and/or equipment which is used for thermal production, melting or remelting of ferrous and non-ferrous metals as well as to enable the molten material to be held, heated, alloyed and restructured before recasting into predetermined shapes.

Equipment used to remelt and re-alloy selected scrap material to produce primary ingots for remelting.

Equipment used to change the structure of the solid material by heating and cooling through various temperature gradient changes before its return to ambient temperature.

Equipment used to pre-heat metal prior to mechanical working or joining.

3.2 glass making plant

Plant and/or equipment which is used to heat and melt the constituents which make up glass and to allow for their proper mixing before the molten material is used directly to manufacture glass products.

Plant and/or equipment which is used for heat treatment or forming of glass products.

3.3 ceramic manufacturing plant

Plant and/or equipment which is used for firing, heating and/or melting ceramic raw material and/or products (e.g. tiles, sanitary ware, table ware, bricks) to process the product to its intermediate or final state.

Plant and/or equipment for the reheating and drying of such products to apply glaze and other decoration to the item.

3.4 cement, lime and gypsum manufacturing plant

Plant and/or equipment used to calcine and/or fire selected raw materials to produce cement, lime and gypsum.

3.5 chemical plant

Plant and/or equipment which provides the heat input into chemical plants used in processes such as thermo-chemical reactions, oxygenation, catalysing, reduction, chain reactions and distillation.

3.6 waste incineration equipment

Equipment used to dispose of by burning, household and industrial waste, sewage sludge, tyres, special and toxic waste, medical and hospital waste but excluding atomic waste.

3.7 drying equipment

Equipment used to cure or expel moisture or volatiles from a product or material by heating.

3.8 cooling equipment

Equipment with heating and/or cooling systems used to reduce the temperature of products.

4 List of hazards

Anticipated significant hazards are listed in broad outline in the scope and are detailed in table 1.

For ease of reference table 1 also indicates the corresponding preventative measures and should be used in conjunction with clauses **5** and **6**.

NOTE. When personal protective equipment is referred to, the manufacturer should recommend it in the information for use manual.

Table 1. List of hazards, hazardous situations and preventative measures

1 Clause	2 Hazard	3 Hazardous Situation	4 Preventative Measures	5 References
1	General		General design concept (Structure, access for operation, maintenance and cleaning, lighting, etc.)	**5.1.1** to **5.1.3**
2	Mechanical			
2.1	General		Design, structural details;	**5.2.1**
			Emergency stops; Guards.	EN 418, prEN 953
2.2	Crushing	Moving parts Traps created by auto and manual feeding/take-off mechanisms	Fit guard,	**5.2.2**, prEN 953
			fit interlocks,	prEN 1088
			Means of warning (audible, visual),	EN 457, prEN 842, EN 981, EN 61310-1
			Provision of safety distances,	EN 294; EN 349; EN 811; EN 547-1
			Provision of warning signs,	ISO 7000; EN 61310-1
			Emergency stops,	EN 418
			Push button with visual inspection, Maintenance/cleaning, good practice (particularly on guards).	
2.3	Shearing	Moving parts, moving of charging doors, feeding/take-off mechanism	Fit guard,	**5.2.3**; prEN 953
			Fit interlocks,	prEN 1088,
			Means of warning (audible, visual),	EN 457, prEN 842, EN 61310-1, EN 981
			Provision of warning signs,	ISO 7000, EN 61310-1
			Safety distances, Perimeter fencing, marking, Push button with visual inspection.	EN 349; EN 547-1
2.4	Entanglement	Rotating shafts (e.g. fan shafts, conveyors, transmission machinery)	Guards	prEN 953, **5.2.4**
2.5	Drawing-in	Nips created by rolls (e.g. conveyors)	Guards	prEN 953, **5.2.5**
2.6	Impact	Struck by moving parts (e.g. doors, chargers)	Guards, Perimeter fencing systems or signs	prEN 953, **5.2.6**
2.7	High pressure fluids	Hydraulic leaks/failure Steam and service fluids	Prevent as far as possible by adopting good maintenance procedures. Design features; Guards,	**5.2.7**, prEN 982; prEN 983, prEN 953
			Containing and draining.	

Table 1. List of hazards, hazardous situations and preventative measures *(continued)*

1 **Clause**	2 **Hazard**	3 **Hazardous Situation**	4 **Preventative Measures**	5 **References**
2.8	Ejection of parts	Molten metal, Process components/ materials, Machinery parts	Effective protection of defined areas or sections;	**5.2.8**
			Provision of personal protective equipment	**6.4.15**
			Guarding, Design features, Method of operation	prEN 953
2.9	Implosion	Ejection of parts	Design features; method of operation	**5.2.9**, prEN 746-7
2.10	Stability	Collapsing of parts or equipment or materials;	Design (e.g. civil engineering) and maintenance;	5.2.10
		Movement of components or of machinery	Design,training, understanding of the system, signs	ISO 7000; EN 61310-1
2.11	Slip/trip	Floor surfaces, Walkway surfaces,	Ladders/walkways designed in accordance with defined specifications: no trip conditions; easy to maintain and clean; good maintenance and cleaning	**5.2.11**
		Spilled fluids,	Provide containment and draining;	
		Inadequate lighting.	Provide adequate lighting	
2.12	Falls	1) From equipment;	Ensure openings are covered or guarded;	**5.2.12**
		2) Into equipment (e.g. openings, charging);	Provide adequate hand holds; Flat safe surrounding floors; Ensure openings closed during normal operation;	
		3) Inadequate lighting	Provide adequate lighting.	
3	Electrical			
3.1	General		– For electroheat installations, design and operation to be in accordance with EN 60519-1, EN 60519-2, and other Parts of IEC 519	**5.3.1**, EN 60519-1; EN 60519-2, IEC 519 : Parts 3 to 9
			– For all other thermoprocessing equipment: design and operation 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, IEC 364-4-46 and EN 60204-1.	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, IEC 364-4-46 and EN 60204-1
3.2	Contact			
3.2.1	Direct	Exposed or accessible live connectors, bus bars, etc.	Appropriate protection (fixed/interlocking guards), locked control cabinets, safety audit, enclosed electrical control and supply rooms	**5.3.2**, prEN 953, prEN 1088
			– For electroheat installations see EN 60519-1, EN 60519-2, IEC 519-3 and following Parts;	EN 60519-1 EN 60519-2 IEC 519 : Parts 3 to 9
			– For thermoprocessing equipment see 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, IEC 364-4-46;	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, IEC 364-4-46
			– Guards.	**5.3.2.2**; prEN 953; prEN 1088

Table 1. List of hazards, hazardous situations and preventative measures *(continued)*

1 **Clause**	2 **Hazard**	3 **Hazardous Situation**	4 **Preventative Measures**	5 **References**
3.2.2	Indirect	Insulation breakdown Earthing faults Physical contact	– For electroheat installations see EN 60519-1, EN 60519-2, and following Parts	**5.3.2** EN 60519-1; EN 60519-2 IEC 519 : Parts 3 to 9
			– For thermoprocessing equipment see 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, IEC 364-4-46.	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, IEC 364-4-46
3.3	Electrostatics	Discharge into the measuring, controlling and regulating devices e.g. stored programme system or computer	Design and protection in accordance with supplier's requirements	**5.3.3**
3.4	Electrical overload and short circuit	Breakdown/Reduction of electrical insulation; Fire; Radiation; Ejection of molten particles; Chemical reactions.	Adequate protection should avoid this factor during normal operation: design; correct placement and protection of cables.	**5.3.4**; EN 60519-1; EN 60519-2; IEC 519 : Parts 3 to 9; 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, IEC 364-4-46
3.5	Thermal radiation or other phenomena	Fire;	Protect as far as possible from fire/explosion effects;	**5.3.5**
		Molten metal, Molten metal fusion in an electrical panel;	Protect from any likely splash of molten metal;	
		Heat.	Equipment and cabling designed and positioned to avoid damage (e.g. heat shields, cooling).	
3.6	External influences	Electromagnetic fields (see also **7.2.4**).	For electroheat installations with high electromagnetic fields: – forbidden area for people with pacemakers.	**5.3.6**; **6.4.17**
		Induced voltage peaks (in control circuits) by switching high currents or voltage;	Proper design for control circuits	**5.3.6**
		Disturbing signals in control circuits, RF interference, Lightning.		
4	Thermal			
4.1	General		Design features	**5.4.1**; ISO 7933
4.2	Heat Sources	Contact with hot/cold surfaces	Reduce access where possible;	**5.4.2**
		Heat radiation	Provide protection (insulation barriers and screens, ventilation etc.);	EN 563, prEN 953
		Contact with hot gases and flames	Provide warnings Danger zone marking; Personal protective equipment provision and usage;	**6.4.15**
		Ejection of hot parts (molten material or liquids);	Provision of information in Instruction handbook: – commissioning; – use, – maintenance;	**6.4**
		Extremes of temperature	Design work position to minimize exposures. Personal protective equipment	ISO 7933; **6.4.15**

Table 1. List of hazards, hazardous situations and preventative measures *(continued)*

1 **Clause**	2 **Hazard**	3 **Hazardous Situation**	4 **Preventative Measures**	5 **References**
4.3	Fire/explosion			
4.3.1	Fire	Failure of controls and/or equipment leading to fire;	Design; Operation handbook;	**5.4.3.1**; **6.4**
		Escape of flames	Guards; maintenance;	**6.4**; prEN 953
		Escape of materials	Guards; proper procedures and maintenance;	**6.4**; prEN 953
		Heat transfer fluids fire;	Proper procedures and devices for the use of heat transfer fluids;	**5.4.3.1**
		Fires in quench oil	Maintain cleanliness; agitate; control temperature; avoid contamination; auto extinguish system;	**5.4.3.1**; prEN 746-8
		Fires in service oil/fuel oil.	Protection; design; maintenance.	
4.3.2	Explosion	Failure of control and/or equipment leading to explosion; Ejection of hot parts or liquids	Provision of explosion relief sufficient to prevent disintegration of equipment; Provision of explosion relief designed to deflect effects away from work areas;	**5.4.3.2**; prEN 1127-1
			Instruction handbook: – commissioning; – use; – maintenance;	**6.4**; **6.5**
			Design to prevent escape of unburnt gases, flash back in the pipework	**5.1.3**
			Design work position to minimize exposures;	
			Protection against ejection of service or process fluids;	**5.4.4**
		Flame failure: generation of explosive atmospheres	Flame safeguard, Provision of adequate explosion relief, Remove explosion hazards	**5.4.3.2**; EN 746-2
		Failure of purge (evacuating gases)	Purging procedures clearly defined (e.g. number of volume changes) in accordance with circumstances	**5.4.3.2**; EN 746-2; EN 746-3
4.4	Ejection of hot particles/workpieces	Molten metal; Process components/materials; Machinery parts;	Effective protection of defined areas or sections; Guarding; Design features;	**5.4.4**; prEN 953;
			Method of operation;	**6.4**
			Personal protective equipment provision.	**6.4.15**
4.5	Thermal stress/other physiological effects	Contact with hot surfaces or liquids; Extremes of temperature (including draughts, cold);	Reduce access, where possible; Protection by: insulation barriers, screens, ventilation, etc.	**5.4.5**
			Provide warnings, danger zone marking;	EN 61310-1; ISO 7000
			Personal protective equipment; provision and usage;	**6.4.15**
			Provision of information in instruction handbook.	**6.4**
			Design work position to minimize exposures	ISO 7933

Table 1. List of hazards, hazardous situations and preventative measures *(continued)*

1 **Clause**	2 **Hazard**	3 **Hazardous Situation**	4 **Preventative Measures**	5 **References**
5	Noise			
5.1	Noise effects	Sound emission	Noise-reducing design; enclosures, silencers;	**5.5.1** EN ISO 11690-2
			Reduce vibration.	**6.4.7**
5.2	Hearing loss and physiological effects	Sound emission	Noise reduction measures, soundproof booth Hearing protectors	**5.5.1**; **6.4.7**
5.3	Interference with communications	Messages incorrectly heard, warnings not understood due to sound emission	Ensure the functioning of the communication system; Noise reducing measures;	**5.5.2**; **6.4.7**
			Provide audible/visual alarms.	EN 457; prEN 842
6	Vibration			
6.1	Vibration effects	Vibration effects (also physiological)	Design; maintenance Antivibration mountings	**5.6**; prEN 1299
7	Radiation			
7.1	General			**5.7.1**
7.2	Non ionizing radiation			**5.7.2**
7.2.1	Infrared; visible; UV radiation;	Burning from flames, arcs, furnace walls, materials.	Prevent direct sight of radiation sources.	**5.7.2.1**
		Excessive heat, UV eye and skin damage, Damage to sight Eye and tissue damage.	Provision and use of safety tinted glasses or tinted view holes Provide warning signs	ISO 7243; ISO 7933; **6.4.16**; EN 61310-1
7.2.2	Electric Arc	Eye and tissue damage	Prevent direct sight of radiation sources.	**5.7.2.1**; **5.7.2.2**
			Provision and use of safety tinted glasses or tinted view holes	**6.4.16**
			Provide warning signs.	EN 61310-1
7.2.3	Laser beam	Contact with eye	Any laser application should meet EN 60825	**5.7.2.3**; EN 60825
7.2.4	Electromagnetic field:	Exposure of pacemaker, Physiological effects;	Specific exclusion of users of pacemaker;	**5.7.2.4**; **6.4.17**
	Low frequency, Medium frequency, High frequency	Induced burns from the wearing of/or implanted metals on persons	Instructions concerning removal of metal objects in contact with the body	**5.7.2.4**; **6.4.17**
			Measures to prevent persons with implanted metal from being in the area	**5.7.2.4**; **6.4.17**
7.2.5	Microwaves	Body tissue and organ damage (Physiological)	Provision in accordance with IEC 519-6	**5.7.2.5**; IEC 519-6
7.3	Ionizing radiation	Accidental exposure to ionizing radiation;	Use only sealed sources in accordance with IEC 405.	**5.7.3**; IEC 405
			Provide marking and warning signs	ISO 7000; EN 61310-1; EN 61310-2
8	Materials and substances			
8.1	General			**5.8.1**
8.2	Harmful by-products	Escape of dust/fume from combustion, from process, from workpiece, from quenching;	Provision of local exhaust ventilation; Provision of proper evacuation;	**5.8.2**; EN 626-1
		Gas by-products from special atmospheres (these can be toxic, flammable, asphyxiant or cause distress) including inhalation,	Provision of detecting devices, Provision of specific danger warning sign, Provision of warning devices,	EN 746-3
		ingestion, absorption, asphyxiation, toxicity	Periodic environmental sampling of working atmosphere,	
			Defined maintenance procedures;	**6.5**

Table 1. List of hazards, hazardous situations and preventative measures *(continued)*

1 **Clause**	2 **Hazard**	3 **Hazardous Situation**	4 **Preventative Measures**	5 **References**
8.3	Fire/explosion	See **4.3.1** and **4.3.2**	Flameguards	**5.8.3**; prEN 1127-1
			Fuel cut-off devices and interlocks	EN 746-2
			Fire detectors — flammable gas detectors	EN 746-3
8.4	Biological and microbiological contamination	Exposure to biological and microbiological organisms e.g. contaminated cooling systems or processed material	Specify treatment for systems; Adequate filtration; Prevent contact and exposure	**5.8.4**; **6.4.5**
9	Ergonomic			
9.1	General		Principles for design	**5.9**
			Referenced group standards to be observed	EN 614-1
	Insufficient lighting	Vicinity of the machine or process	Provide sufficient lighting	**5.1.3**
10	Hazard combination			
10.1	General	Refer to clause **5.10.1**	General (design) provision to prevent enhanced cumulative effects of hazards combination	**5.10.1**
11	Malfunction			
11.1	General			**5.11.1**
11.2	Failure of energy supply	Loss of control (process and power)	Effective safe shut-down;	**5.11.2**
			Provision of preferential supply systems.	**6.3.9**
	Failure of service fluids	Partial or total loss of services	Standby safety and reserve supply system;	**5.11.2**; **6.3.9**
		Failure of equipment to operate correctly	Instruction, training, good maintenance	**6.4**; **6.5**
11.3	Ejection of parts (or fluids)	See **2.7**, **2.8**, **4.4**		**5.2.7**; **5.2.8**; **5.4.4**
11.4	Errors of fitting/assembly	See also stability **4.2.10**	Design, training, understanding of the system, marking, identification, etc.	**5.11.4**; **6.4.1**; **6.5.1**
11.5	Effect of malfunction of control system devices	Unexpected operating condition	Well-trained and instructed personnel; Good maintenance	**5.3.6**; **5.11.5**; **6.4**; **6.5**; EN 954-1
11.6	Lack of information/ warning devices	No reaction to situations requiring remedial action (auto or manual) e.g. flame failure, high temp etc. Over use of devices and hence loss of effectiveness	Provide means to identify dangerous deviations from normal operation. Maintenance; Design; Training	**5.11.6**; EN 981; EN 61310-1; EN 61310-2
11.7	Warning signs	No warning of particular dangers (in addition to the device)	Comply with EN 61310-1 Signs are to be pictorially clear, correctly positioned, difficult to remove or permanently marked.	**5.11.7**; **6.2.3**; **6.2.4**
11.8	Failure of equipment	Inadequate instructions to operating personnel Inadequate maintenance	Instruction handbook; Training Instruction handbook Maintenance at prescribed intervals	**5.11.8**; **6.4** **6.4**; **6.5**
12	Missing/incorrectly fitted safety devices			
12.1	General			**5.12.1**
12.2	Guards	Absence or incorrect fitting can cause injury or death to the operator or by-standers	Maintenance, Design, Training.	**6.4**; **6.5**
12.3	Safety devices	Absence or incorrect fitting can cause injury or death to the operator or by-standers.	Maintenance, Design, Training.	**5.1.3;** **6.4**; **6.5**
12.4	Start/stop	Absence or incorrect fitting can cause injury or death to the operator or by-standers.	Maintenance, Design, Training.	**6.4**; **6.5** prEN 1037

Table 1. List of hazards, hazardous situations and preventative measures *(continued)*

1 Clause	2 Hazard	3 Hazardous Situation	4 Preventative Measures	5 References
12.5	Information/warning signs	Absence or incorrect fitting can cause injury or death to the operator or by-standers.	Maintenance, Design, Training.	**6.4**; **6.5** EN 61310-1
12.6	Energy supply disconnection devices	Absence or incorrect fitting can cause injury or death to the operator or by-standers.	Proper energy isolating devices	**5.12.2**; EN 292-2 : 1991; prEN 1037
12.7	Emergency stops	Absence or incorrect fitting can cause injury or death to the operator or by-standers	Maintenance, Design, Training.	EN 418; **6.4**; **6.5**
12.8	Feeding/take-off devices	Absence or incorrect fitting can cause injury or death to the operator or by-standers	Maintenance, Design, Training.	**6.4**; **6.5**
12.9	Adjustment/ maintenance	Absence or incorrect fitting can cause injury or death to the operator or by-stander.	Maintenance, Design, Training.	**6.4**; **6.5**
12.10	Gases evacuation		Refer to **5.8.2** and **6.5.13** of this standard and EN 746-2 and EN 746-3	**5.8.2**; **6.5.13**; EN 746-2; EN 746-3
12.11	Failure of equipment			
	a) by operator	Absence or incorrect fitting can cause injury or death to the operator or by-standers	Maintenance, Design, Training,	**5.11.8;** **6.4**; **6.5**
	b) by manufacturer or supplier	Absence or incorrect fitting can cause injury or death to the operator or by-standers		

5 Safety requirements, measures and verification means

5.1 General

5.1.1 *Requirements*

The manufacturer shall meet the requirements detailed in this standard.

Where particular requirements of other parts of EN 746 and/or other standards exist, they shall supplement or modify the common requirements.

Verification of the preventative measures detailed in this clause can, in most cases, be carried out by simple inspection.

If other methods of verification apply these are given under the relevant subclause in this clause.

5.1.2 *Signs, warning labels, etc.*

Any signs or warning labels, etc., attached to or adjacent to any machinery dealt with in this Part of EN 746 shall meet the requirements of ISO 7000, IEC 417, EN 61310-1 and EN 61310-2 as appropriate (see also **5.3.1**, **5.4.2**, **5.7.2**, **5.7.3**, **5.8.2**, **5.11.6**, **5.11.7**, **6.2.3**, **6.2.4**).

5.1.3 *General design and construction requirements*

The manufacturer shall maintain evidence that all aspects of the design referred to in this Part of this standard have been addressed.

The structural assembly, e.g. civil foundations, steel sections, auxiliaries and services which form part of the equipment shall be stable, suitable for function and the intended use.

In particular the design shall include solutions and constructional details relating to:

– static stability of the equipment including structures intended for containing the processed materials and the materials entering and leaving the equipment;

– accessibility;

– maintenance and cleaning clearances;

– movement of material and machinery;

– safety in operation;

– health and safety at the work place;

– protection against fire;

– pollution.

Cut-off, regulating and measuring devices, pipework and tanks carrying or containing fluids which are likely to solidify and/or have high viscosity shall be protected against the effects of solidification and subsequent blockage.

If internal parts of the equipment require frequent inspection, they shall be either provided with lighting appropriate to the structure and the nature of the process, or the user shall be advised to install suitable lighting at the time of placing the order.

The design of the equipment and the action of the regulating and safety devices shall prevent:

– escape of unburnt gases to the equipment, to pipes not intended for such gases or to the outside;

– flashback in the pipework.

The safety devices shall:

– be efficient and durable throughout the range of adjustment to the regulation of the equipment;

– not cause one device inadvertently to override another.

Safety devices shall be fitted in such a manner that they are accessible and protected against harmful effects. In particular they shall withstand continuous operation in the area in which they are to be used and under the same working conditions.

Where auxiliary fluids such as lubricants, dielectric, diathermic and dynamic fluids are used, their chemical composition, as far as is possible, shall be such that in the event of fire the products of combustion are not harmful.

Floor drains which form part of the equipment shall discharge into a suitably isolated sump. Means shall be provided for the collection and removal of such discharges.

Pipework distribution systems forming part of the equipment and which are likely to become dangerous if subjected to corrosion or extreme temperature or wide variations in temperature, pressure, voltage, etc., shall be marked.

5.1.3.1 *Access*

All parts of the equipment to which personnel require to have access for operation and maintenance shall be served by adequate means of access, preferably fixed. Stairways, platforms and service floors shall be safe and shall be equipped with adequate safeguards (see also **5.2.11**).

Inspection and service floors of the equipment shall be safe, well lit, well ventilated, protected against heat radiation and be fire resistant (see **5.4.3.1**).

Account shall be taken of the need for emergency escape routes inside the equipment to avoid trapping personnel in the event of a hazard (such as fire or the build up of toxic gases).

5.1.3.2 *Roofs and covers*

Where the roofs or covers of equipment (e.g. ceramic kilns or melting equipment) have been designed to be walked on they shall be accessible by safe means.

Roofs or covers to which access is not intended shall be marked and designated as not accessible or shall be adequately guarded to prevent access.

Roofs or covers which have to be walked on for operating, maintenance and inspection purposes, and which are more than 1 m above floor level, shall be accessible through safe ascents and shall be fitted with railings to prevent falls. When the heat source is located in the roof, e.g. in the ceramics or glass industry, one escape route shall be available in front and one behind the firing zone of which at least one shall be a stairway.

5.1.3.3 *Access channels*

In general the dimensions of access channels shall be in accordance with EN 547-1. However for channels intended for repair purposes below tunnel furnaces or kilns as defined in **3.3** the unobstructed passageway shall be at least 1,80 m high × 0,70 m wide and be accessible through two stairways, one of which shall be in front of, and the other behind, the firing zone.

If the stairways are in the area of the firing zone, emergency exits shall be available in front of and behind the firing zone.

5.2 Mechanical

5.2.1 *General*

(formulated as general principles)

The design shall be such as to avoid injury by movement of machinery parts of equipment, by crushing, shearing, entanglement, drawing-in or impact. It shall also prevent hazardous situations arising when high pressure fluids are used or where parts of equipment and material being processed are liable to be ejected. The stability of the equipment during operation and the safety of the access areas around the equipment shall also be considered.

Where the construction of the equipment includes:

– corners and projections;

– passages of reduced height;

– manhole covers, drains, etc.

they shall be protected and marked in such a way so as not to present a hazard.

5.2.2 *Crushing*

(formulated as general principles)

The design shall incorporate means to minimize hazards to personnel arising from:

– movement of materials and machinery;

– automation;

– suspended loads;

– falling materials;

– moving parts.

All moving machinery that can present a hazard shall be guarded wherever practicable. When guarding is not practicable audible and/or visual signals shall be provided in accordance with EN 61310-1, EN 457 and/or prEN 842.

Strategically positioned emergency stops shall be provided to enable potentially hazardous moving machinery to be halted.

Emergency stop devices shall comply with EN 418. Guarding, when provided, shall comply with prEN 953 and prEN 1088.

Any traversing part of the equipment or material carried by it shall not be closer to any fixed structure than the safety distance requirements given in EN 349.

The design of the equipment shall take account of the minimum distance requirements given in EN 349, EN 294, EN 811, EN 547-1 and/or EN 547-2.

5.2.3 ***Shearing***

(formulated as general principles)

When possible shear traps shall be eliminated by:

a) filling the gaps or reducing the maximum clearance between the moving parts so that parts of the body cannot enter the gap;

b) increasing the minimum clearance between the shearing parts such that parts of the body can enter the gap safely, see EN 349 and EN 547-1.

Where it is not possible to avoid the creation of a shear trap adequate guarding shall be used (see prEN 953 and prEN 1088).

Means shall be provided to prevent unintentional closure or opening of doors.

5.2.4 ***Entanglement***

(formulated as general principles)

Design measures shall be taken, or suitable guards shall be provided, to prevent entanglement by rotating shafts, conveyors and transmission machinery (see prEN 953).

5.2.5 ***Drawing-in***

(formulated as general principles)

Design measures shall be taken, or suitable guards shall be provided, to avoid drawing-in (see prEN 953).

5.2.6 ***Impact***

(formulated as general principles)

Impact hazards are caused by objects which act against the inertia of the body but do not penetrate.

The speed, force or torque, and inertia of the moving parts should be kept to a minimum by the designer, in order to reduce the possibility of injury.

When this is impractical adequate guarding or safety devices shall be provided including a perimeter fence if necessary.

5.2.7 ***High pressure fluids***

An injury can be caused by the ejection of fluids such as compressed air, steam and high pressure hydraulic oil or water.

All components within the system shall be operated within their manufacturer's specification and all parts of the system shall be protected against overpressure. See also prEN 982 and prEN 983.

Verification of leak tightness shall be achieved by pressure testing to at least the intended operating pressure. Any pressure relief device can be verified by testing in accordance with their manufacturer's instructions.

Piping should be permanent. Where the use of flexible hoses is unavoidable, equipment suitable for the most arduous duty and operating conditions likely to be experienced shall be used. Special care shall be taken to guard against flexing or twisting during movement, and thermal damage.

5.2.8 ***Ejection of parts***

(formulated as general principles)

The body may be crushed or penetrated by material or parts of the equipment ejected unexpectedly or accidentally.

When there is a risk of ejection of parts occurring, adequate guarding shall be provided (see prEN 953).

5.2.9 ***Implosion***

All parts of the equipment which work with a vacuum shall be constructed in such a way that implosions are avoided as far as is possible.

Suitable devices shall ensure, after repressurizing, a gradual decompression of the equipment before the doors can be opened, e.g. interlocked double release devices which ensure detaching of the door before the complete opening.

For particular measures/provisions for vacuum thermoprocessing equipment see prEN 746-7.

5.2.10 ***Stability***

The equipment structures shall be designed and calculated for their static and dynamic strength. The design shall take into account both the normal and foreseeable accidental thermal static and dynamic working stresses, including those resulting from chemical and physical explosion and any operation below atmospheric pressure.

The design shall also take account of vibration, wind pressure, impact and other foreseeable external forces.

5.2.11 ***Slip/trip***

Working platforms shall be designed so as to provide a level standing space of adequate size with a firm foothold. Walkways shall be made from materials which remain as slip resistant as practicable under working conditions and suitable guard rails, posts and toe boards shall be provided.

Where necessary a fixed access ladder with handholds or a stairway with handrails or some other suitable means shall be provided to give safe and convenient access to all equipment needing adjustment, lubrication or maintenance.

5.2.12 ***Falls***

(formulated as general principles)

Where the design of the equipment or the movement of equipment requires floor openings which can constitute a hazard, automatic guards, safety warning devices or barriers shall be provided.

5.3 Electrical

5.3.1 *General*

Electrical components and installations for any equipment and services located in the same unit(s) up to the defined equipment limits shall be suitable for their function and intended use.

The following requirements shall be considered:

– Safety of Electrical Installation and Use regulations and standards given in clause **2**;

– the design and operation of electroheat installations shall be in accordance with EN 60519-1, EN 60519-2 and IEC 519 : Parts 3 to 9 as appropriate;

– the design and operation of electric installations in other equipment shall comply with IEC 364-4-41, IEC 364-4-43, IEC 364-4-45, IEC 364-4-47, IEC 364-4-442, IEC 364-4-443, IEC 364-4-473 and IEC 364-4-46 or EN 60204-1;

– energy supply of moving parts of the installation shall be shut off in case of emergency in accordance with EN 60204-1 'Stop Category 0'.

A detailed analysis of the electrical installation shall be made, including the following elements:

– piping conveying flammable gases shall not be installed in channels, pipes or trenches carrying cables. Channels, pipes or trenches carrying cables shall be installed in such a location to prevent the unintended conduit of flammable gases;

– electrical power carrying capacity and insulation characteristics of the conductors in the installed positions;

– temperature rise of conductors and the ambient temperature environment;

– the suitability of connectors and terminations;

– minimization or elimination of undesirable induction heating effects;

– estimated temperature of operation of devices in their installed position;

– minimizing electrical induction or interference between power and control cables, sensors, etc.;

– protection of cables, groups of cables, devices or motors against overload and short circuit;

– prevention of damage to conductors from heat, shearing, trapping, cutting, crushing, fluids or other contamination;

– prevention of or protection against earth leakage;

– prevention of or protection against electric arcs;

– safe access or prevention of access to live circuits;

– adequate warning signs;

– adequate identification of devices, cables, fuses and distribution boards;

– adequate electrical schematic drawings, cable schedule drawings, software programs and their adequate provision to equipment engineering, operation and maintenance operatives.

Verification of preventative measures shall be made in accordance with EN 60204-1 or 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 as well as with EN 60519-1 and IEC 519 if applicable.

5.3.2 *Direct or indirect contact*

5.3.2.1 Measures against direct or indirect contact with live conductors/terminations shall be taken for electroheat installations in accordance with EN 60519-1, EN 60519-2 and IEC 519 : Parts 3 to 9 as appropriate and for other thermoprocessing equipment in accordance with IEC 364-4-43, IEC 364-4-47, IEC 364-4-442, IEC 364-4-443, IEC 364-4-473, IEC 364-4-41, IEC 364-4-45 and IEC 364-4-46.

5.3.2.2 Where it is necessary during commissioning, re-commissioning, maintenance or fault-finding operations to gain access to live installations, appropriate interlocks, protection systems or guarding shall be incorporated (see prEN 953 and prEN 1088).

5.3.3 *Electrostatics*

Suitable earthing or other means shall be provided to minimize hazards caused by electrostatic effects.

Where electrostatic effects can cause loss of normal control and present a hazardous situation then safety shut-down or stopping devices shall be fitted to those parts of the equipment affected.

5.3.4 *Effects of electrical overload*

Measures shall be taken to prevent electrical overload in electroheat installations in accordance with EN 60519-1, EN 60519-2 and IEC 519 : Parts 3 to 9 and for other thermoprocessing equipment 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.

5.3.5 *Thermal radiation or other phenomena*

(formulated as general principles)

The layout, installation, mounting, cable grouping, selection and protection of electrical conductors and devices shall be such as to ensure reliable normal operation and to minimize hazards to health and safety during predictable failure modes of the equipment. Particular attention shall be given to the sitting of electrical conductors and devices in areas affected by the discharge of hot components, opening, exhausts and vents for hot gases, vapours or fluids.

5.3.6 *External influences*

(formulated as general principles)

The design shall minimize the hazards presented to health and safety by the effect of external influences on the electrical power, controls and systems.

Disconnection and/or restoration of the electricity supply shall not cancel the safety and interlock conditions.

The electrical control system shall be suitably protected or guarded against mechanical damage from operations within the equipment environment.

NOTE. Such influences can be beyond the boundaries defined within the scope of this standard and should be dealt with in contract between the supplier, agents importers and/or users of the equipment.

5.4 Thermal

5.4.1 *General*

The use of this type of equipment involves many thermally hazardous situations, therefore precautions shall be taken to prevent operators or by-standers from coming into unintended contact with workpieces, flames or industrial thermoprocessing equipment which can be at elevated or below ambient temperatures.

Special requirements are given in **5.4.2**, **5.4.3**, **5.4.4** and **5.4.5**.

NOTE. Such influences can be beyond the boundaries defined within the scope of this standard and should be dealt with in contract between the supplier, agents importers and/or users of the equipment.

5.4.2 *Contact with hot/cold surfaces*

Precautions shall be taken to prevent contact with operating controls at elevated temperature either accidentally or whilst operating them. In general the temperatures of operating controls shall not exceed the values specified in EN 563.

Where it is not possible, for process reasons or other constraints, to maintain surface temperature below those specified then steps should be taken to prevent hot operating controls being touched. Wherever possible this shall be by means of guards complying with prEN 953.

If these measures are not practicable then areas of elevated temperatures shall be indicated by means of suitable marking, warning signs, etc. In addition, attention shall be drawn in the technical documentation to the presence of such hazards.

Where it is not possible to avoid contact with controls, etc., which are at temperatures above those specified in EN 563 then suitable protective clothing shall be used. Requirements for such clothing shall be included in the technical documentation (see **6.4.15**).

5.4.3 *Fire/explosion*

5.4.3.1 *Fire*

As far as is practicable, equipment shall be constructed of fire resistant material, and installed in and on a fire resistant structure (fire resistance shall be not less than 60 min). Where the use of flammable materials cannot be avoided, and it is not practicable to meet the fire resistance conditions above, the materials shall be insulated from heat and ignition sources.

The design and construction of the equipment shall be such as to prevent the leakage of hot gases, combustion products and flames, other than at purpose designed flues, vents, and doors, etc.

In particular the following shall be considered:

– discharge of hot gases or flames from openings;

– loading and unloading of hot workpieces.

When the equipment is heated by gaseous, liquid or solid fuel then the fuel circuits shall be designed to prevent leakage. In addition the fuel circuits shall be capable of withstanding foreseeable mechanical damage. Further guidance is given in EN 746-2.

Where hydraulic oil actuated components are used, piping and hydraulic equipment shall be protected from flames. Any oil leakage shall be prevented from reaching hot parts by suitable design, location and proper maintenance.

Particular attention shall be given to quench tanks containing flammable oil. Further guidance is given in prEN 746-8.

Heat-transfer fluids shall be non toxic and shall not be used at temperatures exceeding the maximum recommended by the manufacturer or supplier of the fluid. The humidity and oxygen content in the fluid should be controlled.

When considering the maximum level of the heat-transfer fluid, account shall be taken of its expansion during normal working conditions. The system shall be fitted with safety vents that are protected against the ingress of hazardous contaminants (e.g. moisture and air).

Any heating equipment for heat-transfer fluids shall be provided with a device to prevent over-temperature.

Suitable devices to control the burner, heating element and/or circulation pump shall be fitted when any of the following parameters are of consequence for safety:

– pressure;

– temperature;

– level (of fluid).

Further guidance is given in EN 746-2.

Where applicable, fire extinguishing facilities shall be installed on the equipment at positions where there is the greatest risk of fire occurring. Particular attention shall be given to the selection of the type of extinguisher to be used.

5.4.3.2 *Explosion*

The equipment shall be designed to minimize the risk of a foreseeable explosion.

The design shall incorporate means to prevent the explosive co-existence of a flammable substance and an oxidizing agent (usually air) with an ignition source within the flammability limits (see also **5.2.3.1** of EN 746-2 : 1997).

The removal of a flammable mixture can be achieved by means of a purge with air or an inert gas (see EN 746-2 and EN 746-3).

Particular attention shall be given to workpieces which are not themselves flammable but which may, by design or otherwise, be coated with substances which could give rise to a flammable mixture.

Unless it can be shown that the probability of a flammable mixture being formed is minimal, or that any foreseeable explosion will be safely vented by other means, or safely contained, then explosion relief(s) of sufficient area and mass to relieve foreseeable explosions shall be fitted.

Explosion reliefs shall be positioned such that they are unimpeded, both inside and outside the equipment, and shall discharge in such a manner that personnel are not subject to hazards. The strength of the relief(s) shall be such as to relieve the pressure of an explosion before serious damage is caused to the equipment.

Where doors are not designed as explosion reliefs they shall be fastened in such a manner they cannot open when subjected to the force of a foreseeable explosion. Doors shall not open other than in their intended direction.

5.4.4 *Ejection of hot particles/workpieces*

The equipment shall be designed to contain hot particles/workpieces within its structure. Particular attention shall be paid to the loading/unloading areas. If additional guards or barriers are required they shall comply with prEN 953.

Where liquid metals, oils or salts are being heated, the introduction of moisture into the liquid shall be prevented (reference should be made to prEN 746-4, prEN 746-5, prEN 746-6 or prEN 746-8, as appropriate).

5.4.5 *Thermal stress and other physiological effects*

The equipment shall be designed so that the effects of thermal stress on human beings are minimized (see ISO 7933). An estimation shall be made of temperatures that could be reached in areas to which operators have access. Preventative measures, such as ventilation and operating booths with cooling, shall be provided if necessary.

5.5 Noise

5.5.1 *General*

All equipment emits noise to a greater or lesser extent, determined in noise-emission values. Therefore it shall be so designed and constructed that risks resulting from the emission of airborne noise are reduced to the lowest level, taking account of technical progress and the availability of means of reducing noise, particularly at source.

The designer shall be aware of potential noise hazards and devise preventative measures to cope with them. In order of preference, the designer shall consider the following measures:

– Noise reduction at source

  Reduce noise by design, e.g.:

  – choose low noise burners;
  – optimize the burner rating;
  – choose low noise components.

– Noise abatement by devices

  Reduce noise using e.g.:

  – baffles for ventilators;
  – baffles adjacent to burner(s);
  – encasing of pumps;
  – silencers;
  – noise absorbing walls and covers (see EN ISO 11690-2);
  – enclosures.

– Noise abatement at workstation

  Reduce noise using e.g.:

  – cabin for the operators;
  – hearing protectors (see **6.4.7**).

The designer shall consider and, where practicable, reduce the noise generated by the movement of process material.

The measurement and verification of noise emission values shall be made in accordance with prEN 1547.

5.5.2 *Interference with communications*

The manufacturer should design the equipment and reduce its noise emission so that spoken communications and acoustic signals, warnings, etc., are audible.

Consideration shall be given to the spectrum of the airborne noise and audible signals as well as the weighted noise level.

If it is necessary to specify personal hearing protection then the effect of wearing such equipment on communications will need to be considered.

5.6 Vibration

(formulated as general principles)

The equipment shall be designed and constructed such that hazards associated with vibration are reduced to the lowest level. Primary measures shall be by the reduction of vibration at source.

When secondary measures are required then the use of anti-vibration mountings or other measures is recommended. Guidance on the minimization and reduction of vibration is given in prEN 1299.

5.7 Radiation

5.7.1 *General*

Means shall be provided to minimize the harmful effects of radiation emission as specified in **5.7.2** and **5.7.3**, and, for electrically heated equipment, in EN 60519-1, EN 60519-2 and IEC 519 : Parts 3 to 9. Such means shall be appropriate to the circumstances obtained within the thermoprocessing equipment.

5.7.2 *Non ionizing radiations*

Any inspection points, where operators are liable to exposure from infra-red and ultra-violet radiation, shall be shielded by the use of appropriately tinted sights so as to avoid direct contact.

The design of controls, measuring instruments and monitoring accessories employing non-ionizing radiations, microwaves, laser, electromagnetic fields and/or radio frequency fields, that are integral part of the equipment, shall comply with regulations and directives concerning emission limits.

5.7.2.1 *Infra-red/visible/UV radiation (optical and thermal)*

Suitable protection against infra-red, visible and UV radiation shall be provided (see also **5.4.5**).

Direct sight contact with the radiation source shall be prevented. Inspection sight holes shall be shielded, and where necessary control cabinets and rooms integral with the equipment shall have tinted glass windows.

Specific danger warning signs shall be provided.

5.7.2.2 *Electric arcs*

The requirements given in the second and third paragraph of **5.7.2.1** shall apply.

5.7.2.3 *Laser beam*

Laser equipment and its use shall comply with EN 60825. Where necessary lasers shall be positioned so that casual operator contact is impossible. Suitable interlock(s) shall be fitted to prevent access to the laser beam.

Specific warning signs shall be provided.

5.7.2.4 *Electromagnetic fields*

Sources of electromagnetic fields sufficient in power to be a hazard shall be separately enclosed and isolated, as far as is possible, from normal operator working and resting positions.

In areas where electromagnetic fields are operative warning signs shall be provided prohibiting the entrance of persons having heart pacemakers, metallic implants or who are wearing metallic rings, bracelets, etc.

5.7.2.5 *Microwaves*

Microwave equipment shall comply with IEC 519-6.

5.7.3 *Ionizing radiations*

Where measuring instruments and monitoring accessories employing x-rays and/or radionuclides are used on the equipment they shall not constitute a risk to people. Only sealed sources complying with IEC 405 shall be used.

Such installations and instruments shall be marked with the specific danger sign. Specific hazard warning signs shall be provided in the area.

If the equipment is likely to be accessible during production and in foreseeable circumstances then:

– interlocks shall be fitted so that access is only obtained if the shutter is closed (sealed source) or the power is cut off;

– clear warnings indicating the status of the equipment (e.g. shutter open/shutter closed or on/off lights about to start rays) shall be installed.

5.8 Materials and substances

5.8.1 *General*

The equipment designer shall take note of possible hazards and avoid as many as possible by suitable choice of design features. In addition the instruction handbook shall clearly specify any particular working practices and personnel protection which are necessary to ensure safe use of the equipment (see EN 626-1).

NOTE. Hazardous situations can arise as a result of the nature of the process being undertaken by the equipment, such as contact with, or inhalation of, dust or harmful liquids, gases, vapours, mists and fumes.

5.8.2 *Harmful by-products*

The design shall take account of the dangers of toxicity and asphyxia. The design shall incorporate devices for preventing the leakage of dust, fumes and gaseous by-products. Where some leakage is unavoidable then suitable vents connected to an induced draught system shall be provided (see also EN 626-1). Specific hazard warning signs shall be provided.

NOTE. It is not possible to be specific about the by-products until the material(s) to be processed has/have been specified by the user.

5.8.3 ***Fire/explosion***

(formulated as general principles)

The equipment shall incorporate appropriate measures to prevent or minimize the risk of fire and/or explosion.

Such measures shall include, where appropriate, the fitting of:

a) flame guards;

b) fuel cut-off devices and interlocks;

c) cooling means for equipment or workpieces;

d) fire detection means (extinguish facilities already referred to in **5.4.3.1**);

e) gas detectors.

In addition the fuels as well as the combustion and the controlled atmospheres to be used in the process shall comply with **5.4.3** and EN 746-2 and EN 746-3.

5.8.4 ***Biological/microbiological contamination***

See **6.4.5**.

5.9 Ergonomics

(formulated as general principles)

The equipment shall be designed to take account of the ergonomic aspects of using, maintaining and servicing the equipment (see EN 614-1).

5.10 Hazard combination

5.10.1 ***General***

(formulated as general principles)

Provision shall be made to prevent hazards from occurring in combination or cumulatively.

NOTE. For example, the failure of a stop device to operate could cause a series of hazardous events. Control circuits should be designed to minimize, as far as is practicable, the foreseeable hazard combinations that are likely to occur (see EN 60204-1).

5.11 Malfunction

5.11.1 ***General***

The manufacturer shall take account of the hazards and hazardous situations detailed in this clause in the design of the equipment concerned.

5.11.2 ***Failure of power supply and auxiliary fluids***

Undesirable and unscheduled changes in the pressure of the auxiliary fluid actuating instruments and monitors (e.g. compressed air, oil hydraulic circuit fluid, main fluid in the case of self actuated devices, etc.) shall be detectable by some suitable devices if the condition is likely to cause a hazardous situation.

If pressure change is likely to cause a hazardous situation then devices shall be provided to shut the equipment down or place it in a safe condition.

For failure in electricity supply see **5.3.6** and **6.3.9**.

Additional standby machinery such as air compressors, electrical supply units, compressors for service fluids and power engines shall be located separately from the thermoprocessing equipment. Air intakes shall be located in open places away from gaseous discharges or flammable vapours, e.g. vehicle exhausts (gaseous discharge) or stored material, e.g. paraffin (flammable vapour).

5.11.3 ***Ejection of parts or fluids***

The requirements of clauses **5.2.7**, **5.2.8** and **5.4.4** shall apply.

5.11.4 ***Errors of fitting/assembly during installation***

There shall be adequate supervision of fitting and assembly operations.

The design shall, where possible, ensure that parts cannot be incorrectly fitted or assembled. Where not practicable parts shall be appropriately identified and marked.

5.11.5 ***Effect of malfunction of control system/component devices***

The manufacturer shall assess the effect of malfunctions of control systems/component devices in the design analysis. In the event of malfunction of a control component an unsafe situation shall not arise (see EN 954-1).

5.11.6 ***Information/warning devices***

Where applicable the equipment shall be provided with information and warning devices relating to the occurrence of a malfunction. Such devices shall meet the requirements of EN 981, EN 61310-1 and ISO 7000.

5.11.7 ***Safety signs***

If safety signs are provided they shall meet the requirements of EN 61310-1 and ISO 7000.

5.11.8 ***Failure of equipment***

The instruction handbook and maintenance instructions shall include suitable text (see also **6.4** and **6.5**).

5.12 Missing and incorrectly fitted safety devices

5.12.1 ***General***

(formulated as general principles)

In considering the design and construction of the equipment, the designer/manufacturer shall take account of the possibility that in use parts, components or safety devices might be incorrectly refitted or removed altogether. Appropriate fittings or identification of parts shall be provided.

The information for use documentation shall provide further assistance and also give suitable warnings about incorrectly fitted or missing parts in those areas where the manufacturer assesses that a hazard could occur if parts are missing or incorrectly fitted.

5.12.2 ***Power supply disconnection devices***

The equipment shall be fitted with devices to disconnect it from all power sources and to dissipate all stored energy. Devices to ensure that disconnection and dissipation has been achieved shall be provided, e.g. by means of pressure gauges, meters, audible or visual signals. Further guidance is given in prEN 1037 and EN 292-2 : 1991.

6 Information for use

6.1 General

6.1.1 The information for use handbook shall make reference to the following:

– the foreseeable use for which the equipment has been designed;

– that the equipment has been designed for use by trained operators or supervisors.

The information for use handbook shall draw the user's attention to hazards that experience has shown can occur.

The handbook shall include any drawings and diagrams that are relevant to safety.

Additional specific requirements shall be given if the equipment is designed to operate in potentially explosive atmospheres.

6.1.2 The format and content of the information for use handbook shall comply with clause **5** of EN 292-2 : 1991.

6.2 Marking

6.2.1 A durable data plate containing at least the following information shall be fixed to the equipment at a location which is visible after installation:

– name and address of manufacturer;

– mandatory marks[1)];

– designation of series or type;

– serial number, if any;

– year of construction;

and if applicable:

– source of energy used;

– maximal thermal load in kilowatts;

– maximum permissible temperature;

– maximum permissible charge load or output to be treated;

– atmospheres which can be used (e.g. non inflammable, explosive, toxic).

6.2.2 Auxiliary electrical installations shall be fitted with a durable data plate containing data in accordance with EN 60204-1, including the casing protection grade.

6.2.3 Where it is not possible to fit a safety device a durable warning sign shall be fitted to warn against foreseeable hazards.

Warning signs shall be considered to be as important as any safety devices that have been fitted.

6.2.4 Warning signs shall be fitted in a position where they are clearly visible. The colour of the plates shall be such as to stand out from the surface to which they are fixed. The wording shall be easily readable from a safe distance.

6.2.5 Services shall be:

– painted or identified by the appropriate colour code;

– marked with the specific danger sign.

6.3 Technical data, installation and commissioning

Technical data, installation and commissioning instructions shall be provided and shall contain at least the following information.

6.3.1 The stability requirements for the equipment structure shall be as given in **5.2.10**.

6.3.2 The flooring around the equipment shall be non-combustible (class of reaction 0);

NOTE. See annex F of prEN 1539 : 1995 for further information.

6.3.3 The accidental leakage of molten materials or dangerous liquids should be prevented or contained by tanks or collecting pits in case of emergency situations.

Means should be provided for the collection and removal of such discharges.

Storage and use of flammmable materials in the vicinity of the equipment is prohibited.

6.3.4 The manufacturer shall include in the technical documentation a list of essential spare parts to cater for immediate safety and maintenance emergencies.

6.3.5 During installation and demolition operations, technical means and individual protection shall be provided to ensure the safety of persons, property and the environment.

6.3.6 The user shall ascertain that the room or location intended to hold the equipment and the means required for construction and installation comply with the safety requirements of this part of this standard. Adequate ventilation shall be provided.

If necessary, the building containing the equipment or the equipment itself, if partially or completely located in the open air, shall be protected from atmospheric electrical discharge (i.e. lightning).

[1)] For EU countries, the CE-mark, for example.

6.3.7 The user should be made aware of the possibility that the noise level can be affected by the surroundings in which the equipment is to be installed.

6.3.8 Any measuring and monitoring device using laser or radionuclides shall be accompanied by instructions covering correct and safe installation/use, calibration, maintenance and disposal.

6.3.9 If shut-down resulting from a failure of electrical supply is dangerous, the user should provide in the equipment either a preferential supply system or a stand-by supply system or install equipment with automatic start-up and operation.

If appropriate, automatic admission of inert gas to the equipment should be adopted by the user in the event of a power failure to pressurize and/or purge the equipment.

6.3.10 If applicable the manufacturer and the user should agree on the date and conditions for the start-up and for the acceptance testing of the equipment in accordance with the stated conditions for the use. It is recommended that, prior to start-up, a test report should be drawn up countersigned by both parties.

An example of a suitable test report is given in annex B.

Supervision of commissioning until hand-over of the equipment shall be the responsibility of the manufacturer in the absence of any other special documented agreement.

When delivery, commissioning and testing have been carried out and the user has accepted the equipment, responsibility passes to the user unless any other special agreements have been made.

6.4 Instruction handbook (operation)

The manufacturer shall supply an operating instructions manual covering the description of the equipment, the heating system and all auxiliary systems. These instructions accompanied by diagrams, drawing and leaflets when applicable, shall contain at least the following details:

– data plate information;

– type of equipment;

– heating and fuel, burner, electrical installations;

– airborne noise emission (see prEN 1547);

– safety and regulating devices;

– starting, operating and shut-down arrangements;

– when possible, action to be taken in the event of faults or irregularities and abnormal operation;

NOTE. When it is not possible to include such information in the instruction handbook then such actions should be recorded in a special hazard prevention user instruction manual.

– use limitation;

– instructions for preventing hazardous conditions by suitable user training and control;

– details of necessary emergency escape routes;

– consideration of the effect of equipment failure and instructions to prevent it through appropriate maintenance, training, service life of components;

– personal protection requirements for special workstations, if applicable.

The manual shall include at least the following.

6.4.1 Clear means for demonstrating the correct positioning of safety devices and clear identification of the components concerned.

NOTE. When practicable, parts should be marked for identification.

6.4.2 Start-up and shut-down procedures for combustion and fuel handling systems in accordance with EN 746-2.

In particular the flow of fuel shall be shut off such that the fuel does not continue to flow through the burners. This technique shall be used to avoid explosive mixtures from developing inside the equipment, in the fume ducts and in the air and fuel pipes.

6.4.3 Information for equipment with controlled atmospheres in accordance with EN 746-3.

6.4.4 Information for equipment with emission of volatile compounds.

NOTE. For instance prEN 1539.

6.4.5 Specifications concerning treatment, installation details or monitoring procedures that are necessary to ensure that cooling systems or the material being processed cannot become contaminated with harmful organisms.

6.4.6 Noise emission in accordance with annex A, **1.7.4**f of EN 292-2 : 1991 and **5.5.1** of this Part of this standard.

6.4.7 Information that when noise reduction measures in accordance with **5.5.1** cannot be incorporated sufficiently, hearing protectors shall be worn. The effect that ear protection can have on communications shall be considered.

Proper warnings shall be provided when applicable.

6.4.8 Information that the instruction handbook should be updated by the user where modifications are made by the user after the original installation.

6.4.9 Instruction that the personnel operating the equipment shall be trained and competent in the operation of the equipment and in the hazards associated with the process, and their prevention.

6.4.10 Instruction that the equipment shall be started and stopped in accordance with the manufacturer's written instructions.

6.4.11 Instruction that the safety devices shall:

– be effective or not rendered ineffective;

– not be bypassed (see exception in **6.5.4**).

6.4.12 Instruction that the efficient operation of safety and control equipment shall be the responsibility of competent personnel, who shall be instructed to inform the supervisor of any hazards or faults which arise during the operation of the equipment.

6.4.13 Instruction that if equipment is put out of action through the operation of a safety device, it shall only be put back into action after remedial action by authorized personnel.

NOTE. A safety automatic system of supervision can be considered if special agreement has been made between the manufacturer and the user.

6.4.14 Instruction that cut-off, regulating and measuring devices shall not be shut off or disconnected during a temporary shutdown of the equipment. The parts of equipment equipped with cooling and sealing water circulation shall be protected against frost.

Particular attention shall be paid to the build-up and the removal of encrustations at the prescribed maintenance/servicing intervals.

6.4.15 Instruction that where it is not possible to avoid contact with hot elements, suitable protective clothing shall be used. This also applies where hot gases and vapours can exhaust, to hot workpieces during charging/discharging or where hot parts or fluids can be ejected (see also ISO 7243). Advice on medication to counter dehydration, etc., shall be given, if applicable. Troublesome and harmful draughts shall be avoided. The thermal stress and physiological effects of wearing specified protective clothing shall be considered.

6.4.16 Instruction that for short duration work where shielding is impracticable (e.g. during component loading or unloading) operators shall be provided with appropriate eye protection.

6.4.17 Instruction that electromagnetic fields, marked as such, shall not be entered by persons having heart pace makers or metallic implants or who are wearing metallic rings, bracelets, etc.

6.4.18 Recommendation that relevant extracts from the instruction handbook, produced in durable form and with an indication of their date of issue, should be displayed near the equipment control panel.

6.4.19 Recommendation that a log should be kept to note any problems encountered, faults or incidents which occur and maintenance carried out under the responsibility of the user.

6.5 Instruction handbook (maintenance)

The manufacturer shall supply a maintenance manual which gives information to the user on the methods to be used to comply with the following subclauses.

6.5.1 Clear means for demonstrating the correct positioning of safety devices including clear identification of the components concerned.

NOTE. When practicable, parts should be marked for identification.

6.5.2 In both routine and special maintenance operations the requirements of this Part of this standard shall be adopted in order to ensure the proper and safe functioning of the equipment.

NOTE. Maintenance operations can either be routine or special. Routine maintenance operations are normally carried out with the equipment in operation or shut down. Special maintenance operations are normally carried out with the equipment shut down. In the case of special maintenance operations auxiliary equipment can be retained in operation.

6.5.3 The proper functioning of the safety devices shall be subject to a periodical inspection programme. The frequency of such inspections shall be defined at the design stage in accordance with the device type, its fragility, its reliability and its importance. They can be modified during the operation stage.

6.5.4 Where the continuous nature of the process prevents the equipment being stopped when a fault condition occurs it can be necessary to bypass or over-ride the safety measures detailed in clause **5** to allow maintenance, inspection and repair to be carried out. In this situation safe systems of work shall be used to give an equivalent level of safety. Special emphasis shall be given to the need for the use of trained personnel and the requirements for training.

6.5.5 The safety, regulating and measuring devices shall be subject to periodic inspection, and, if necessary, adjusted, serviced or replaced to ensure their continued efficient operation and suitability for service. In particular the calibration of the devices and their efficiencies shall be checked by means of periodical test operations at frequencies detailed by the manufacturer. Such checks shall also be carried out after modifications or maintenance of the equipment. The results should be recorded.

6.5.6 A periodic inspection and maintenance programme, carried out at the frequency detailed by the manufacturer, shall be established to verify that the equipment continues to perform correctly for thermal, electrical and mechanical performance conditions as well as for proper functioning of any components.

6.5.7 The periodic inspection and maintenance programmes shall be performed by competent and trained persons.

If, during one of these inspections, a faulty or ineffective safety device is discovered, then the equipment shall be made safe or be shut down until the proper functioning of the safety device has been restored or the safety device has been replaced or serviced (see also **6.5.4**).

6.5.8 Essential maintenance operations carried out in hazardous areas such as:

– working in gas-danger areas;
– working on or in gas pipes;
– welding in confined spaces;
– cleaning waste gas systems;
– working in access channels or confined spaces

shall be carried out by competent and trained persons who fully understand the risks involved. In such case a second person shall be present and they shall maintain close communication during the operation concerned.

Essential maintenance operations carried out in hazardous areas shall be authorized and performed in accordance with a Permit-To-Work Certificate. A typical Permit-To-Work Certificate is shown in annex C.

6.5.9 The sequence logic of the interlocked automatic devices and in particular the modes of the ignition and cut-off functions shall be verified before every maintenance operation and at the frequency detailed by the manufacturer in the maintenance manual.

6.5.10 The maintenance of the equipment and of any insulation or baffles provided for noise reduction shall be carried out in accordance with the maintenance and servicing instructions.

6.5.11 The instructions concerning periodical sampling of thermal fluids, in particular to control humidity and oxygen content, shall be provided.

6.5.12 Before purging, the ducts of liquid and gaseous fuels shall be safely blanked off, e.g. by blind flange, etc. The atmosphere in ducts and combustion chambers shall be rendered inert. On continuous shut-down, branches shall be blanked off from the operating system, e.g. by blind flange, or removed.

The solid fuel supply hoppers shall be closed and the duct shall be empty and clean.

6.5.13 The maintenance of vent systems and their detecting instruments (if applicable) shall be carried out together with periodic sampling of the working environment (if applicable). Adequate room air changes shall be provided.

The manufacturer shall specify any devices or instruments to be provided by the user which are considered necessary to detect and warn of hazardous environmental conditions.

NOTE. The user is responsible for operations which involve dismantling, taking down of parts for major repairs or modifications, repairing the furnace walls, demolition and complete removal of the equipment to ensure the safety of bystanders and the environment.

When major works are involved, a supervisor should be responsible for coordinating the work the persons carrying out the contract to ensure the safety of all personnel in the area. The work should be programmed if applicable.

6.6 Instruction handbook (decommissioning)

The manufacturer shall provide decommissioning instructions which identify the risks. The manufacturer shall indicate procedures and measures to be carried out (e.g. purge, use of personal protective equipment and/or special devices or area delineations).

Annex A (informative)
List of industrial thermoprocessing equipment covered by prEN 746-1

Common Safety Requirements for industrial thermoprocessing equipment	See also relevant parts of EN 746 or other European Standards
1) in metallurgical and metal working plant for:	
1.1) Thermal production:	
Roasting	EN 746-2
Calcining, reducing, firing	EN 746-2[1)]
Sintering, agglomeration	EN 746-2
Non-ferrous metal refining	EN 746-2[1)], prEN 746-6, 7[1)]
Melting out of metals (such as metal distillation)	EN 746-2[1)], prEN 746-6, 7[1)]
1.2) Melting, pouring:	
Melting (steel/iron, non-ferrous metals)	EN 746-2[1)], prEN 746-6, 7[1)]
Holding (liquid phase)	EN 746-2[1)], prEN 746-6, 7[1)]
Pouring	EN 746-2[1)], prEN 746-7[1)], EN 1247
Remelting	EN 746-2[1)], prEN 746-6, 7[1)]
1.3) Heating:	
Heating, preheating, cooling, holding	EN 746-2[1)], 3[1)], prEN 746-7[1)]
Drying	EN 746-2[1)], 3[1)], prEN 746-7[1)]
1.4) Heat treatment:	
Annealing	EN 746-2[1)], 3[1)], prEN 746-5[1)], 7[1)]
Hardening	EN 746-2[1)], 3[1)], prEN 746-5[1)], 7[1)]
Tempering	EN 746-2[1)], 3[1)], prEN 746-5[1)], 7[1)]
Quenching	EN 746-2[1)], 3[1)], prEN 746-5[1)], 6[1)], 8
Sintering, pressure sintering	EN 746-2[1)], 3[1)], prEN 746-7[1)]
1.5) Surface treatment:	
Carburizing	EN 746-2[1)], 3[1)], prEN 746-5[1)], 7[1)]
Carbonitriding	EN 746-2[1)], 3[1)], prEN 746-5[1)], 7[1)]
Nitriding	EN 746-2[1)], 3[1)], prEN 746-7[1)]
Nitrocarburizing	EN 746-2[1)], 3[1)], prEN 746-5[1)], 7[1)]
Oxidizing	EN 746-2[1)], 3[1)], prEN 746-5[1)]
1.6) Coating:	
Metallic coating	EN 746-2[1)], 3[1)], prEN 746-7[1)]
Hot dip galvanizing	EN 746-2[1)] , prEN 746-4
Non-metallic coating	EN 746-2[1)], 3[1)], prEN 746-7[1)], prEN 1539[1)]
Varnish drying	EN 746-2[1)], prEN 1539[1)]
Vapour deposition (CVD, PVD)	EN 746-3[1)], prEN 746-7
1.7) Joining:	
Brazing, soldering	EN 746-2[1)], 3[1)], prEN 746-5[1)], 7[1)], prEN 1539[1)]
Welding	EN 746-2[1)], 3[1)], prEN 746-7[1)]

[1)] If appropriate to the specific case considered.

Common Safety Requirements for industrial thermoprocessing equipment	**See also relevant parts of EN 746 or other European Standards**
1.8) Surface pretreatment:	
Cleaning, degreasing	EN 746-2[1)], prEN 746-5[1)], 7[1)], prEN 1539[1)]
Delaquing	EN 746-2[1)], prEN 746-5[1)], prEN 1539[1)]
2) in glass making plant for:	
Melting	EN 746-2[1)], prEN 746-6
Cooling	EN 746-2[1)]
Decorating	EN 746-2[1)], prEN 746-7[1)], prEN 1539
Heat treatment	EN 746-2[1)]
3) in ceramic manufacturing plant for:	
Dewaxing	EN 746-2[1)], prEN 746-7[1)]
Drying	EN 746-2[1)]
Heating	EN 746-2[1)]
Annealing	EN 746-2[1)]
Sintering	EN 746-2[1)], prEN 746-7[1)]
Firing	EN 746-2[1)], 3[1)]
Decorating	EN 746-2[1)], prEN 1539[1)]
4) in cement, lime and gypsum manufacturing plant for:	
Calcining	EN 746-2, (WI 151 011)[2)]
Firing	EN 746-2, (WI 151 011)[2)]
Heating	EN 746-2, (WI 151 011)[2)]
Cooling	EN 746-2, (WI 151 011)[2)]
5) in chemical/petrochemical plant for:	
Calcining	EN 746-2[1)]
Distillation	EN 746-2[1)], prEN 746-7[1)]
Drying	EN 746-2[1)], prEN 746-7[1)]
Endoth./exoth. gas production	EN 746-2[1)], 3
Gasifying	EN 746-2[1)]
Impregnating	EN 746-2[1)], prEN 746-7[1)]
Liquefying	EN 746-2[1)], prEN 746-7[1)]
Polymerization	EN 746-2[1)]
Pyrolizing	EN 746-2
Reaction	EN 746-2[1)]
Reforming, cracking	EN 746-2[1)]
Sintering	EN 746-2[1)]
Melting	EN 746-2[1)], prEN 746-6
Vulcanizing, curing	EN 746-2[1)], prEN 746-5[1)]

[1)] If appropriate to the specific case considered.
[2)] A standard is being prepared by CEN/TC 151 under the work item WI 151 011.

Common Safety Requirements for industrial thermoprocessing equipment	**See also relevant parts of EN 746 or other European Standards**
6) in waste incineration equipment for:	
Incineration of domestic refuse, sewage, sludge, refuse derived fuel, industrial and special waste (such as toxic)	EN 746-2
Pyrolizing	EN 746-2
Gasifying	EN 746-2
7) in other industries for:	
Drying paper, printings	EN 746-2[1)], prEN 1539[1)]
Drying granular	EN 746-2[1)], prEN 746-7[1)]
Drying textiles	EN 746-2[1)], EN 31111
Drying wood	EN 746-2[1)], prEN 746-7[1)]
Reclaiming used foundry sands	EN 746-2

[1)] If appropriate to the specific case considered.

Annex B (informative)

Typical test report (as described in 6.3.10)

This report should:

– contain adequate description of tests and actions carried out, indication of standards and guides employed and of the results obtained;

– be countersigned by attending persons and by contractors' parties.

The test mode should be agreed between parties, preferably in the ordering stage and as far as possible in accordance with this standard and to the guarantee terms.

Test report				
Company				
Works of				
Tested equipment				
Mod/type				
Serial no.				
Construction year				
Name plate data				
.....				
.....				
Equipment (listing):				
Accesories and their characteristics				
.....				
.....				
Start time of test of.....				
(specify test object)				
of ..... (date)				
in accordance with standards (list and specify section, chapter, clause)				
.....				
.....				
Testing methods (specify)				
Employed instrumentation:				
calibration of the..... (date)				
Measurement conditions				
Results				
Tested characteristic or device examined	Expected value	Measured value	Contract tolerance	Deviation STD
.....	.....	.....	.....	.....
Note: Specify possible difficulties or disturbing cause.				
Final observations.....				
List of attending persons and their representatives				
Undersigning, place and date				

Annex C (informative)
Permit-To-Work Certificate (as described in 6.5.8)

Entering/working into confined spaces (containers, tanks, pits, ducts)
1) Order

Object: .....

Register no.: ..... Building: ..... Department: .....

Size (m^3):..... Content:.....

Entry into this equipment will be authorized for the purpose of inspection/cleaning/repair/modification/dismantling/revision within approved time on condition that the safety measures in accordance with clauses **5** and **6** have been carried out prior to start.

Maintenance/repair order has been submitted.

Date:..... .....

(Signature/authorized person)

2) *The following safety measures are to be carried out prior to work:*		Yes	No
2.1)	Clear confined space	0	0
2.2)	Clean empty confined space	0	0
	Rinsing..... hours using..... hot/cold ..... times		
	Purging:..... hours using air/steam/nitrogen/CO_2 ..... times		
	.....		
2.3)	Disconnect other devices and pipework by	0	0
	* Removal of joint elements/pressure equalization		
	* Blanking off connections		
	* Closing of isolating valves/display of warning signs		
	*.....		
2.4)	De-energize drives and electrical connections and secure against restarting by fitting the appropriate signs at fuses/switches, locking switches in 'close'-position, removal of	0	0
2.5)	Call for a fire attendant (for works like welding, oxyacetylene cutting etc.)	0	0
2.5.1)	Application form for fire attendant is attached to this certificate		0
2.6)	Continuous oxygen measurement (required ca. 21 %)	0	0
2.7)	Continuous CO-measurement (required less than 50 ppm)	0	0
2.8)	Analysing air constituents. Analysis being attached to this certificate	0	0
2.9)	Other safety measurements:.....	0	0
3)	*During work the following safety measures must be applied to:*		
3.1)	Wearing protective clothes:	0	0
	* Protective goggles (normal-/heat radiation-/acid-type), rubber boots, protective shoes (electrostatically conducting, acid proof), protective gloves, helmet, acid protective harness, welding protective harness*		
	*.....		
3.2)	Use appropriate breathing apparatus. The Fire Brigade decides which type of breathing apparatus must be used. The use of heavy breathing apparatus is only permitted under supervision of the Fire Brigade and is restricted to trained persons proved to be fit for use by medical examination	0	0
3.3)	Electrical lamps and appliances: low voltage/protective transformer/explosion-proof	0	0

(continued)			
3.4)	Use of spark avoiding tools (copper-beryllium)	0	0
3.5)	Provide adequate ventilation: fresh air by suction/forced flow /utilizing natural draft	0	0
3.6)	Use of ladder for entry/plastic ladder/integrated ladder/.....	0	0
3.7)	Use life belt and life line	0	0
3.8)	Observation by fire attendant with/without prepared breathing apparatus	0	0
3.9)	Keep fire fighting equipment ready for use (responsible Fire Brigade). Dry chemical extinguisher/CO_2-extinguisher/hose-system	0	0
3.10)	Keep working area wet	0	0
3.11)	Further safety measures:.....	0	0

Distributors:	Checked and authorized for the following time: from: ..... to: .... (Signature/Department) (Signature/wkg-group)	The safety measures laid down have been carried out. The operation and the wearing of personal protective clothes will be supervised. (To be signed only shortly before work is being started.)

Annex D (informative)
Used definitions

Trilingual index

D.1 English–German–French

Ref.	English	German	French
3.4	Cement, lime and gypsum manufacturing plant	Zement-, Kalk- und Gipswerk	usine de production de ciment, de chaux et de plâtre
3.3	Ceramic manufacturing plant	Keramikwerk	usine de fabrication de produits céramiques
3.5	Chemical plant	Chemiewerk	usine chimique
3.8	Cooling equipment	Kühlanlage	équipement de refroidissement
3.7	Drying equipment	Trocknungsanlage	équipement de séchage
3.2	Glass making plant	Glashüttenwerk	verrerie
3.1	Metallurgical and metal working plant	Metallerzeugende und-verarbeitende Werke	usines métallurgiques et de travail des métaux
3.6	Waste incineration equipment	Abfallverbrennungsanlage	équipement d'incinération de déchets

D.2 German–English–French

Ref.	German	English	French
3.6	Abfallverbrennungsanlage	Waste incineration equipment	équipement d'incinération de déchets
3.5	Chemiewerk	Chemical plant	usine chimique
3.2	Glashüttenwerk	Glass making plant	verrerie
3.3	Keramikwerk	Ceramic manufacturing plant	usine de fabrication de produits céramiques
3.8	Kühlanlage	Cooling equipment	équipement de refroidissement
3.1	Metallerzeugende und-verarbeitende Werke	Metallurgical and metal working plant	usines métallurgiques et de travail des métaux
3.7	Trocknungsanlage	Drying equipment	équipement de séchage
3.4	Zement-, Kalk- und Gipswerk	Cement, lime and gypsum manufacturing plant	usine de production de ciment, de chaux et de plâtre

D.3 French–German–English

Ref.	French	German	English
3.6	équipement d'incinération de déchets	Abfallverbrennungsanlage	Waste incineration equipment
3.8	équipement de refroidissement	Kühlanlage	Cooling equipment
3.7	équipement de séchage	Trocknungsanlage	Drying equipment
3.1	usines métallurgiques et de travail des métaux	Metallerzeugende und-verarbeitende Werke	Metallurgical and metal working plant
3.5	usine chimique	Chemiewerk	Chemical plant
3.3	usine de fabrication de produits céramiques	Keramikwerk	Ceramic manufacturing plant
3.4	usine de production de ciment, de chaux et de plâtre	Zement-, Kalk- und Gipswerk	Cement, lime and gypsum manufacturing plant
3.2	verrerie	Glashüttenwerk	Glass making plant

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 the 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.

blank

BSI — British Standards Institution

BSI is the independent national body responsible for preparing British Standards. It presents the UK view on standards in Europe and at the international level. It is incorporated by Royal Charter.

Revisions

British Standards are updated by amendment or revision. Users of British Standards should make sure that they possess the latest amendments or editions.

It is the constant aim of BSI to improve the quality of our products and services. We would be grateful if anyone finding an inaccuracy or ambiguity while using this British Standard would inform the Secretary of the technical committee responsible, the identity of which can be found on the inside front cover. Tel: 020 8996 9000. Fax: 020 8996 7400.

BSI offers members an individual updating service called PLUS which ensures that subscribers automatically receive the latest editions of standards.

Buying standards

Orders for all BSI, international and foreign standards publications should be addressed to Customer Services. Tel: 020 8996 9001. Fax: 020 8996 7001.

In response to orders for international standards, it is BSI policy to supply the BSI implementation of those that have been published as British Standards, unless otherwise requested.

Information on standards

BSI provides a wide range of information on national, European and international standards through its Library and its Technical Help to Exporters Service. Various BSI electronic information services are also available which give details on all its products and services. Contact the Information Centre. Tel: 020 8996 7111. Fax: 020 8996 7048.

Subscribing members of BSI are kept up to date with standards developments and receive substantial discounts on the purchase price of standards. For details of these and other benefits contact Membership Administration. Tel: 020 8996 7002. Fax: 020 8996 7001.

Copyright

BSI
389 Chiswick High Road
London
W4 4AL