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Industrial furnaces and associated processing equipment — Safety —

Part 1: General requirements

Fours industriels et équipements associés — Sécurité —

Partie 1: Exigences générales

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Foreword

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

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

The committee responsible for this document is ISO/TC 244, *Industrial furnaces and associated processing equipment.*

This second edition cancels and replaces the first edition (ISO 13577-1:2012), which has been technically revised. The following changes have been made:

— reconfiguration of the scope (no technical change);

— elimination of the requirements related to the implosion hazard;

— reconfiguration of the requirements related to electrical safety as the following:

  — the referenced safety requirements for electrical equipment of industrial furnaces and associated processing equipment (TPE) are integrated to IEC 60204-1 (referencing IEC 60519 series was eliminated);

  — referencing ISO 13577-4 for the requirements of protective systems (safety related control systems) was introduced;

  — independent subclause for the electroheat installations where electrical energy is directly used as the heating energy was established;

  — associated changes were made in Table 1 in regards to the changes in 4.3;

— change of title of regional Annex E from "Requirements specific to Japan" to "Information specific to Japan" and modification of its content;

— addition of regional Annex H specific to Canada;

— other editorial changes.

A list of all parts in the ISO 13577 series can be found on the ISO website.

Introduction

This document is a type-C standard as stated in ISO 12100.

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

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

Industrial furnaces and associated processing equipment (TPE) generally consists of the following components:

— processing chambers (e.g. steel construction with lining or without lining);

— heating systems;

— protective system;

— control and instrumentation system/operator-control level.

This document gives additional requirements for TPE in certain countries or regions. When applying the requirements specific to a country or region, which are given in the relevant annexes, it is essential that a level of safety be ensured that is at least equivalent to that provided for by the requirements of the main body of this document.

Industrial furnaces and associated processing equipment — Safety —

Part 1: General requirements

1 Scope

This document specifies the general safety requirements common to industrial furnaces and associated processing equipment (TPE).

This document deals with the significant hazards, hazardous situations or hazardous events relevant to TPE, as listed in Annex A, when TPE is used as intended and also under conditions of misuse that are reasonably foreseeable by the manufacturer.

Annex B provides a list of common industrial furnaces and associated processing equipment.

This document specifies the requirements intended 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 that can occur in the equipment.

These general safety requirements apply to all TPE, unless an exception is given in other parts of ISO 13577 dealing with specific equipment. The provisions of other parts of ISO 13577 that directly apply to specific types of TPE take precedence over the provisions of this document.

This document is not applicable to blast furnaces, converters (in steel plants), boilers or equipment not covered under ISO 12100.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 12100:2010, *Safety of machinery — General principles for design — Risk assessment and risk reduction*

ISO 13577-2:2014, *Industrial furnaces and associated processing equipment — Safety — Part 2: Combustion and fuel handling systems*

ISO 13577-3[1)], *Industrial furnaces and associated processing equipment — Safety — Part 3: Generation and use of protective and reactive atmosphere gases*

ISO 13577-4, *Industrial furnaces and associated processing equipment — Safety — Part 4: Protective systems*

ISO 13732-1, *Ergonomics of the thermal environment — Methods for the assessment of human responses to contact with surfaces — Part 1: Hot surfaces*

ISO 13850, *Safety of machinery — Emergency stop function — Principles for design*

ISO 13854, *Safety of machinery — Minimum gaps to avoid crushing of parts of the human body*

1) Under preparation. Stage at the time of publication: ISO/FDIS 13577-3:2016.

ISO 14119, *Safety of machinery — Interlocking devices associated with guards — Principles for design and selection*

ISO 14120, *Safety of machinery — Guards — General requirements for the design and construction of fixed and movable guards*

ISO 14122-2, *Safety of machinery — Permanent means of access to machinery — Part 2: Working platforms and walkways*

ISO 14122-3, *Safety of machinery — Permanent means of access to machinery — Part 3: Stairs, stepladders and guard-rails*

IEC 60079-0, *Explosive atmospheres — Part 0: Equipment — General requirements*

IEC 60204-1:2009, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements*

IEC 60519 (all parts), *Safety in electroheat installations*

IEC 60825-1, *Safety of laser products — Part 1: Equipment classification and requirements*

IEC 62598, *Nuclear instrumentation — Constructional requirements and classification of radiometric gauges*

EN 1547, *Industrial thermoprocessing equipment — Noise test code for industrial thermoprocessing equipment including its ancillary handling equipment*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12100 and ISO 13574 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

4 Safety requirements and/or protective measures

4.1 General

4.1.1 Requirements

The TPE shall comply with the safety requirements and/or protective measures described in Clause 4 and shall be verified in accordance with Clause 5. In addition, the TPE shall be designed in accordance with the principles of ISO 12100 for relevant hazards, but not significant hazards, which are dealt with by this document.

Anticipated significant hazards are listed in Table A.1.

For ease of reference, Table A.1 also indicates the corresponding preventive measures and should be used in conjunction with Clauses 4, 5 and 6.

Where particular requirements of the other parts of ISO 13577 apply, they shall supplement or modify these general safety requirements.

For regional requirements, see Annexes E, F, G, H and I.

4.1.2 General design and construction requirements

The manufacturer shall maintain evidence that all safety requirements of the design have been fulfilled.

The structural assembly, steel sections, auxiliaries and services (utilities) that form part of the TPE shall be stable and suitable for function and the intended use.

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

— static stability of the TPE, including structures intended for containing the processed materials and the materials entering and leaving the TPE;

— accessibility;

— maintenance and cleaning clearances;

— movement of material and machinery;

— safety in operation;

— health and safety at the workplace;

— protection against fire and prevention of explosion;

— emissions from the process;

— protection against earthquakes where seismic intensity exceeds 325 gal, as determined by the seismic zone.

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 TPE 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.

The design of the TPE and the action of the regulating and safety devices shall prevent

a) unintended release of flammable or hazardous fluids to the outside of the TPE,

b) a backflow of flammable or hazardous fluids to pipes not intended for such fluids, and

c) flashback in the pipework.

The safety devices shall

— be suitable for the range of adjustment required for the regulation of the TPE, and

— not cause one device inadvertently to over-ride 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. Auxiliary fluids, such as lubricants, dielectric, diathermic and dynamic fluids, shall be selected to minimize the hazard of their products of combustion resulting from a fire.

Drains that form part of the TPE 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 TPE shall be designed to withstand corrosion.

Pipework distribution systems that form part of the equipment and can become dangerous if subjected to extreme temperatures or pressures, wide variations in temperature or pressures, or voltage shall be marked.

4.1.2.1 Stability

The TPE structures shall be designed to withstand their static and dynamic loads. The TPE shall be designed for normal and foreseeable accidental thermal static and dynamic working stresses, including those resulting from overpressurization or operation below atmospheric pressure.

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

4.1.2.2 Access

All parts of the TPE that need to be accessed by personnel 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 4.2.10). Inspection and service floors of the TPE shall be safe, well lit, well ventilated, protected against heat radiation and be fire-resistant (see 4.4.3.1).

Account shall be taken of the need for emergency escape routes to avoid the trapping of personnel in the event of hazardous situations (such as fire or the buildup of toxic gases).

4.1.2.3 Roofs and covers

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

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

Roofs or covers that have to be walked on for operating, maintenance and inspection purposes and that are more than 1 m above floor level shall be accessible through safe ascents and shall be fitted with railings to prevent falls. Where the heat source is located in the roof, for example in the ceramics or glass industry, one escape route shall be available in front of, and one behind, the firing zone, one of which shall be a stairway. For design requirements, see 4.1.2.4.

4.1.2.4 Access channels and stairs

In general, the design of access channels and stairs shall be in accordance with ISO 14122-2 and ISO 14122-3. For channels intended for repair purposes below tunnel furnaces or kilns, the unobstructed passage way shall be at least 1,80 m high by 0,70 m wide, and shall 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.

4.2 Mechanical safety

4.2.1 General

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

Where the construction of the TPE includes

— corners and projections,

— passages of reduced height, and

— manhole covers, drains, etc.

they shall be protected and marked in such a way as to minimize the hazard.

Emergency stop devices shall be in accordance with ISO 13850.

4.2.2 Crushing

The design shall incorporate means to minimize hazard to personnel arising from

— movement of materials and machinery,

— automation,

— suspended loads,

— falling materials, and

— moving parts.

All moving machinery that can present a hazard shall be guarded wherever practicable. Where guarding is not practicable, audible and/or visual signals shall be provided. Strategically positioned emergency stop mechanisms shall be provided to stop potentially hazardous moving machinery.

Guarding, where provided, shall comply with ISO 14119 and ISO 14120.

Any traversing part of the TPE or material carried by it shall not be closer to any fixed structure than the safety distance requirements given in ISO 13854.

The design of the TPE shall take account of the minimum distance requirement. See ISO 13854, ISO 13857, ISO 15534-1 and/or ISO 15534-2.

4.2.3 Shearing

Where possible, shear traps shall be eliminated by

a) filling the gaps or reducing the maximum clearance between the moving parts, such that parts of the body cannot enter the gap, and

b) increasing the minimum clearance between the shearing parts, such that parts of the body can enter the gap safely (see ISO 13854 and ISO 15534-1).

Where it is not possible to avoid the creation of a shear trap, adequate guarding shall be used (see ISO 14119 and ISO 14120).

Means shall be provided to prevent unintentional closure or opening of moving parts (e.g. doors, conveyors and elevators) during operation and maintenance.

4.2.4 Entanglement

Design measures shall be taken, or suitable guards shall be provided, to prevent entanglement by rotating shafts, conveyors and transmission machinery (see ISO 14120).

4.2.5 Drawing-in

Design measures shall be taken, or suitable guards shall be provided, to avoid drawing-in (see ISO 14120).

4.2.6 Impact

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

The speed, force or torque, and inertia of the moving parts shall be kept to a minimum by the designer, in order to reduce the possibility of injury. Where this is not practicable, adequate guarding or safety devices shall be provided. Where guarding or safety devices cannot be provided, a perimeter fence shall be provided.

4.2.7 High-pressure fluid ejection

In order to minimize the risk of injury 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 specifications and all parts of the system shall be protected against overpressure,

— verification of leak tightness shall be achieved by pressure testing to at least the intended operating pressure, and

— any pressure relief device shall be verified by testing in accordance with the 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. If flexible hoses are used for hydraulic oil, they shall be shielded from ignition sources (e.g. hot surfaces). Replacement intervals shall be defined in the instruction handbook.

NOTE For fuel gases and liquid fuel, ISO 13577-2 specifies requirements for piping including flexible tubing.

4.2.8 Ejection of parts

In order to minimize the risk that a body can be crushed or penetrated by material or parts of the equipment that have been ejected unexpectedly or accidentally, adequate guarding shall be provided (see ISO 14120).

4.2.9 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 that are 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.

4.2.10 Falls

Where the design of the TPE or the movement of the TPE requires floor openings that can constitute a hazard, automatic guards, safety warning devices (see 6.3) or barriers shall be provided.

4.2.11 Transport

Where applicable, TPE shall be designed for transport. Instructions for transport shall be provided.

4.3 Electrical safety

4.3.1 Electrical equipment of TPE

4.3.1.1 General

Electrical equipment of any TPE located in the same unit(s) up to the defined TPE limits shall be suitable for their function and intended use. A risk assessment shall be done for each emergency condition and the results shall determine the action to take on the electrical energy supply to the TPE.

Electrical equipment of TPE shall be in accordance with IEC 60204-1:2009. However, the requirement to meet IEC 62061 and/or ISO 13849 in IEC 60204-1:2009, 9.4.1 is not applicable where the requirements of the protective system specified in ISO 13577-4 apply.

The functional requirements to which the protective systems according to ISO 13577-4 apply are specified in the other parts of ISO 13577.

For electroheat installations where electrical energy is directly used as the heating energy, see 4.3.2.

Piping that conveys flammable fluids shall not be installed in channels, ducts, pipes or trenches carrying electrical conductors, unless an explosion-proof method is provided in accordance with IEC 60079-0 suitable for the applicable hazardous area.

Where it is necessary during commissioning, pre-commissioning, maintenance or fault-finding operations to gain access to live parts appropriate interlocks, protection systems or guarding shall be incorporated (see ISO 14119 and ISO 14120).

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

Electrical conductors and devices shall not be located in areas affected by the discharge of hot components or openings, exhausts and vents for hot gases, vapours or fluids.

4.3.1.2 External influences

The TPE shall be designed to minimize hazards resulting from known 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 TPE environment.

NOTE Such influences can be beyond the boundaries defined within the scope of this document and are intended to be dealt with in contract with/among the supplier, agent importers and/or users of the TPE.

4.3.2 Electroheat installations/equipment

Electroheat installations/equipment as part of TPE under the scope of this document shall be suitable for their function and intended use. They shall be in accordance with the relevant parts of IEC 60519.

4.4 Thermal and cryogenic safety

4.4.1 General

The manufacturer shall design the TPE to prevent unintended contact with workpieces, flames, surfaces or devices, which can be at elevated temperatures or below ambient temperatures.

NOTE Such influences can be beyond the boundaries defined within the scope of this document and are intended to be dealt with in contract with/among the supplier, agent importers and/or users of the TPE.

4.4.2 Contact with hot/cold surfaces

Precautions shall be taken to prevent contact with operating controls at elevated or below ambient temperature either accidentally or while operating them.

Where it is not possible, for process reasons or other constraints, to maintain surface temperature at an appropriate level, steps should be taken to prevent hot operating controls from being touched. Wherever possible, this shall be by means of guards complying with ISO 14120.

If these measures are not practicable, areas of elevated temperatures shall be indicated by means of suitable marking, warning signs, etc. (see 6.3). 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. that are at elevated or below ambient temperatures, requirements for protective clothing shall be included in the instruction handbook.

4.4.3 Fire/explosion

4.4.3.1 Fire

The TPE shall be designed to minimize fire hazards resulting from overheating or those inherent in the TPE from operating at elevated temperatures.

The design and construction of the TPE shall prevent the leakage of hot gases, combustion products and flames, other than via designed flues, vents and doors, etc.

In particular, the following shall be considered:

a) discharge of hot gases or flames from openings;

b) loading and unloading of work pieces.

Where the TPE is heated by gaseous or liquid fuel, the fuel pipework shall be designed to prevent leakage. In addition, the fuel pipework shall be capable of withstanding foreseeable mechanical damage. Further guidance for gaseous and liquid fuels is given in ISO 13577-2.

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

Heat-transfer fluids shall be non-toxic and shall not exceed the maximum temperature specified by the manufacturer. The humidity and oxygen content in the fluid shall not exceed levels specified by the manufacturer. These values shall be specified in the instruction handbook.

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).

Heat-transfer fluid systems shall be provided with a safety device to prevent over-temperature.

Suitable safety devices shall be fitted where any one of the following parameters impact safety:

— pressure;

— temperature;

— level (of fluid);

— flow.

For further guidance, see ISO 13577-2.

Where used, fire extinguishing system(s) shall be installed on the TPE at positions where there is the greatest risk of fire occurring. Particular attention shall be paid to the selection of the type of extinguisher for use.

4.4.3.2 Explosion

The TPE shall be designed and constructed in such a way as to avoid any risk of explosion posed by the TPE itself or by gases, liquids, dusts, vapours and other substances produced or used by the TPE.

The design shall incorporate means to avoid the explosive co-existence of a flammable substance and an oxidizing agent (usually air) within the flammability limits with an ignition source (see ISO 13577-2).

Attention shall be given to work pieces that are not themselves flammable but that may, by design or otherwise, be coated with substances that can give rise to a flammable mixture.

Pressure relief(s) from an ignited flammable mixture shall be provided, unless it can be shown that the mixture cannot exceed 25 % of the lower flammability limit (LFL), the ignited flammable mixture is safely vented by other means or an ignited flammable mixture is safely contained.

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

Where doors are not designed as pressure reliefs, they shall be fastened in such a manner that they cannot be opened when subjected to an overpressure condition. Doors shall not open other than in their intended direction.

4.4.4 Ejection of hot particles, work pieces and process liquids

The TPE shall be designed to contain hot particles, work pieces or process liquids within its structure. Attention shall be paid to the loading/unloading areas. If additional guards or barriers are required, they shall comply with ISO 14120.

Where liquid metals, oils or salts are being heated, the introduction of moisture into the liquid shall be avoided.

4.4.5 Thermal stress and other physiological effects

The TPE 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 can be reached in areas to which operators have access. Preventive measures, such as ventilation and operating booths with cooling, shall be provided if necessary.

4.5 Noise

4.5.1 General

Because TPE emits noise to a greater or lesser extent, determined in noise-emission values, the equipment shall be designed and constructed to reduce the risks resulting from the emission of airborne noise.

The TPE shall be designed to minimize the potential noise hazards. To cope with these noise hazards, preventive measures, in order of preference, are as follows:

a) noise reduction at source, i.e. reduction of noise by design, for example:

   1) choose low-noise burners;

   2) optimize the burner rating;

   3) choose low-noise components;

b) noise abatement by devices, i.e. reduction of noise using, for example:

   1) baffles for ventilators;

   2) baffles adjacent to burner(s);

   3) encasing of pumps;

   4) silencers;

   5) noise-absorbing walls and covers (see ISO 11690-2);

   6) enclosures;

c) noise abatement at workstation, i.e. reduction of noise using, for instance, a cabin for the operators.

The TPE shall be designed to reduce the noise generated by the movement of process material.

The measurement and verification of noise emission values shall be in accordance with EN 1547 or a regional standard.

4.5.2 Interference with communications

The TPE shall be designed to 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, the effect of wearing such equipment on communications shall be considered.

NOTE Visual, instead of audible, communications might be required.

4.6 Vibration

Primary measures shall comprise the reduction of vibration at source.

Where secondary measures are required, use anti-vibration mountings or other measures.

NOTE Guidance on the minimization and reduction of vibration is given in EN 1299.

4.7 Radiation safety

4.7.1 General

Means shall be provided to minimize the harmful effects of radiation emissions, as specified in 4.7.2 and 4.7.3 for particular electroheat installation as part of the TPE covered by the scope of this document and in the relevant part(s) of IEC 60519. Such means shall be appropriate to the circumstances obtained within the TPE.

NOTE IEC 60519 consists of 13 parts including *General requirements* and *Particular requirements for specific types of electroheat installations*.

4.7.2 Non-ionizing radiation

Any inspection points where operators are likely to be exposed to harmful infrared and ultraviolet radiations shall be shielded by 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, which are integral parts of the TPE, shall comply with regulations and directives concerning emission limits.

4.7.2.1 Infrared/visible/UV radiation

Suitable protection against harmful infrared, visible and UV radiation shall be provided (see 4.4.5).

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 TPE shall have appropriate protection.

Specific danger warning signs shall be provided (see 6.3.).

4.7.2.2 Laser beams

Laser equipment and its use shall comply with IEC 60825-1. 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 (see 6.3.4).

4.7.2.3 Electromagnetic fields

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

In areas where hazardous 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. (see 6.3.3 and 6.3.4).

4.7.2.4 Microwaves

Microwave equipment shall comply with IEC 60519-6.

4.7.3 Ionizing radiation

Where measuring instruments and monitoring accessories employing X-rays and/or gamma ray are used on the TPE, they shall not constitute a risk to people. Only sealed sources complying with IEC 62598 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

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

b) 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 (see 6.3.4).

4.8 Materials and substances processed, used or exhausted

4.8.1 General

Hazardous situations can arise as a result of the nature of the process being undertaken by the TPE, such as contact with, or inhalation of, dust or harmful liquids, gases, vapours, mists and fumes; therefore, the TPE shall be designed to remove possible hazards arising from materials and substances by suitable choice of design features. In addition, the instruction handbook shall clearly specify any particular working practices and personnel protection that are necessary to ensure safe use of the TPE (see ISO 14123-1).

4.8.2 Harmful by-products

The TPE shall be designed to minimize 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, suitable draught systems shall vent these leakages to an approved location (see ISO 14123-1). Specific hazard warning signs shall be provided (see 6.3.4).

4.8.3 Fire/explosion

The TPE shall incorporate appropriate measures to prevent or minimize the risk of fire or high pressure from an ignited flammable mixture.

At least, the fitting of the following apparatus shall be considered:

— flame guards;

— fuel cut-off devices and interlocks;

— cooling means for TPE or work pieces;

— fire-detection means (for fire extinguishing facilities, see 4.4.3.1);

— gas detectors;

— purging equipment;

— safety temperature monitoring.

In addition, the fuels, the combustion and the controlled atmospheres used in the process shall comply with ISO 13577-2:2014, 4.4.3 and ISO 13577-3.

4.9 Ergonomics

The TPE shall be designed to take account of the ergonomic aspects of using, maintaining and servicing the TPE (see ISO 7731, ISO 7933 and ISO 11429). Hot surfaces shall comply with ISO 13732-1 (see also ISO 7243 and ISO 15534-1).

4.10 Hazard combination

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

NOTE For instance, the failure of a stop device to operate can 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 IEC 60204-1).

4.11 Malfunction

4.11.1 Failure of power supply and auxiliary fluids

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

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

For failure in electricity supply, see 4.3.1.2.

Additional stand-by machinery, such as air compressors, electrical supply units, compressors for service fluids and power engines, shall be located separately from the TPE.

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).

4.11.2 Errors of fitting/assembly during installation

There shall be adequate supervision of fitting and assembly operations.

The TPE shall be designed to ensure that parts cannot be easily incorrectly fitted or assembled.

4.11.3 Effect of malfunctions of the control system/component safety devices

The TPE shall be designed so that malfunctions cause the system to revert to a safe condition.

4.12 Missing and incorrectly fitted safety devices

4.12.1 General

Safety devices shall be identified and documented in the instruction handbook to avoid their incorrect installation. The information for use documentation shall provide further assistance; it shall also give suitable warnings about incorrectly fitted or missing parts in those areas where the manufacturer assesses that a hazard can occur if parts are missing or incorrectly fitted.

4.12.2 Power supply disconnection devices

The TPE 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 have been achieved shall be provided, e.g. by means of pressure gauges, meters, audible or visual signals (see 6.3). For further guidance, see ISO 12100 and ISO 14118.

5 Verification

Proof of compliance of the safety requirements and/or protective measures shall be demonstrated by any one, or a combination, of the following:

a) visual inspection;

b) functional tests;

c) measurements;

d) examination of drawings/calculations.

See Table 1.

Table 1 — Verification

Subclause	Safety requirements and/or measures	Verification			
		Visual/ auditory inspection[a]	Functional test[b]	Measurement[c]	Examination of drawings/ calculations[d]
4.1	General				
4.1.1	Requirements				X
4.1.2	General design and construction requirements				X
4.1.2.1	Stability				X
4.1.2.2	Access	X			
4.1.2.3	Roof and covers	X			
4.1.2.4	Access channels and stairs			X[f]	
4.2	Mechanical safety				
4.2.1	General				X
4.2.2	Crushing	X		X[e]	
4.2.3	Shearing	X		X[e]	
4.2.4	Entanglement	X		X[e]	
4.2.5	Drawing-in	X		X[e]	
4.2.6	Impact				X
4.2.7	High-pressure fluid ejection	X	X	X	
4.2.8	Ejection of parts	X		X[e]	
4.2.9	Slip/trip				X
4.2.10	Falls		X		
4.2.11	Transport				X
4.3	Electrical safety				
4.3.1	Electrical equipment of TPE				
4.3.1.1	General	See note k.			
4.3.1.2	External influences		X		
4.3.2	Electroheat installations/equipment	See note l.			
4.4	Thermal and cryogenic safety				
4.4.1	General	X			
4.4.2	Contact with hot/cold surfaces	X		X[e]	
4.4.3	Fire/explosion				

Table 1 *(continued)*

Subclause	Safety requirements and/or measures	Verification			
		Visual/ auditory inspection[a]	Functional test[b]	Measurement[c]	Examination of drawings/ calculations[d]
4.4.3.1	Fire				X
4.4.3.2	Explosion				X
4.4.4	Ejection of hot particles, work pieces and process liquids			X[e]	
4.4.5	Thermal stress and other physiological effects	X			X
4.5	Noise				
4.5.1	General			X[g]	
4.5.2	Interference with communications	X			
4.6	Vibration				X
4.7	Radiation				
4.7.1	General				X
4.7.2	Non-ionizing radiation				X
4.7.2.1	Infrared/visible/UV radiation	X			
4.7.2.2	Laser beams	X	X		
4.7.2.3	Electromagnetic fields	X			
4.7.2.4	Microwaves				X
4.7.3	Ionizing radiation	X	X		
4.8	Materials and substances processed, used or exhausted				
4.8.1	General			X[h]	
4.8.2	Harmful by-products	X		X[h]	
4.8.3	Fire/explosion				X
4.9	Ergonomics			X[i]	
4.10	Hazard combination				X
4.11	Malfunction				
4.11.1	Failure of power supply and auxiliary fluids		X		X
4.11.2	Errors of fitting/assembly during installation				X
4.11.3	Effect of malfunctions of the control system/component safety devices		X		
4.12	Missing and incorrectly fitted safety devices				

Table 1 *(continued)*

Subclause	Safety requirements and/or measures	Verification			
		Visual/ auditory inspection[a]	Functional test[b]	Measurement[c]	Examination of drawings/ calculations[d]
4.12.1	General	X			X
4.12.2	Power supply disconnection devices	X	X[j]		

[a] Visual/auditory inspection should be carried out for testing the required characteristics and properties by visual/auditory study of the delivered TPE and components.

[b] The functional test shows whether the parts in question function in such a way as to satisfy the requirements.

[c] Verification by means of measuring instruments used to check whether the requirements are fulfilled within the specific limits (e.g. the safety distances between the guard and the running nip).

[d] Drawings and calculations should be used to check whether the design characteristics of the components used the specific requirements.

[e] See ISO 14120.

[f] See ISO 14122-2 and ISO 14122-3.

[g] See EN 1457 or regional standards.

[h] See ISO 14123-2.

[i] See ISO 13732-1.

[j] See ISO 14118.

[k] See IEC 60204–1:2009, Clause 18.

[l] See relevant part(s) of IEC 60519.

6 Information for use

6.1 General requirements

The manufacturer shall draft and provide information on the use of TPE. Such information for use of equipment consists of communication links, such as explanations, signs, signals, symbols or diagrams, used separately or in combination to convey information to the furnace operator. It is directed to trained operators and supervisors.

Information shall be provided to the user about the intended use of the TPE, taking into account, notably, all its operating modes.

It shall contain all directions required to ensure intended and correct use of personal protective equipment.

With this in view, it shall inform and warn the operator; the supervisor shall be notified and warned of residual risks.

The information shall include:

a) details of the required training;

b) personal protective TPE requirements;

c) additional details of the guards or protective devices.

It shall include uses of the TPE that are consistent with its design and intended use.

Information for use shall cover, separately or in combination, transport, assembly and installation, commissioning, use (setting, teaching/programming or process changeover, operation, cleaning, fault-finding and maintenance) of the TPE, and, if applicable, de-commissioning, dismantling and disposal.

6.2 Location and nature of the information for use

Depending on the risk, the time when the information is needed by the furnace operator or the supervisor and the TPE design, it shall be decided whether the information (or parts thereof) is to be given by the manufacturer or the user

a) in/on the TPE itself,

b) in accompanying documents (see 6.4),

c) on the packaging, and

d) by other means, such as signals and warnings outside of the TPE.

6.3 Signals and warning devices

6.3.1 General

Requirements concerning where signals and warning devices shall be fitted are given in Clause 4.

It is essential that these signals be

a) emitted before the occurrence of the hazardous event,

b) unambiguous,

c) clearly perceived and differentiated from all other signals used, and

d) clearly recognized by the furnace operator and other persons.

WARNING — During an alert, too much information given at the same time can overload the operator. Safety relevant information should be prioritized.

The warning devices, if used, shall be designed and located such that checking for proper operation is easy. The information for use shall prescribe regular checking of warning devices.

For further guidance, see IEC 61310-1.

6.3.2 Marking

6.3.2.1 The TPE shall bear, at least, the following markings in a visible and legible manner:

a) the serial number, if any, or the name of the TPE;

b) the name and address of the manufacturer;

c) the year of construction;

d) the year of modification.

6.3.2.2 Additional marking may include the following:

a) type of heating energy (electricity, fossil fuel, etc.) to be used and its calorific value, if applicable;

b) nominal fuel rating of the equipment;

c) maximum and minimum fuel supply pressure;

d) maximum charge load or output to be treaded;

e) maximum operation temperature;

f) atmosphere to be used (e.g. non-inflammable, explosive, toxic), if specific.

6.3.3 Personnel protection

The TPE shall bear necessary signs and written warnings as appropriate for its intended use, for instance

a) necessity of wearing personal protective equipment, or

b) guard adjustment data.

Markings shall comply with recognized standards (see ISO 7000).

As regards the marking of electrical equipment, see IEC 60204-1.

6.3.4 Warning signs

Warning signs shall comply with recognized standards (see ISO 7010).

For electrical hazards, see IEC 60204-1 and IEC 61310-2.

6.4 Instruction handbooks/manuals

The instruction handbook(s)/manual(s) shall contain at least the following:

a) information relating to transport, handling and storage of the TPE, including, but not limited to,

   1) storage conditions for the TPE,

   2) dimensions, mass value(s), position of the centre(s) of gravity, and

   3) indications for handling,

b) information relating to the installation and commissioning of the TPE (an example of a suitable test report is given in Annex C), including, but not limited to,

   1) fixing/anchoring and vibration-dampening requirements,

   2) assembly and mounting conditions,

   3) the space needed for use and maintenance,

   4) permissible environmental conditions (e.g. temperature, moisture, vibration, electromagnetic radiation),

   5) instructions for connecting the TPE to power supply (particularly about protection against electrical overloading),

   6) recommendations about process waste removal/disposal, if applicable, and

   7) recommendations for the user to implement protective measures for safety distances, safety signs and signals (for additional safeguards, see ISO 12100:2010, Figure 2, footnote d),

c) information relating to the TPE, including, but not limited to,

   1) a description of the TPE, its fittings (e.g. pipe thread type), its guards and/or protective devices,

2) the range of applications, for which the TPE is intended,

3) diagrams (e.g. schematic representation of safety functions), and

4) data about noise, vibration, radiation, gases, vapours or dusts emitted or generated by the TPE, with reference(s) to the measuring method/standard,

d) information relating to the operation of the TPE, including, but not limited to,

1) the intended use,

2) a description of manual controls (actuators),

3) the setting, adjustment and list of setting values and adjustment values of the TPE at the completion of the commissioning test,

4) modes and means for start-up, operation and stopping (e.g. emergency stop),

5) residual risks, and

6) the handing of TPE fault(s),

e) information for maintenance, including, but not limited to,

1) the method and frequency of inspections for safety functions,

2) maintenance items that may only be conducted by the TPE manufacturer or his/her designated representative,

3) instructions, drawings, and diagrams related to maintenance,

4) a recommended format for record keeping, and

5) instructions stating that the essential maintenance operations carried out in hazardous areas should be authorized and performed in accordance with a work permit authorization (for a typical work permit authorization, see Annex D), and

f) information for de-commissioning, dismantling and/or disposal.

Annex A
(informative)

List of significant hazards

This annex lists all significant hazards, hazardous situations and events, as far as they are dealt with in this document, that are identified by risk assessment as significant for this type of equipment and that require action to eliminate or reduce the risk. The following significant hazards can occur in the use of TPE.

Table A.1 — List of significant hazards

No.	Hazard	Hazardous situation/ event	Preventative measures	Subclause (reference)
A.1	General		General design concept (structure, access for operation, maintenance and cleaning, lighting, etc.) Provision of markings, signs, etc. Instruction handbook/manual	4.1.1 4.1.2 6.3 6.4
A.2	Mechanical hazards			
A.2.1	General		Design, structural details Emergency stop guards Provision of markings, signs, etc. Instruction handbook/manual	4.2.1 6.3 6.4
A.2.2	Crushing	Moving parts Traps created by auto and manual feeding/ take-off mechanisms	Fit guard Provision of safety distances Fit interlocks Means of warning (audible, visual) Provision of warning signs Emergency stops Push button with visual inspection Maintenance/cleaning and its good practice (particularly on guards)	4.2.2 4.3.1.1 6.3 6.4
A.2.3	Shearing	Moving parts Moving of charging doors, feeding/take-off mechanism	Fit guard Safety distances, perimeter fencing, marking Fit interlocks Means of warning (audible, visual) Provision of markings, signs, etc. Push button with visual inspection	4.2.3 4.3.1.1 6.3 6.3.4
A.2.4	Entanglement	Rotating shafts (e.g. fan shafts, conveyors, transmission machinery)	Guards	4.2.4
A.2.5	Drawing-in	Nips created by rolls (e.g. conveyors)	Guards	4.2.5
A.2.6	Impact	Struck by moving parts (e.g. doors, chargers, roller tables)	Guards Perimeter fencing systems or signs	4.2.6

Table A.1 *(continued)*

A.2.7	High-pressure fluids	Hydraulic leaks/failure Steam and service fluids	Design features Guards Containment and draining Prevent as far as possible by adopting good maintenance procedures	4.2.7 4.1.2 6.4
A.2.8	Ejection of parts	Molten metal Process components/ materials, machinery parts	Design features Guarding Effective protection of defined areas or sections Provision of personal protective equipment Method of operation	4.2.8 6.3.3
A.2.9	Stability	Collapsing of parts or TPE or materials Movement of components or of machinery	Design (e.g. civil engineering) and maintenance Design Provision of markings, signs etc. Understanding of the system Training	4.1.2.1 6.1 6.3 6.4
A.2.10	Slip/trip	Floor surfaces Walkway surfaces Spilled fluids Inadequate lighting	Ladders/walkways designed in accordance with defined specifications: No trip conditions Handrails Easy to maintain and clean Good maintenance and cleaning Provision of containment and draining Provision of adequate lighting	4.2.9 4.1.2.2 4.1.2.3 4.1.2.4 6.4 4.1.2 4.1.2.2
A.2.11	Falls	From equipment Into equipment (e.g. openings, charging) Inadequate lighting	Ensure openings are covered or guarded Provision of adequate hand holds Flat safe surrounding floors Ensure openings closed during normal operation Provision of adequate lighting	4.2.10 4.1.2.2 4.1.2.3 4.1.2.4 4.1.2.2 4.1.2.3 4.1.2.4 4.1.2.2
A.2.12	Transport			4.2.11
A.3	Electrical			
A.3.1	General		For electrical equipment of TPE, design in accordance with IEC 60204-1:2009	4.3.1.1
			For electroheat installations/equipment as part of TPE, design in accordance with relevant parts of IEC 60519	4.3.2
A.3.2	Contact			

Table A.1 *(continued)*

A.3.2.1	Direct	Exposed or accessible live connectors, bus bars, etc.	Appropriate protection (fixed/interlocking guards), locked control cabinets and safety audit Enclosed electrical control and supply rooms For electroheat installations/equipment as part of TPE, design in accordance with relevant parts of IEC 60519 Guards (enclosure)	4.3.1.1 (IEC 60204-1) 4.3.2 4.3.1.1 (IEC 60204-1)
A.3.2.2	Indirect	Insulation breakdown (Ground) earthing faults Physical contact	For electrical equipment of TPE, design in accordance with IEC 60204-1:2009 For electroheat installations/equipment as part of TPE, design in accordance with relevant parts of IEC 60519	4.3.1.1 4.3.2
A.3.3	Electrostatics	Discharge into the measuring, controlling and regulating devices, e.g. stored programme system or computer	Grounding Safety shut-down	4.3.1.1 (IEC 60204-1)
A.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	4.3.1.1 4.3.2
A.3.5	Thermal radiation and heat flow	Fire Molten metal Molten metal fusion in an electrical panel Heat	Protect as far as possible from fire/explosion effects Protect from any likely splash of molten metal Equipment and cabling designed and positioned to avoid damage (e.g. heat shields, cooling)	4.3.1.1 4.4.3 4.4.5 4.3.1.1 4.4.3 4.4.5 4.3.1.1 4.4.3 4.4.5
A.3.6	External influences	Electromagnetic fields (see A.7.2.1.4) Induced voltage peaks (in control circuits) by switching high currents or voltage Disturbing signals in control circuits Radio frequency interference Lightning	For electroheat installations with high electromagnetic fields: forbidden area for people with pacemakers. Proper design for control circuits	4.3.1.2 4.3.2 4.3.1.2

Table A.1 *(continued)*

A.4	Thermal			
A.4.1	General		Design features	4.4.1
A.4.2	Heat sources	Contact with hot/cold surfaces	Reduce access where possible	4.4.2
		Heat radiation	Provision of protection (insulation barriers and screens, ventilation, etc.)	4.7.2 4.7.2.1
			Provision of warnings	6.3
		Contact with hot gases and flames	Danger zone marking	6.3.3
			Personal protective equipment provision and usage	
		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	4.9 6.3.3
A.4.3	Fire/explosion			
A.4.3.1	Fire	Failure of controls and/or equipment leading to fire	Design	4.4.3.1
			Instruction handbook	4.3.1.1
				4.8
				6.4
		Escape of flames	Guards	4.4.3.1
			Maintenance	4.8
				6.4
			Guards	4.4.3.1
		Escape of materials	Proper procedures and maintenance	4.8
				6.4
		Heat-transfer fluids fire	Proper procedures and devices for the use of heat-transfer fluid	6.4
		Fires in service oil/ fuel-oil	Protection	4.4.3.1
			Design	4.8
			Maintenance	6.4

Table A.1 *(continued)*

A.4.3.2	Explosion	Failure of control and/or equipment leading to explosion	Provision of explosion relief sufficient to prevent disintegration of equipment	4.4.3.2
			Provision of explosion relief designed to deflect effects away from work areas	4.8
			Instruction handbook: commissioning; use; maintenance	6.4
		Ejection of hot parts or liquids	Design to prevent escape of unburnt gases, flash back in the pipework	4.4.3.1
				4.8.3
			Design work position to minimize exposures	4.9
			Protection against ejection of service or process fluids	4.4.4
		Flame failure: generation of an ignitable atmosphere	Flame safeguard	4.4.3.2
			Provision of adequate pressure relief	
			Remove explosion hazard	
		Failure of purge (evacuating gases)	Purging procedures clearly defined and monitored (e.g. number of volume changes) in accordance with circumstances	4.4.3.1
				4.8.3 (ISO 13577-2 if applicable)
A.4.4	Ejection of hot particles/ workpieces	Molten metal	Effective protection of defined areas or sections	4.4.4
		Process components/ materials	Guarding	
			Design features	
		Machinery parts	Method of operation	6.4
			Provision of personal protective equipment	6.3.3
A.4.5	Thermal stress/other physiological effects	Contact with hot surfaces or liquids	Reduce access, where possible	4.4.5
			Protection by: insulation barriers; screens; ventilation, etc.	
			Provision of warnings	4.1.2
		Extremes of temperature (including draughts, cold)	Danger zone marking	6.4
			Personal protective equipment	6.3.3
			Provision and usage	6.4
			Provision of information in instruction handbook	
			Design work position to minimize exposure	4.9
A.5	Noise			
A.5.1	Noise effects	Sound emission	Noise-reduction design; enclosures, silencers	4.5.1
			Reduce vibration	
A.5.2	Hearing loss and physiological effects	Sound emission	Noise-reduction measures	4.5.1
			soundproof booth	
			Hearing protectors	

Table A.1 *(continued)*

A.5.3	Interference with communica-tions	Messages incorrectly heard; warnings not understood due to sound emission	Ensure the functioning of the communication system Noise-reduction measures Provision of audible/visual alarms	4.5.2 6.3
A.6	Vibration			
A.6.1	Vibration effects	Vibration effects (also physiological)	Design, maintenance Anti-vibration mountings	4.6
A.7	Radiation			
A.7.1	General			4.7.1
A.7.2	Non-ionizing radiation			
A.7.2.1	General			4.7.2
A.7.2.1.2	Infrared, visible, UV radiation	Burning from flames, arcs, furnace walls, materials Excessive heat UV eye and skin damage Damage to sight Eye and tissue damage	Prevent direct sight of radiation sources Provision and use of safety tinted glasses or tinted view holes Provision of warning signs	4.7.2.1 4.7.2 4.1.2 6.3.4
A.7.2.1.3	Laser beams	Contact with eye	Any laser application should meet requirements of IEC 60825–1	4.7.2.2
A.7.2.1.4	Electro-magnetic field: Low frequency Medium fre-quency High frequency	Exposure of pacemaker Physiological effects Induced burns from the wearing of/or implanted metals on persons	Specific exclusion of users of pacemaker Instructions concerning removal of metal objects in contact with the body Measures to prevent persons with metallic medical implants from being in the area	4.7.2.3 4.7.2.3 6.3.3 6.3.4 4.7.2.3
A.7.2.1.5	Microwaves	Body tissue and organ damage (physiological)	Provision in accordance with IEC 60519–6	4.7.2.4
A.7.3	Ionizing radiation	Accidental exposure to ionizing radiation	Use only sealed sources in accordance with IEC 62598. Provision of markings, signs, etc. Instruction handbook/manual	4.7.3 6.3 6.4
A.8	Material and substances			
A.8.1	General			4.8.1
A.8.2	Harmful by-products	Escape of dust/fume from combustion, from process, from work-piece, from quenching Gas by-products from special atmospheres (these can be toxic, flammable, asphyx-iant or cause distress), including inhalation, ingestion, absorption, asphyxiation, toxicity	Provision of local exhaust ventilation Provision of proper evacuation Provision of detecting devices Provision of specific danger warning sign Provision of warning devices Periodic environmental sampling of working atmosphere Defined maintenance procedures	4.8.2 6.3 6.4 6.4

Table A.1 *(continued)*

A.8.3	Fire/explosion	See A.4.3.1 and A.4.3.2	Flame guards	4.8.3 4.4.3 (ISO 13577-2 if applicable)
			Fuel cut-off devices and interlocks	4.8.3 4.4.3 (ISO 13577-2 if applicable)
			Fire detectors, flammable gas detectors	4.8.3 4.4.3 (ISO 13577-2 if applicable)
A.9	Ergonomic			
A.9.1	General		Principles for design	4.9
			Referenced group standards to be observed	
	Insufficient lighting	Vicinity of the machine or process	Provision of sufficient lighting	4.1.2.2
A.10	Hazard combination			
A.10.1	General		General (design) provision to prevent enhanced cumulative effects of hazards combination	4.10
A.11	Malfunction			
A.11.1	Failure of energy supply	Loss of control (process and power)	Effective safe shut-down	4.11.1
			Provision of preferential supply systems	
	Failure of service fluids	Partial or total loss of services	Stand-by safety and reserve supply system	
		Failure of equipment to operate correctly	Instruction, training, good maintenance	6.4
A.11.2	Ejection of parts (or fluids)	See A.2.7, A.2.8, A.4.4		4.2.7 4.2.8 4.4.4 4.11.1
A.11.3	Errors of fitting/ assembly	See A.2.9	Design, training, understanding of the system, marking, identification, etc.	4.11.2 Clause 6
A.11.4	Effect of malfunction of control system devices	Unexpected operating conditions	Well-trained and instructed personnel	4.11.3
			Good maintenance	Clause 6
A.11.5	Lack of information/ warning devices	No reaction to situations requiring remedial (auto or manual) action, e.g. flame failure, high temperature, etc.	Provision of means to identify dangerous deviations from normal operation	Clause 6
			Maintenance	
			Design	
		Overuse of devices, hence loss of effectiveness	Training	

Table A.1 *(continued)*

A.11.6	Warning signs	No warning of particular dangers (in addition to the device)	Signs are to be pictorially clear, correctly positioned, difficult to remove or permanently marked See IEC 61310–1	6.2 6.3
A.11.7	Failure of equipment	Inadequate instructions to operating personnel Inadequate maintenance	Instruction handbook Training Instruction handbook Maintenance at prescribed intervals	6.4 6.4
A.12	Missing/incorrectly fitted safety devices			
A.12.1	General			4.12.1
A.12.2	Guards	Absence or incorrect fitting can cause injury or death to the operator or by-standers	Maintenance Design Training	4.11.2 4.12.1 6.4
A.12.3	Safety devices	Absence or incorrect fitting can cause injury or death to the operator or by-standers	Maintenance Design Training	4.11.2 4.12.1 6.4
A.12.4	Start/stop	Absence or incorrect fitting can cause injury or death to the operator or by-standers	Maintenance Design Training	4.11.2 4.12.1 6.4
A.12.5	Information/ warning signs	Absence or incorrect fitting can cause injury or death to the operator or by-standers	Maintenance Design Training	6.3.4 6.4
A.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	4.11.2 4.12.2
A.12.7	Emergency stops	Absence or incorrect fitting can cause injury or death to the operator or by-standers	Maintenance Design Training	6.4
A.12.8	Feeding/ take-off devices	Absence or incorrect fitting can cause injury or death to the operator or by-standers	Maintenance Design Training	4.11.2 6.4
A.12.9	Adjustment/ maintenance	Absence or incorrect fitting can cause injury or death to the operator or by-standers	Maintenance Design Training	4.11.2 6.4

Table A.1 *(continued)*

A.12.10	Gases evacuation	Absence or incorrect fitting can cause injury or death to the operator or by-standers	Maintenance and design	4.11.1 4.11.2 4.12.2 4.8.2 6.4
A.12.11	Failure of equipment: by operator by manufacturer or supplier	Absence or incorrect fitting can cause injury or death to the operator or by-standers Absence or incorrect fitting can cause injury or death to the operator or by-standers	Maintenance Design Training Quality control and commissioning	4.11.2 6.4 Clause 5 6.1

Annex B
(informative)

List of common industrial furnaces and associatedprocessing equipment

B.1 Metallurgical and metal-working plants

Common TPE in metallurgical and metal-working plants are used for

a) thermal production:
   1) roasting;
   2) calcining, reduction, firing;
   3) sintering, agglomeration;
   4) non-ferrous metal refining;
   5) melting out of metals (such as metal distillation);
   6) pelletizing;

b) melting and pouring:
   1) melting (steel/iron, non-ferrous metals);
   2) holding (liquid phase);
   3) pouring;
   4) remelting;

c) heating:
   1) heating, preheating, cooling, holding;
   2) drying;

d) heat treatment:
   1) annealing;
   2) hardening;
   3) tempering;
   4) quenching;
   5) sintering, pressure sintering;

e) surface treatment:
   1) carburizing;
   2) carbonitriding;
   3) nitriding;

4) nitrocarburizing;

5) oxidizing;

f) coating:

1) metallic coating;

2) hot dip galvanizing;

3) non-metallic coating;

4) varnish drying;

5) vapour deposition (CVD, PVD)

g) joining:

1) brazing, soldering;

2) welding;

h) surface pretreatment:

1) cleaning, degreasing;

2) delacquering;

3) pickling.

B.2 Glass-making plants

Common TPE in glass-making plants are used for

a) melting,

b) cooling,

c) decorating, and

d) heat treatment.

B.3 Ceramic-manufacturing plants

Common TPE in ceramic-manufacturing plants are used for

a) dewaxing,

b) drying,

c) heating,

d) annealing,

e) sintering,

f) firing, and

g) decorating.

B.4 Cement-, lime- and gypsum-manufacturing plants

Common TPE in cement-, lime- and gypsum-manufacturing plants are used for

a) calcining,

b) firing,

c) heating, and

d) cooling.

B.5 Chemical/petrochemical plants

Common TPE in chemical/petrochemical plants are used for

a) calcining,

b) distillation,

c) drying,

d) endothermic/exothermic gas production,

e) gasifying,

f) impregnating,

g) liquefying,

h) polymerization,

i) pyrolizing,

j) reaction,

k) reforming, cracking,

l) sintering,

m) melting, and

n) vulcanizing, curing.

B.6 Waste incineration

Common TPE of waste incineration are used for

a) incineration of domestic refuse, sewage, sludge, refuse derived fuel, industrial and special waste (such as toxic),

b) pyrolizing, and

c) gasifying.

B.7 Other industries

Common TPE in other industries are used for

a) drying paper, printing,

b) drying granular materials,

c) drying textiles,

d) drying wood, and

e) baking.

Annex C
(informative)

Typical test report

The typical test report should

— contain adequate description of tests and actions carried out,

— include an indication of the standards and guides employed,

— give the results obtained, and

— be countersigned by attending persons and by contracting parties.

The test mode should be agreed between parties, preferably in the ordering stage and, as far as possible, according to this document and to the terms of the guarantee.

Test report
Company …… Works of …… Tested equipment …… Mod./type …… Serial no. …… Construction year …… Name plate data …… …… …… Equipment (listing): …… …… Accessories and their characteristics …… …… …… Start time of test of …… (specify test object) …… of …… (date) …… in accordance with standards (list and specify clause, subclause) …… …… 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 cause(s) of disturbance.
Final observations
List of persons in attendance and their representatives

Signature, place and date

Annex D
(informative)

Work-permit authorization

This annex shows an example of a work-permit authorization (see 6.4).

Entering/working in confined spaces (containers, tanks, pits, ducts)

1 Order

Object ……

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

Size (m3) : …… Content: ……

Entry into this equipment is authorized for the purposes of INSPECTION/CLEANING/REPAIR/MODIFICATION/DISMANTLING/REVISION within the approved time limit on condition that the safety measures in accordance with Clauses 4 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	Clean confined space	0	0
2.2	Clean empty confined space Rinsing: …….. hours using …….. hot/cold …… times Purging: …… hours using AIR/STEAM/NITROGEN/CO_2 …….. times ……	0	0
2.3	Disconnect other devices and pipework by * Removal of joint elements/pressure equalization * Blanking off connections * Closing of isolating valves/Display of warning signs *……	0	0
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 fuses for pumps/agitation equipment/electrical heating, etc. ……	0	0

2.5	Request a fire attendant (for work such as welding, oxyacetylene cutting)	0	0
2.5.1	Application form for fire attendant is attached to this certificate		0
2.6	Carry out continuous oxygen measurement (required ca. 21 %)	0	0
2.7	Carry out continuous CO measurement [required less than 0,005 % (50 ppm)]	0	0
2.8	Carry out analysis of air constituents. Attach analysis to this certificate	0	0
2.9	Other safety measurements: ……	0	0
3	During work the following safety measures are to be applied:		
3.1	Wearing protective clothing: *Protective goggles (normal-/heat radiation-/acid-type), rubber boots, protective shoes (electrostatically conducting, acid proof), protective gloves, helmet, acid protective harness, welding protective harness * ……	0	0
3.2	Use appropriate breathing apparatus. The Fire Brigade decides which type of breathing apparatus is to 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
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 of life belt and life line	0	0
3.8	Observation by fire attendant with/without prepared breathing apparatus	0	0
3.9	Keeping fire fighting equipment ready for use (responsibility of Fire Brigade). Dry chemical extinguisher/Co_2-extinguisher/hose system	0	0
3.10	Keep working area wet	0	0
3.11	Additional safety measures: ……	0	0

Annex E
(informative)

Information specific to Japan

E.1 General

For the purposes of this document, the specific regional information given in E.2 is applicable to Japan.

E.2 Background

In addition to the safety requirements specified in this document, at least the following laws and regulations are relevant where industrial furnaces are being designed, manufactured and commissioned:

a) *Fire Service Law*;

b) *The Building Standard Law of Japan*;

c) *Industrial Safety and Health Law*;

d) *High Pressure Gas Safety Law*;

e) environment-relevant laws.

In particular, issues concerning the following two types of equipment which are listed in Annex B are ultimately subject to each specific law:

— equipment with regards to chemical/petrochemical plants listed in B.5 are ultimately subject to examination under the High Pressure Gas Safety Law,

— waste incineration equipment listed in B.6 are ultimately subject to examination under the Waste Disposal and Public Cleaning Law.

E.3 Relevant domestic standards

E.3.1 Chemical/petrochemical plant

JIS B 8265 and JIS B 8266 are applicable to equipment listed in B.5.

Annex F
(informative)

Requirements specific to the USA

F.1 General

For the purposes of this document, the specific regional requirements given in F.2 to F.4.2 are applicable to the USA.

The requirements of this annex shall ensure a level of safety of at least equivalent to the main body of this document.

F.2 Background

For equipment intended to be used in the USA, the "Authority having jurisdiction" (AHJ) has the ultimate authority to approve the overall system installation of the equipment. The AHJ may be a state government, local fire marshal, local building inspector, local board or commission, the user's insurance underwriter, an engineer or the end user. The federal and state governments of the USA have occupational safety and health requirements for a given installation via the Occupational Safety and Health Administration (OSHA), but the OSHA does not typically act as the AHJ during the initial installation and commissioning of the equipment.

The OHSA requirements for the USA (29 CFR Part 1910 General Industry Standards) can be downloaded at www.osha.gov. Some common hazards are covered in Annex A of this document in the "List of significant hazards". However, complying with these may not be enough to satisfy the OSHA requirements in the USA for a given installation.

The end user is responsible for identifying the AHJ for a given installation.

For applications to which this document is applicable, NFPA 86 is the recognized American national standard in the USA. The scope of NFPA 86 is limited to hazards associated with fires and explosions. In addition to equipment requirements, it also includes requirements for the end user and the installation location, whereas this document only covers requirements for the equipment. Thus, complying with this document does not mean that the installation meets the requirements of NFPA 86 or the AHJ, who might have additional or different requirements than those in this document. However, since all installations are subject to the approval of the AHJ, it is possible for equipment complying with the requirements of this document to be accepted.

F.3 Normative references

For the purposes of this annex, the following normative references apply.

ANSI/ASME B1.20.1, *Pipe Threads, General Purpose (Inch)*

ANSI/ASME B31.1, *Power Piping*

ANSI/ASME B31.3, *Process Piping*

ANSI/ASME B16.20, *Metallic Gaskets for Pipe Flanges — Ring-Joint, Spiral-Wound, and Jacketed*

ANSI/ASME B16.21, *Non Metallic Flat Gaskets for Pipe Flanges*

NFPA 31, *Standard for the Installation of Oil-Burning Equipment*

NFPA 54, *National Fuel Gas Code*

NFPA 55, *Compressed Gases and Cryogenic Fluids Code*

NFPA 70, *National Electrical Code*

NFPA 79, *Electrical Standard for Industrial Machinery*

NFPA 86:2011, *Standard for Ovens and Furnaces*

F.4 Safety requirements for the USA

F.4.1 General design and construction requirements

In addition to 4.1.2, the following apply.

a) Gas pipework materials shall comply with NFPA 54.

b) Liquid fuel pipework materials shall comply with NFPA 31.

c) Pipework connections, including pressure limitations, shall comply with the following, as applicable:

   1) ANSI/ASME B1.20.1;

   2) ANSI/ASME B31.1;

   3) ANSI/ASME B31.3;

   4) ANSI/ASME B16.20;

   5) ANSI/ASME B16.21.

d) Oxygen or oxygen-enriched installations shall comply with the following, as applicable:

   1) NFPA 55;

   2) NFPA 86:2011, 6.4 and 8.14.

NOTE 1 For guidance on the preparation and cleaning of pipework, see CGA-4.1.

NOTE 2 For guidance on pipework, see CGA-4.4.

F.4.2 General electrical safety

In addition to 4.3.1, electrical installations shall comply with the following, as applicable:

a) NFPA 70;

b) NFPA 79.

Annex G
(informative)

Requirements specific to the EU and associated countries

G.1 General

For the purposes of this document, the specific regional requirements given in G.2 to G.3are applicable to the EU and associated countries.

The requirements of this annex shall ensure a level of safety of at least equivalent to the main body of this document.

G.2 Background

For equipment intended to be used in the European Economic Community (EEC) member countries, in the European Free Trade Association (EFTA) member countries subject to European (EU) legislation, and in all other countries subject to European legislation, this document gives the specific essential health and safety requirements of Annex 1 of the applicable directive to which this document refers or with which it is harmonized, and only for the products within the scope of this document.

This means that essential requirements of other European directives can be applicable.

Examples of potential additional requirements are as follows:

— equipment intended for use in hazardous locations shall, additionally, comply with the requirements of Directive 94/9/EC [commonly referred to as the ATEX (“Atmosphères explosibles”) Products Directive];

— equipment intended for use under pressure (vessels, piping) exceeding 0,5 bar can additionally need to comply with EEC-PED requirements;

— equipment intended for use with voltages between certain limits shall additionally comply with the requirements of Directive 2006/95/EC (commonly referred to as the Low Voltage Directive) and Directive 2004/108/EC (commonly referred to as the EMC Directive).

It shall be verified from the scope of each European directive whether or not the directive is additionally applicable.

Other requirements are not given in this document, but are specified in the EC directives themselves. Certification, declaration, literature and language requirements are specified in each directive. It shall be verified, for each applicable directive, which additional conditions are required for the TPE before it is installed and commissioned in countries specified in this subclause.

G.3 Normative references

For the purposes of this annex, the following normative references apply.

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

EN 1547, *Industrial thermoprocessing equipment — Noise test code for industrial thermoprocessing equipment including its ancillary handling equipment*

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 1299, *Mechanical vibration and shock — Vibration isolation of machines — Information for the application of source isolation*

Annex H
(informative)

Requirements specific to Canada

H.1 General

For the purposes of ISO 13577 (all parts), the specific regional requirements given in H.2 to H.4 are applicable to Canada.

The requirements of this annex shall ensure a level of safety of at least equivalent to the main body of this document.

H.2 Background

For equipment intended to be used in Canada, the "Authority having jurisdiction" (AHJ) has the ultimate authority to approve the overall system installation of the equipment. The AHJ may be a federal, provincial or municipal government.

H.3 Normative references

For the purposes of this annex, the following normative references apply to the installation, certification and/or approval of TPE intended for use in Canada.

CAN/CSA B51 *Boiler, Pressure Vessel and Pressure Piping Code*

CAN/CSA B149 series of *Fuel Gas Codes*

CAN/CSA B139 series of *Liquid Fuel Codes*

CAN/CSA C22.1 *Canadian Electrical Code*

H.4 Marking requirements for Canada

For the purposes of ISO 13577 (all parts), all required markings and ratings shall be provided in both English and French languages.

Annex I
(informative)

Requirements specific to China

I.1 General

For the purposes of ISO 13577 (all parts), the specific regional requirements given in I.2 to I.3 are applicable to China.

The requirements of this annex shall ensure a level of safety of at least equivalent to the main body of this document.

I.2 Background

For the equipment intended to be used in China, the “Authority having jurisdiction” (AHJ) has the ultimate authority to approve the overall system installation of the equipment. The AHJ may be a state, provincial, municipal government or the end users.

Safety, healthy, environment and fire protection relative laws or regulations should be mainly considered.

I.3 Normative references

The following normative references apply to the installation, certification and approval of TPE intended for use in China.

GB, GB/T, JB series of Boiler, Pressure Vessel and pressure piping codes

GB, GB/T series of gas/liquid fuel codes

GB, GB/T series of Electrical device codes

GB, GB/T series of building designing codes

Bibliography

[1] ISO 7000, *Graphical symbols for use on equipment — Registered symbols*

[2] ISO 7010, *Graphical symbols — Safety colours and safety signs — Registered safety signs*

[3] ISO 7243, *Hot environments — Estimation of the heat stress on working man, based on the WBGT-index (wet bulb globe temperature)*

[4] ISO 7731, *Ergonomics — Danger signals for public and work areas — Auditory danger signals*

[5] ISO 7933, *Ergonomics of the thermal environment — Analytical determination and interpretation of heat stress using calculation of the predicted heat strain*

[6] ISO 11429, *Ergonomics — System of auditory and visual danger and information signals*

[7] ISO 11690-2, *Acoustics — Recommended practice for the design of low-noise workplaces containing machinery — Part 2: Noise control measures*

[8] ISO 13574, *Industrial furnaces and associated processing equipment — Vocabulary*

[9] ISO 13857, *Safety of machinery — Safety distances to prevent hazard zones being reached by upper and lower limbs*

[10] ISO 14118, *Safety of machinery — Prevention of unexpected start-up*

[11] ISO 14123-1, *Safety of machinery — Reduction of risks to health resulting from hazardous substances emitted by machinery — Part 1: Principles and specifications for machinery manufacturers*

[12] ISO 14123-2, *Safety of machinery — Reduction of risks to health resulting from hazardous substances emitted by machinery — Part 2: Methodology leading to verification procedures*

[13] ISO 15534-1, *Ergonomic design for the safety of machinery — Part 1: Principles for determining the dimensions required for openings for whole-body access into machinery*

[14] ISO 15534-2, *Ergonomic design for the safety of machinery — Part 2: Principles for determining the dimensions required for access openings*

[15] IEC 60825-1, *Safety of laser products — Part 1: Equipment classification and requirements*

[16] IEC 61310-1, *Safety of machinery — Indication, marking and actuation — Part 1: Requirements for visual, acoustic and tactile signals*

[17] IEC 61310-2, *Safety of machinery — Indication, marking and actuation — Part 2: Requirements for marking*

[18] EN 1299, *Mechanical vibration and shock — Vibration isolation of machines — Information for the application of source isolation*

Relevant to Japan

[19] Government of Japan, *Fire Service Law*

[20] Government of Japan, *Industrial Safety and Health Law*

[21] Government of Japan, *The Building Standard Law of Japan*

Relevant to the USA

[22] UNITED STATES DEPARTMENT OF LABOR. OSHA, 29 CFR, Part 1910: General Industry Standards. Available at www.osha.gov

[23] CGA G-4.1, *Cleaning Equipment for Oxygen Service*

[24] CGA G-4.4, *Oxygen Pipeline Systems*

Relevant to the EU and related/associated countries

[25] European Commission, Directive 94/9/EC of 23 March 1994 on the approximation of the laws of the Member States concerning equipment and protective systems intended for use in potentially Explosive Atmospheres

[26] European Commission, Directive 2004/108/EC relating to electromagnetic compatibility and repealing Directive 89/336/EEC

[27] European Commission, Directive 2006/95/EC of the European Parliament and of the Council of 12 December 2006 on the harmonisation of the laws of Member States relating to Electrical Equipment designed for use within certain voltage limits

[28] European Union legislation. Available at: http://eur-lex.europa.eu/en

[29] IEC 60364-4-41, *Low-voltage electrical installations — Part 4-41: Protection for safety — Protection against electric shock*

[30] IEC 60364-4-43, *Low-voltage electrical installations — Part 4-43: Protection for safety — Protection against overcurrent*

[31] IEC 60364-4-44, *Low-voltage electrical installations — Part 4-44: Protection for safety — Protection against voltage disturbances and electromagnetic disturbances*

[32] IEC 60364-5-53, *Electrical installations of buildings — Part 5-53: Selection and erection of electrical equipment — Isolation, switching and control*

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