BRITISH STANDARD

BS EN
12581:2005
+A1:2010

Coating plants — Machinery for dip coating and electrodeposition of organic liquid coating material — Safety requirements

ICS 87.100

BSI
British Standards

National foreword

This British Standard is the UK implementation of EN 12581:2005+A1:2010. It supersedes BS EN 12581:2005 which is withdrawn.

The start and finish of text introduced or altered by amendment is indicated in the text by tags. Tags indicating changes to CEN text carry the number of the CEN amendment. For example, text altered by CEN amendment A1 is indicated by [A1] 〈A1〉.

The UK participation in its preparation was entrusted to Technical Committee MCE/3, Safeguarding of machinery, to Subcommittee MCE/3/8, Thermoprocessing equipment — safety.

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 16 January 2006

ISBN 978 0 580 63167 2

Amendments/corrigenda issued since publication

Date	Comments
31 August 2010	Implementation of CEN amendment A1:2010

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 12581:2005+A1

June 2010

ICS 87.100

Supersedes EN 12581:2005

English Version

Coating plants - Machinery for dip coating and electrodeposition of organic liquid coating material - Safety requirements

Installations d'application - Installations au trempé et par électrodéposition de produits de revêtements organiques liquides - Prescriptions de sécurité

Beschichtungsanlagen - Tauchbeschichtungsanlagen und Elektrotauchbeschichtungsanlagen für organische flüssige Beschichtungsstoffe - Sicherheitsanforderungen

This European Standard was approved by CEN on 28 October 2005 and includes Amendment 1 approved by CEN on 6 May 2010.

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COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: Avenue Marnix 17, B-1000 Brussels

Ref. No. EN 12581:2005+A1:2010: E

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Foreword

This document (EN 12581:2005+A1:2010) has been prepared by Technical Committee CEN/TC 271 “Surface treatment equipment — 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 December 2010, and conflicting national standards shall be withdrawn at the latest by December 2010.

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

This document includes Amendment 1, approved by CEN on 2010-05-06.

This document supersedes EN 12581:2005.

The start and finish of text introduced or altered by amendment is indicated in the text by tags A1 A1.

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 Annexes ZA and ZB, which are integral parts of this document.

This European Standard is one of a set of standards devoted to the health and safety requirements of coating plants for the application and drying of organic liquid coating material and varnishes.

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

Introduction

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

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

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

1 Scope

1.1 This European Standard applies to the design and construction of machinery for dip coating and electrodeposition of organic liquid coating material to industrial items.

This machinery consists of the following equipment:

— Transport system including hoists;

— Dip tank and safety tank;

— forced ventilation system;

— ancillary equipment such as pumps, filters, heaters.

This European Standard deals with the significant hazards, hazardous situations and events relevant to dip and electrophoretic coating machinery when they are used as intended and under the conditions foreseen by the manufacturer (see Clause 4).

In addition, the equipment marking and minimum use requirements are specified.

1.2 This European Standard does not cover:

— automatic loading and unloading systems;

— lifting accessories;

— dip and electrophoretic coating tanks without any technical devices such as enclosure, lip extractions, pumps, heaters;

— machinery for organic liquid coating material preparation, supply and draining systems (e.g. pumps);

— water and waste liquids treatment machinery;

— dip and electrodeposition coating machinery for web or coil coating;

— dip and electrophoretic coating machinery with tank volume less than 1 m^3;

This European Standard is not applicable to industrial machinery for dip or electrophoretic coating processes which are manufactured before the date of publication of this European Standard by CEN.

2 Normative references

The following referenced documents are indispensable for the application of this European Standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 294, *Safety of machinery — Safety distance 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 525, *Non-domestic direct gas-fired forced convection air heaters for space heating not exceeding a net heat input of 300 kW*

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 547-3, *Safety of machinery — Human body measurements — Part 3: Anthropometric data*

EN 563, *Safety of machinery — Temperature of touchable surfaces — Ergonomics data to establish temperature limit values for hot surfaces*

EN 574, *Safety of machinery — Two-hand control devices — Functional aspects - Principles for design*

EN 619, *Continuous handling equipment and systems — Safety and EMC requirements for equipment for mechanical handling of unit loads*

EN 809, *Pumps and pump units for liquids — Common safety requirements*

EN 811, *Safety of machinery — Safety distances to prevent danger zones being reached by the lower limbs*

EN 953, *Safety of machinery — Guards — General requirements for the design and construction of fixed and movable guards*

EN 954-1:1996, *Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design*

CR 954-100, *Safety of machinery — Safety-related parts of control systems — Part 100: Guide on the use and application of EN 954-1:1996*

EN 971-1, *Paints and varnishes — Terms and definitions for coating materials — Part 1: General terms*

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 999, *Safety of machinery — The positioning of protective equipment in respect of approach speeds of parts of the human body*

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*

〚A1〉 EN 1127-1:2007 〈A1〛, *Explosive atmospheres — Explosion prevention and protection — Part 1: Basic concepts and methodology*

EN 1760-1, *Safety of machinery — Pressure sensitive protective devices — Part 1: General principles for the design and testing of pressure sensitive mats and pressure sensitive floors*

EN 1760-2, *Safety of machinery — Pressure sensitive protective devices — Part 2: General principles for the design and testing of pressure sensitive edges and pressure sensitive bars*

EN 1837, *Safety of machinery — Integral lighting of machines*

EN 1838, *Lighting applications — Emergency lighting*

EN 12445*, Industrial, commercial and garage doors and gates — Safety in use of power operated doors — Test methods*

EN 12453*, Industrial, commercial and garage doors and gates — Safety in use of power operated doors — Requirements*

prEN 12621, *Machinery for the supply and circulation of coating materials under pressure — Safety requirements*

prEN 12650-1, *Automatic door systems — Part 1: Product requirements and test methods*

prEN 12650-2, *Automatic door systems — Part 2: Safety at automatic pedestrian doors*

EN 12978, *Industrial, commercial and garage doors and gates — Safety devices for power operated doors and gates — Requirements and test methods*

EN 13463-1:2001, *Non-electrical equipment for potentially explosive atmospheres — Part 1: Basic method and requirements*

▌A1⟩ EN 13463-5:2003 ⟨A1▌, *Non-electrical equipment intended for use in potentially explosive atmospheres — Part 5: Protection by constructional safety “c”*

EN 13478, *Safety of machinery — Fire prevention and protection*

EN 14462, *Surface treatment equipment — Noise test code for surface treatment equipment including its ancillary handling equipment — Accuracy grades 2 and 3*

▌A1⟩ EN 14986*, Design of fans working in potentially explosive atmospheres* ⟨A1▌

EN 50073, *Guide for the selection, installation, use and maintenance of apparatus for the detection and measurement of combustible gases or oxygen*

▌A1⟩ EN 60079-0:2009, *Explosive atmospheres — Part 0: Equipment — General requirements (IEC 60079-0:2007)* ⟨A1▌

▌A1⟩ EN 60079-15:2005, *Electrical apparatus for explosive gas atmospheres — Part 15: Construction, test and marking of type of protection "n" electrical apparatus (IEC 60079-15:2005)* ⟨A1▌

▌A1⟩ EN 60079-17:2007*, Explosive atmospheres — Part 17: Electrical installations inspection and maintenance (IEC 60079-17:2007)* ⟨A1▌

▌A1⟩ EN 60079-29-1:2007, *Explosive atmospheres — Part 29-1: Gas detectors —- Performance requirements of detectors for flammable gases (IEC 60079-29-1:2007, modified)* ⟨A1▌

EN 60204-1:1997, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements (IEC 60204-1:1997)*

EN 60529, *Degrees of protection provided by enclosures (IP code) (IEC 60529:1989)*

EN 61000-6-1, *Electromagnetic compatibility (EMC) — Part 6-1: Generic standards — Immunity for residential, commercial and light-industrial environments (IEC 61000-6-1:1997, modified)*

EN 61000-6-3, *Electromagnetic compatibility (EMC) — Part 6-3: Generic standards — Emission standard for residential, commercial and light-industrial environments (IEC 61000-6-3:1996, modified)*

EN 61000-6-4, *Electromagnetic compatibility (EMC) — Part 6-4: Generic standards — Emission standard for industrial environments (IEC 61000-6-4:1997, modified)*

EN 61496-1, *Safety of machinery — Electro-sensitive protective equipment — Part 1: General requirements and tests (IEC 61496-1:2004, modified)*

〚A1〉 *deleted text* 〈A1〛

EN ISO 11688-1, *Acoustics — Recommended practice for the design of low-noise machinery and equipment — Part 1: Planning (ISO/TR 11688-1:1995)*

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

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

EN ISO 14122-1, *Safety of machinery — Permanent means of access to machinery — Part 1: Choice of fixed means of access between two levels (ISO 14122-1:2001)*

EN ISO 14122-2, *Safety of machinery — Permanent means of access to machinery — Part 2: Working platforms and walkways (ISO 14122-2:2001)*

EN ISO 14122-3, *Safety of machinery — Permanent means of access to machinery — Part 3: Stairs, stepladders and guard-rails (ISO 14122-3:2001)*

EN ISO 14122-4, *Safety of machinery — Permanent means of access to machinery — Part 4: Fixed ladders (ISO 14122-4:2004)*

3 Terms and definitions

For the purposes of this European standard, the terms and definitions given in EN 971-1 and EN ISO 12100-1:2003 apply.

Additional terms and definitions specifically needed for this European Standard are added below.

3.1
dip coating machinery
dip coating machinery are the machines constituting a dip coating installation. Dip coating installations are used to apply organic liquid coating material to industrial items. Dip coating installation may consist of the following machinery and parts:

— transport equipment,

— transport system consisting of the following parts (dip, drip, dry),

— dip tank and safety tank,

— forced ventilation system,

— equipment for draining area with method of containing,

— equipment for flash-off area,

— ancillary equipment such as pumps, filters, heaters, stirring device ...;

NOTE Dip coating machinery can be placed:

— inside a workshop (no specific enclosure) - see Figure C.1;

— in a treatment tunnel (enclosure) - see 3.6 and Figure C.2.

3.2
electrophoretic coating machinery
machinery for electrodeposition of organic liquid coating material to industrial items. Electrophoretic coating installation may consist of the following machinery and parts:

— transport equipment,

— transport system consisting of the following parts (dip, drip, dry),

— electrophoretic dip tank and safety tank,

— forced ventilation system,

— equipment for draining area with method of containing,

— equipment for flash-off area,

— ancillary equipment such as pumps, filters, heaters, stirring device ...;

NOTE 1 Electrophoretic coating machinery can be placed:

— inside a workshop (no specific enclosure) - see Figure C.3;

— in a treatment tunnel (enclosure) - see 3.6 and Figure C.4.

NOTE 2 Electrodeposition of paint is a process in which electrically charged paint particles are plated out of water suspension to coat a conductive object.

3.3
transport system
a transport system may consist of the following machinery or components:

— transport supporting frame (e.g. rails)

— conveying drives

— hoists;

— lifting accessories (e.g. spreader, belt, chain, rope, hook etc.)

— carriers (e.g. frame, drum, basket, metal cage)

3.4
automatic dip or electrophoretic coating machinery
arrangements of baths with program-controlled loading equipment

3.5
transport
the movement of the items through the coating installation

3.6
treatment tunnel
enclosure, closed on all sides except for the openings to allow ingress and egress of work items and access doors

3.7
storage tank
vessel for containing the coating material (dip process) which is used to supply the coating tank or to empty the coating tank, e.g. for maintenance

3.8
safety tank
enclosed tank able to receive, in case of emergency, the total volume of coating material contained in the coating tank and able to be isolated automatically

3.9
draining area
enclosure or area of the transport system where drops of coating material or rinsing liquids from the coated work items are collected

3.10
flash-off area
forced ventilated enclosure of the transport system where solvent evaporation takes place

3.11
rinsing area
enclosure or tunnel of the transport system where the electrophoretic coated work items are washed and/or rinsed to eliminate non-adherent coating

3.12
organic liquid coating material
product or mixture, in liquid form containing organic resins and/or polymers, that when applied to a substrate (see 3.29) forms a film possessing protective, decorative and/or specific technical properties (for example industrial paints, varnishes, etc.)

3.12.1
solvent-borne coating material
coating material in which the binder (see 3.13) is dispersed or dissolved in a continuous phase consisting mainly of organic solvent (see 3.14)

3.12.2
water-borne coating material
coating material in which the binder is dispersed or dissolved in a continuous phase consisting mainly of water

3.13
binder
the non-volatile part of the medium which forms the film (see 1.6 of EN 971-1)

3.14
solvent
single liquid or blends of liquids, volatile under specified drying conditions, and in which the binder is completely soluble (see 1.45 of EN 971-1:)

NOTE Solvents are also contained in liquids used as cleaning or washing agents.

3.15
application process
action of putting organic liquid coating material on a substrate (see 3.29) so that it forms a surface film

3.16
dip coating process
application of coating material by immersing of work items in a dip tank containing the coating material

NOTE Two types of organic liquid coating material are used: water-borne coating material and solvent-borne coating material.

3.17
electrophoretic coating processes
application of water-borne coating material by immersion of work items in a dip tank containing the coating material which is deposited by application of direct current (DC)

NOTE There are two types of electrophoretic coating processes:

— cataphoretic coating where the work item is used as cathode;

— anaphoretic coating where the work item is used as anode.

3.18
flammable substance
substance in form of gas, vapour, liquid, solid or mixtures of these, able to undergo an exothermic reaction with air when ignited ⟨A1⟩ (see 3.48 of EN 13237:2003) ⟨A1⟩. "Combustible material“ and "flammable substance“ are equivalently used terms in this standard

3.19
recirculated air
air extracted from a volume and reintroduced into it. In this standard, the volume is equal to the machinery's dimension (L x W x H)

3.20
make-up air
air introduced into a volume to replace the air exhausted from it

3.21
forced ventilation
air circulation achieved by one or several fans. This air-circulation is located inside the machinery

3.22
explosive atmosphere
mixture with air, under atmospheric conditions, of flammable substances in the form of gases, vapours, mists or dusts, in which, after ignition has occurred, combustion spreads to the entire unburned mixture ⟨A1⟩ (see 3.37 and 3.38 of EN 13237:2003) ⟨A1⟩

3.23
explosion range
range of the concentration of a flammable substance in air, within which an explosion can occur ⟨A1⟩ (see 3.33 of EN 13237:2003) ⟨A1⟩

3.24
lower explosion limit (LEL)
lower limit of the explosion range ⟨A1⟩ (see 3.74 and 3.33 of EN 13237:2003) ⟨A1⟩. Explosion limit" and "Ignition limit" are equivalent. In accordance with international usage, only the term "Explosion limit" is used in this standard

3.25
exposure limits
concentration limits of hazardous substances in air required by worker health legislation

NOTE Limits can be different according to the countries (see Annex E).

3.26
flash point
minimum temperature at which, under specified test conditions, a liquid gives off sufficient combustible gas or vapour to ignite momentarily on application of an effective ignition source

3.27
hazardous areas
areas where hazards due to explosive atmosphere may exist. The probability of occurrence of explosive atmosphere is classified in zones. Limits of hazardous zones are given in Annex A. For this standard, only the hazardous zone 2 is suitable ⟨A1⟩ (in accordance with 3.119 of EN 13237:2003) ⟨A1⟩

3.27.1
zone 0
place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapour or mist is present continuously or for long periods or frequently ⟨A1⟩ (see 3.119-1 of EN 13237:2003) ⟨A1⟩

3.27.2
zone 1
place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapour or mist is likely to occur in normal operation occasionally ⟨A1⟩ (see 3.119-2 of EN 13237:2003) ⟨A1⟩

3.27.3
zone 2
place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapour or mist is not likely to occur in normal operation but, if it does occur, will persist for a short period only ⟨A1⟩ (see 3.119-3 of EN 13237:2003) ⟨A1⟩

3.28
equipment category
NOTE Equipment for potentially explosive atmospheres is divided into groups and categories. Group II: Equipment for places with a potentially explosive atmosphere, other than mines susceptible to firedamp; this group comprises three categories according to the level of safety provided.

3.28.1
equipment Group II category 1
equipment designed to be capable of functioning in conformity with the operational parameters established by the manufacturer and ensuring a very high level of protection

Equipment in this category is intended for use in areas in which explosive atmospheres caused by mixtures of air and gases, vapours or mists or by air/dusts mixtures are present continuously, for long periods or frequently.

It is essential that equipment of this category ensures the requisite level of protection, even in the event of rare malfunctions relating to equipment, and is characterised by means of protection such that:

— either, in the event of failure of one means of protection, at least an independent second means provides the requisite level of protection,

— or the requisite level of protection is assured in the event of two faults occurring independently of each other.

3.28.2
equipment Group II category 2
equipment designed to be capable of functioning in conformity with the operational parameters established by the manufacturer and ensuring a high level of protection

Equipment in this category is intended for use in areas in which explosive atmospheres caused by mixtures of air and gases, vapours or mists or by air/dusts mixtures are likely to occur.

It is essential that the means of protection relating to equipment in this category ensures the requisite level of protection, even in the event of frequently occurring disturbances or equipment faults which normally have to be taken into account.

3.28.3
equipment Group II category 3
equipment designed to be capable of functioning in conformity with the operational parameters established by the manufacturer and ensuring a normal level of protection

Equipment in this category is intended for use in areas in which explosive atmospheres caused by mixtures of air and gases, vapours or mists or by air/dusts mixtures are unlikely to occur or, if they do occur, are likely to do so only infrequently and for a short period only.

Equipment of this category ensures the requisite level of protection during normal operation.

3.29
substrate
surface to which the coating material is applied or is to be applied (see 1.49 of EN 971-1)

3.30
danger points
defined locations in the danger zone of machines where persons can be injured by movements of

— parts of machines

— tools of machines or parts of tools

— items or parts of items

— materials being processed

NOTE Danger points can exist, for example, on gear, chain and worm drives, V-belt, flat belt, pulling and supporting elements on continuous conveyors, spoke wheels and fly wheels, shafts and shaft ends, rollers, slides, push rods and similar parts, tools and clamping devices.

Particular points of danger are:

— crushing and shearing points

— trapping points

— inrunning nips

— cutting, punching and impact points.

3.31
accessible danger zone
areas where, for example, area guards or ESPDs allow whole-body access. The objective is to prevent anyone starting the machine while persons are within the danger zone

3.32
automatic machines and equipment
machines and equipment in which systems are used to control their operation without further intervention from the operator once the start control has been activated. Such machines may be either free standing or included in a complex installation

3.33
closed machine
a machine offering access to the (dip or electrophoretic coating) process by safe guarded covers or doors that remain closed during the process and which can be opened for maintenance and loading or unloading purposes only

3.34
ESPD
electro-sensitive protective device

3.35
hold-to-run control device
control device where the actuator automatically returns to the start position when released and where machine operation is started and maintained only as long as the actuator is hold depressed

3.36
normal operation
the situation where the equipment, protective system, and components perform their intended function within their design parameters (see also 5.2.2 a) of EN ISO 12100-2:2003)

3.37
safety data sheet
the document, drawn up in 16 chapters in compliance of the Directive 67/548/EEC, reporting the characteristics of a chemical product to evaluate the potential risks soaring from its use

3.38
thermal cut-off
a safety device which disconnects the heating system or any heat source from the mains in order to avoid over temperature

4 List of significant hazards

4.1 General

This clause contains the significant hazards, hazardous situation and events, as far as they are dealt with in this standard, identified by risk assessment as significant for one or more, or all types of machinery included in the scope, and which require action to eliminate or reduce the risk.

Hazards occurring from a combination of the dip or electrophoretic coating equipment with equipment not covered by the scope of this European Standard shall be assessed by those responsible for the assembly of such combinations.

NOTE 1 Examples of the classification of dip or electrophoretic coating machinery are given in Annex C.

NOTE 2 Information on the method of risk analysis is given in EN 1050.

4.2 Mechanical hazards

NOTE Transport systems could be equipped with e.g.

— suspended transport cars, with transversal crosshead, both central and side guidance of the lifting device, running both on side and central running rail,

— portal transport cars, with transversal crosshead, side guidance of the lifting device, running on rails within the area of the dip tanks,

— side transport cars with supporting frame, side guidance of the lifting device, running on a one-sided running rail, with support rails,

— continuous conveyors,

— endless conveyors.

4.2.1 Shearing, crushing, cutting, entanglement, drawing-in and impact hazards

These hazards are related to:

— dislodging of work items;

— actuation of hoisting devices;

— moving parts (e.g. work item supports, frames, drums, work items) and transport systems;

— fans, pumps, dampers, adjusters, etc;

— carriers with their load;

— charging points.

4.2.2 Loss of stability (of the dip or electrophoretic coating machinery)

These hazards are related to:

— improper positioning of the dip or electrophoretic coating machinery;

— overload;

— overfilling.

4.2.3 Entrapment hazard

Entrapment can occur when obstacles or obstructions can impede a quick evacuation by the operator(s) from the machinery in case of mechanical accident or fire.

4.2.4 Personnel's slip, trip and fall of personnel

These hazards are related to:

— gangways, platforms, ladders and stairs equipping the machinery;

— gratings laid down on the ground;

— ground rendered slippery from e.g. coating material deposits or other substances;

— falling into the tank.

4.3 Electrical hazards

4.3.1 Electrical shock

Electric shock can occur from direct or indirect contact, for instance, by touching:

— electrically live parts that are non insulated for operational reasons (electrode connection to work item);

— conductive parts which are not at dangerous voltage under normal operation, but which could be in case of failure;

— electrical installation when insulation is damaged by contact with solvents or by mechanical influences;

— pipes, pumps or any metallic component containing the liquid coating material in electrophoretic coating machinery which may be electrically live parts because of the conductivity of liquids located inside.

4.3.2 External influence on electrical equipment hazards

Hazardous external influences can occur, for instance, when interaction of the electromagnetic high voltage equipment with construction elements of the control and safety systems can cause dangerous malfunctions (e.g. short circuits on electronic safety circuits, entrance guards, alarm unit).

4.4 Thermal hazards

Burns and scalds are related to:

— contact with hot surfaces within working and/or traffic areas;

— flames or explosions (see 4.7.1 and 4.7.2 specific to these hazards);

— radiation of heat sources;

— unexpected ejection of hot fluids.

4.5 Hazards generated by noise

Hazardous noise levels can be reached for instance due to noise emission of pumps, fans, handling devices, compressed air operating equipment (motors, valves, etc.).

Emission of airborne noise can cause hearing impairment, accidents due to interferences with verbal communication and acoustical danger signals, extra-auditory effects, shock reactions.

4.6 Hazards resulting from dangerous substances

The following hazards are related to e.g. open tank conditions, leaks, spills and splashes of material from coating machinery:

— contact with/or absorption of hazardous fluids (organic liquid coating material, solvents, etc.) causing skin and eye damage, dermatitis, allergies: for instance splashing when work item is dislodged;

— inhalation of hazardous substances released from organic liquid coating material;

— inhalation of toxic gases released by direct fired make-up air heating system (heating gases, gases from combustion);

— contact with hazardous foams or inhalation of hazardous gases, vapours emitted by fire extinguishing equipment.

4.7 Fire and explosion hazards

4.7.1 Fire hazard

Fire can be caused for instance by ignition of

— flammable coating material contained in the tanks;

— flammable deposits inside draining areas;

— flammable coating material or solvents contained in addition systems;

— flammable deposits on the jigs;

— flammable fluids which discharge inside the machinery because of failure or leaks of flexible pipes.

Potential sources of ignition include:

— equipment misuse or a mechanical/electrical defect (e.g. fans, handling devices, hot surface, overheating; electrostatic discharges);

— maintenance operations requiring use of cutting or welding tools, energy released can also initiate combustion;

— furthermore ignition could occur by sparks over the tank containing flammable organic liquid coating material.

A risk for neighbouring areas is present if the material being used can generate a condition of fast fire propagation. The use of water-borne coating material does not generally present a fire hazard (see Annex D).

4.7.2 Explosion hazard

Explosion can occur in the machinery when the concentration of the flammable substances in air exceeds the lower explosion limit (LEL) and if an effective ignition source is present.

Examples of flammable substances increasing concentration above normal are:

— evaporation of flammable vapours from the surface of liquid contained in the tank and/or of coated work items;

— gases from the combustion of the heating system;

— gases released from deposits;

— combustible heating gases;

— solvent vapours from any leakage, from broken pipes or fittings, and/or during additions;

— solvent vapours coming from cleaning fluids.

Examples of sources of ignition are:

— hot surfaces (e.g. of heating system, electrical equipment);

— heating systems;

— sparks created by mechanically induced energy (e.g. fans, conveyors);

— electrostatic discharges;

— electrical sparks;

— welding and other sources of thermal energy used during maintenance and cleaning.

4.8 Hazards caused by failure of energy supply

Failure of energy supply can lead to:

— failure of ventilation (leading to increase of flammable or hazardous vapour concentration);

— failure, malfunction of control system and of safety circuits;

— failure of luminous warning and lighting for emergency exits (ways).

4.9 Hazards related to failure of control systems

These hazards may lead to:

— breakdown of forced ventilation;

— increased emission of vapours in case of reduction or loss of cooling capacity;

— overtemperature due to failure of maximum temperature control.

5 Safety requirements and/or measures

5.1 General

Machinery shall comply with the safety requirements and/or protective measures of this clause. In addition, the dip or electrophoretic coating machinery shall be designed according to the principles of EN ISO 12100 for hazards relevant but not significant which are not dealt with by this European Standard (e.g. sharp edges).

All ancillary equipment which can be incorporated in the dip or electrophoretic coating machinery to achieve its intended use; e.g. organic liquid coating material heaters, pumps (EN 809), pipes for coating material (prEN 12621), conveyors (EN 619), platforms (EN ISO 14122-2), shall comply with the appropriate EN standards.

5.2 Mechanical safety requirements

5.2.1 Safeguarding of danger points

Danger points within the working and traffic area of dip or electrophoretic coating machinery and danger points on this machinery shall be avoided by design or safeguarded by means of safety devices.

Danger points (see 3.30) shall be safeguarded e.g. by guards or by applying the safety distances specified in EN 349 and EN 811.

If danger points and sources of hazards cannot be avoided on dip or electrophoretic coating machinery by design or by the process, they shall at least be observed within the working and traffic area, especially by one of the following safety devices for transport devices:

1) Guards, especially enclosing guards, distance guards (according to EN 953), fence-type enclosures with consideration of the safety distances according to EN 294);

2) stationary guards, especially two-hand control devices (according to EN 574), hold-to-run-control devices, enabling control devices with actuation by several persons, pressure sensitive trip bars and mats related to persons (according to EN 1760-1 and EN 1760-2);

3) impeding guards, especially controlled hand rejectors (according to EN 999 and with consideration of EN 547-1 and EN 547-3);

4) trip devices, especially electro sensitive protective systems (photoelectric curtain, light grids and barriers or the like) (according to EN 61496-1), pendulum-type flaps, pressure sensitive bumpers, trip wires, pressure sensitive trip bars or mats for area securing

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5) When fixed guards are applied, they shall be fixed by systems that can be opened or removed only with tools. Their fixing systems shall remain attached to the guards or to the machinery when the guards are removed. Where possible, these guards shall be designed in such a way that they can only remain in place using their fixing system. A1

or

6) capture hoods, capture bows, capture sheets, supports in case of fracture of wheels, safety devices in case of rope rupture, devices preventing the leaving of guidances.

Guards shall have no openings or openings for feeding the material (for example work pieces). The safety distances shall be established in relation to the width of the opening in accordance with EN 294. Fixed and movable guards shall satisfy the requirements of EN 953.

For dip or electrophoretic coating machinery constituting movable parts see 7.2.1, first indent.

In the individual case, protective devices shall be chosen, combined and, if necessary, be interlocked or coupled with the hazardous movements in such a way, that the requirements of the first paragraph above are satisfied.

Note For continuous handling equipment see EN 619 and EN 620

5.2.1.1 Safety devices and their interlocks or couplings shall be designed, arranged and mounted in such a way, that they

a) satisfy the intended effect and resist the stress during intended use of the transport devices

and

b) do not hinder to operate, set-up, maintain and inspect the dip or electrophoretic coating machinery more than necessary, especially by

— providing the required access,

— being easy to handle

and

— providing the required transparency.

Interlocking shall satisfy the requirements of EN 1088.

5.2.1.2 Safety devices shall be designed and arranged in such a way that they cannot be set out of operation by unauthorized persons, or be bypassed easily.

To satisfy this requirement, it is necessary, for instance that

— fixtures of enclosing guards or distance guards can only be removed by using a tool,

— parts of the enclosing guard or distance guard are safeguarded against removal, e.g. by means of a lock,

— the drive of the hazardous movement is cut-off automatically, e.g. by means of a limit switch, during swinging away or opening the enclosing guard or distance guard,

— ESPD, e.g. light barriers are provided.

Enclosing guards and distance guards, which are only slipped on or hanged up, do not satisfy these requirements.

A safety device is also bypassed easily if its response value can be misadjusted in such a way that it does not respond any more (e.g. improperly stretched trip wires). Furthermore, e.g. enclosing guards, distance guards and fence guards shall prevent that persons could bend or fall into the danger points.

5.2.1.3 Interlocks and couplings of safety devices and devices with safety function shall be designed in such a way as to be positively (always) effective at the beginning of the hazardous movement.

Furthermore, it shall be ensured, that

1) the safety device or device with safety function remain positively (always) effective during the hazardous movement,

2) the hazardous movement is finished automatically when removing or opening the safety device or device with safety function.

5.2.1.4 When safeguarding danger points by means of electrical interlocks, mechanically operated limit switches shall be arranged and connected in such a way, that the limit switches are actuated automatically with positive fit.

This can be achieved e.g. by electrically interlocked doors and sliding gratings.

An automatic actuation with positive fit is given if rolls, slides and the like of limit switches can only be moved by the actuator (overrun curve, switching curve).

5.2.1.5 Restart of the charging device after actuation of the safety device interlocked with the drive shall only be possible, after at least one control device has been actuated (restart barrier).

This requirement includes, that, if further safety devices have been actuated, even of the machinery during standstill, restart shall only be possible, if the corresponding switching device according to 5.2.1.4 has been actuated.

5.2.1.6 If persons can be injured by hazardous movements during set-up, repairing of failures during the work process and during maintenance, the transport devices shall be designed in such a way, that these works can be carried out during standstill. If these works cannot be carried out during standstill of the transport device, the safety devices required for the danger points shall also be applicable for these works. If these works cannot be carried out during standstill and if the safety devices and devices with safety function cannot be applied, or if their degree of protection is not sufficient, additional devices shall be provided, which

1) do not require actions within danger points,

2) make an accidental reaching of nearby danger points difficult,

3) allow the rapid standstill of the hazardous movements,

or

4) allow to reduce the speed of hazardous movements.

5.2.1.7 Prevention of unexpected close or fall of covers, lids and doors

Non-powered covers, lids and doors shall be safeguarded against gravity fall or unexpected close if this creates a hazard of injury.

This requirement can be achieved, by one of the following measures:

— devices for balancing the weight,

— pneumatic spring,

— latches which automatically hold the parts open,

— ensuring that the centre of gravity of the guard in the open position is sufficiently far behind the axis of rotation.

Powered covers, lids and doors according to EN 12445 or EN 12453 or prEN 12650-1 or prEN 12650-2 or EN 12978 shall be safeguarded by hold to run devices placed at a safe distance.

5.2.2 Safety measures against loss of stability (of dip or electrophoretic coating machinery and their parts)

5.2.2.1 General

Dip or electrophoretic coating machinery and their parts shall be designed, constructed and installed so that their stability shall be ensured and any permanent or excessive deformation shall not occur when filled with organic liquid coating material.

The design shall take into consideration the intended or foreseeable use in relation to the nature and the mass of the organic liquid coating material to be used and the items.

5.2.2.2 Safety measures against overload

Overload of the dip or electrophoretic coating machinery shall be prevented by:

— load limiting devices;

— suitable marking and warning specifying the maximum admissible load capacity of the dip or electrophoretic coating machinery;

— detailed indications in the instruction handbook (see 7.2).

5.2.2.3 Safety measures against overfilling

Overfilling of the dip or electrophoretic coating machinery shall be prevented by:

— filling limiting devices;

— overflow outlet connected to a tank;

— suitable marking and warning specifying the maximum admissible organic liquid coating material capacity of the dip or electrophoretic coating machinery;

— detailed indications in the instruction handbook.

In addition the provision of a sealed retention area/trap/pit which shall be able to contain the quantity of organic liquid coating material which may escape is required.

5.2.3 Protective measures against entrapment

Any enclosure accessible by operator shall be designed so that in case of emergency an operator can exit the enclosure in a minimum time without obstacles or obstructions.

The doors provided for personnel

— shall be capable of being opened and closed from inside and outside;

— shall always open outwards;

— shall be capable of being opened from inside by mere push;

— shall be self closing;

— shall have a minimum 800 mm width and minimum of 2 000 mm height;

— shall be set up in such a way that to reach them the operator shall have to cross:

  — not more than 10 m when solvent-borne liquid coating material is used,

  — or, not more than 20 m when water-borne liquid coating material is used.

An enclosure including a tank with access ways on both sides shall be provided with at least one door permanently accessible on each side.

If a permanent opening for loading of work items is used as well as personal door, a clearance of 800 mm x 2 000 mm exceeding maximum width of the work items shall be provided, as defined in 4.1 of EN 547-1 and 4.1 of EN 547-3.

5.2.4 Measures against personnel's slip, trip and fall

Ladders, gangways and handrails that equip the dip coating and electrophoretic machinery shall comply with EN ISO 14122-1, EN ISO 14122-2, EN ISO 14122-3 and EN ISO 14122-4.

Floor grating joints shall not have projections or holes capable of tripping and/or hindering the operator.

Floor and all gangways shall be non-skid (according to EN ISO 14122-2).

Where the tank side is used to prevent operators falling into the tank from an adjacent walkway, the tank top shall be at least 1,1 m above personal passage level. If not, other safety measures, such as handrails of the same minimum dimensions, shall be provided.

5.3 Electrical safety requirements

5.3.1 General

Electrical equipment shall comply with EN 60204-1.

5.3.2 Measures against electrical shock

Access to areas with live parts above 60 V DC of electrophoretic coating machinery (such as bath electrodes) shall be prevented during operation. This shall be achieved by interlocks between electric power unit and one or several of the following devices: doors, guards.

Protection of operators against electric shock from direct or indirect contact shall be achieved by application of Clause 6 of EN 60204-1:1997.

The insulation of electrical equipment shall be resistant against solvents and other aggressive fluids. Electrical equipment shall be protected against outside mechanical influence.

In electrophoretic coating machinery, all the metallic components connected to the electrodip tank and in contact with the liquids (e.g. pipes, valves, pumps, instrumentation) shall be earthed (according to 8.2.1 and 8.2.3 of EN 60204-1:1997) as liquids (paint, ultrafiltrate, anolyte etc.) are electrical conductors.

See also 5.7.2.4.2 for electrical equipment.

5.3.3 Measures against external influence on electrical equipment

All systems and apparatus shall be constructed in such a way that they cannot be influenced by interaction with electromagnetic fields (in accordance with EN 61000-6-1, EN 61000-6-3, EN 61000-6-4).

According to 4.4 and 20.6 of EN 60204-1:1997, physical effects of environmental and operating conditions have to be taken into account.

5.4 Safety requirements and measures against thermal hazards

5.4.1 Heating systems

Dip or electrophoretic coating machinery shall be designed and constructed to minimise any risk of injury caused by contact, radiation or convection from hot surfaces of the machinery and its parts or organic liquid coating material and items being processed.

Limits of temperatures of touchable surfaces given in EN 563 shall be observed.

Hazards can be covered by e.g. the following measures, single or in combination:

— limitation of organic liquid coating material temperature (see also 5.4.4);

— reduction of the surface temperature by insulation and protection (see also 5.4.2);

— guards (screen, barrier, according to EN 953).

Further by additional:

— marking and warning signals (according to EN 894-1, EN 894-2, EN 894-3, EN 61310-1, EN 981);

— instructions for use;

— personal protective equipment.

In addition, the dip or electrophoretic coating machinery shall be designed and constructed in such a way that the organic liquid coating material shall not exceed the “maximum admissible design temperature”. Over temperature shall be avoided by

— temperature limiting device and

— protection of the maximum set point by key lock or code system (see also 5.4.4).

Heating systems and their components shall be designed and constructed to avoid dangerous situations. This applies to:

— materials to be used and their compatibility with organic liquid coating materials;

— foreseeable nature and characteristics of the organic liquid coating material to be used;

— specific surface thermal load at which a chemical decomposition may occur;

— foreseen working temperature of the organic liquid coating material.

Heating elements and temperature control probe shall be protected by low organic liquid coating material level control with cut-off and alarm, audible and/or visible, to ensure that they are immersed into the organic liquid coating material.

Heating systems and their components which can lead to dangerous situations due to baked on deposits (e.g. because of reduced heat dissipation) shall be dismountable and accessible for maintenance and inspection without any physical obstacle. This applies to:

— electric heaters and/or burner heat exchangers;

— tanks containing organic liquid coating materials when risks can arise from a low level.

Location, means and frequency of maintenance, shall be indicated in "information for use".

5.4.2 Measures against contact of the skin with hot surfaces

Protection against burns by hot surfaces shall be secured by means of appropriate insulation or protection against contact of all elements within arm's reach and within the working area. According to EN 563 at an ambient temperature of 20 °C the surface temperature shall be less than 60 °C. Exceptions are permissible in small localised areas of the surface (for example flanges of burners, bolts, fan and roller shaft).

5.4.3 Measures against radiation and/or convection of heat

If radiation and/or convection of heat (e.g. burns caused by hot plumes) can lead to dangerous or unhealthy situations generated by the organic liquid coating material or parts of dip or electrophoretic coating machinery, risk reduction measures by design shall be adopted separately or combined by:

— forced ventilation;

— cooling system;

— covers, lids, doors;

Additional optical and/or audible alarms (according to EN 981) shall indicate all identified failures of the examples of systems mentioned above.

5.4.4 Measures against overheating of organic liquid coating material

When overheating can generate additional hazards the dip or electrophoretic coating machinery shall be equipped with a thermal cut-off with audible and/or visible signal according to EN 981.

The set point adjustment shall only be accessible by a competent person.

The reset of the cut-off shall be manual, restart of the heating shall not be done automatically.

Temperature control devices and temperature limiting devices shall be independent from each other.

Temperature limitation is not required, if the heating medium, even in the case of operational failure, cannot raise the temperature above the "maximum admissible design temperature".

5.5 Safety requirements and measures against noise

The dip or electrophoretic coating machinery shall be designed and constructed so that the risks resulting from the emission of airborne noise are reduced to the lowest level, taking into account technical progress and availability of means for noise reduction, especially at source.

For example the following measures can be adopted:

— equipment set on anti-vibratory supports;

— flexible connections between the ducts and especially between fans and ducts;

— choice of fan speed according to the most favourable noise curves;

— air velocity reduction in ducts;

— ducts soundproofing;

— other means able to avoid that vibrations, resonance and any other noise generated by ancillary equipment permanently installed and connected to the machinery propagate to the installation structure.

NOTE 1 This list is not exhaustive. Other alternative technical measures with identical or greater efficiency can be used by the manufacturer.

Recommendations on the design of low-noise machinery given in EN ISO 11688-1 shall be taken into account.

NOTE 2 EN ISO 11688-2 gives useful information on noise generation mechanism in machinery.

The determination, declaration and verification of airborne noise emission of dip or electrophoretic coating machinery shall be carried out according to EN 14462.

If relevant, the manufacturer shall recommend wearing hearing protectors (see 7.2.1).

5.6 Safety requirements against dangerous substances

5.6.1 Measures against contact with/or absorption of dangerous fluids (organic liquid coating material, solvents)

5.6.1.1 Tank and ancillary equipment construction

— **Tank construction**

Tank volume shall be minimised but shall be sufficient to contain displaced organic liquid coating material caused by immersion of the work item.

Material for tank construction shall be selected in such a way as to ensure the suitability with the organic liquid coating material specified for the use in dip coating machinery.

Tanks shall be free from leaks.

Electrochemical processes affecting the tank construction shall be minimised.

— **Circulation/filtration systems**

Valves, pipe work and fittings shall be of materials resistant to corrosion by the organic liquid coating material. They shall be capable of sustaining the prevailing fluid pressures and temperatures.

All joints and connections shall be leak free, e.g. materials for sealings shall be suitable with the organic liquid coating materials used.

The arrangement of pipes for delivery of organic liquid coating materials to tanks and/or fluid pressure shall be such that the generation of splashes is minimised. Where splashes cannot be avoided screens shall be provided.

— **Draining areas**

Drag-out of the organic liquid coating materials by dripping work items shall be avoided. This can be achieved by e.g.:

— sufficient draining time of dip coated work items above the dip tank

and/or

— an external draining area.

Where the work items are immersed in the organic liquid coating material by a discontinuous conveyor with vertical stroke device the dip tank can be used to capture drips. Such a dipping device shall be equipped with a timer to allow the work to drain before it is moved beyond the tank boundaries.

If the dip coating machinery is equipped with an external draining area, the dimensions of the draining area shall be designed in accordance to the size of the work items, speed of conveyor system and viscosity of organic liquid coating material. The draining area shall return organic liquid coating material to the dip tank or a separate container.

5.6.1.2 Personal protective equipment

The manufacturer shall inform the user about the use of adequate personal equipment in accordance with the provisions of 7.2.2.

5.6.2 Measures against inhalation of dangerous volatile substances

5.6.2.1 Forced ventilation

In dip or electrophoretic coating machinery prevention of inhalation of dangerous volatile substances shall be performed by reducing the concentration in the operator's working area below the admissible exposure limit values (see Annex E). This shall be achieved by a forced ventilation for the dip or electrophoretic coating machinery adequate to the type of application, size and shape of work items to be coated, amount of dangerous volatile substances, their exposure limits, and all application conditions. Devices shall be fitted and/or working methods adopted to control the effectiveness of the forced ventilation or the emissions of volatile substances (see 5.6.2.6).

The manufacturer shall provide information to the user about working area limits in accordance with the provisions of 7.2.1.

For maintenance and cleaning operations, see 7.2.3.

5.6.2.2 Dip coating machinery without specific enclosure – with or without operator (see Figure C.1)

Dip coating machinery without specific enclosure - with or without operator - shall be equipped with forced ventilation to avoid hazardous concentrations of dangerous substances. This shall be achieved preferably by one of the following measures:

a) Tanks for intended use of solvent-borne organic liquid coating material with surface area less than 6 m² shall be equipped with lip extraction on

- one side if the width is less than 900 mm;
- both sides if the width is more than 900 mm and less than 1200 mm;
- one side and blowing from the opposite side if the width is more than 1200 mm and less than 2000 mm;

For tanks with a surface area exceeding 6 m^2 see 5.6.2.3 and Figure C.2.

b) Tanks for intended use of water-borne coating material shall be equipped with lip extraction or measures of comparable safety level shall be applied in order to prevent exceeding of exposure limit(s) for substances evaporated from coating material.

In any case, draining area shall be enclosed in a tunnel with calculated airflow, complying with the requirements of 5.6.2.3.

5.6.2.3 Dip coating machinery with specific enclosure with or without operator (see Figure C.2)

A specific enclosure is required

- for any tank containing solvent borne coating material

and

- with a surface area exceeding 6 m^2.

Forced ventilation shall be designed so that hazardous solvent vapour concentration at any operator’s working area does not exceed the exposure limits (see Annex E).

a) with operator working inside the enclosure

The air flow direction shall avoid the operator being in an atmosphere contaminated by dangerous substances.

The air flow shall be as uniform as possible throughout the whole working area of the operator.

Air escaping from the machinery to the workshop shall be avoided, e.g. by self closing doors (see 5.2.3).

b) without operator inside the enclosure

In the case of machinery without operator, inhalation hazards exist only when the operator enters inside the installation for inspection or maintenance purpose. In this case – before entering the dip coating machinery – the formation of dangerous solvent vapours (limitation of dangerous substances concentration in air) shall be avoided by an increase of the forced ventilation. Further information on the additional use of personal protective equipment (PPE) shall be given in the information for use (see 7.2.2).

5.6.2.4 Electrophoretic coating machinery without specific enclosure – with or without operator (see Figure C.3)

The air flow direction shall avoid the operator being in an atmosphere contaminated by dangerous substances.

The concentration of dangerous substances in the operator's breathing zone shall not exceed the exposure limits.

5.6.2.5 Electrophoretic coating machinery enclosed in a treatment tunnel - without operator (see Figure C.4)

In the case of machinery without operator, inhalation hazards exist only when the operator enters inside the installation for inspection or maintenance purposes. In this case – before entering the electrophoretic coating machinery – the formation of dangerous solvent vapours (limitation of dangerous substances concentration in air) shall be avoided by an increase of the forced ventilation. Further information on the additional use of personal protective equipment (PPE) shall be given in the information for use (see 7.2.1).

The enclosure shall be equipped with a forced ventilation system (see Annex A).

5.6.2.6 Safety devices

5.6.2.6.1 Prevention of insufficient forced ventilation

The minimum flow rate through the dip coating machinery using solvent-borne coating material shall be monitored by flow control devices.

The flow control devices shall be interlocked with the position switches of the dampers that are used to adjust the flow through the dip coating machinery using solvent-borne coating material and interlocked with the transport system. They shall be designed in such a way that any possible position of the dampers ensures a minimum volume flow that is required to maintain safe functioning of the dip coating machinery. Manually adjustable dampers shall be fixed after commissioning.

If variable speed fans are used to adjust the flow through the dip coating machinery, the control of the fan speed shall be interlocked with the control of the volume flow. A minimum flow shall be ensured.

NOTE The fan speed can be controlled by a monitoring device e.g. by determination of a specified minimum value at the frequency converter. The flow can be monitored e.g. by means of a differential pressure switch.

The transport system shall operate only if forced ventilation is working effectively.

In the event of insufficient forced ventilation failure the dipping operation (transport system) shall automatically stop and only be reset when the forced ventilation is restored. Restart of the dipping operation shall not be automatic.

5.6.2.6.2 Control devices and their actuators, control stations

a) Every transport system with hazardous movements shall be equipped with control devices of its own for starting and stopping, the actuation of which can determine the beginning and the end of the hazardous movements.

b) Control devices for starting hazardous movements shall be safeguarded against unintended actuation. The prevention of unexpected start-up according to EN 1037 applies.

c) Control devices for non-automatically controlled movements of transport system shall be designed in such a way, that the transport system will stop automatically after releasing the control devices (hold-to-run devices).

d) Control devices on transport system with manual operation or program control shall be interlocked interdependently with forced ventilation. The mode transport system shall be safeguarded against unauthorized actuation.

NOTE If reaching the centre of the bath is needed, this can be achieved by arrangement of two actuators of control devices simultaneously (e.g. drive forward and identification of the centre position).

e) Control stations shall be designed and control devices shall be designed and arranged in such a way, that the transport system can be operated in a safe way.

NOTE Control stations are those places from which the control devices of the transport system are actuated (control stand).

f) Actuators of control devices for transport system shall be arranged in such a way that from the control stations the hazardous movements can be overlooked within the corresponding working area. If several hazardous areas exist, clear partial areas shall be created, in which the correspondent control devices are installed.

g) paragraph f) shall not be applicable for program-controlled transport system and with continuous conveyor type transport system.

h) Actuators and control devices for starting and stopping hazardous movements shall be easily and safely accessible and operable from the control station.

5.6.2.6.3 Emergency control devices

Every transport system shall be equipped with emergency control devices in accordance with the requirements of EN 418, in order to eliminate or reduce the imminently or immediately occurring hazard, by which the hazardous movement is stopped or eliminated otherwise. Actuators of emergency control devices shall be installed at least at every control position.

A restart without resetting of the emergency stop shall not be possible.

5.6.2.6.4 Movement limiting devices

Where necessary, the movement of power operated parts (e.g. lifting and lowering movement of transport system, linear movement of transport system) shall be limited by a travelling limiter interlocked with the power supply of the drive system.

Electrical braking shall not be by reverse current.

Activation of the travelling limiter shall not prevent, if necessary, initiation of a reverse movement.

5.6.2.6.5 Power supply disconnection devices

a) The dip coating installation and where necessary constituting parts (e.g. conveying system, forced ventilation system) shall be equipped with power supply disconnection devices according to EN 60204-1:1997, 5.3.2.a), b), c) or d).

b) The power disconnection devices shall be clearly indicated, easily accessible and safeguarded against unauthorized and accidental switching on.

5.6.3 Measures against inhalation of toxic gases released by the heating device

In machinery equipped with direct gas heated air make-up system, the toxic gas concentration from combustion shall be kept below the exposure limits required by worker health legislation (for examples, see Annex E).

This will be achieved by use of a direct gas-fired heating system according to EN 746-2 and EN 525 and/or a gas monitoring device which shuts down the heating system in the event of the exposure limit values being exceeded (see Annex E).

Make-up air intake and combustion gas exhaust ducts shall be located so that any risk of cross contamination is avoided.

The function of gas burners shall be interlocked with forced ventilation.

5.6.4 Measures against contact with hazardous foams or inhalation of hazardous gases, vapours emitted by fire extinguishing equipment

Machinery equipped with an automatic fire extinguishing system shall be provided with a warning device, which sounds before discharge of hazardous fire extinguishing materials (see 5.7.1.4).

Further information on additional provisions for the user of fire extinguishing equipment has to be given in 7.2.1.

5.7 Safety requirements and measures against fire and explosion

5.7.1 Fire

5.7.1.1 General

To preclude the fast propagation of fire, all elements of construction of the dip coating machinery defined in 3.1 and its equipment shall comply with the requirements for fire prevention and protection of machines as described in EN 13478.

These requirements are applicable only to dip coating machinery defined in 3.1 using solvent-borne coating material.

5.7.1.2 Ignition sources

Heating devices located in hazardous areas of dip coating machinery using solvent-borne coating material shall not ignite the paint aerosol and solvent vapours (e.g. the air heater and burner flame shall be outside the presence of flammable substances and zone 2/see also Annex A).

5.7.1.3 Elements of construction

Constituent elements of construction shall be of materials, which do not support combustion and shall be sufficiently resistant to fire.

Constituent elements are for instance:

— fixed elements of construction (enclosure, walls, ceilings);

— floors and gratings;

— movable elements (loading and personnel doors, gates, etc.);

— ventilation ducts and chimneys which shall not affect the fire resistance of any wall traversed.

The heat insulation and small components parts material properties shall not support a fire or increase the risk of fire.

Materials for filters for air inlet and cleaning of exhaust air, flexible connections and sealing mastics shall at least be non easily flammable.

NOTE Information on classification of material's reaction to fire is given in Annex D.

5.7.1.4 Fire extinguishing equipment

Flammable potential shall be reduced in case of fire, for example by covering the dip tank (e.g. automatically in the absence of operator) or moving the flammable coating material into the safety tank.

Fire extinguishing equipment shall be present

— depending on the size and type of the machinery, the presence of operator and the risk of fire (nature of coating material), either portable or automatic equipment shall be present;

— automatic fire extinguishing system shall be installed in all hazardous zones (as classified in 3.27) of machinery when processes are automatically performed;

— all automatic fire extinguishing installations shall be equipped with an automatic fire warning system.

In case of fire the operator shall be able to quickly evacuate the enclosure in complete safety.

Means of access shall be doors for personnel complying with 5.2.3.

NOTE Local regulation in fire hazard zones should be considered.

5.7.2 Explosions

5.7.2.1 General

To prevent an explosion it is necessary to implement the following:

— to maintain the flammable substances concentration below *LEL* by forced ventilation or by keeping the temperature of the solvent-borne coating material below its flash point (see also 7.2.1);

— to eliminate or reduce ignition sources.

Forced ventilation is required for the enclosure, if the temperature of the coating material is comparable to the flash point of the solvent-borne coating material. The rate of forced ventilation can be calculated (see 5.7.2.2).

Forced ventilation is not necessary, if the flash point of the solvent-borne coating material is at least 20 °C higher than the normal operating conditions.

Furthermore, precautions shall be taken to eliminate combustible gases leakages to avoid possibilities of explosions for instance: natural convection, pre or post ventilation, leak testing on gas train.

5.7.2.2 Limitation of flammable substances concentration

The limit value of concentration given hereafter shall only be used for classification in hazardous zones (see 5.7.2.3) and determination of electrical and non electrical equipment (see 5.7.2.4.2 and 5.7.2.4.3).

For calculation (see Annex B), if the *LEL* of solvents is unknown, a value of 40 g/m^3 shall be used.

In dip coating machinery using solvent-borne coating material the concentration of flammable substances shall be limited to a value of 25 % *LEL* maximum and/or the temperature of the solvent-borne coating material is at least 20 °C below the flash point.

The tank shall be equipped with thermostat to avoid temperatures higher than normal operating conditions. When higher temperatures are reached, thermostat shall stop the heating of the bath.

NOTE 1 Dip coating machinery installed in a workshop without any specific enclosure will meet the exposure limits (see 5.6.2.1) which are far below the LEL, so that hazardous explosive atmosphere cannot occur.

NOTE 2 When an operator is inside the enclosure for any reason the concentration limits specified in 5.6.2.2 and 5.6.2.4 apply.

NOTE 3 In dip coating machinery with specific enclosure, the flammable substances concentration never exceeds 25 % LEL or bath temperature is 20 °C below flash point.

NOTE 4 It should be noted that in case of treatment tunnel depending on the steps of the process, different concentration of solvent vapours could occur.

5.7.2.3 Classification in hazardous zones (according to 3.27)

The classification of hazardous zones is an integral part of the safety concept for explosion prevention. The ignition prevention category of equipment and components implemented to dip coating machinery using solvent-borne coating material is dependent on limitation of flammable substance concentration by forced ventilation.

a) In case of values of flammable substances concentration between 10 % and 25 % of LEL the integral volume of the enclosure of the dip coating machinery including ducts for recirculated and exhaust air and in external volumes but within a distance up to 1 m from permanent openings, are classified as Zone 2 (Figure A.1);

b) In case of values of flammable substances concentration not exceeding (in all circumstances) 10 % of LEL the internal volume of the enclosure of the dip coating machinery is not classified as a hazardous zone (Figure A.2).

5.7.2.4 Avoidance or reduction of ignition sources

5.7.2.4.1 General

All electrical and non-electrical equipment and components, intended for use in potentially explosive atmospheres, shall be designed and constructed according to good engineering practice and in conformity with the required categories for group II equipment to ensure avoidance of any ignition source. To classify the category of the equipment it shall be subjected to an ignition hazard assessment in accordance with 5.2 of EN 13463-1: 2001.

5.7.2.4.2 Electrical equipment

Any electrical equipment, installed and located in Zone 1 shall be at least Category 2 and shall comply with the requirements of EN 60079-0. Where relevant EN 60079-0 may be supplemented or modified by ⟦A1⟩ EN 60079-6 ⟨A1⟧, EN 60079-2, ⟦A1⟩ EN 60079-5 ⟨A1⟧, EN 60079-1, EN 60079-7, and ⟦A1⟩ EN 60079-11 ⟨A1⟧, EN 60079-18, EN 60079-25 as appropriate.

Electrical equipment installed and located in zone 2 shall be at least of category 3 complying with EN 60079-0 and EN 60079-15.

In particular the following measures shall be considered:

— all conductive components shall be interconnected and earthed according to EN 60204-1;

— for lighting devices fitted behind transparent impact resistant panels sealed to the enclosure structure, so that solvent vapour inside the enclosure cannot ingress, IP 54 of EN 60529 is sufficient;

〉A1〈 NOTE 1 The requirement is related to the properties of the panel to effectively enclose the hazardous atmosphere. The enclosure of the lighting fitting itself is not located in a classified zone with potential explosive atmosphere. 〈A1〉

— For motor outside the enclosure at least IP44 of EN 60529 shall be used;

— Undesirable electrostatic discharges shall be avoided by earthing and interconnecting all the metallic components.

〉A1〈 NOTE 2 〈A1〉Further information on this topic is given in the 〉A1〈 CLC/TR 50404:2003, *Electrostatics — Code of practice for the avoidance of hazards due to static electricity* 〈A1〉.

Integral lighting shall be in accordance with the requirements of EN 1837.

5.7.2.4.3 Non electrical equipment

Any non-electrical equipment, intended for use in a potentially explosive atmosphere, shall comply with the requirements of EN 13463-1 and EN 13463-5, and where relevant, the selected European standard for the specific type of ignition protection.

Group II category 3 equipment for installation in zone 2 shall not contain any effective ignition source in normal operation. Group II category 2 equipment for installation in zone 1 shall not contain any effective ignition source in normal operation or expected malfunction.

In particular the following requirements shall be observed:

— hot surfaces of all apparatus inside the hazardous zones of the dip coating machinery shall not be able to ignite paint aerosols and solvent vapours. The admissible temperatures of these hot surfaces are described in 6.4.2 of 〉A1〈 EN 1127-1:2007 〈A1〉.

— Undesirable electrostatic discharges shall be avoided by earthing and interconnecting all the metallic components.

〉A1〈 NOTE 〈A1〉 Further information on this topic is given in the 〉A1〈 CLC/TR 50404:2003, *Electrostatics — Code of practice for the avoidance of hazards due to static electricity* 〈A1〉.

— particular protection shall be provided for fans for exhaust and recirculation air 〉A1〈 (EN 14986) 〈A1〉.

〉A1〈 *deleted text* 〈A1〉

5.8 Safety requirements and measures against failure of energy supply

If the changes due to energy supplies and other or subsequent functional disorders can give rise to higher than designed for concentrations and the possibility of an ignition source and explosion this shall be taken into account during the design risk analysis and the selection of safety features identified within this standard.

The following measures shall be considered in such circumstances e.g. by:

1) Preservation of bath temperature 20 °C below flash point.

2) Interruption of transport.

3) Measures to prevent uncontrolled start-up (restart) shall be in accordance with EN 1037.

4) Measures to negate or reduce the effect of reductions in forced ventilation flow rate such as

   — emergency ventilation,

   — extended rundown characteristics of fan,

   — uninterrupted or back up power supply.

Luminous warnings and lighting for emergency ways and automatic fire extinguishing system (when appropriate) shall be supplied by an alternative energy source in case of failure of the normal energy supply) (see 7.2.1).

Emergency lighting shall comply with EN 1838.

Hydraulic powered equipment shall fulfil the requirements of EN 982.

Pneumatic powered equipment shall fulfil the requirements of EN 983.

Electrical powered equipment shall fulfil the requirements of EN 60204-1.

5.9 Safety requirements and measures against failure of control systems

5.9.1 General

The control circuits of the following equipment are considered safety-related:

— forced ventilation (see 5.6.2.6.1);

— filling limiting device (see 5.2.2);

— all interlocking devices (see 5.6.2.6.1, 5.6.2.6.2, 5.6.2.6.3, 5.6.2.6.4, 5.2.1.3, 5.2.1.5);

— mode selector devices (see 5.6.2.6.2);

— temperature limiting device (see 5.4.1, 5.4.4);

— speed limiting devices of e.g. powered turntables (see 5.6.2.6.2);

— supply circuits for each type of energy used (see 5.6.2.6.2);

— hold-to-run devices (see 5.2.1.7);

— hydraulic/pneumatic devices (see 5.8);

— movement limiting devices (see 5.6.2.6.2, 5.6.2.6.4);

— emergency stop and alarm devices (see 5.6.2.6.3, 5.9.3);

— load limiting devices (see 5.2.2.2).

Control switches for starting hazardous movements shall be in accordance with the requirements of EN 1037.

Dip and electrophoretic coating machinery shall be provided with separate main control switches for each type of energy used. The requirements of EN 1037 shall be satisfied.

5.9.2 Level of safety

Control circuits which are used in safety-related functions shall fulfil the requirements of EN 954-1 category 3 and EN 1088. For safety-related functions see EN 954-1 and CR 954-100.

For control requirements for dip and electrophoretic coating machinery which do not require routine and regular access to danger points, the following measures shall apply:

— The safety related part of a hydraulic/pneumatic control system shall satisfy at least category 1 (see 6.2.2 of EN 954-1:1996).

— The safety related part of an electric/electronic control system shall satisfy at least category 3 (see 6.2.4 of EN 954-1:1996). It is allowed to provide single main contactors.

NOTE Category 3 means that faults in the safety related part of a control system (e.g. auxiliary relays, auxiliary contactors, computers for safety-related functions or special PLCs (Programmable Logic Control) for monitoring) are detected and that measures are taken to bring the controlled equipment into a safe state (e.g. stop of hazardous movements). According to EN 60204-1 programmable electronic control functions are not considered safe in all cases.

5.9.3 Emergency stop equipment

Emergency stop equipment shall fulfil the requirements of EN 418.

Electrically operated emergency stop devices and circuits shall fulfil the requirements of EN 60204-1.

5.9.4 Failure or malfunction of the control system

To avoid a dangerous situation in the case of malfunction of the control system, dip and electrophoretic coating machinery shall be designed to prevent uncontrolled start-up (restart) according to EN 1037 and where applicable:

— Shall be designed to prevent unexpected overrun;

— Shall be equipped with a detection device which detects any failure or reduction of the cooling capacity and which indicates the failure by optical and/or audible alarms according to 5.4.3 and 5.4.4. See also 5.2.2.2.

  This device shall lead to a shut-off of other systems (e.g. heating, transport). Examples of possible additional measures are:

  — Increase capacity of exhaust fans;

  — Automatically closing doors or covers;

  — Reduction of thermal inertia.

Failure and/or malfunction of control system can result in hazards, which are the same as resulting from the failure of energy supply.

6 Verification of the safety requirements and/or measures

6.1 General

The safety requirements detailed in Clause 5 shall be checked by testing, calculation, inspection or other methods, according to the following clauses.

Verification shall be checked before or during commissioning.

6.2 Mechanical

Verification of requirements under 5.2 and the measures adopted can be carried out by visual and/or physical inspection.

6.3 Electrical

Verification of requirements under 5.3 shall be carried out according to EN 60204-1 and the following tests shall be performed on all dip or electrophoretic coating machinery when the electrical equipment is fully connected to the machinery:

— continuity of the protective bonding circuit (according to 20.2 of EN 60204-1:1997);

— insulation resistance tests (according to 20.3 of EN 60204-1:1997);

— voltage tests (according to 20.4 of EN 60204-1:1997);

— functional tests (according to 20.7 of EN 60204-1:1997).

6.4 Thermal

Verification of requirements under 5.4 shall be carried out by visual inspection and suitable instrumentation for temperature measurement.

Instrumentation shall be used which ensures a minimum accuracy in the measurement of ± 2 K.

6.5 Noise

The measurement of the emission sound pressure levels at the workstations and of the sound power level shall be carried out according to EN 14462 during commissioning.

6.6 Dangerous substances

6.6.1 Tank and ancillary equipment

The safety requirements in relation to tank and ancillary construction, coating circulation systems and draining areas shall be verified by visual and document inspection and/or by test when necessary.

6.6.2 Measures against contact with/or absorption/or inhalation of hazardous fluids or vapours

6.6.2.1 Contact with or absorption of coating material (organic liquid coating material, solvents)

Verification of safety instruction given in 7.2.1.

6.6.2.2 Inhalation of hazardous volatile substances

The correct functioning of safety devices described in 5.6.2.6 shall be checked by functional testing.

— **Forced ventilation verification**

For machinery with operator inside, measurement of hazardous substances concentration value and comparison with exposure limits.

— **Verification of air flow direction**

Place a smoke generator in the solvent borne dip coating area and check that all the smoke is extracted by the equipment provided for this purpose.

— **Air volume exchange**

By calculation after measuring of the volume of the internal space of the machinery and air volume flow measured in the exhaust duct.

6.6.2.3 Inhalation of toxic gases released by the heating device

Verification of compliance of heating devices with specific standards shall be done before start-up.

NOTE The direct gas fired air heater manufacturer should provide a declaration of conformity with tests required in EN 746 and EN 525 for the burner may be used.

6.6.2.4 Contact with hazardous foams or inhalation of hazardous gases, vapours emitted by fire extinguishing equipment.

Correct functioning of warning system and a check made to ensure enough time is left to allow operator to exit from the machinery.

6.7 Verification of the safety requirements and measures against fire and explosion

6.7.1 Fire

By inspection and suitability verification of fire extinguishing equipment.

By inspection of documents concerning combustible properties of used construction material.

6.7.2 Explosion

Verification procedures if design precautions are provided to reduce or prevent explosion hazards.

6.7.3 Limitation of concentration

Verification of air volume exchange (see 6.6.2.2).

Flammable substances concentration measurement

— if calculated concentration is below 25 % LEL, the measurement(s) shall be effected in the air exhaust duct(s);

— the measurement shall be effected by using a concentration monitoring system according to [A1⟩ EN 60079-29-1 ⟨A1];

— the concentration monitoring system shall be calibrated with e.g. xylene in the conditions (temperature, pressure, humidity...) provided by the manufacturer. If the concentration monitoring system has been calibrated using a solvent different from the one contained in the coating material, the result should be corrected using information obtained from the manufacturer of the apparatus (see EN 50073);

— measurements shall be performed in the conditions of use (temperature, pressure, humidity...) specified by the manufacturer of the apparatus (see EN 50073);

— measurements shall not be performed at temperatures over the limit indicated by the manufacturer of the apparatus (see EN 50073);

— if technical reasons do not allow the concentration measurement as defined above, procedures by calculation and air flow verification shall be followed.

6.7.4 Hazardous areas and ignition sources

Compliance of electrical equipment and non electrical equipment with relevant standards for zone 2 shall be verified during commissioning.

Other requirements shall be checked visually.

6.8 Failure of energy supply

The maintenance of luminous warnings and lighting for emergency ways for a minimum period of 1 h after the failure of energy supply shall be visually checked.

Safety circuits shall be checked before start-up in order to verify if the fail safe is assured.

6.9 Control systems

Verification of the requirements detailed in 5.9 shall be carried out by testing and visual inspection. The presence, function, labelling of safety devices shall be checked.

7 Information for use

7.1 General

Information for use shall be drawn up in accordance with Clause 6 and in particular with 6.5 of EN ISO 12100-2:2003 for instruction handbook.

The information for use shall be drawn up in one of the languages of the EEA. On being put in service, dip or electrophoretic coating machinery shall be accompanied by a translation of the instructions into the language of the country in which the machinery is to be used and by the instructions in the original language issued by the manufacturer.

Specifications for the installation, commissioning and use shall be provided together with normal maintenance information for dip or electrophoretic coating machinery and the intended use.

7.2 Instruction handbook

7.2.1 The instruction handbook shall contain the following minimum information:

— performance data:

- description of dip or electrophoretic coating machinery, the type of coating material for which the machinery has been designed and safety devices;
- design data, characteristics;
- schematic diagrams for safety functions;
- maximum size of the item or object to be coated;
- air volume flow: …… m³/h;
- types and maximum amounts of flammable solvents contained in the coating material applied in one hour and any other safety requirements limiting the use. In case of change of maximum surface to be treated in one hour, the user shall verify that additional hazards do not occur;
- temperature limits of the air inside the dip or electrophoretic coating machinery during the application step;
- noise emission values determined according to EN 14462 i.e.:
  - the A-weighted emission sound pressure level at workstations, where this exceeds 70 dB; where this level does not exceed 70 dB, this fact shall be indicated;
  - the A-weighted sound power level where the A-weighted emission sound pressure level at workstations exceeds ▌A1⟩ 80 dB ⟨A1▐
- minimum flash point of solvent-borne coating material admissible for use in the dip or electrophoretic coating machinery (reference to the material data sheet of the manufacturer of the solvent-borne coating material);
- instruction for verification of the limit temperature in relation to the flash point and characteristics of the solvent-borne coating material according to the safety data sheet of the solvent-borne coating material;
- instructions relating to the installation such as floor plans, exhaust systems, floor mountings;

— information and instruction for fixing the machinery and any constituting equipment to the floor. This includes information about the necessary space to be reserved for the location of the machine in such way that no additional crushing and shearing risk is created between the moving parts of the machine or work-piece and other fixed adjacent machines, part of the building or stocks of material etc.;

— instructions on how to keep up the safety of surrounding areas where ventilation ducts, pipes and chimneys pass through a wall. The fire resistance of this wall shall not be modified;

- loading/unloading areas (marked on the floor and limited by guards);
- area classification with restricted areas and hazardous zones with reference to fire and explosion (if applicable);
- information on explosion and fire prevention measures during cleaning, maintenance and handling of deposits of residues from processes;
- Warnings against:
  - use of halogenated products for cleaning inside the dip or electrophoretic coating machinery;

- use of naked flames, objects with incandescent surfaces, equipment or items capable of generating sparks (tools, equipment, etc.), inside the dip or electrophoretic coating machinery or in the surrounding of it;
- smoking in the hazardous areas. A display showing "No smoking" shall be affixed on the dip or electrophoretic coating machinery, and on all entrance doors of the machinery;
- any storage of flammable substances or their empty containers or any other material which have been in contact with these products (rags, paper, etc.) in the dip or electrophoretic coating machinery and in front of the doors;

— safe working practices – information about

- required fire extinguishing equipment;
- any special earthing measures;
- recommendation on lighting;
- the connection details for the equipment of the workshop forced ventilation system.
- use of qualified, trained and authorised personnel for operation and adjustment of the dip or electrophoretic coating machinery according to the manufacturer's specifications;
- location of the operator's workplaces in the non-contaminated atmosphere (for dip coating machinery with horizontal ventilation);
- the availability of at least suitable manually operated fire extinguishers, if applicable, and how they have to be used in a safe way;
- use of personal protective equipment with respect to contact with and/or breathing of hazardous materials, gases or vapours, according to the safety data sheet of the coating materials;
- wearing of hearing protectors, if relevant.

Furthermore, the instruction handbook shall point at:

— information relating to safe conditions of transportation and handling;

— commissioning report (e.g. on compliance of earthing measures, air velocity, safety interlocks);

— information relating to fitted safety devices and their function;

7.2.2 Information relating to the use of the dip and electrophoretic coating machinery

— description of controls and their function;

— instruction for start-up (operation);

— instructions on making any adjustments;

— information on cleaning;

— instructions on appropriate arrangements (for example provision of suitable glasses and protective clothing) when contact with materials used for dipping or cleaning could cause dermatitis or other skin complaints;

— instructions on the use of personal protective equipment or a breathing mask connected to fresh air, when an operator enters the dip or electrophoretic coating machinery for adjustment, control or maintenance purposes.

— instruction on correct addition of solvent in the bath of organic liquid coating material: only with the agitator operating and with running forced ventilation.

— information on the requirement that the forced ventilation operates

  — until concentration of dangerous substances is below exposure limits before entering inside an automatic dip or electrophoretic coating machinery for any adjustment, repair or maintenance works.

  — during cleaning operation with flammable solvents.

— information on microbiological problems, particularly humidity control, and appropriate arrangements, for example:

  — provision of protective clothing and fresh air breathing equipment;

  — provision of easy access for cleaning ductwork and/or plenum chambers;

— information on the requirements when an operator has to enter inside the tank (according to physical and chemical properties of coating material inside the tank):

  — a second operator has to remain outside the tank to supervise the operation;

  — a personal protection or a breathing mask connected to fresh air shall be worn;

— [A1] the operating method to be followed in the event of accidents, breakdowns or blockages that are likely to occur [A1].

7.2.3 Maintenance

a) preventative maintenance

The manufacturer shall inform at least on the following:

  — check at regular intervals[1)] for clogging of filtration and exhaust systems as well as the deposits of coating material on equipment, walls and floor of the dip or electrophoretic coating machinery;

  — check at regular intervals[1)] the earthing of the dip or electrophoretic coating machinery and items to be processed;

  — indicate the safety precautions to be taken in non-operating steps if a naked flame, incandescent object or equipment or item capable of generating sparks is brought into the dip or electrophoretic coating machinery for maintenance work, (for instance entire cleaning of the dip or electrophoretic coating machinery to remove organic liquid coating material deposits);

  — give precise instructions for maintenance of heating devices and notably the periodicity of maintenance;

  — indicate the periodicity of filter replacement and how this can be done in a safe way;

---

1) The variations of indications given by command devices (pressure, flow, etc.) of filtration systems and exhaust circuits help to determine the maintenance action.

— use of material and tools as recommended by the manufacturer;

— [A1] the specifications of the spare parts to be used, when these affect the health and safety of operators; [A1]

— instruction for cleaning.

b) corrective maintenance

The manufacturer shall inform the user that corrective maintenance shall only be carried out by a competent, qualified person according to EN 60079-17 following the specifications of the manufacturer. The specification shall mention:

— means to detect and correct breakdowns and failures which might occur;

— methods to identify all parts or material that are replaceable;

— obligatory insulation and energy dissipation before working on energy powered systems;

— causes of breakdowns or failures and how they occur.

7.3 Marking

Dip or electrophoretic coating machinery shall be clearly and permanently marked with at least the following data:

— name and address of the manufacturer;

— type, model and serial number identifying the dip or electrophoretic coating machinery;

— year of production ..... modified on ..... (year of modification(s));

— method of organic liquid coating application for which the dip or electrophoretic coating machinery is designed (example: automatic or manual shall be mentioned);

— type of liquid coating material or characteristics and limitations to define the intended use of the machinery;

— amount of flammable solvent contained in the liquid organic coating material applied (see 7.2.1). For the maximum surface to be treated in one hour maximum required at the initial start-up of the machinery;

— power installed:

  — electric ..... (kVA),

  — other ..... .

Annex A
(normative)

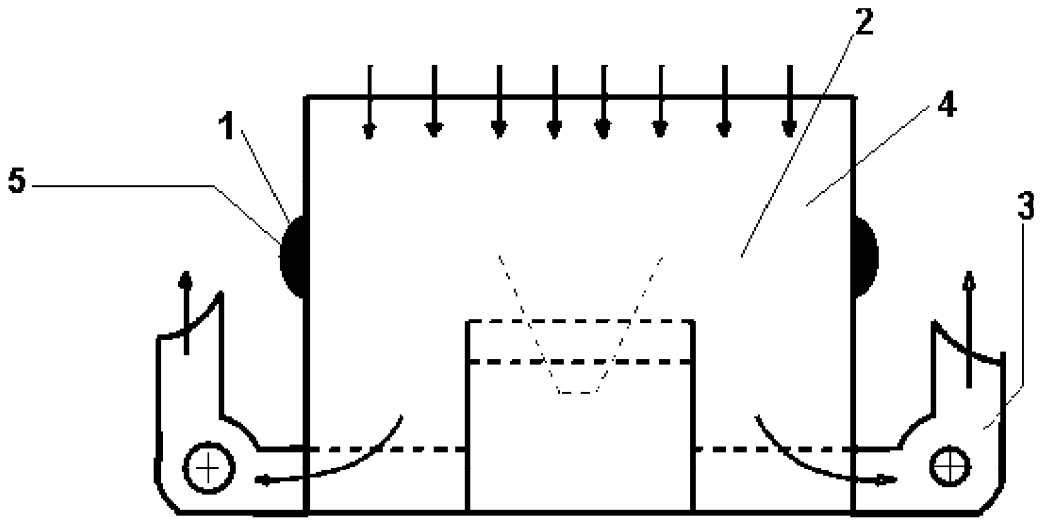
Diagrams related to hazardous zones of potentially explosive atmosphere

EN 1127-1 specifies methods for the identification of hazardous situations that may lead to an explosion. It details the design and construction measures to achieve the required safety. It includes the relationship between categories and zones and the applicable equipment in the different zones.

Refer to 5.7.2.3 for the classification of hazardous zones as defined in 3.27.

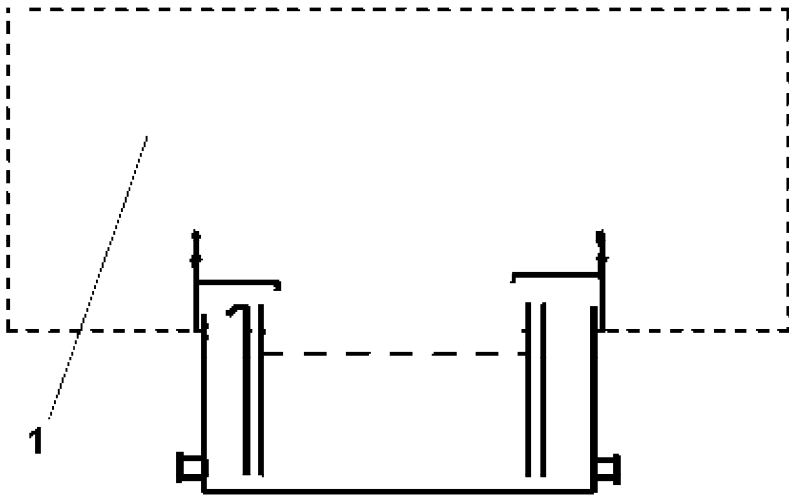
NOTE 1 See EN 60079-10.

NOTE 2 Doors are not considered to be permanent openings.



Key
1 Permanent opening
2 Conveyor
3 Enclosure extract
4 Zone 2
5 Zone 2

Figure A.1 — Dip coating machinery using solvent-borne coating material, with enclosure
(5.7.2.3a) – Assumption: Solvent concentration is between 10% and 25% of LEL)



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Key

1 No zone required

Figure A.2 — Dip coating machinery using solvent-borne coating material with or without enclosure (5.7.2.3.b) – Assumption: Solvent concentration is below 10% of LEL)

Annex B
(normative)

Determination of concentration of flammable solvents in terms of LEL

B.1 Dip coating machinery using solvent borne coating material

B.1.1 General

The following text describes a method based on B.4 of EN 60079-10:2003. It should be appreciated that the method is subject to the assumptions described and therefore only gives approximate results.

B.1.2 Calculation

In order to simplify the comparison with the lower explosion limit (LEL), the concentration is expressed as C_{LEL} (percentage of LEL).

$$C_{max} = \frac{C_{LEL\,max} \times LEL}{100} \quad \text{(B.1)}$$

The minimum air flow required to maintain the flammable solvent vapour concentration is given by:

$$Q_{min} = \frac{(M_{max} \times k_1 + M_{sol}) \times k_2 \times k_3}{C_{max}} \quad \text{(B.2)}$$

Where:

Q_{min}	is the minimum volume flow inside the dip coating machinery which dilutes the released flammable solvents vapour to the required concentration level;	m^3/h
C_{max}	is the maximum concentration of flammable solvents in air inside the dip coating machinery, as function of specified permissible $C_{LEL\,max}$.	g/m^3
$C_{LEL\,max}$	is the maximum permissible concentration of flammable solvents in air according to 5.7.2.2 and 5.7.2.3 ($C_{LEL\,max10}$ = 10 and $C_{LEL\,max25}$ = 25);	in % of LEL
LEL	is the lower explosion limit of solvent or solvent mixture at 293 K; The LEL of a solvent mixture shall be taken as the lowest value of the component substances. If the constituents of the solvent mixture are unknown then a value of 40 g/m^3 shall be used.	g/m^3
M_{max}	is the maximum rate of addition of coating material to the dip tank (make up);	g/h
k_1	is the mass fraction of flammable solvent in the coating material;	
k_2	is the fraction of the input quantity of flammable solvents released inside the dip coating machinery as a result of evaporation from the coating bath surface and the work items;	

NOTE The knowledge of the maximum release rate of gas or vapour at the source of release could be obtained either by verified experience, reasonable calculation or founded assumption.

$k_3 = 3$ is the quality factor taking into account the solvent concentration heterogeneity. This factor denotes the efficiency of the ventilation in terms of its effectiveness in diluting the explosive atmosphere, with k_3 ranging from $k_3 = 1$ (ideal situation) to $k_3 = 5$ (impeded air flow);

M_{sol} is the quantity of solvents added to the bath during operation (for example, to maintain the coating viscosity); g/h

NOTE If the enclosure is a multi-zone ventilation C_{LEL} will be determined separately in each ventilation zone (tank, dipping zone, flash off zone, etc). C_{LEL} value of the worst zone will be taken.

B.1.3 Example: Calculation of the required minimum exhaust volume flow

Work items are coated in an enclosed dip tank using a solvent borne material. The design capacity of the machinery is 15 work items per hour. The average coated surface per work item is 10 m^2. 100 g coating materials per m^2 are required for the coating.

The solvent content of the coating is 60 % (mass fraction). The coating drips off over the dip tank. In 1 h of operation 2 500 g solvents have to be added due to the release of solvents from the bath surface and in order to maintain the viscosity of the coating material. The LEL of the solvent mixture used is unknown.

From the above example:

Coating material used and therefore added coating material

$$M_{max} = 15\,h^{-1} \cdot 10\,m^2 \cdot 100\,g/m^2 = 15\,000\,g/h$$

Solvent content of the coating material:

$$k_1 = 60\,\% = 0{,}6$$

Solvent added per hour:

$$M_{sol} = \frac{2\,500\,\mathrm{g}}{1\,\mathrm{h}} = 2\,500\,\mathrm{g/h}$$

In addition, the following shall be considered:

LEL = 40 g/m^3 because the LEL of the solvent mixture used is unknown

k_2 = 70 % = 0,7 estimated release rate of solvents (bath surface, coated work items)

k_3 = 3 quality factor (of ventilation)

From the formula (B.2) of B.1.2 we can take

$$Q_{min} = \frac{(M_{max} \cdot k_1 + M_{sol}) \cdot k_2 \cdot k_3}{(C_{LELmax} \cdot \mathrm{LEL})/100} \qquad \text{(B.3)}$$

If a solvent concentration in air of 10 % of the LEL shall not be exceeded, then according to formula (B.3)

$$Q_{\min 10} = \frac{(15\,000 \cdot 0{,}6 + 2\,500) \cdot 0{,}7 \cdot 3}{10 \cdot 40 / 100}$$

$$Q_{\min 10} = 6037 \mathrm{m}^3/\mathrm{h}$$

If a solvent concentration in air of 25 % of the LEL shall not be exceeded, then according to formula (B.3)

$$Q_{\min 25} = \frac{(15\,000 \cdot 0{,}6 + 2\,500) \cdot 0{,}7 \cdot 3}{25 \cdot 40 / 100}$$

$$Q_{\min 25} = 2\,415 \mathrm{m}^3/\mathrm{h}$$

Result: The required measures are to be taken according to concentration threshold values given in 5.6.2 and explosion values in 5.7.2.3.

B.2 Electrophoretic and dip coating machinery using water borne coating material

B.2.1 General

The following data is only an example.

The calculation is done considering that all solvent vapours are extracted above the tank.

B.2.2 Data

— Solvents

  — Phenoxy propanol (PPH): Vapour pressure: 0,0463 mm Hg (at 25 °C)

    LEL: 0,70 in volume %

    Molecular weight: 136 g

  — Butyl glycol (BG): Vapour pressure: 0,87 mm Hg (at 25 °C)

    LEL: 1,10 in volume %

    Molecular weight: 118 g.

— Maxi daily additions

  — Binder: 3 876 kg containing 1 % of phenoxy propanol

  — Paste: 1 340 kg containing 5 % of butyl glycol

B.2.3 calculation

— The mole of a substance will evaporate to form 22,414 dm^3 of vapour at 0 °C and at atmospheric pressure. The volume at 25 °C (normal temperature) becomes:

$$22{,}414\left(\frac{25+273{,}15}{273{,}15}\right)=24{,}465\ \mathrm{dm}^3$$

— Volume of phenoxy propanol evaporated per one hour:

$$\frac{3\,876\,000}{136}\times\frac{1}{100}\times 24{,}465\times\frac{1}{24}=290{,}52\ \mathrm{dm}^3/h$$

— Volume of butyl glycol evaporated per one hour:

$$\frac{1\,340\,000}{118}\cdot\frac{5}{100}\cdot 24{,}465\cdot\frac{1}{24}=578{,}80\quad \mathrm{dm}^3/h$$

— Tank enclosure volume: 20 m x 5 m x 5 m = 500 m^3 = 500 000 dm^3

— Phenoxy propanol concentration:

$$\frac{290{,}52\cdot 100}{500\,000}=0{,}0581\quad\%$$

— Butyl glycol concentration:

$$\frac{578{,}80\cdot 100}{500\,000}=0{,}1158\quad\%$$

In order to obtain a concentration lower than 25 % LEL of the mixture of these two gases, the following equation shall be (Le Chatelier's formula):

$$\frac{n_1}{N_1}+\frac{n_2}{N_2}\le 0{,}25 \qquad \text{(B.4)}$$

with n_1 = phenoxy propanol concentration

N_1 = LEL in volume % of phenoxy propanol

n_2 = butyl glycol concentration

N_2 = LEL in volume % of butyl glycol

we obtain:

$$\frac{n_{PPH}}{0{,}70}+\frac{n_{BG}}{1{,}10}\le 0{,}25$$

so:

$$1{,}10n_{PPH}+0{,}70n_{BG}\le 0{,}25\cdot 0{,}7\cdot 1{,}1$$

$$1{,}10n_{PPH}+0{,}70n_{BG}\le 0{,}1925$$

$$1{,}10n_{PPH}=1{,}10\cdot 0{,}0581=0{,}06391$$

$$0,70\mathrm{n}_{BG} = 0,70 \cdot 0,1158 = 0,08106$$

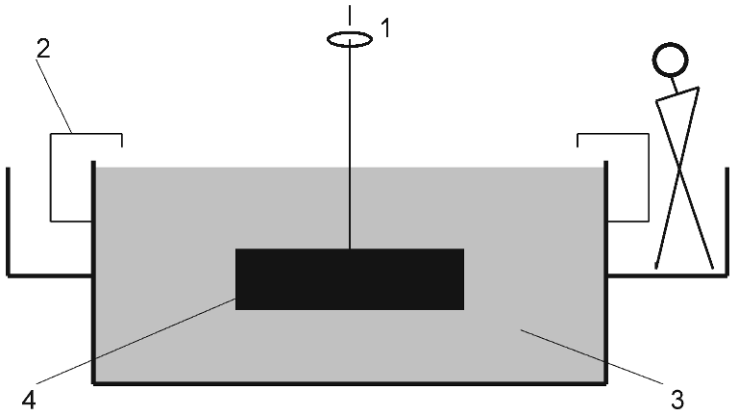
$$1,10\mathrm{n}_{PPH} + 0,70_{BG} = 0,14497$$

The equation (B.4) complies with an air change of

$$\frac{0,14497}{0,1925} = 0,75 \quad time\ per\ hour$$

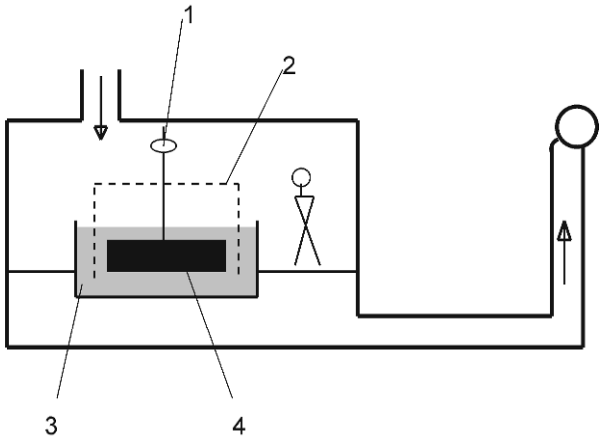
Annex C
(informative)
Diagrams relative to dip and electrophoretic coating machinery classification

The figures only describe examples for dip and electrophoretic coating machinery



Key
1 Handling device
2 Lip extraction
3 Tank
4 Work item

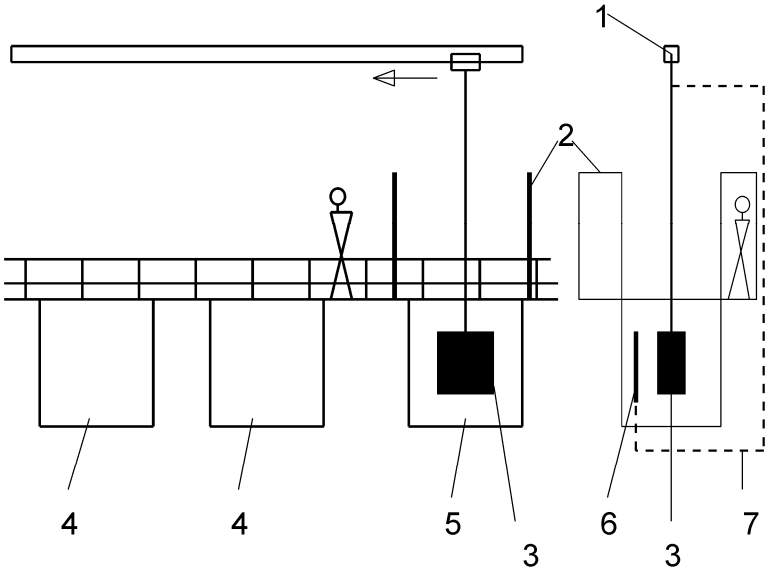
Figure C.1 — Dip coating machinery without specific enclosure - with or without operator (see 5.6.2.2)



Key

1 Handling device
2 Opening for work items
3 Tank
4 Work item

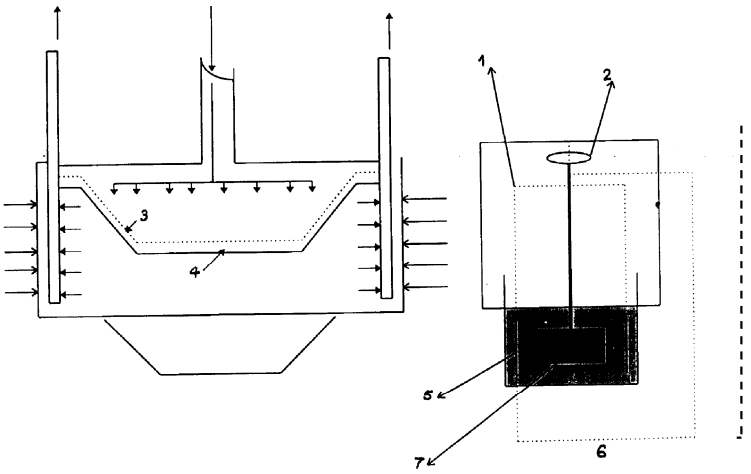
Figure C.2 — Dip coating machinery with specific enclosure – with or without operator (see 5.6.2.3)



Key

1 Handling device
2 Guard
3 Work item
4 Rinsing tank
5 Electrodip
6 Electrode
7 Tank

Figure C.3 — Electrophoretic coating machinery without specific enclosure - with or without operator (see 5.6.2.4)



Key

1 Opening for work items
2 Handling device
3 Conveyor
4 Electrodip Tank
5 Electrode
6 DC
7 Work item

Figure C.4 — Electrophoretic coating machinery enclosed into a treatment tunnel - without operator
(see 5.6.2.5)

Annex D
(informative)

Classification of material's reaction to the fire - National standards

According to 5.7.1 of this standard, the specific properties for the material for construction (such as non combustible, non easy flammable) are necessary for fire prevention and protection.

At this time there are no harmonised EN-standards for the fire behaviour of material for construction for the fire prevention and protection of machines.

Therefore, national standards should prevail until such time as harmonised CEN standards are available e.g.:

Austria	Önorm B 3800-1:	Brandverhalten von Baustoffen und Bauteilen — Baustoffe — Anforderungen und Prüfungen.
	Önorm B 3800-2:	Brandverhalten von Baustoffen und Bauteilen — Bauteile — Begriffsbestimmungen Anforderungen, Prüfungen.
	Önorm B 3800-3:	Brandverhalten von Baustoffen und Bauteilen — Sonderbauteile — Begriffsbestimmungen Anforderungen, Prüfungen.
	Önorm B 3800-4:	Brandverhalten von Baustoffen und Bauteilen — Bauteile — Einreihung in die Brandwiderstandsklassen.
United Kingdom	H.F.L. 72	Highly flammable liquids and liquefied petroleum gases regulations.
and relevant parts of	BS 476	Fire tests on building material and structures.
France	NF P 92-501	Safety against fire — Material for construction to fire tests - Radiation test for rigid material or for material on rigid substrates (flooring and finishes) of all thicknesses and for flexible material thicker than 5 mm.
	NF P 92-507	Safety against fire — Material for construction — Reaction to fire tests — Classification according to the reaction against fire.
Germany	DIN 4102	Fire behaviour of material and components for construction — Material for construction — Definitions, requirements and tests.
Italy	UNI 9177	Classification of material — Reaction to fire of combustible material.

Annex E
(informative)

Reference to national exposure limit values

Exposure limit values are commonly defined by member states regulations. The national references - as far as known - are as follows:

Country	References to national exposure limit values for hazardous substances	Technical terms for limits
A	Amtliche Mitteilungen des Bundesministeriums für soziale Verwaltung (2/93)	MAK, TRK
B	Koninklijk Besluit tot wijziging van Bijlage II van Titel II, Hoofdstruk II bis van het ARAB wat de vaststelling van de grenswaarden voor blootstelling aan chemische agentina betreft Order in council on the modification of annex II of title II, chapter II from the ARAB that establishes the limit of exposure to chemical agents Ordonnance prise en conseil privé sur la modification de l'annexe II du titre II, chapitre II bis de l'ARAB qui établit les limites d'exposition des agents chiminiques	VLE VLE VLE
CH	SuVa Publikation: Grenzwerte am Arbeitsplatz 1997 Maximale Arbeitsplatzkonzentrationswerte gesundheitsgefährdender Stoffe. Biologische Arbeitsplatztoleranzwerte – Arbeitshygienische Grenzwerte für physikalische Einwirkungen	MAK BAT
CzR	Directive of Ministry of Health No. 58/1981 Coll., about principal hygienic requirements for maximum permitted concentration of the most important injurants in air und assessment of Level of pollution	NPK NPK-P
DK	Instruction No 3.1.0.2., December 1996, Exposure Limit Values for Substances and Materials	GV
SF	At present unknown	
F	[A1] *deleted text* [A1] [A1] ED 695 – *Guide pratique de ventilation N°0 – Principe généraux de ventilation.* ED 657 – *Guide pratique de ventilation N°1 – l'assainissement de l'air des locaux de travail.* ED 651 – *Guide pratique de ventilation N°2 - Ventilation des cuves de traitement de surface* [A1]	VME VLE
D	Technische Regeln für Gefahrstoffe TRGS 900 "Luftgrenzwerte"	MAK, TRK BAT
G	At present unknown	
ISL	At present unknown	
IRL	At present unknown	
I	Threshold Limit Values and Biological Exposure Indices published by American Conference of Governmental Industrial Hygienists (ACGIH)	TLV
L	At present unknown	
NL	Ministerie van Sociale Zaken en Werkgelegenheid: de nationale MAC-waardenlijst 2005	MAC
N	Administrative normer for forurensing i arbeidsatmosfaere 1996	AT 361
P	At present unknown	
ES	At present unknown	

S	(Threshold Limit values) AFS 1996:2 Hygieniska Gränsverden	NGV, TGV KTV
GB	Health and Safety Executive H&SE EH 40/97, Part 2: "List of occupational exposure limits and other tables"	MEL, OES

Annex ZA
(informative)

A1 Relationship between this European Standard and the Essential Requirements of EU Directive 2006/42/EC

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association to provide a means of conforming to Essential Requirements of the Recast Machinery Directive 2006/42/EC.

Once this standard is cited in the Official Journal of the European Union under that Directive and has been implemented as a national standard in at least one Member State, compliance with the normative clauses of this standard confers, within the limits of the scope of this standard, a presumption of conformity with the relevant Essential Requirements ((except Essential Requirements 1.2.1 3rd paragraph, 1.2.4.2, 1.1.2.c), 1.7.4.2.o), 3, 4)) of that Directive and associated EFTA regulations.

WARNING – Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard. 〈A1

Annex ZB
(informative)

Relationship between this European Standard and the Essential Requirements of EU Directive 94/9/EC

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association to provide a means of conforming to Essential Requirements of the New Approach Directive ATEX 94/9/EC.

Once this standard is cited in the Official Journal of the A1 European Union A1 under that Directive and has been implemented as a national standard in at least one Member State, compliance with the normative clauses of this standard given in Table ZA confers, within the limits of the scope of this standard, a presumption of conformity with the relevant Essential Requirements of that Directive and associated EFTA regulations.

A1 Table ZB A1 - Correspondence between this European Standard and Directive 94/9/EC

Clause(s) of this European Standard	Essential Requirements of Directive 94/9/EC
5.1, 5.7.2.1, 5.7.2.2, 5.7.2.3	1.0 General requirements
5.6.1.1, 5.7.1.3	1.1 Selection of materials
5.7.2.1, 5.7.2.2	1.2 Design and Construction
5.7.2.1, 5.7.2.4	1.3 Potential ignition sources
5.7.2.3	1.4 Hazards arising from external effects
5.8, 5.9	1.5 Requirements in respect of safety related devices
5.8, 5.9	1.6 Integration of safety requirements relating to the system
5.7.2.4	2.2 Requirements applicable to equipment in category 2 of equipment-group II
5.7.2.4	2.3 Requirements applicable to equipment in category 3 of equipment-group II

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

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[2] EN 614-1, *Safety of machinery — Ergonomic design principles — Part 1: Terminology and general principles*

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[6] EN 746-2, *Industrial thermoprocessing equipment — Part 2: Safety requirements for combustion and fuel handling systems*

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[9] EN 894-2, *Safety of machinery — Ergonomic requirements for the design of displays and control actuators — Part 2: Displays*

[10] EN 894-3, *Safety of machinery — Ergonomic requirements for the design of displays and control actuators — Part 3: Control actuators*

[11] EN 1050, *Safety of machinery — Principles for risk assessment*

〚A1〛 *deleted text* 〈A1〉

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

〚A1〛 *deleted text* 〈A1〉

[13] EN 60079-1*, Electrical apparatus for potentially explosive atmospheres — Part 1: Flameproof enclosure "d" (IEC 60079-1:2003)*

[14] EN 60079-2, *Electrical apparatus for explosive gas atmospheres — Part 2: Pressurized enclosures "p (IEC 60079-2:2001)*

〚A1〛

[15] EN 60079-5*, Explosive atmospheres - Part 5: Equipment protection by powder filling "q" (IEC 60079-5:2007)*

[16] EN 60079-6, *Explosive atmospheres — Part 6: Equipment protection by oil immersion "o" (IEC 60079-6:2007)*

[17] EN 60079-11, *Explosive atmospheres — Part 11: Equipment protection by intrinsic safety "i" (IEC 60079-11:2006)* 〈A1〉

[18] EN 60079-7, *Electrical apparatus for explosive gas atmospheres — Part 7: Increased safety "e" (IEC 60079-7:2001)*

[19] EN 60079-10, *Electrical apparatus for explosive gas atmospheres — Part 10: Classification of hazardous areas (IEC 60079-10:2002)*

[20] EN 60079-18, *Electrical apparatus for explosive gas atmospheres — Part 18: Construction, test and marking of type of protection encapsulation "m" electrical apparatus (IEC 60079-18:2004)*

[21] EN 60079-25, *Electrical apparatus for explosive gas atmospheres - Part 25: Intrinsically safe systems (IEC 60079-25:2003)*

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