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Vroče brizganje - Varnostne zahteve za opremo za vroče brizganje - 6. del: Kabina, sistem za ravnanje, zbirka prahu, odsesovalni sistem, filter

Thermal spraying - Safety requirements for thermal spraying equipment - Part 6: Spray booth, Handling system, Dust collection, Exhaust system, Filter

Thermisches Spritzen - Sicherheitsanforderungen für Einrichtungen für das thermische Spritzen - Teil 6: Spritzkabinen, Handhabungssystem, Staubsammlung, Abluftsystem, Filter

Projection thermique - Exigences de sécurité relatives au matériel de projection thermique - Partie 6: Cabine de projection, Système de manipulation, Collecte de poussière, Système d'évacuation, Filtre

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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Foreword

This document (CEN/TR 15339-6:2014) has been prepared by Technical Committee CEN/TC 240 “Thermal spraying and thermally sprayed coatings”, the secretariat of which is held by DIN.

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1 Scope

This Technical Report specifies safety requirements of machines and equipment for thermal spraying, in this case of spray booths, handling, dust collection, exhaust, and filter systems.

This Technical Report should be used in conjunction with the Technical Report CEN/TR 15339-1 which deals with general aspects for design, manufacture, and/or put into service of machines or equipment and with the responsibility to issue the CE Conformity Declaration.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 657, *Thermal spraying - Terminology, classification*

EN 12198-1, *Safety of machinery — Assessment and reduction of risks arising from radiation emitted by machinery — Part 1: General principles*

CEN/TR 15339-1, *Thermal spraying — Safety requirements for thermal spraying equipment — Part 1: General requirements*

EN ISO 10218-2, *Robots and robotic devices - Safety requirements for industrial robots - Part 2: Robot systems and integration (ISO 10218-2)*

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

EN ISO 15667, *Acoustics - Guidelines for noise control by enclosures and cabins (ISO 15667)*

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

EN 60974-10, *Arc welding equipment - Part 10: Electromagnetic compatibility (EMC) requirements*

3 Function of thermal spraying equipment for thermal spraying

3.1 General

The spraying processes are described in EN 657. Thermal spraying creates process related heat, fume, dust, radiation and high levels of noise. Therefore thermal spraying systems are usually installed in firm enclosures. They are designed to protect personnel and environment and to control and minimise the exposure of the operator and others. Dust and fume can be captured and removed safely by a suitable ventilation, exhaust and filter system and the enclosure provides a guard against mechanical, electrical, thermal and noise risks.

3.2 Function and construction of a spray cabin

3.2.1 General requirements

The spray cabin shall be designed that the noise level outside the cabin fulfils the legal requirements. Even if more than one piece of equipment is operated the total noise level in the workshop shall fulfil these requirements.

3.2.2 Features of a spray cabin

There are some different types of spray cabins available.

Usually, modularly built single wall enclosures made out of about 100 mm thick elements are used for plasma, arc and HVOF spraying processes. They consist of a solid steel sheet on the outer side and a perforate steel sheet on the side towards the noise source. The space between those sheets is filled with a non-flammable isolation material, for example with glass wool or rock wool.

Also the doors and windows shall be able to protect the outside working personnel from excessive noise, dust, gases, fumes and intensive light, IR and UV radiation. Openings needed for electrical cables, gas or water hoses, and piping for ventilation and exhausting shall be sealed, in order to avoid acoustic tunnelling and to minimise the escape of dust and vibrations.

If the roof of the spray cabin has to carry installations like ventilator, power sources or heat exchangers and/or small lifting devices or manipulating equipment have to be mounted onto the ceiling, adequate reinforcement shall be applied. Sufficient space for maintenance and a safe access to this area is required.

In the case of mechanised spraying, the operator will enter the cabin only for changing the part to be coated or for maintenance. If loading and unloading of the parts can be executed through an opening, while the spraying process is shut off, the enclosure can be built as small as possible and thus be more effective for dust extraction. For automatic processes loading and unloading may be done through a lock, while the process runs.

3.2.3 Layout for a spray cabin or a thermal spraying equipment in the workshop

Spraying equipment shall not create safety hazards for nearby processes. A spray cabin or the spraying equipment should be located close to an outside wall to facilitate easy gas supply and the installation and effectiveness of the ventilation and extraction equipment.

The workshop building should be single storey and be as spacious as possible with a high ceiling and good natural ventilation achieved by a sufficient number of air inlets, roof vents and opening doors and windows. In that way, gas accumulation can be avoided in unventilated areas overhead, such as voids above false ceilings or in voids below floor level, such as pits, service trenches, gullies or underground rooms, where gases heavier than air could accumulate. A mechanized ventilation can be necessary, in order to draw away gases heavier than air at lower height, as e. g. LPG, propane, argon.

3.2.4 Ventilation and exhausting for the spray cabin

3.2.4.1 Reasons for ventilation and exhausting

To avoid explosive gas or dust mixtures or hazardous conditions the spray cabin shall be ventilated. A suitable air change and flow in the spray cabin prevents the formation of a burnable or explosive atmosphere inside the enclosure, reduces temperature rise, serves for removing gases, fumes, dusts, further by-products and provides for a safe spraying operation. The filtration of the exhausted air and gas mixture avoids an inadmissible contamination of the environment. The national or local laws or regulations for emissions into the atmosphere shall be followed.

3.2.4.2 Ventilation of the spray cabin

The air volume needed for the ventilation of the spray cabin is given by the exhaust air volume. The design of air inlet into the spray cabin and of the exhausting shall provide an air flow in suitable flow direction and local speed. A laminar continuous air flow, which can be reached by a great number of small inlet openings equally distributed is preferred, so far as the air flow is not decisive disturbed by the spraying equipment and the manipulating system. A turbulent air flow causes swirls and low pressure areas, where dust can remain or fall out.

The ventilation capacity and speed in the cabin shall function in the sense of displacement ventilation. Capacity and speed shall serve:

— for an adequate transport of spray dusts to the exhaust system;

— to avoid too low an oxygen content by diluting the atmosphere in the cabin (e. g. in the case of cold spraying);

— to avoid unacceptable gas concentration, which can remain in dead spots;

— to maintain the air temperature in the duct in a range that the filters will not be damaged (e. g. in the case of HVOF kerosene spraying).

3.2.4.3 Exhausting the spray cabin

The exhaust volume shall be adequate for the spray process and the size and shape of the exhaust hood and the component. Table 1 includes typical values in m^3/h depending on the spray process. It should be noted that the better the exhaust hood is adjusted to the size and form of the component, the lesser are problems with remaining dust in the air and on the floor and cabin walls.

The air speed to capture the rebounding particles and those which did not meet the part should be at least 1 m/s in front of the exhaust hood.

In the case of manual spraying in a cabin an Air Change Rate (ACR), see Formula (1) of at least 60 to 180 changes per hour depending on the spraying process is recommended. The Air Change Rate is calculates as follows:

$$N = Q/Vol \quad (1)$$

Where

N number of air changes per hour

Q Volumetric flow rate of air in cubic meter per hour

Vol Space volume: length × width × height, in cubic meter

Table 1 — Exhaust volumes

Spray process	Exhaust volume min. m^3/h
Flame spraying	3 000 to 5 000
Arc spraying	8 000 to 12 000
Plasma spraying	8 000 to 10 000
HVOF (gaseous fuel)	10 000 to 12 000
HVOF (liquid fuel)	12 000 to 15 000
Cold spraying	5 000 to 15 000

Exhaust and ventilation systems will create a lower pressure in the spray cabin. This lower pressure shall not cause difficulties opening the doors while the extraction is running. An adequate air inlet shall be calculated and designed to avoid this.

The start of the spray system shall be interlocked with the exhaust system to ensure adequate extraction during spray operation.

Sometimes ventilators with two running speeds are recommended either to keep a low ventilation level mode, if the cabin door is opened for maintenance, set-up or teach-in programming or to increase the ventilator capacity in the case of emergency to avoid a dangerous or explosive atmosphere in the cabin.

The exhaust system should have a short run lengths and preferably should lead only from one or two spray equipment to each collector. The exhaust and filter system should have smooth walls inside and no dead spots where dust can accumulate. The exhaust channel should have as few bends as possible of large a radius as possible to avoid loss of pressure and gathering of dust. The recommended air speed in the duct should be between 16 m/s and 25 m/s. Accessibility for cleaning and inspection is required.

Depending on the material sprayed, additional measures shall be taken to avoid fire and explosion risks. Generally, the national or local regulations shall be fulfilled.

3.3 Equipment in the spray cabin

3.3.1 General

Often a spray cabin contains the part fixture system (turning device for spraying, turn table, automatic part changing equipment, etc.), the manipulator system to move the spray torch (industrial robot, X-Y-Z-axis manipulator system, etc.), the exhaust hood for spray dust, fume, and heat, exhaust channels, and the spray torch with its hose assembly, and devices for cooling the part.

The control panel shall be mounted outside the spray cabin for mechanised or automatic spraying, for manual spraying it can also be mounted outside, if a second person with visual contact to the spraying area is present. This person shall monitor the process and shut-off the spray system in case of emergency.

Sources of danger identified by a risk assessment shall be considered and marked, if appropriate, for example by mechanical barriers, stop devices, warning barriers, warning signs.

3.3.2 Function and description of the manipulating systems

Manipulating systems can help to increase the quality assurance and to avoid exposures of the operating personnel. They can be of:

— linear speed traverse;

— rotating tables;

— X-Y-Z-axis manipulator; or

— industrial robot type.

The safety requirements for industrial robots are specified in EN ISO 10218-2.

3.3.3 Electrical equipment and installation

Electrical Apparatus is a prime source for ignition an explosive atmosphere. The installation shall conform to the EN ISO 60204-1 and the local national regulations for electrical installations including the electromagnetic compatibility according to EN 60974-10 and to the manufacturer's instructions.

The safety relevant control loops, determined by the risk assessment, shall be developed according to EN 13849-1.

3.4 Extraction and filtering equipment

3.4.1 General

Its purpose is to collect, extract and filter the spray dust from the air, in order to remove the fine sized particles before the air is released to the atmosphere. The limiting values for emission of fine, coarse and carcinogenic dusts are specified in National Environmental Legislation. Wet extraction is not suitable for thermal spraying applications, because it is not able to meet emission reduction requirements.

3.4.2 Dry extraction

3.4.2.1 Dry working collector systems

Sprayed particles, which either miss the part or rebound from it, should be captured close to their source of creation. The extraction equipment can vary from:

— a basic hood behind the part to be coated, adequately adjusted to its shape and the local conditions and moved correspondingly with the motion of the spray torch; or

— floor extraction system ('floorwash'), which can provide a higher extraction rate of sprayed particles and better cleanliness in the spray cabin. However, the energy needed to capture and transport the particles is extremely high;

— other systems which use for example, part of the cabin wall or a combination of several systems.

The air speed shall be a minimum of 1 m/s in front of the hood. A fire trap should be mounted to prevent hot particles getting into the filter, especially if arc spraying is applied.

3.4.2.2 Dry extraction systems – filter systems

As a pre-filtering operation multi cell cyclones can be used for pre-extraction of coarse grain particles to avoid over loading or damage of the cartridge filter elements. However, they are not able to capture spray particles below 5 µm in size.

Usually, cartridge filters, which possess an efficiency of > 99%, are used. They comprise a series of filter elements folded to form a pleated material, mounted within a steel casing. Due to mounting of the elements in several rows the required filter surface can be reached and can avoid exceeding the admissible surface loading. It is recommended that the filter should be located outside the building, so that the safe opening of an explosion vent is possible.

Filtration method, exhaust air speed, and cleaning of the cartridges depend upon the spraying process and its running time. Cleaning the cartridges is carried out automatically by periodic reverse pulsing with compressed air while operating. A suitable cleaning cycle provides a suitable free filter surface at all times.

The maximum operation temperature of the filter cartridge shall be considered. Typically, this value is 60°C.

To avoid an inadmissible emission into the environment in the case of damaged or broken filter elements a pressure sensor, shall detect any alteration of pressure. Additionally, a tribo-electrical automatic filter controller should be installed to detect an increase of the dust loading in the filtered exhaust air, before a real damage of one or more filter elements occurs measures to be taken are described in 5.8.3.