CEPE

Conseil Européen de l'Industrie des Peintures, des Encres d'Imprimerie et des Couleurs d'Art. Depuis 1951

Safe Powder Coating Guideline

7th Edition

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1. Introduction

Industrial thermosetting powder coatings are typically produced by blending and extruding together resins, curing agents, pigments and additives. The resultant matrix is ground into fine discrete particles. Such powders are applied to a substrate or workpiece via a pressurised spray application system, complete with electrostatic charging of the powder coating to charge the particles and effect a high level of transfer on to the work piece.

Application can be via either fully automated or manual systems, with the workpiece transported through a spray zone containing a number of guns and into a stoving oven via an overhead conveyor.

Air pressures in the order of 0.8-2.0 kPa (10-30 psi) and electrical potentials in the order of 10-90 kV at a current between 1,5µA (Tribo) and 100 µA are typically employed.

Systems are designed to minimise the amount of overspray. Excess powder is removed by exhaust extraction and collected for re-use or disposal.

From the information in this Guide relating to safe working procedures, it is clear that there is a lower level of hazard when using powder coatings compared to conventional solvent-based paints. Dust clouds in air require 50-100 times the energy necessary to ignite a solvent vapour/air mixture, and are therefore inherently more difficult to ignite. Also powder mixtures in air need to be above a certain concentration, known as the lower explosion limit (LEL) before ignition or explosion can occur.

However, certain hazards do exist when using powders depending on various factors. Precautions must be taken to avoid them, and these are referred to here as safe working procedures. If these are followed, any risk should be reduced to a minimum.

The main hazards involved in the electrostatic application of powder coatings are:

(i) Dust explosion and fire
(ii) Electrical shock
(iii) Exposure to hazardous substances
(iv) Compressed air

2. Dust explosion and fire hazards

2.1 Causes

2.1.1 Powder coatings, being fine organic materials, can give rise to dust explosions. A dust explosion may occur when both:

(i) the concentration of dust in the air is between the Lower Explosive Limit (LEL) and Upper Explosion Limit (UEL).

and

(ii) a source of ignition of the required energy for the dust cloud is present. Such sources of ignition can include:

(a) hot surfaces or flames
(b) electrical discharges or sparks
(c) electrostatic discharges

2.1.2 A fire may occur when a layer of deposited powder coating or a cloud comes into contact with an ignition source such as those listed in 2.11 (ii) above. A fire within the powder coating system may result in a dust explosion if either burning particles are allowed to enter confined sections of equipment, such as dust collectors, or if burning dust deposits are disturbed.

2.2 Prevention of powder dust explosion

2.2.1 An explosion can be prevented if both or either of the conditions shown in 2.1.1 are avoided. Powder coating systems should be designed to prevent both conditions occurring, but due to the difficulty of totally eliminating sources of ignition, more reliance should be placed on the prevention of explosive concentrations of powder. This can be achieved by ensuring that the powder in air concentration is kept below 50% of the LEL.

Appendix 1 describes how the concentration of the powder coating, which may be present in the spray booth, can be calculated.

2.2.2 Determined LELs on the range of typical powder coatings lie between 20 g/m^3 and 70 g/m^3 dependent on the specific chemical and physical properties.

It is recommended that a twofold safety margin is applied to maximum dust concentrations. Spray booths and associated equipment such as dust collectors, should, therefore, be designed and constructed to ensure that dust concentrations never exceed 10 g/m^3. Dust concentrations should be reduced as far below this value as is reasonably practicable. Reference should be made to Pr EN 12981 and Pr EN 50177 for information on the design and operation of booths and spray equipment.

2.2.3 The application unit should be clearly marked with the capacity of the extraction unit and the maximum number and capacity of the spray guns. The configuration of the unit and coating powder usage should be regularly checked against stated values to ensure that airborne concentrations do not exceed 10 g/m^3.

2.2.4 A regular maintenance and cleaning schedule should be introduced to prevent accumulation and build up of dusts. In the case of electrical equipment, build up of dusts can result in their ignition through overheating. The temperature of external surfaces, or surfaces liable to be exposed to dust, of electrical equipment should not exceed 270ºC. This value is 2/3 of the minimum ignition temperature.

2.2.5 The use of compressed air or dry brushing for cleaning up spills for cleaning down equipment should be avoided.

Suitably designed dust-tight vacuum cleaners to Standard IP6X/IP54 of EN60529, or wet brushing are preferred methods.

2.2.6 Smoking should be strictly prohibited and all sources of ignition, such as matches and lighters, should be excluded.

2.2.7 The principles of avoiding the creation of dust clouds together with ignition sources are equally applicable to general handling and cleaning processes.

3. Electrical hazards

3.1 Causes

The main sources of electrical hazard are :

(i) inadequate or defective earthing (grounding) systems leading to build-up of static and subsequent sparking or shock.

(ii) breakdown or overheating of the electrical equipment leading to fire or shock.

3.2 Prevention

3.2.1 The contact between the workpiece, carrier jigs and conveyor should be designed and regularly tested to ensure an adequate earth is maintained at all times. Jigs should be designed to avoid any unnecessary build-up of coating. They should be cleaned on a regular basis to maintain correct contact.

Automatic cut-out or warning systems should be installed, wherever practicable, to constantly monitor the efficiency of the earthing system between the jig and the conveyor.

3.2.2 Metal objects to be coated should have a resistance to earth not exceeding 10^6 Ω.

3.2.3 Floors and other surfaces with which operators can make contact should be conductive and have a resistance not exceeding 10^6 Ω. Non-conductive materials can be coated with conductive floor compounds and coatings.

3.2.4 As an additional precaution, all components of the spraying facility should be connected together through an equipotential bonding system. This should include all electrical equipment enclosures, metal floors, ceilings, fences, partitions, and conveyors as well as the HV generator.

3.2.5 As an alternative to physical earthing of the workpiece, ionising devices can be used to discharge any accumulated electrostatic charges. The device should be sited as near as possible to the work piece.

3.2.6 Conveyors should be designed to minimise swinging of the work piece.

3.2.7 Regular maintenance and cleaning programmes should be introduced to ensure that dusts are not allowed to build up on electrical equipment and that ventilation ducts and cooling fins are kept clean and unobstructed.

3.2.8 Only the spray gun(s) and associated electrical cables and powder supply hoses should be sited inside the booth.

If the siting of other electrical equipment, including the HV generator, in the booth or adjacent areas is unavoidable, this equipment must meet the requirements of EN 50050 (handguns)and EN 50 177 (automatic guns) and must be dust tight to Standard IPX.

3.2.9 Operatives should wear anti-static overalls, non-insulating gloves and anti-static footwear meeting the requirements of ISO 2023/2024.

4. Health Hazards

4.1 Causes

Health problems when handling or using a powder coating may arise through exposure to hazardous substances, which may be contained in the coatings, or to the powder coating itself.

4.2 Prevention

4.2.1 Implemented EU legislation requires that an employer carries out an assessment of the nature and extent of exposure to hazardous substances in the workplace and the measures necessary to prevent or control exposure.

4.2.2 As part of the assessment, reference should be made to the label on the package, the accompanying safety data sheet and other information provided by the supplier.
Coating powders are classified and labelled in accordance with the EU Dangerous Preparations Directive. Coating powder manufacturers provide health and safety data in a standardised form based on the requirements of this Directive.
Due account should be taken of information given in the safety data sheet when carrying out the assessments. Information contained in these will include:

(i) details and information on any hazardous substance
(ii) guidance on health hazards associated with the product and substances
(iii) guidance on occupational exposure limits
(iv) advice on safe handling and use
(v) advice on precautions necessary to avoid exposure

4.2.3 The following should also be borne in mind when carrying out the assessment:

(i) Coating powders can create airborne dusts and these may present a health hazard. Where airborne concentrations of individual substances exceed, or are likely to exceed any exposure limit, as is mentioned in the national legislation or any in-house occupational exposure limit, action must be taken to prevent or control exposure.

4.2.4 TGIC containing powder coating resins

(i) Classification & labeling of powder coating resins containing TGIC

Concentration limit (% w/w)	Classification	Labelling		
		R-Phrases	Danger symbol	Indication of danger
C ≥ 25	Mutagenic C2 Toxic Harmful Irritant Sensitising Dangerous for the environment	46 – 23/25 – 48/22- 41 – 43 – 52/53		Not applicable
10 ≤ C < 25	Mutagenic C2 Harmful Irritant Sensitising	46 – 20/22 – 48/22- 41 – 43		Not applicable
5 ≤ C < 10	Mutagenic C2 Harmful Irritant Sensitising	46 – 20/22 – 36 – 43		Not applicable

Concentration limit (% w/w)	Classification	Labelling		
		R-Phrases	Danger symbol	Indication of danger
3 ≤ C < 5	Mutagenic C2 Harmful Sensitising	46 – 20/22 – 43		Not applicable
1 ≤ C < 3	Mutagenic C2 Sensitising	46 – 43		Not applicable
0.1 ≤ C < 1	Mutagenic C2	46 & special phrase		Not applicable

Special phrase:Contains 1,3,5-Tris(oxiranylmethyl)-1,3,5-triazine-2,4,6(1H,3H,5H)-trione. May produce an allergic reaction.

Wording of R-phrases
R36 Irritating to eyes
R20/22 Also harmful by inhalation and if swallowed

It should be noted that TGIC containing powder coating resins (C ≥ 0.1 % w/w) are subjected to the provisions as laid down in Directive 1999/38/EC (Protection of workers from the risks related to exposure to carcinogens & mutagens at work)

According to European legislation TGIC containing products have to be replaced, if comparable TGIC – free products are available.

The occupational exposure limit is 3 mg/m3.

(ii) Coating powder dusts may cause adverse skin or respiratory reactions, including sensitisation in certain cases.

(iii) Hazardous products of degradation may be formed during the burning off of powder coating deposits from jigs and hangers. Refer to the supplier for more information on these if required.

4.2.4 It should be noted that some coating powders contain lead based pigments. Such coatings may be subject to national legislation of lead control at work as well as occupational hygiene. The German powder coatings industry has a self obligation to a renunciation of lead pigments.

Concentration Limit (% w/w)	Classification	Labeling		
		R-Phrases	Danger symbol	Indication of danger
C ≥ 25	Repr. R_E Kat.1 Repr. R_F Cat.3 Harmful Dangerous for the environment	61-20/22-33-62-50/53		
2,5 ≤ C < 25	Repr. R_E Kat.1 Repr. R_F Cat.3 Harmful Dangerous for the environment	61-20/22-33-62-51/53		
1 ≤ C < 2,5	Repr. R_E Kat.1 Harmful Dangerous for the environment	61-20/22-33-52/53		
0,5 ≤ C < 1	Repr. R_E Kat.1	61-33-52/53		
0,25 ≤ C < 0,5		52/52		

Applies to lead compounds with the exception of those specifically listed in the EU rating guidelines of Commission Directive 2004/73/EG dated 29 April 2004.
The concentrations specified here and in the preparation guideline are to be understood as weight percentages of the metals with reference to the total weight of the preparation.

Additional labeling:
Additional labeling instruction from 1999/45/EC, Appendix V: The packaging label for paints and coating compounds containing lead, whose total lead content exceeds 0.15% (expressed as the weight of the metal) of the total weight of the preparation must bear the following inscription - "Contains lead. Should not be used on surfaces liable to be chewed or sucked by children."
The warning on packages containing less than 125 ml can be as follows: "Warning! Contains lead."

Additional labeling in accordance with German TRGS 200, No. 6.9:
"Only for professional use"

Workplace limit values (TRGS 900):
0.1 mg/m^3 with reference to the inhalable fraction

Preventive medical checkup:
German BG-Grundsätze für arbeitsmedizinische Vorsorgeuntersuchungen G2 (basic guidelines for occupational medical checkups): Lead and its compounds (with the exception of alkyl lead compounds):

Additional regulations covering or forbidding the use of pigments containing lead:
EU Directive 2000/53/EC regarding end-of-life vehicles
EU Directive 76/769/EEC regarding use limitations
EU Directive 2002/95/EC (RoHS) for limiting the use of certain dangerous materials in electrical and electronic devices

4.2.6 Measures which should be introduced to prevent or adequately control exposure include the following:
(i) installation of properly constructed spray booths with exhaust ventilation equipment to extract dust and maintain airborne concentrations below the OEL (5 mg / m^3) within the workplace.
Where manual application techniques are in use, the direction of the air flow should be from behind the operator, over the workpiece being coated and into the exhaust ducts. These should be situated as close to the workplace as possible.
If the powder coatings concentration exceeds 10 mg / m^3, respiratory protective equipment (RPE) should be worn in compliance with the local legislation.

The operation and effectiveness of extraction and ventilation systems should be inspected, tested and maintained in accordance with national legislation.
Allergy sufferer and people who have difficulty in breathing should not work in a powder coatings line.

(ii) Installation and design of stoving ovens should be such that any by-products or volatile components are exhausted to a safe place and prevented from escaping or returning into the work area.

Ovens should be inspected, tested and maintained to ensure their operational effectiveness.

(iii) facilities for jig cleaning should, wherever possible, be fully contained systems, with exhausts properly ventilated to a safe place. Where this is not practicable, employees should be

provided with appropriate personal protective clothing (PPE), including respiratory protective equipment (RPE) if necessary.

(iv) All other stages in the handling of coating powders e.g. opening the packages, loading of hoppers, collection of unused powders should, wherever possible, be contained to prevent the escape of dust. Local exhaust ventilation and appropriate PPE should be provided in the event this is not practicable.

(v) All employees involved in the handling of coating powders should be provided with anti-static coveralls designed to prevent ingress of the powder. Suitable gloves should be provided to minimise skin contact.
Where engineering controls are inappropriate or not possible for reducing exposure to the required levels, suitable RPE must be provided. Depending on the circumstances either dust respirators or air fed respiratory equipment will be required. In either case an adequate level of protection must be ensured.

(VI) Eating, drinking and smoking should be strictly prohibited within the workplace.

4.2.5 Employees exposed to hazardous substances should be considered for health surveillance according to national legislation.

5. Compressed Air

5.1 Causes

5.1.1 Compressed air can be dangerous in a number of ways :-

(i) it can enter the body via orifices such as the mouth, ears etc. causing internal injury.

(ii) it can penetrate the skin causing embolisms.

(iii) particles in the air stream can damage eyes.

(iv) pressurised systems can explode with violent effect when ruptured or damaged.

5.2 Prevention

5.2.1 Compressed air should not be used for cleaning of clothing or skin.

5.2.2 The pressure system should be maintained in good repair and subject to periodic inspection.

5.2.3 suitable and adequate instructions for the use of the pressure system are provided to any person operating it. The instructions must include the action to be taken in the event of an emergency.

6. Construction of Plant and Equipment

6.1 Full guidance

Full guidance is contained in CEN Standards Pr EN12981, Pr EN 50177, 1999/92/EC, and reference should be made to these before installation and operation of any powder coating plant and equipment.

6.2 The spraying facility

The spraying facility should be located taking the following into account :-

(i) provision of safe means of escape.

(ii) ventilation of, and extraction from, the area.

(iii) ready access for emergency services in the event of fire.

6.3 Spray Booths

6.3.1 The powder supply and coating powder feedlines should be interlocked with the air extraction system, so that, in the event of failure of the ventilation system, the coating powder and powder supplies are cut off. Airflow monitor switches are the preferred method of detecting failure of the ventilation system. Such equipment will also be sensitive to blocked filters and broken or loose fan blades.

6.3.2 A fire detecting device, interlocked to shut off powder and coating powder supplies and ventilation may be installed in the booth and coating powder processing areas an additional precaution.

6.3.3 A flame detection device is recommended for fully automatic booths. It should be sited inside the booth and be interlocked with the high

voltage supply, the coating powder feed line and the fans in the extract system.

6.4 Stoving Ovens

6.4.1 The stoving oven should be situated at least 1m from the powder spraying installation and arranged so that powder cannot accumulate or be spilled near to the oven, its air intakes, hot surfaces or any electrical apparatus. Air movement within the oven should not be so high as to blow off powder from the workpiece before fusion.

6.4.2 The clean air change requirements of the oven should be known and visibly marked on the oven.

6.4.3 For conveyor ovens and especially those using radiant heat sources, an interlock should be provided to significantly reduce or shut down the energy source if the conveyor stops, in order to prevent overheating and possible ignition of the coating powder or workpiece.

6.4.4 Gas and oil fired ovens should be provided with explosion relief panels which can operate effectively to prevent the pressure in the oven building up to dangerous levels in the event of a gas or fuel oil explosion. The explosion relief should be located so as not to discharge towards the powder spraying installation or into occupied areas.

6.5 Application Equipment

6.5.1 All handled spray guns should conform to the requirements of EN 50050 and EN 50053-1 (ref. 5). This will ensure that an incendive spark is not produced when the gun comes close to an earthend article. Automatic spray guns should conform to the requirements of EN 50177.

6.5.2 High voltage cables, particularly those leading to automatic reciprocating guns, must be protected against mechanical damage.

6.5.3 All electrical equipment should be capable of being isolated from a safe position in the event of a fire or emergency.

6.6 Ventilation and ducting

6.6.1 Ventilation systems are required to maintain the concentration of airborne dusts below the OEL in occupied work areas and below one half of the LEL in enclosed areas.

6.7 Ventilation and powder collection system

6.7.1 Enclosed filter membrane collectors and cyclone collectors should be provided with explosion relief unless the openings provided give sufficient protection. The collection unit should preferably to located outside in a safe place, with minimum of enclosure required for weather protection. If it is necessary for the dust collection unit to be sited indoors, it should be in a separate area away from the working area.

6.7.2 The dust collector should be discharged by one of the following methods :

(i) via a rotary valve with a sufficiently fine clearance between the valve blades and rotor casing or other suitable choke to prevent passage of an explosion flame front. A suitable limit switch should be provided, arranged so that the powder supply to the valve is cut off in the event

of an explosion to prevent burning particles being carried through by rotation of the valve.

(ii) directly into strong metal container clamped firmly to the discharge outlet.

(iii) where powder is to be recycled, before mixing with fresh powder it should be sieved to remove foreign bodies. Where recycling is automatic, the sieve should be in-line between the recovery system and the powder hopper.

(iv) Powder hoppers and recovery systems should be designed and located to ensure filling, emptying and cleaning operations can be carried out with minimum discharge of powder into surrounding areas. Local exhaust ventilation should be provided where necessary to reduce dust levels in air.

APPENDIX

Method for the calculation of the concentration Of a powder coating in the spray booth

The maximum concentration of powder coating that can be present in the spray booth is determined from the formula:

$$C = \frac{M}{V}$$

Where

- C is the concentration of powder in the spray booth;
- M is the mass of powder coating emitted from the gun(s) in a unit time at the maximum emission rate of the gun(s). No allowance should be made for any powder coating deposited on the workpiece.
- V is the volume of air extracted by the ventilation system set at its lowest extraction rate, measured over the same time period as M.