JOINT - PROTOCOL ON IMPROVED CONDITIONS OF USE OF EB-TECHNOLOGY IN THE PRINTING AND COATING INDUSTRY IN EUROPE

PROTOCOLE COMMUN DE L'EUROPE SUR LES MEILLEURES CONDITIONS DE MISE EN ŒUVRE DES TECHNOLOGIE EB DANS L'IMPRIMERIE ET LES INDUSTRIES DE REVETEMENTDE SURFACE

PROTOCOLLO COMUNE SUL MIGLIORAMENTO DELLE CONDIZIONI DI LAVORO TRAMITE L'UTILIZZO DELLA TECNOLOGIA AI RAGGI EB NELL'INDUSTRIA DELLA STAMPA E DEL RIVESTIMENTO IN EUROPEA.

GEMEINSAMES PROTOKOLL ÜBER VERBESSERTE EINSATZBEDINGUNGEN DER ESH-TECHNOLOGIE IN DER DRUCK UND BESCHICHTUNGSINDUSTRIE IN EUROPA.

PROTOCOLO COMÚN SOBRE LAS CONDICIONES MEJORADAS DEL USO DE LA TECNOLOGÍA EB EN LA INDUSTRIA GRÁFICA Y DE RECUBRIMIENTO EN EUROPA

GEMEENSCHAPPELIJK PROTOCOL VOOR VERBETERDE VOORWAARDEN VOOR DE TOEPASSING VAN DE EB TECHNOLOGIE IN DE GRAFISCHE EN COATING INDUSTRIE IN EUROPA

The following organisations are underwriters of the protocol and support the recommendations described therein:

Berufsgenossenschaft Druck und Papierverarbeitung (BGDP); Germany
Caisse Nationale de l'Assurance Maladie des Travailleurs Salariés (CNAMTS); France
Federale Overheidsdienst Werkgelegeneheid, Arbeid en Sociaal Overleg (FOD WASO); Belgium
Service publique fédérale Emploi, Travail et Concertation sociale (SPF ETCS); Belgium
Health and Safety Executive (HSE); United Kingdom
Istituto Superiore per la Prevenzione e la Sicurezza del Lavoro (ISPESL); Italy
Instituto Nacional De Seguridad E Hygiene En El Trabajo (INSHT); Spain
Vereinigung der Metall-Berufsgenossenschaften, Fachausschuss Metall und Oberflächenbehandlung (VMBG); Germany
Schweizerische Unfallversicherungsanstalt (Suva); Switzerland

The document has been initiated by RadTech Europe (European Association for the promotion of UV/EB Technology) and VDMA (German Engineering Federation). It has been established in conjunction with the underwriting organisations and industry members.

A version in any other language made by translation under the responsibility of the respective Institute into its own language and notified to the original creators has the same status as the official version.

To prevent misunderstandings and misinterpretation, the underwriting organisations recommend that individual sentences and paragraphs should not be quoted out of context.

1 Introduction

This document covers only machinery with inherently protected EB units[1].

This document does not cover machinery with EB units for high energy EB applications, which may be operated only in controlled areas.

Current knowledge of epidemiology still seems insufficient to confirm whether this technology is more or less dangerous than the use of conventional printing and coating[2] formulations.

EB Technology will not cause health problems providing the safety proposals from the EB Protocol, regarding technical equipment and handling of printing inks and coatings, are correctly and carefully applied.

EB Technology is experiencing a new upsurge due to:

- further developments in materials and machinery;
- the conditions imposed by the regulations covering the use of volatile organic solvents in the printing and coating industry;
- the need to the efficient use of energy;
- new possibilities arising from the increased availability of EB formulations in the printing and coating industry.

The signatories therefore deem it appropriate to proactively define a mutually agreed guideline for the safe use of EB Technology.

1.1 Aim

The EB Protocol suggests improved conditions for the use of EB printing, coating and laminating technology - in particular as it may affect the health and safety in the workplace and the protection of the environment.

1.2 Status

The EB Protocol represents what is considered to be good practice for EB Technology in Europe. The content conforms to the essential requirements of the relevant European Directives[3].

European Standards[4] specify the technical details regarding the essential requirements of the relevant European Directives for the machinery concerned.

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[1] inherent protection is usually achievable (with technical reasonable effort) for units with accelerating voltages of up to 300 keV

[2] For the content of the EB protocol the term "coatings" refers to paint, lacquer, varnish etc.

[3] Relevant European Directives are:

- Council Directive 98/24/EC of 7 April 1998 on the protection of the health and safety of workers from the risks related to chemical agents at work (fourteenth individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC)
- Directive 98/37/EC of the European Parliament and of the council of 22 June 1998 on the approximation of the laws of the Member States relating to machinery.
- Council Directive 96/29/Euratom of 13 May 1996 laying down the basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionising radiation.

Following the contents of the EB Protocol is not compulsory, but it is expected that printers/coaters following the guidance described here, will comply with the relevant European legislation. The underwriting organisations will refer to this document when illustrating good practice.

This document does not limit the possibility of any underwriting organisation to adopt additional provisions that would enhance workers health and safety or environmental protection, particularly in response to developments in the technology or knowledge of risk control measures.

All European partners are invited to submit any suggestions for additional provisions which will be discussed with relevant interested parties.

This document is based on general principles of health and safety at work, which in turn depend on a combination of the materials used and the way in which they are used.

1.3 The EB printing and coating process

The term EB Technology refers to a process where a liquid or powder is converted into a solid by means of electron beam radiation. Electron beam processors are electron accelerators providing electrons at energy levels sufficient to initiate chemical reactions; typically polymerization of coatings, crosslinking of plastics or grafting reactions.

The components of most EB curable printing and coating materials are based on

- reactive acrylates,
- admixtures
  (Oligoether acrylates, Urethane acrylates, Melamine acrylates, Amine modified acrylates, Chlorinated polyes acrylates, Epoxy acrylates, Polyester acrylates, Silicone acrylates, Acrylated acrylates, Phosphated modified (meth)acrylates),
- colourants,
- additives.

EB curing is very fast and typically takes place in micro-seconds. Low voltage EB processors providing electron beam energies in the energy range up to 300 keV are best suited for efficient treatment of thin products. Regulations covering the use of ionising radiation have to be taken into account in the case of EB curing.

In order to initiate the polymerization high energy electrons are sufficient and photoinitiators are not necessary. Pigments as well as further additives can be part of the formulation. Under normal conditions the EB printing and coating formulations can be considered as solvent-free.

EB Technology is established for more than 30 years. The range of EB applications includes printing and overprint varnishes, industrial applications like laminating adhesives and pressure sensitive adhesives (PSA), siliconisation as well as coating of wood, plastic and metal. It is widely used in the corresponding industries on substrates like paper, plastics, metal, wood or textile.

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[4] The relevant European Standards are developed in the following Technical Comittees:

- CEN/TC 198 "Printing and Paper machinery"
- CEN/TC 271 "Surface Treatment Equipment - Safety"
- CLC/SC 31-8 "Electrical apparatus for explosive atmospheres; Electrostatic painting and finishing equipment"

2 Precautions

This section lists the significant hazards related to EB Technology. The tables in the subsections list possible measures for the safe application as proposed by the underwriting organisations. The proposed measures may be applied alone or in combination to achieve a process as safe as possible.

The EB Protocol covers only the significant hazards specific to EB Technology[5]. These significant hazards are:

1. Contact with or inhalation of EB printing and coating materials, diluents, wash-up solvents as mists or liquids
2. Inhalation of Ozone[6]
3. Exposure to ionizing radiation (X-rays, Bremsstrahlung)[7]

The EB protocol does not cover hazards not significant to EB Technology (e.g. fire, explosion).

Technical measures shall be preferred to organizational measures.
Organizational measures shall be preferred to personal protection measures.

In all cases, appropriate instruction of workers is required.

Following the basic principles of health and safety in the workplace as detailed in section 3 of the EB Protocol is recommended for the application of EB Technology. Additional references are provided at the end of this publication.

[5] Significant Hazards which are common to conventional printing and coating applications are not covered in this document.

[6] Generation of ozone is only relevant to processes without inert gas atmosphere. Due to chemical characteristics of EB coatings, inert gas atmosphere is connected to the vast majority of the coating processes. Surface treatment (no coating) with EB technology may take place in air. Crosslinking of polyolefin and the curing of laminating adhesives buried between two layers (no oxygen present) by EB may take place in air.

[7] EB radiation does not cause effects of radioactivity.

2.1 Contact with or inhalation of printing and coating materials, diluents, wash-up solvents

2.1.1 Contact with printing and coating materials

Skin contact with uncured EB printing and coating materials may cause skin irritation. In addition, acrylates may lead to sensitisation; which can manifest itself at any time in some cases as an allergic reaction. For a sensitised person, further contact with the material concerned, even at very low doses, may cause a severe reaction with effects that are, in most circumstances, irreversible.

<table>
<tr><th>Proposed safety measures</th><th>Printing</th><th>Coating</th></tr>
<tr><td>Technical</td><td>- Varnish pumping systems
- Blanket wash unit
- Washing systems for cleaning impression cylinders
- etc.

- Automatic ink, varnish and lacquer dosing should be considered. If implementation is not possible, tools and containers should be used which allow transporting of ink, varnish and lacquer without skin contact.</td><td>Design and construction of equipment according to:
- EN12215 (spray booth)
- EN13355 (combined spray booth)
- EN12981 (powder spray booth)
- EN12581 (dip coating plant)
- EN12621 (machinery for supply and/or circulation of coating materials)
- EN12757-1 (Mixing machinery for coating materials)
- EN1953, EN50176, EN50177 (application systems)
Use cleaning machines for spray guns
Reduction of mist or dust from coating material by use of appropriate spray processes (e.g. electrostatic processes, HVLP)</td></tr>
<tr><td rowspan="2">Working procedures
Organizational</td><td colspan="2">- Hazard-free procedures must be developed for clearing jams in the machines in all places where there is a danger of exposure to uncured EB inks or coatings. Operators are to be issued suitable equipment for personal protection and instructed in its use.
- Collection/disposal of used cleaning agents in appropriate and marked waste containers</td></tr>
<tr><td></td><td>- guide spray gun perpendicular to workpiece surface
- adopt spray jet width to the workpiece
- spray parameters as recommended by the manufacturer:
- minimize distance workpiece/spraygun
- use low spray pressure</td></tr>
<tr><td rowspan="2">Personal protection</td><td colspan="2">- Protective goggles,
- Respiratory protection,
- Protective gloves, according to the recommendations of the varnish and lacquer manufacturer / regular change
- Protective clothing including cleaning/storage/disposal</td></tr>
<tr><td></td><td>- Protective clothing and independent breathing air supply</td></tr>
</table>

2.1.2 Contact with or inhalation of mist / dust of printing or coating material

Printing:
All types of printing material may become airborne due to fast roller speeds and produce an aerosol ink-/lacquer mist in the workplace. This is more prevalent with increased press speeds. It is commonly referred to as ink-fly, and since the undried components of the inks and varnishes contain materials which are classed as irritants and potential sensitisers that can be harmful to skin, eyes and respiratory tract, the ink-fly may be hazardous to health if not adequately controlled.

Coating:
For spray application the generation of mist is essential to the coating process. The use of adequate safety measures is essential to avoid the hazard of contact or inhalation of mists or dusts of coating material. For dip coating application the generation of mist is no significant hazard.

Proposed safety measures	**Printing**	**Coating**
Technical measures to **reduce generation of mist** of printing or coating materials	- misting may be diminished by reducing the machine speed. - Cooling systems for the inking mechanisms and other machine/ink contact surfaces/zones are recommended in order to obtain a constant viscosity of ink and varnish. - Ink agitators should be used to homogenise the viscosity of inks, varnishes and lacquers in the formulation containers.	- Reduction of mist or dust from coating material by use of appropriate spray processes (e.g. electrostatic processes, HVLP) - See table of section 2.1.1
Technical measures to **extract mist** of printing or coating materials	- If there is a danger of aerosol (misting/ink-fly) formation, the inking and varnishing mechanisms should be equipped and operated in conjunction with effective extractor systems. Disposal shall then be in accordance with local environmental protection regulations.	- See table of section 2.1.1
Working procedures Organizational	See table of section 2.1.1	
Personal protection	See table of section 2.1.1	

2.1.3 Contact with or inhalation of wash-up solvents

The effects of exposure to wash-up solvents depend on the type of solvent used. Dry skin, dermatitis, headaches, nausea or effects which do not show up until much later can result from the misuse of solvents.

<table>
<tr><th>Proposed sefaty measures</th><th>Printing</th><th>Coating</th></tr>
<tr><td rowspan="2">Technical measures</td><td>- An automatic roller cleaning system with disposal of solvents that does not involve hand contact should be considered.</td><td>- Use cleaning machines for spray guns
- Forced ventilation (see table of section 2.1.1)</td></tr>
<tr><td colspan="2">- If any machine parts, regularly need to be removed for cleaning, a suitable work space is to be provided with local exhaust ventilation for gasses released and a facility for draining off liquids.</td></tr>
<tr><td>Personal protection measures</td><td colspan="2">- For cleaning procedures, operators should wear gloves. For example, disposable nitrile gloves may be worn. The gloves should correspond to the RadTech study[8] or the recommendations made by the producers / suppliers of wash-up solvents.
- Direct skin contact with EB printing or coating material washing fluid and varnish detergent must be avoided. Observe current EN safety data sheets.
- Cleaning should be performed using only solvents with a high flash point which conform to any existing national agreements and initiatives.
- Protective clothing according to the type of work to be carried out, shall be supplied. This may include overalls and protective gloves, protective goggles or breathing masks.
- Care should be taken that gloves with a good overlap of the sleeves of overalls are used. For longer periods of exposure, or for mechanical processes, neoprene or nitrile gloves with a thickness of at least 0.4 mm should be worn.
- Damaged or degraded gloves, i.e. gloves which have lost their shape, elasticity or colour, must be replaced in all cases.
- Collection/disposal of used cleaning agents in appropriate and marked waste containers</td></tr>
</table>

[8] CEFIC/RadTech study

2.2 Inhalation of ozone

Ozone is generated when EB curing takes place in air by reaction of electrons with the oxygen molecules . Exposure to ozone gas can lead to eye, nose and throat irritation and at higher levels, headache or nausea. At even higher levels chest pains and a cough may occur. Due to the higher energy content, EB radiation generates more ozone than UV radiation.

Generally EB curing takes place under inert atmosphere (N_2) and no ozon is therefore produced.

Proposed safety measures	**Printing**	**Coating**
Technical (alternatives)	**Prevent generation of ozone** - Inertisation (e.g. with Nitrogen atmosphere) will prevent the generation of ozone.	
	Safe containment of generated ozone - Ozone formed shall not escape in dangerous concentration into the workshop, but be removed using suitable extractor systems. - The extracted air shall not be reintroduced into the workshop. - Before exhausting to the environment appropriate treatment devices (e.g. filter) should be considered to accord with local legislation.	
Organisational	- Ozone levels should be checked during commissioning to ensure that the risk from ozone is adequately controlled. Subsequent checks should also be carried out if the equipment is substantially altered.	

2.3 Exposure to hazardous radiation (X-rays)

Energetic electrons produce X-rays when absorbed by matter. This natural phenomenon is used in medical, industrial and safety related X-ray equipment. The intensity of this radiation depends upon the characteristics of the absorbing material and the electron energy. X-rays scatter in all directions as they interact with atoms and molecules and have a long range in air.

Electron processors must be distinguished from radioactive radiation sources which emit radiation continuously and cannot be turned “ON” and “OFF” through simple electrical controls. There is no radiation when the EB-system is turned off and absolutely no residual radiation or radioactivity in the products treated or the electron processors itself.

In high doses X-rays present a health hazard to humans. X-rays are very penetrating and pass the human body, but are completely absorbed by an appropriate layer of high density material, such as lead. Exposure of the whole body to very high radiation levels over a short period is fatal. At lower doses radiation exposure may result in the possibility of developing cancer and leukaemia, but this possibility decreases in proportion to the dose.

Low energy EB equipment (< 300 keV) with integrated shielding qualifies for installation in an unrestricted and uncontrolled area. It may be installed and operated without additional shielding and precautions in any public access environment provided the external radiation levels do not exceed the radiation levels allowed for the general public: 1 µSv/h. The use of personal dosimeters or other control systems by the operating personnel is not necessary.

Proposed safety measures	**Printing**	**Coating**
Technical measures	- The radiation levels outside the EB equipment may not be higher than the natural radiation levels the public is exposed to. - Electron beam equipment must be shielded with fully integrated radiation shielding - often called self-shielding. The shielding must be designed so that: - No openings exist in the shielding except for the entrance and exit of the product. - The openings for entrance and exit of the product have to be designed in such a way that radiation and leakage are absorbed. - Visual contact with the electron illuminated process zone may not be possible. - Access to dangerous zones shall be safeguarded by interlocking with shielding of the hazardous radiation source. - Shielding (in general fixed guards) of the hazardous radiation source which have to be removed frequently or for make-ready shall be interlocked with guard locking with the radiation source in such a way that the radiation source will be switched off perforce before opening or removal of the shielding. *Note* *EB systems may be equipped with environmental radiation monitors mounted at relevant locations on the EB-equipment to ensure operation within the limits specified by the authorities (1 µSv/h).*	

Organizational measures	- Before the first comissioning at least the safety standard of the EB unit should be checked and recorded by a competent person. Determination of the radiation levels in the accessible areas should be part of this inspection. - Regular radiation mapping is required and should be covered in the preventive maintenance procedure. - The use of personal dosimeters or other control systems by the operating personnel is not necessary.

3 Basic principles of health and safety in the workplace for the use of hazardous products

Applying the measures described in section 2, it is recommended to follow the basic principles of health and safety at work:

- Elimination, i.e. total avoidance of the chemical substances or processes which give rise to hazards;
- Substitution, i.e. as soon as a less hazardous substitute is available;
- Limiting exposure in terms of quantity and time;
- Personal precautions, e.g. protective gloves and face masks;
- Monitoring, i.e. measuring of actual exposure.

3.1 Consider the elimination or substitution of products

The aim is to consider eliminating those products which present the highest risk to human beings and the environment. Product suppliers are obliged to provide up to date safety information sheets, as well as to identify known hazards on the product labels. The users must ensure that they have up to date information on the products and that they have identified the specific hazards before use.

European print and coating industry companies (European ink, varnish and lacquer manufacturers, printers, coaters and employees involved in the coating industry) should refer to the Guide to the Classification and Labelling of Acrylates developed by the CEFIC Sector Group of UV/EB Acrylate Producers (see section 5 for details). This explains how the European Union legislation is applied to the classification and labelling of EB curable acrylates.

Using the information provided in safety data sheets, and any national guidance or agreements designed to encourage the preferred use of lower hazard acrylate based materials, print and coating employers should carry out risk assessment and select the lowest risk product (section 4).

European partners will continue to work together to produce further practical guidance for implementation of this document. An example of such an agreement in the UK is the ‘Acrylate Preference Criteria’ scheme. Further details are available from European Associations involved in Surface Technology and Institutions involved in working conditions.

3.2 Personal hygiene and housekeeping

Care should be taken to ensure the highest standard of personal hygiene and housekeeping. This will involve regular cleaning of the working areas and the use of high quality hand cleansers and moisturisers. Suppliers of EB curable inks, lacquers and varnishes should be able to advice on suitable products.

If protective clothing is contaminated with a small amount of EB curable resin, then it should be disposed safely. Work clothing should be stored separately from personal clothing and should not be taken home for laundering.

Waste cleaning materials such as for example contaminated wipes etc. should be disposed of in dedicated, specially labelled bins and in accordance with local waste disposal regulations.

3.3 Provide Health surveillance

Hand this document to the company doctor or medical officer.

For each shift, nominate a responsible person to perform checks of exposed areas of skin in order to detect any skin disorders.

Promote awareness of respiratory problems caused by ink fly and encourage employees to report any symptoms.

Keep records of health checks.

Contacts

Further information may be obtained from the BG, CNAMTS, FMTWA, HSE, ISNHT, ISPESL, SUVA and manufacturers or suppliers of coating machines or EB curable materials. These include:

Berufsgenossenschaft Druck und Papierverarbeitung
Rheinstraße 6 – 8
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4 Publications

4.1 HSE

Free publications:

- Dermatitis in printing IACL101
- Supply of chemical to printers IACL96
- Solvent safety in printing IACL85
- Work related upper limb disorders in printing IACL91
- Precautions against humidifier fever in the print industry IACL28

Priced booklets

- The printer's guide to health and safety HSE Books 1998; (ISBN 0 7176 1486 7)
- Printing industry: health and safety training package HSE Books 1998; (ISBN 0 7176 1481 6)
- Chemical safety in the printing industry HSE Books 1995; (ISBN 0 7176 0846 8)
- Fire safety in the printing industry HSE Books 1992; (ISBN 0 11 8863 75 4)
- Safe use of isocyanates in printing and laminating HSE Books 1997; (ISBN 0 7176 1312 7)
- COSHH Essentials for Printers - forthcoming

HSE priced and free publications are available by mail order from HSE Books, PO Box 1999, Sudbury, Suffolk CO10 6FS. Tel: 01787 881165: Fax 01787 313995.HSE priced publications are also available from good booksellers. For other enquiries ring HSE's Infoline Tel: 0541 545500, or write to HSE's Information Centre, Broad Lane, Sheffield S3 7HQ.

4.2 BG Druck und Papierverarbeitung

Booklets:

- Arbeiten im Offsetdruck (Bestellnummer 202)
- Sicherheitsregeln für Durchlauftrockner von Druck- und Papierverarbeitungsmaschinen (BGR 107)
- UV-Trocknung (Bestellnummer 205)
- Sicheres Arbeiten mit chemischen Produkten (Bestellnummer 216)
- Sicheres Arbeiten in der Siebdruckerei (Bestellnummer 218)
- Brancheninitiative zur Vermeidung von Lösemittelemissionen im Offsetdruck (Bestellnummer 228)

Information sheets:

- Reinigungsmittel auf Pflanzenölbasis für den Offsetdruck (Bestellnummer 404)
- Isopropanol (Bestellnummer 518)
- Lösemittel im Druck und in der Papierverarbeitung (Bestellnummer 521)
- Wasch- und Reinigungsmittel für den Offsetdruck - zulässige Produkte (Bestellnummer 522)
- Brancheninitiative in der Druckindustrie zur Verminderung von Lösemittelemissionen im Offsetdruck (Bestellnummer 525)
- Ozon (Bestellnummer 526)
- Hand- und Hautschutz (Bestellnummer 528)

4.3 Publications de l'Institut National de Recherche et de Sécurité

Publications gratuites:

- Effets sur la santé de l'exposition professionnelle aux rayonnements UV, DMT, 57 (TC 48)
- Fiches toxicologiques:
  - ozone (FT 43)
  - 1-vinyl-2-pyrrolidone (FT 235)
- Sérigraphie (ED 711)
- Emission d'ozone par les photocopieurs et les imprimantes laser (ED 1422)
- Les maladies professionnelles (TJ 19)
- Recommandation (Mise en œuvre des rayons ultraviolets (R 240))

http://www.inrs.fr

4.4 Pubblicazioni ISPESL

Protezione della salute dei lavoratori nelle industrie grafiche: revisione della letteratura e della normativa comunitaria – Fogli di Informazione ISPESL marzo 1999, pp17-27.

Profilo di rischio nel comparto plastica stampata –

http://www.ispesl.it/profili_di_rischio/_plstampstamp/index.htm

Profilo di rischio nel comparto stampa offset

http://www.ispesl.it/profili_di_rischio/_stampoff/index.htm

4.5 Publications CEFIC

Études sur les gants.

Guide de classification et d'étiquetage de certains acrylates (en annexe 1)

http://www.cefic.org

4.6 Other publications

UK Acrylate Preference Criteria. Available from the British Coatings Federation Limited, James House, Bridge Street, Leatherhead, Surrey KT22 7EP, United Kingdom. Telephone: 44 1372 360660. Fax: 44 1372 376069

5 GUIDE TO THE CLASSIFICATION AND LABELLING OF UV/EB ACRYLATES (Second edition, 15th October 2003)

Available at the cefic internet site:

- http://www.cefic.be/templates/shwAssocDetails.asp?NID=473&HID=26&ID=39