

Safe Use of Isocyanates

BCF Guidance:

Marine Coatings Series No.2

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" The information and guidance contained in this publication is believed at the time of publication to be true and accurate. It is based on general principles and is intended for general guidance and information only. Its applicability to individual circumstances must be considered having full regard to the specific prevailing conditions. All recommendations contained in this publication are made without guarantee and the British Coatings Federation cannot accept any liability in respect of consequences arising (whether directly or indirectly) from the use of such advice."

FOREWORD

This guidance has been prepared by the British Coatings Federation and accepted by the Shipbuilding and Shiprepairing Health and Safety Consultative Committee.

1. INTRODUCTION

In applying any type of coating, precautions appropriate to the risk need to be taken. This document, which has been produced by the British Coatings Federation, concentrates on the controls that need to be adopted with coatings containing isocyanates, to ensure that users are not exposed to avoidable risks to health.

The inhalation of isocyanate fumes, aerosols and dusts arising from coating processes may lead to sensitisation or to irritation of the respiratory system. Sensitised persons will exhibit symptoms on exposure even to trace levels. Splashes or spray in the eye may cause severe chemical conjunctivitis. Isocyanates can be mild skin irritants and in rare cases may cause dermatitis and/or skin sensitisation.

The Control of Substances Hazardous to Health Regulations (COSHH) require employers to prevent or adequately control exposure to hazardous materials such as isocyanates. Substitution with a less hazardous alternative product should be considered.

Isocyanates are assigned a Maximum Exposure Level (MEL) in the HSE publication, Occupational Exposure Limits EH40. Under COSHH, exposure to a substance with a MEL must be reduced at least below the limit, and in addition, to as low a level as is reasonably practicable.

COSHH requires that a risk assessment should be undertaken prior to carrying out activities involving hazardous materials. This should identify the hazards that exist in the process and the nature and degree of the risks that might arise and the measures required to prevent exposure or control the risks. The risk assessment should also identify how much training and information is required for employees.

The advice given in this document is general and manufacturers' labels, safety data sheets and other technical literature should be consulted before using any individual product.

This guidance note has been produced by the Marine Coatings Group of the British Coatings Federation in conjunction with the Shipbuilders and Shiprepairers Association and the Health and Safety Executive.

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2. RISK ASSESSMENT

COSHH requires employers to make a suitable and sufficient assessment of the risks to health created by work with hazardous substances. Several HSE documents give guidance on risk assessment (see Section 5). When carrying out the risk assessment, the following questions should be asked:

- Are isocyanates likely to be released? (Hazard identification)
- Where and when will they be released?
- Is exposure likely?
- Who is likely to be exposed and to what extent?
- Can the exposure be prevented?
- What control measures are needed to reduce exposure?

The assessment should be reviewed regularly, particularly if there are any changes to either the process or materials.

2.1 Hazard Identification and Risk Assessment for Individual Types of Product

The product label and supplier's safety data sheet should be consulted to ascertain the hazard associated with the particular type of coating to be used. The specific hazards associated with different types of isocyanate are given below:

i) Urethane Oils or Urethane Alkyds

These contain no unreacted isocyanate therefore the precautions required in the application of coatings of this type do not differ from those required for other, non-isocyanate, brush, roller or spray applied coatings.

ii) Two-component Paints based on Isocyanates

These systems comprise:

- a hardener component, with or without organic solvent, which contains an isocyanate-based material
- a base component which may be pigmented or clear and which contains reactive hydroxyl groups, normally in the form of a polyol.

For use, the two components are mixed immediately before application. They cure by chemical reaction and until fully cured the mixture contains unreacted isocyanate.

iii) Moisture Cured Products

These are one-pack coatings, which cure in-situ by the reaction of atmospheric moisture with their isocyanate content. The hazards present will depend on the nature of the isocyanate constituent and its percentage weight content. The label of the container and safety data sheet will indicate the degree of precautions to be observed. However in all cases care should be taken to ensure that the atmospheric concentration of the isocyanate vapour does not exceed the occupational exposure limit (see Annex 2).

3. GENERAL PRECAUTIONS

3.1 Selection, Supervision and Health Surveillance

Persons with chronic respiratory disease (including asthmatic hay fever) or chronic eczema should not be engaged in any process which involves the use of coatings containing isocyanates.

Pre-employment and regular routine medical examinations should be carried out to determine the fitness of personnel for work with isocyanate-containing coatings, particularly for spray processes, and for wearing air-fed respiratory protective equipment.

Persons suffering from adverse respiratory or skin effects should obtain medical advice immediately and if medical opinion confirms that these are due to isocyanates, further exposure to isocyanates should not be permitted.

3.2 Training, Instruction and Information

COSHH requires that employees should be instructed about the risks to health arising from exposure to any hazardous substance used and informed of the precautions to be taken to ensure their safe use. Supervisors and operators should be advised of their responsibility to ensure that safe methods of work are used. Employees should report any obvious deficiencies in the control measures.

The Protective Equipment at Work Regulations require employees to be trained in the use of respiratory protective equipment (RPE), to ensure that it fits properly, and to be given clear instructions about when it should be used and serviced.

In addition, training ought to provide a general awareness of:

- the health effects of isocyanates and the need to report any observed symptoms of occupational asthma
- the role of health surveillance and the employee's responsibility to take part
- how to use, and the purpose of, control measures such as local exhaust ventilation and RPE, the methods to test their efficiency and the action to be taken if any anomaly is detected
- the safe systems of work to be followed, including during routine and emergency maintenance activities
- first aid measures

3.3 Personal Protective Equipment

i) General

All personal protective equipment (PPE) including RPE supplied should be selected to meet the requirements of the COSHH and Personal Protective Equipment at Work Regulations. All new PPE supplied should carry the CE Mark.

Protective clothing should be cleaned or renewed regularly. Protective clothing becoming heavily contaminated with isocyanate materials should be removed immediately and replaced. Heavily contaminated clothing should be decontaminated before disposal or laundering.

It may be helpful for the visor of any PPE to have a replaceable or sacrificial face piece to minimise loss of visual field through coating accumulation.

It is recommended that protective clothing be removed before eating, drinking or smoking.

In addition to the provision of PPE, it is also necessary that suitable accommodation be provided for the PPE so that it can be safely stored or kept when not in use.

Information covering the following should be provided to employees to whom PPE has been supplied:

- the risks the PPE will reduce;
- how to use the PPE;
- any required action for maintaining the PPE.

Employees should use and look after any PPE provided and report any loss of or defect in it to their employer.

ii) Respiratory protection

RPE should be thoroughly cleaned and maintained in accordance with the maker's instructions. In no case should a person use respiratory protective equipment that has been used by another person until it has been cleaned, disinfected and serviced.

More recommendations on the use of RPE, appropriate to the process undertaken, are given in Section 4.

iii) Skin Protection

Personnel applying coatings should wear suitable overalls made of cotton or cotton/synthetic materials (preferably minimum 60% cotton). Overalls should cover, or be taped to the boots to prevent spray mist from penetrating.

Care should be taken when removing, handling and laundering soiled PPE to avoid contamination. Overalls should be laundered separately from other clothing to avoid cross-contamination.

Gloves should be of an antistatic type, made of suitable solvent-resistant material. Advice should be sought from glove suppliers on appropriate types. Gloves should preferably be of the gauntlet type, or be taped to the overalls to prevent ingress of spray mist. Gloves should be regularly examined for physical damage (e.g. cuts etc.) and also for damage caused by permeation of solvents. Advice from glove manufacturers should be sought with regard to the break-through times for the solvents in use. Special care should be taken with regard to gloves as they can easily become contaminated on the inside.

A skin care programme, including routine examination for dermatitis, should be installed for people potentially exposed to coatings products.

iv) Eye Protection

Whenever there is a risk of coating splashing into the eyes, e.g. when opening containers, mixing, cleaning up etc. or when spraying, eye protection designed to protect against liquid splashes should be worn. Goggles are preferred over safety glasses with side shields.

v) Other Protection

Antistatic boots should be worn.

Highly insulating overalls such as polyester or acrylic should be avoided due to the possible build-up of static charges, which may occur particularly when the overalls are removed. Overalls should not be removed in areas where there might be a flammable or contaminated atmosphere.

Hard hats may need to be worn, as required by the employer.

It should be ensured that there is compatibility between the various components of PPE, e.g. hard hat, RPE, eye protection, to ensure that they do not impede the efficiency of each other.

Persons engaged in any "hot" work such as welding or brazing before application of the coating should take measures to avoid the inhalation of fumes which may be given off.

If dry sanding or blasting is being undertaken prior to painting, operators should wear suitable RPE.

3.4 Personal Hygiene

Employees engaged in any isocyanate process should observe high standards of personal hygiene. In order to avoid accidental contamination with isocyanate materials they should wash their hands before smoking, eating, drinking or going to the toilet.

Industrial solvents should not be used for removing skin contaminants. Soap and water or a proprietary skin cleanser should be used instead.

3.5 Housekeeping and Maintenance

High standards of housekeeping should be observed at all premises where isocyanate-containing coatings are stored or applied.

Exhaust ventilation systems should be regularly inspected and maintained in good order and thoroughly examined and tested at least every 14 months, as required by the COSHH Regulations. They should be positioned such that captured air, containing isocyanate vapours, is not vented where it could contaminate other areas.

3.6 Spillages and Decontamination

Spillages should be contained and collected with non-combustible absorbent materials, e.g. sand, earth, vermiculite, diatomaceous earth and place in a suitable container. The contaminated area should be cleaned up immediately with a suitable decontaminant. One possible (flammable) decontaminant comprises: water (45 parts by volume)/ethanol or isopropanol (50 parts)/concentrated (d: 0.880) ammonia solution (5 parts). A non-flammable alternative is sodium carbonate (5 parts)/water (95 parts). Add the same decontaminant to any residues and allow to stand for several days in a non-sealed container until no further reaction occurs. Once this stage is reached, close the container and dispose of in accordance with the waste regulations. Do not allow to enter drains or water courses.

The precautions required will depend on type and quantity of isocyanate, and location of the spill, however, sources of ignition should be excluded, non-essential personnel excluded and precautions taken to avoid breathing in the vapours.

3.7 Flammability

Care must be taken to ensure that all equipment conforms to the flammability safety requirements appropriate to the coating products used.

3.8 Monitoring

Procedures and actual work practices should be monitored to ensure that the control measures in place remain appropriate and adequate.

4. SPECIFIC CONTROL MEASURES

The following advice, although aimed at specific processes, is general in nature. It is not intended to replace conclusions arising from the employers' risk assessment, which will be based on the particular circumstances of the operation and the particular coating being used. The safety data sheet supplied for the product should always be consulted in order that the risk assessment is relevant to the hazards of the product being used.

In all cases, employers should ensure that exposure of employees to isocyanates is either prevented or, where this is not reasonably practicable, adequately controlled. As specified in COSHH, consideration should be given to substitution of the material or process with a less hazardous one and to the use of engineering controls e.g. local exhaust ventilation. For substances with a MEL i.e. isocyanates, the exposure must be reduced as low as is reasonably practicable.

4.1 Handling and Mixing

Personnel engaged in handling and mixing isocyanate-containing coatings should wear eye protection, overalls and impervious gloves to avoid skin and eye contact protection (see Section 3).

Because of their low vapour pressure, handling and mixing operations are unlikely to present an isocyanate vapour hazard. Nevertheless such operations should be carried out in conditions which avoid the creation of mists and aerosols.

Sufficient ventilation should be provided to ensure that the atmospheric concentration of isocyanate vapours does not exceed the occupational exposure limit. (see Annex 2).

In case of doubt or uncertainty about the appropriate precautions to be taken, reference should be made to the suppliers safety data sheet.

4.2 Application by brush or roller

Personnel engaged in applying isocyanate-containing coatings by brush or roller should wear eye protection, overalls and impervious gloves to avoid skin and eye contact (see Section 3).

Because of the nature of the application process and the products used, brush and roller operations are unlikely to present an isocyanate vapour hazard. Nevertheless such operations should be carried out in conditions which avoid the creation of airborne drops or mists. The HSE suggests that full-face respirators with AXP3 filters (to BS EN 371) may be used when isocyanates are present in the working atmosphere as long as there is no risk of oxygen deficiency.

Sufficient ventilation should be provided to ensure that the atmospheric concentration of any isocyanate vapours does not exceed the occupational exposure limit (see Annex 2).

In case of doubt or uncertainty about the appropriate precautions to be taken, reference should be made to the supplier's safety data sheet.

Air-fed RPE should be used if there is any likelihood of the MEL being exceeded.

4.3 Spray application

Personnel engaged in applying any coating based on isocyanates by spray should wear eye protection, overalls and impervious gloves in addition to the recommended respiratory protection (see Section 3).

i) General

The safe application of any coating by spraying requires that precautions must be taken to avoid the inhalation of vapours and aerosols.

The inhalation of unreacted isocyanates in such vapours or aerosols can cause sensitisation. Symptoms are not always indicative. Exposure may lead initially to chest tightness or wheeziness, either of which may be delayed for several hours. Once sensitised, a person may react to very low concentrations of isocyanates in either vapour or aerosol form. Symptoms of over-exposure are described in Annex 1 of this document.

Observance of the following recommendations together with good standards of industrial hygiene will enable coating products containing isocyanates to be sprayed without risks to health.

Any coating spraying operation requires careful consideration of the protection of the operatives and other persons who may be in the vicinity at the time.

ii) Respiratory Protection

When applying coatings in a shipyard or dry-dock it is essential that appropriate RPE is worn at all times.

Air fed RPE should always be worn when spraying coatings containing free isocyanate. Full face air-fed RPE should be worn unless otherwise indicated by the risk assessment (e.g. possibly for touch-up operations of short duration. In such cases suitable canister respirators should be worn. Filters should be changed in accordance with the manufacturer's instructions. It should be noted that a canister-type mask will have a lower protection factor and is to be considered very much a second choice to air-fed RPE).

RPE should not be removed if there is the possibility of exposure. This scenario could possibly be encountered when spraying in restricted areas resulting in the coating of the face panel of the RPE with overspray. Operators might then remove the mask while continuing to spray. This practice should be forbidden and can be avoided by providing a set of peelable transparent visor covers which can be removed as and when vision becomes impaired.

In selecting and using RPE, attention should be paid to:

- its suitability for the conditions of use;
- any limitations on its performance recommended by the manufacturer;
- the face fit (seal) for the wearer;
- wearability and comfort;
- the length of time the equipment is to be worn

HSE guidance gives practical advice on the selection, use and maintenance of RPE.

RPE should be inspected at suitable intervals (every month at the very minimum, unless the risk assessment indicates more frequently) and be maintained, cleaned and disinfected after each period of use. It should be stored in a suitable container or locker to avoid contamination. RPE, which has been worn, should not be used by another person unless it has been thoroughly cleaned and disinfected. If it is not practicable to maintain a respirator properly, it should be discarded and replaced.

The design of equipment used to supply compressed air to breathing apparatus should conform to BS 4275:1997. In particular, care should be taken to ensure that the supply of air to the compressor is

drawn from an uncontaminated source and that an efficient oil/water and fume filter is fitted to provide respirable quality air.

4.4 Other People

Non essential and unprotected people should be excluded from the spraying area if exposure is possible. Other persons who need to be present e.g. potmen, coating inspectors should be provided with appropriate PPE, including RPE, depending on the duration and level of exposure. Air fed RPE should be used if the exposure cannot be controlled below the MEL. Other PPE (e.g. eye or skin protection), as detailed in Section 3, should also be provided.

It is important for the safety of rescuers that they wear appropriate respiratory protection during rescue from hazardous atmospheres.

5. REFERENCES AND FURTHER READING

Legislation

Health and Safety at Work etc. Act, 1974
The Management of Health and Safety at Work Regulations, 1992 and amendments
Control of Substances Hazardous to Health Regulations, 1999 and amendments
Personal Protective Equipment at Work Regulations, 1992

Guidance

COSHH Regulations 1999: Approved Code of Practice, L5, HSE Books
A step by step guide to COSHH assessment, HSG97, HSE Books
Occupational Exposure Limits, EH40 (revised annually) , HSE Books
Isocyanates: Health hazards and precautionary measures, EH16, HSE Books
The selection, use and maintenance of respiratory protective equipment - a practical guide, HSG53, HSE Books
Personal Protective Equipment at Work Regulations - Guidance on regulations, HSE Books
Organic isocyanates in air, MDHS 25/3, HSE Books
An introduction to local exhaust ventilation, HSG37, HSE Books
The maintenance of local exhaust ventilation, HSG54, HSE Books
Health surveillance under COSHH: guidance for employers, ISBN 0 7176 0491 8, HSE Books
Preventing asthma at work; how to control respiratory sensitisers, L55, HSE Books
Spraying of highly flammable liquids EH9 , HSE Books
The Spraying of Flammable Liquids, HSG178, HSE Books
Respiratory sensitisation and COSHH – An employers leaflet on preventing occupational asthma, INDG95
Breathe freely – A worker's information card on respiratory sensitisation, INDG172
BS 4275:1997, Guide to implementing an effective respiratory protective device programme, British Standards Institution

ANNEX 1. ISOCYANATE OVER-EXPOSURE

RECOMMENDATIONS FOR FIRST AID TREATMENT

SYMPTOMS

Vapour and spray mists containing isocyanates are highly irritant to the eyes and respiratory tract and may cause inhalation sensitisation. In sensitised persons even minute isocyanate concentrations may lead to severe asthmatic attacks. Respiratory effects may be delayed for up to 12 hours. The liquid may be irritating to the skin and cases of skin sensitisation have been reported.

Atmospheric over-exposure may lead to the following symptoms:

- sore eyes (conjunctivitis)
- running nose (rhinitis)
- sore throat (pharyngitis)
- coughing (bronchitis)
- wheezing, tight chest (asthma)
- fever, breathlessness and cough (pneumonitis)

It is important for the safety of rescuers that they wear appropriate respiratory protection during rescue from hazardous atmospheres.

FIRST AID TREATMENT

In all cases of over-exposure by any route, the affected person should be referred immediately for medical attention after appropriate first aid treatment has been administered. Never give anything by mouth to an unconscious person.

INHALATION

This may be of vapour, mist or aerosol.

Do not delay. Remove the affected person to fresh air. Keep the patient warm and at rest. If they do not recover rapidly, obtain medical attention. If their breathing has stopped, apply artificial respiration and obtain medical attention. Give nothing by mouth. If unconscious, place in the recovery position and seek medical advice. Exposed people will need to be kept under medical observation for at least 48 hours as delayed effects may occur

EYE CONTACT

If isocyanate has entered the eyes, do not delay. Remove contact lenses if present. Flush eyes immediately with direct mains water or sterile water from an eye wash bottle for at least 10 minutes holding the eyelids apart. Seek medical attention.

SKIN CONTACT

Remove contaminated clothing. Wash the skin immediately with copious amounts of water and soap (if available). Do not use solvents or thinners. If there is persistent irritation, obtain medical attention.

[Soiled clothing should be promptly and carefully removed. Clothing should be decontaminated in an aqueous solution containing 2%-5% ammonia (SG 0.880) and 0.2%-0.5% liquid detergent for one hour and then laundered before re-use.

INGESTION

DO NOT induce vomiting. DO NOT give anything by mouth. Keep at rest. Obtain medical attention.

ANNEX 2. OCCUPATIONAL EXPOSURE LIMITS FOR USERS

Isocyanates are given Maximum Exposure Limits in the HSE list of Occupational Exposure limits EH40.

0.02 mg.m⁻³, 8 hour time-weighted average

0.07 mg.m⁻³, 15 minute reference period

These are expressed in terms of the concentration of isocyanate groups (NCO) present.

Users are recommended to consult the HSE guidance notes EH16 and MDHS25/3 for more details on how to measure the above limits in their workplaces.