Control of exposure to triglycidyl isocyanurate (TGIC) in coating powders

Engineering Information Sheet No 15(rev2)

Introduction

This guidance is aimed at anyone involved with the formulation or use of coating powders which contain TGIC. It has been revised:

(a) to reflect changes introduced by the Control of Substances Hazardous to Health (Amendment) Regulations 2003;[1] and also

(b) because, as a Category 2 Mutagen (see 'Health effects of TGIC'), TGIC and products containing it are subject to the additional control measures applied by the Control of Substances Hazardous to Health Regulations 2002 (COSHH)[2] to substances classified as Category 1 or 2 Carcinogens or Mutagens.

Background

Note the following points:

(a) TGIC is a reactive epoxy compound. It is a white granular solid and is normally sold under a trade name, eg Araldite PT810 or Tepic G;

(b) It has been used as a curing/hardening agent in polyester-based powder coating systems since the 1970s;

(c) Such coatings are typically used for outdoor applications because they have good weather/UV radiation resistance;

(d) Polyester coatings usually contain 4-5% by weight of TGIC. In a small number of cases up to 10% may be present.

Health effects of TGIC

TGIC is toxic if inhaled or swallowed. It is a severe eye irritant and a mild skin and nasal irritant. Both pure TGIC and coating powders containing TGIC may cause skin sensitisation in some people which can lead to severe skin rashes (allergic contact dermatitis). In the past there has been at least one claim of respiratory sensitisation associated with exposure to TGIC, but there is insufficient evidence to lead to any reclassification of TGIC as a respiratory sensitiser.

Animal studies have shown that TGIC can cause genetic damage, giving rise to concern about potential reproductive or carcinogenic effects. In particular, there is animal evidence that exposure of men to TGIC may produce genetic changes in the sperm which can lead to heritable effects in the offspring.

As a consequence, TGIC is classified under the Chemicals (Hazard Information and Packaging for Supply) Regulations 2002 (CHIP 3) as Toxic, Irritant, Sensitising, Mutagenic (Category 2) and Dangerous for the environment. It has been assigned the following risk and safety phrases for labelling purposes:

R23/25 Toxic by inhalation and if swallowed

R41 Risk of serious damage to eyes

R43 May cause sensitisation by skin contact

R46 May cause heritable genetic damage

R48/22 Harmful: danger of serious damage to health by prolonged exposure if swallowed

R52/53 Harmful to aquatic organisms, may cause long-term adverse effects in the aquatic environment

S45 In case of accident or if you feel unwell, seek medical advice immediately (show label where possible)

S53 Avoid exposure – obtain special instructions before use

S61 Avoid release to the environment. Refer to special instructions/safety data sheet

The possible health effects arising in humans from long-term exposure to TGIC have not been fully investigated.

How exposure occurs

Exposure occurs by breathing in dust containing TGIC, by skin contact and by ingestion. Ingestion can be caused by contamination of hands, food, drink etc and following inhalation.

Occupational exposure limits for TGIC

A few years ago the Advisory Committee on Toxic Substances (ACTS), reporting to the Health and Safety Commission, concluded from the available information that it would be appropriate for a maximum exposure limit (MEL) to be set for TGIC.

MELs have a legal status which is explained in the COSHH Approved Code of Practice (ACOP)[2] and *EH40: Occupational Exposure Limits*.[3]

For a substance which has been assigned a MEL, exposure must be reduced to the lowest level that is reasonably practicable, and in any case below the MEL.

Following HSE research and a review of available toxicological evidence and consultation with industry, ACTS concluded that TGIC should be assigned a MEL of 0.1 mg/m^3 8-hour time-weighted average (TWA).

This came into force on 10 January 1997 and it should be used in assessing adequate control of exposure. (Proposed changes to the UK Occupational Exposure Limit Framework emphasise the principles of good occupational hygiene control with a single limit as a backstop. If adopted, it is most likely that the current MEL for TGIC will go forward unchanged to the new system.)

What should users of coating powders containing TGIC do?

They should:

(a) carry out an assessment of the risks created by any work which is liable to expose any employee, including maintenance engineers and cleaners, to TGIC. The assessment should include the steps necessary to meet the requirements of COSHH;

(b) remember that the overriding duty under COSHH is to prevent employees' exposure to all substances hazardous to health, which includes TGIC and coating powders containing TGIC. Where this is not reasonably practicable, exposure should be adequately controlled. Employers can best comply with this requirement by eliminating completely the use of TGIC, eg by using an alternative substance, coating powder or process. They should, therefore, check whether a TGIC coating powder is really necessary. If the object to be coated is for indoor use, a polyester powder may not be required. Where polyester coatings are essential, alternative curing agents to TGIC may be available. The ability of the alternative to do the job and the health risks that may be associated with it should be properly assessed before any handling or use. Information will be available from the suppliers of the coating powders. Further details are given in *Seven steps to successful substitution of hazardous substances.*[4]

(c) where it is not reasonably practicable to use an alternative substance, check that all necessary control measures are being taken. Advice on the assessment and control of coating powders can be found in *Controlling exposure to coating powders* (HSG203).[5] In particular, consider all work activities where exposure may occur, for example during the loading of feed hoppers, applications of powders, cleaning of spray booths, spillages, and powder recovery. Wherever possible, totally enclose the work activity concerned. Listed below are a number of control measures that may be appropriate:

(i) eliminate manual transfer of powders from the delivery box to the hopper by feeding the gun(s) direct from the box. Proprietary systems are available where the delivery box is vibrated to produce a mobile bed of powder that can then be taken straight to the point of application. Alternatively, bulk delivery feed systems are available where the coating powder is fed directly by gravity or vacuum transfer into the hopper. In either case local exhaust ventilation (LEV) may be required;

(ii) consider partial enclosure of the feed hopper with LEV, where one of the alternatives in (i) above is not an option;

(iii) consider automatic application of coating powders. This lends itself to much better enclosure and reduced exposure of operators and other personnel. However, care should be taken during 'touch-up' of areas missed by automated guns as exposures can still be high if this is done manually;

(iv) reduce the size of the booth openings as much as possible as this increases the efficiency of the dust capture;

(v) design the method of application to avoid the need for the sprayer to lean into the booth and ensure that all operators are fully trained in the correct method to be adopted. See the training module CD ROM included with HSG203[5] and *Application of thermosetting coatings by electrostatic spraying*;[6]

(vi) ensure dust spillages are cleaned up immediately using a suitable vacuum cleaner. Check that the cleaner's filtration system is such that the amount of powder blown back into the workplace is minimised, skin contact avoided, and personal exposures kept well below the MEL;

(vii) where practicable, clean the interior of the booth from the outside using long-handled tools and with the extraction system switched on;

(viii) avoid the use of compressed air lines for blowing dust from the crevices of spray booths or from operators' clothing; use industrial vacuum cleaners or separate fixed vacuums instead;

(ix) consider materials of construction. For example, wooden floors can trap a large amount of dust in the grooves. They should be replaced or sealed, or covered with an impervious membrane to make cleaning easier. For manual electrostatic operation, conductive flooring is necessary;

(x) prohibit eating, drinking and smoking in the work area;

(xi) clean floors, walls and other surfaces at regular intervals and whenever necessary;

(xii) provide adequate facilities for washing and changing, and for storage of clothes;

(xiii) use suitable warning signs to identify areas/installations that may be contaminated with coating powders containing TGIC;

(iv) store, handle and dispose of coating powders containing TGIC and any waste material containing TGIC safely, using closed and clearly labelled containers;

(xv) provide personal protective equipment (PPE) if the measures above do not prevent exposure or provide adequate control. The materials used for the PPE should not generate static electricity that could cause sparks/explosions. PPE may include:

- ***a one-piece coverall*** made of a material which prevents electrostatic dust from penetrating or clinging to it. Layered polypropylene, type 5 Tyvex or ceramic terylene are more likely to be suitable materials (ceramic terylene may be uncomfortable in hot conditions). Ingress of dust via cuffs, neck and ankles will need to be avoided. In all cases check with the supplier to ensure the garments are suitable for their intended use;

- ***impervious gloves*** which may be required for certain operations, though it should be remembered that covering the skin for considerable periods can itself lead to problems. Suitable materials would include nitrile rubber, natural rubber (medium to heavy weight), and polyethylene (disposable). If the coating powder is being applied by manual electrostatic spray, check that any gloves used are non-insulating;

- ***conductive footwear*** (for safety rather than health reasons). Open-weave materials, eg fabric training shoes, are inappropriate as they will allow dust to pass through;

(xvi) use respiratory protective equipment (RPE) as a last resort. For skin and inhalation protection, a full-face power-assisted respirator to the appropriate standard may be required when powders containing TGIC are being used. Even if all the above measures are adopted, exposures to TGIC may still be approaching or above the MEL, unless there is rigorous control of working practices, especially during spraying and cleaning. Appropriate RPE may still be needed to complement the other measures.

Maintenance of control measures

Any control measures provided must be maintained in an efficient state, in efficient working order and in good repair and, in the case of PPE and RPE, in a clean condition.

All LEV must be thoroughly examined and tested at least once every 14 months. A suitable record containing the information specified in the COSHH ACOP[2] must be kept.

It is recommended that all engineering control measures in use should receive a visual inspection, where possible, at least once every week. Preventative maintenance procedures should indicate which engineering control measures require servicing, the nature of the work to be carried out, the allocation of responsibility, and how defects disclosed will be put right.

A good way of identifying sources of dust emission is to use a Tyndall-beam lamp (dust lamp). Information is given in *The dust lamp: A simple tool for observing the presence of airborne particles* (MDHS82).[7] This will also help identify processes which can give short-term high levels of exposure not identified by long-term sampling.

Examination and, where appropriate, testing of RPE and PPE is required by COSHH.

Monitoring exposure

Monitoring exposure will be necessary under regulation 10 of COSHH. Some air sampling will be needed to monitor the effectiveness of control measures as well as to establish existing exposure levels. Where exposure is not significant, monitoring regimes can be adjusted accordingly.

Remember that TGIC presents hazards both from inhalation **and** skin contact. Air sampling, therefore, will not provide a complete picture of the risks from exposure.

Measuring exposure levels

HSE has developed a validated sampling and analytical method for the measurement of TGIC (and coating powders containing TGIC) in air. It has been published as a formal reference document *Triglycidyl isocyanurate (and coating powders containing triglycidyl isocyanurate) in air* (MDHS85).[8] The method allows employers to measure exposure to TGIC and to make a direct comparison with the MEL.

An estimate of exposure to TGIC in coating powders can also be carried out by measuring exposure to total inhalable particulate (ie the total weight of material collected on the filter) and by calculating how much of this material is TGIC (see *General methods for sampling and gravimetric analysis of respirable and inhalable dust* [9]). In order to do this the material supplier's safety data sheet should be consulted to determine how much TGIC is in the coating powder. The safety data sheet will list the amount of TGIC as being in one of two 'bands'. These are:

(a) Band 1: less than, or equal to, 5% TGIC; and

(b) Band 2: greater than 5%, but less than 10% TGIC.

From these it can be seen that if exposure to total inhalable particulate is below 2 mg/m^3 (8-hour time-weighted average) for Band 1 powders, the exposure will also be below the MEL of 0.1 mg/m^3 for TGIC, ie 5% of 2 is 0.1. Similarly, it can be seen that if exposure is below 1 mg/m^3 (8-hour time-weighted average) for Band 2 powders, then exposure to TGIC will again be below the MEL.

This assumes in both cases that the actual TGIC content is at the top of these ranges, whereas for many powders it will be lower. In addition, HSE has established that some TGIC crosslinks with the polymer during production and therefore is not biologically available.

Taking these factors into account it is clear that, in most cases, control of exposure to total inhalable particulate from coating powders containing TGIC to the appropriate 1 or 2 mg/m^3 value will result in exposures to TGIC which are well below the MEL.

It is therefore essential to recognise that this alternative measurement method, while providing a relatively inexpensive and easy way of assessing exposure, will not give the same accuracy as specifically measuring for TGIC using MDHS85.[8] It is an estimate or rough guide only.

In particular, this method should not simply be seen as a cheaper means of demonstrating full compliance, but more a way of gauging control or routinely monitoring exposure to assess the effectiveness of control. For example, during initial assessment both measurement of exposure to TGIC using MDHS85[8] and of total inhalable particulate using simple gravimetric means could be done. Provided the results show good standards of control below the MEL, for subsequent surveys only gravimetric sampling of total inhalable particulate need be done to show that adequate control is being maintained. If the total inhalable particulate levels fall further as a result of improvements, then the TGIC exposure will also have fallen.

Situations will arise where workers are using a number of different powders, some containing TGIC and others not. In these cases the assessment needs to take account of the complex exposure pattern which may occur.

EH40/2002 Occupational exposure limits 'Part 3 Technical supplement': 'Calculation of exposure with regard to the specified reference periods'[3] provides a method by which such exposure patterns can be assessed (ie to take account of periods of no exposure to TGIC).

However, during shifts where both Band 1 and Band 2 powders are used the assessment becomes more difficult. In these cases a sensible judgement should be made as to the significance of the total inhalable particulate measurement obtained. This involves due consideration of the relative exposure times to 'Band 1' and 'Band 2' powders when interpreting the result against the 1 and 2 mg/m^3 values for total inhalable dust. Remember that this method is only designed to provide an approximate assessment of exposure to TGIC so as to gauge the need for improvements. A really accurate assessment of exposure to TGIC can only be achieved by following the method described in MDHS85.[8]

What about health surveillance?

The need for health surveillance should be determined as part of the COSHH assessment. As TGIC is a skin sensitiser it may be necessary to look for cases of skin irritation or allergic skin reaction. Keep appropriate health records. This requirement is made under regulation 11 of COSHH and further information is given in *Medical aspects of occupational skin disease*.[10]

Information, instruction and training

Employers must provide employees who may be exposed to TGIC with suitable and sufficient information, instruction and training, including:

(a) the risk to health created by exposure;

(b) the MEL for TGIC;

(c) access to the relevant safety data sheet;

(d) other legislative provisions which concern the hazardous properties of TGIC, eg CHIP;

(e) the significant findings of the employer's COSHH risk assessment;

(f) the precautions which must be taken, including the correct use of PPE and RPE;

(g) any results of monitoring of exposure in the workplace; and

(h) information on the collective results of any health surveillance carried out (in a form which prevents it being identified as relating to a particular person).

A CD ROM included with HSG203[5] contains a training module to help employers raise the awareness of their workers.

Employers must make all relevant information available to employees' representatives and should also decide how much of this information they need to give to contractors and visitors who may be exposed to TGIC.

It has been shown that ergonomic improvements in workplace layout (eg designing the job so that the operator does not have to lean into the booth) and operator training are at least as important as the specification of an LEV system in achieving effective control. They are also likely to be particularly cost-effective ways of reducing exposure. Further details are given in HSG203.[5]

Accidents, incidents and emergencies

Employers must prepare plans and procedures to deal with accidents, incidents and emergencies involving exposure to TGIC that goes well beyond the risks associated with normal day-to-day work. In such circumstances, employers must prepare their response to an emergency before it happens.

The employer's emergency arrangements should be proportionate to any possible risk arising from an incident at the workplace involving exposure to coating powder containing TGIC. For example, an employer who stores large quantities of coating powder in containers or drums and where there is clearly the potential for a vast spillage of material, will need far more detailed and comprehensive emergency procedures than an employer who has only small quantities of such material and uses it intermittently.

Employers should prepare procedures and set up warning and communication systems to enable an appropriate response as soon as any incident occurs, and ensure that information on the emergency procedures is available to those who need to see it, including the emergency services. 'Safety drills' should be practised at appropriate intervals.

If an accident, incident or emergency occurs, the employer must take immediate steps to minimise the harmful effects, restore the situation to normal and inform the employees who may be affected. Only those staff necessary to deal with the incident may remain in the affected area and they must be provided with appropriate safety equipment. The COSHH ACOP[2] provides more information.

References

1 *Control of Substances Hazardous to Health (Amendment) Regulations* 2003 SI 2003/978

2 *Control of substances hazardous to health. Control of Substances Hazardous to Health Regulations 2002. Approved Code of Practice and guidance* L5 (Fourth edition) HSE Books 2002 ISBN 0 7176 2534 6

3 *EH40/2002: Occupational exposure limits. Supplement 2003* HSE Books 2003 ISBN 0 7176 2172 3 (to be used in conjunction with EH40/2002 ISBN 0 7176 2083 2 which remains current until further notice; the supplement can also be downloaded off the HSE website)

4 *Seven steps to successful substitution of hazardous substances* HSG110 HSE Books 1994 ISBN 0 7176 0695 3

5 *Controlling exposure to coating powders* HSG203 HSE Books 2000 ISBN 0 7176 1761 0

6 *Application of thermosetting coatings by electrostatic spraying: Code of Safe Practice* (rev) British Coatings Federation 2002 Tel: 01372 360660; Fax: 01372 376069 e-mail: enquiry@bcf.co.uk Website: www.coatings.org.uk

7 *The dust lamp: A simple tool for observing the presence of airborne particles* MDHS82 HSE Books 1997 ISBN 0 7176 1362 3

8 *Triglycidyl isocyanurate (and coating powders containing triglycidyl isocyanurate in air). Laboratory method using pumped filter, desorption and liquid chromatography* MDHS85 HSE Books 1997 ISBN 0 7176 1381 X

9 *General methods for sampling and gravimetric analysis of respirable and inhalable dust* MDHS14/3 (Third edition) HSE Books 2000 ISBN 0 7176 1749 1

10 *Medical aspects of occupational skin disease* MS24 HSE Books 1998 ISBN 0 7176 1545 6

While every effort has been made to ensure the accuracy of the references listed in this publication their future availability cannot be guaranteed.

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This leaflet contains notes on good practice which are not compulsory but which you may find helpful in considering what you need to do.

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