Health and Safety Executive **Information Document**
HSE 730/13

APPLICATION OF SURFACE COATINGS TO SHIPS' TANKS

INTRODUCTION

1 This document contains internal guidance which has been made available to the public. This guide is considered good practice (rather than compulsory) but you may find it useful in deciding what to do to comply with the law. However, the guidance may not be directly applicable in all circumstances and any queries should be directed to the appropriate enforcing authority.

2 The application of surface coatings to ships' tanks involves work in a confined space often using flammable liquids which may create a flammable atmosphere leading to the risk of fire or explosion. Where the coatings are flammable, the hazards of fire and explosion will present risks not only to those involved in the work but also to others who may be working on the vessel.

3 In addition, the inhalation of vapours generated in a tank during surface coating may present an immediate risk to life or may result in ill-health due to prolonged exposure.

4 This document gives guidance on methods of reducing and controlling these risks to health and from fire and explosion during the application of surface coatings to ships' tanks.

HEALTH AND SAFETY RISKS

Health risks

5 A wide range of materials are used for coating ship tanks. These materials may contain a variety of components including:

(1) corrosive materials,eg primers and the amine component of 2-pack paints;

(2) skin irritants and sensitisers including amines and epoxy resins, chromate pigments, acrylic resins;

(3) respiratory irritants and sensitisers, eg isocyanates;

(4) toxic substances, eg cadmium, lead, zinc and 4-diaimino diphenyl methane;

(5) carcinogenic substances, eg coal tar, bitumen, pitch and asphalt; and

(6) a variety of organic solvents.

The risks from the use of these substances arise as a result of exposure from inhalation, skin contact and ingestion.

6 Work involving the use of coatings containing volatile solvents in tanks has the potential to lead to a very high inhalation exposure over a short period of time. Such high exposures may cause unconsciousness and even death. In addition, the use of solvents for cleaning of surfaces prior to coating operations or washing of prepared surfaces can also result in very high short-term exposures.

7 The principal effects of solvents are irritation to the skin, eyes and respiratory tract, headache, nausea, dizziness and light-headedness. Repeated or prolonged exposure and short high exposures to vapours or paint mists through inhalation may result in respiratory sensitisation and/or occupational asthma. Exposure to low concentration of vapours over a longer period of time may lead to serious ill-health problems. Skin contact may cause dermatitis. The possible effects on health will vary according to constituents of the coatings material and solvents to which workers are exposed.

8 The coating manufacturer's or supplier's safety data sheet (SDS) should provide information on the:

(1) immediate or long-term health effects;

(2) physio-chemical data such as solvent volatility etc;

(3) relevant exposure limits for the various components of the coating material; and

(4) possible routes of exposure.

The SDS provides valuable information to assist in carrying out the risk assessment prior to the use of the coatings. However, the SDS only provides generic information on the hazards of the substance being used and should not be seen as a substitute for a specific risk assessment for the activity to be undertaken.

Fire and explosion

9 The main hazards from the use of flammable liquids are fire and explosion involving either the liquid or the vapour given off from the liquid. Fires or explosions are likely to occur when flammable vapours or liquids are released into areas where an ignition source (see paragraphs 31-36) is present, or where an ignition source is introduced into an area where flammable liquids are being, or have been, used.

10 During spraying, liquid is converted into a mist of droplets which is directed onto a surface to produce an evenly distributed film of the required thickness and texture. This fine dispersion of droplets can allow ignition to occur at temperatures below the normal flash point. Flammable vapours are also released during the drying process and may present a serious fire hazard.

11 Fire and explosion incidents in the past have shown that flammable atmospheres do occur during paint spraying, particularly in confined spaces and so it is essential to control all sources of ignition.

LEGAL REQUIREMENTS

12 The Management of Health and Safety at Work Regulations 1992 (MHSWR) require employers to undertake risk assessments of their work activities. For tank coating operations and related work, this must take into account not only workers engaged in the processes, but also other persons in the area who may also be at risk.

13 The Confined Spaces Regulations 1997 (CS Regulations) will apply to places where coating work is carried out in confined spaces such as tanks. The CS Regulations introduce 3 important requirements:

(1) the need to avoid entry to confined spaces, where reasonably practicable;

(2) if entry into a confined space cannot be avoided, a safe system of work must be followed; and

(3) adequate emergency (rescue) arrangements must be put in place before work starts.

14 Further information and guidance is given in the HSE publication L101 *Safe work in confined spaces: Confined Spaces Regulations 1997: Approved Code of Practice (ACoP), Regulations and Guidance* (ISBN 0 7176 14050) which is available from HSE Books PO Box 1999, Sudbury, Suffolk CO10 6FS, tel 01787 881165 fax 01787 313995.

15 The Control of Substances Hazardous to Health Regulations 1994 (COSHH) require that exposure to substances hazardous to health is prevented or, where this is not reasonably practicable, adequately controlled. Prevention may be achieved by substitution by a non-hazardous substance (see paragraph 22) or changing the work practice. Control measures should be based on an assessment of the risks to health associated with the use of the substance and should aim to meet the relevant occupational exposure limits (OEL) for personal exposure (see HSE Guidance Note EH40 *Occupational exposure limits*). Where reasonably practicable, hazardous substances should be replaced by less harmful ones. Other methods of controlling exposure, eg exhaust ventilation, should always be considered first before the use of respiratory protective equipment (RPE). In certain circumstances COSHH also requires health surveillance (see paragraphs 53-57).

16 Respiratory protective equipment must meet the requirements of the Personal Protective Equipment (EC Directive) Regulations 1992 (displaying a 'CE mark') or be a type approved by HSE. HSE approval ended on 30 June 1995, but the equipment can still be used if it is suitable and well maintained. Regulation 9 requires that RPE is thoroughly examined at suitable intervals.

17 The Provision and Use of Work Equipment Regulations 1998 require employers to provide safe equipment and to ensure it is used safely. As well as initial selection of safe equipment, it is also required to be maintained and that employees are trained in its use. Work equipment is widely defined and includes ventilation equipment, lighting etc.

18 Highly Flammable Liquids and Liquefied Petroleum Gases Regulations 1972 (HFL Regulations) cover the storage, handling and use of liquids with a flashpoint below 32°C. They deal with the need to control ignition sources, to prevent the escape of vapours and liquids and the need to disperse dangerous concentrations of vapours.

19 The Electricity at Work Regulations 1989 require equipment which may be exposed to flammable substances to be so constructed as to prevent danger.

20 The Personal Protective Equipment at Work Regulations 1992 require that where risks cannot be adequately controlled by other means which are equally or more effective, suitable personal protective equipment (PPE) should be provided and maintained in efficient working order and in good repair.

CONTROL METHODS

21 In order to ensure that the work can be carried out safely, an assessment of the risks should be made. This will allow for suitable measures to be in place to adequately control the risks before work starts. Paragraphs 22-47 deal with some key matters which need to be borne in mind.

Substitution

22 Elimination of the use of a hazardous substance should always be considered first. This can be achieved by substituting a non-hazardous substance, eg water based, in place of solvent-based materials. However, substitution also includes replacing one substance by another with a lesser hazard. For example, substitution with a product containing a less-hazardous solvent with a lower vapour pressure to reduce the amount of vapour released.

Ventilation

23 The purpose of ventilation is to control the concentration of flammable and hazardous vapours. It should be sufficient to prevent the formation of a dangerous concentration of flammable vapours. The maximum concentration of vapour should not exceed 10% of the lower explosive limit (LEL). The LEL is the minimum concentration of vapour in air which will ignite.

24 The LEL is usually many times the OEL of the substance. In practice, ventilation cannot be expected to reduce the concentrations of vapour in air below the OEL during spraying. The extent to which ventilation reduces concentrations during drying will require assessment.

25 The minimum quantity of air required to ventilate to below the LEL can be calculated from a knowledge of the volume of the tank to be sprayed, the spray rate, the amount of solvent in the paint and the LEL of the solvent. A guide to the minimum amount of air needed to provide dilution to below the LEL can usually be found in the SDSs provided by the manufacturer or supplier. It should be noted that good mixing and uniform distribution are needed for this to be effective. Some users may have their own standards for the amount of air to be supplied to achieve satisfactory dilution. This should always be greater than the amount indicated on the paint SDSs.

26 It should be recognised that not only is the amount of air important but also its distribution in and out of the tank being coated. As the air will take the path of least resistance, the inlet and outlet should not be close together so as to avoid creating dead areas. Solvent vapours tend to be heavier than air so some low level extraction will be required. In situations where due to the nature of the confined spaces there are difficulties in ensuring adequate ventilation via fixed inlet and outlet system, additional openings into the hull or use of flexible ducting may be necessary to ensure air inlet for ventilation in the required location. Access staging may also interfere with potential paths of ventilation air. Forced inlet ventilation may be required in some situations.

27 Ventilation should continue after spraying has finished since solvent vapours will continue to evaporate as the coating dries. If ventilation is stopped too soon after the application of the coating, the solvent retained in the paint film can be released into the atmosphere and vapour concentrations can rapidly build up to dangerous levels. This should be borne in mind if entry into a tank is necessary following coating. An assessment of the risks should be carried out and the necessary precautions taken before entry to the tank.

28 Thought must be given to the siting of the extraction equipment and its point of discharge which must be to a safe place, including away from sources of ignition.

29 Ventilation equipment must be checked to ensure that it is performing correctly. Duct work must be routinely examined to ensure that it is in good order and correctly joined and sealed so that the full extraction takes place at the intended location. Any air inlet ducting should also be checked to ensure that it is correctly joined and that there are no twists etc in the line which could restrict the delivery of air to the required area.

30 Effective arrangements should be in place to stop the spraying operations if the ventilation system fails. One suitable means of achieving this is to ensure that the spraying system has an automatic interlock connected to the ventilation system.

Sources of ignition

31 Fire and explosion incidents in the past have shown that flammable atmospheres do occur during and after paint spraying and so it is essential to prevent sources of ignition from being introduced into areas where tank coating is being carried out. Potential sources of ignition include:

(1) unprotected electrical equipment;

(2) welding and other similar hot work activities (see also paragraph 34);

(3) sparks generated by static electricity discharge;

(4) heating/dehumidifying appliances;

(5) smoking materials; and

(6) internal combustion engines.

32 A significant number of accidents have been reported in which workers involved in coating operations in ship tanks have suffered serious burns resulting from the ignition of vapours as a result of use of unsuitable handlamps.

33 Action is also required to prevent ignition sources being introduced into areas where flammable vapours may be released from the spray area. Consideration should be given to work activities in the vicinity of the exhaust points for air being ventilated from tanks being coated and the potential for ignition of vapours should be minimised.

34 Where welding, thermal cutting and similar hot work is being considered in an area adjacent to a tank which is being coated or has recently been coated, careful assessment of the risks is required to ensure that where this can be permitted, it is only with the appropriate controls in place.

35 All equipment such as lighting and fan motors should be suitable for the required location. It is always preferable to site equipment away from where a flammable atmosphere is likely to occur but, where this cannot be achieved, the equipment should be of a construction suitable for use in such atmospheres.

36 Airless spraying equipment and any other metallic equipment should be earthed to prevent electrostatic discharge.

Safe systems of work

37 The first step in the development of a safe approach to tank coating is a risk assessment. General guidance on risk assessment is given at paragraphs 20-27 of the ACoP. The precautions required in a safe system of work will differ in detail depending on the findings of the risk assessment. The main elements to consider when designing a safe system of work are given in paragraphs 35-79 of the ACoP.

38 A 'permit-to-work' system is the most effective way of managing entry into or work in a ship's tanks. A permit-to-work procedure is an extension of the safe system to work, not a replacement for it.

39 Experience demonstrates that safe systems of work, including 'permit-to-work' systems, will be most effective and workable where those who will use them are consulted during their design.

40 An effective system of communication should be established between workers inside the tank and persons outside.

41 Warning notices and barriers should be erected on routes to tank entrances to prevent workers not involved from introducing sources of ignition into the area.

42 Systems of work should be reviewed from time to time and modified as necessary. Changes in working methods or practices should lead to an immediate review of the risk assessment.

Personal protective equipment

43 The purpose of RPE is to ensure that the wearer is provided with air which is safe to breathe. Requirements for RPE depend upon the nature of the contaminant, its concentration in the air being breathed and the exposure limit for the substances present. The RPE selected should be suitable for the task and the wearer. It should be capable of providing a sufficient quantity of clean air for the wearer to breathe and should fit the wearer correctly. RPE must either be CE marked or HSE approved (see paragraph 16).

44 In the case of tank coating work where high concentrations of vapours well in excess of the OEL can occur, possibly leading to an immediate danger to life or health from breathing the air, RPE must provide air from an independent source. Breathing apparatus suitable for the high solvent levels which could be encountered during coating work, will be positive-pressure; demand; full-facepiece; self-contained compressed air or compressed airline type. Filtering respirators such as canister or cartridge types are not normally acceptable. Further information can be found in HSE guidance HSG53 *The selection use and maintenance of respiratory protective equipment, a practical guide (ISBN 0 7176 1537 5).*

45 Breathing air must be supplied from a clean, secure source. For compressed air, this will involve the use of purpose-designed filters in the supply line. Where an air compressor is used, it should be sited in an area free from potential

contamination such as vapours from the air emerging from the exhaust fan. Further information is given in HSG53 Appendix 3.

46 In addition to RPE, persons involved in the coating operations will need to wear suitable protective clothing including disposable overalls, gloves and boots. Overalls should have a hood and be capable of sealing at wrists and ankles. Protective clothing should be capable of preventing the substances being used from reaching the skin. Often, skin contamination arises from chemicals getting around the clothing, rather than through it, for example from splashes entering the top of boots. Protective clothing should form a barrier to the chemicals in use; the material must be intact and resistant to the solvent for the period of wear.

INSPECTION AND MAINTENANCE

47 Before work starts, a number of checks will need to be carried out to minimise the health risks and the dangers from flammable liquids. Engineering controls should be examined and tested regularly. For exhaust ventilation, the maintenance schedule will need to relate to the intensity of use and experience of reliability of the system; in any case the tests and thorough examinations should be carried out by a competent person not exceeding a period of 14 months and the records of any test and thorough examination should be kept.

48 Routine checks for engineering and other controls should ensure that the equipment is performing to specification. These may include:

(1) ensuring that air flow or air pressure differential switches are working so that ventilation rates are maintained during the course of work;

(2) ensuring that air intakes are not obstructed, the ventilation ducting is in good repair and that discharge vents are correctly sited;

(3) ensuring that interlocks between spray guns and exhaust ventilation are working;

(4) ensuring that the breathing air supplied to the wearers of RPE is clean and that the purpose-designed filters in the supply line are maintained; and

(5) ensuring that escape routes and rescue equipment are suitable and well maintained.

49 The manufacturer's maintenance schedules and instructions should always be followed for PPE, where appropriate, records of the maintenance carried out should be kept. In general, RPE should be examined before use, with particular attention being paid to any rubber parts such as face-pieces seals, exhalation valves, breathing tubes and head harnesses. If the equipment is not in good working order, it should not be used.

50 For the maintenance of the compressor to ensure breathable air, the operating instructions and maintenance schedule provided by the manufacturer

should be carefully followed. The type and frequency of testing needed for the quality of the breathing air system will be determined by the COSHH assessment and air consumption rate.

EMERGENCY PROCEDURES

51 Before any person enters a ship's tank, arrangements for rescue in the event of an emergency should be in place. The arrangements required will depend upon the findings of the risk assessment and on the nature of the likely emergency. The ACoP paragraphs 80-92 give further guidance on what is required.

52 Apart from in exceptional circumstances, no person should work alone in a tank in order that the alarm can be raised in the event of an emergency. Normally, entry to a confined space should be permitted only if there is at least one further person in attendance who is trained and equipped to initiate an effective rescue if the worker is overcome. Appropriate rescue equipment, which may include breathing apparatus, belts/harnesses, lines and hoists should be provided.

HEALTH SURVEILLANCE

53 The SDS should indicate the health hazards of any substances contained in coatings. Health surveillance may be required under COSHH regulation 11.

54 Health surveillance will be appropriate where the exposure of employees to a substance hazardous to health is such that an identifiable disease or adverse health effect may be related to the exposure; there is a reasonable likelihood that the disease or adverse effect may occur under the particular conditions of work and there are valid techniques for detecting indications of the disease or effect.

55 In any case where health surveillance is appropriate there will be a requirement to maintain a health record for each employee who is exposed to substances that are hazardous to health (COSHH regulation 11(3)).

56 An example of substances that would fulfil the criteria for health surveillance are epoxy based coatings. These are known respiratory sensitisers. They are likely in many circumstances of use to induce occupational asthma in exposed workers. Early evidence that sensitisation has occurred can be sought using an appropriate health questionnaire and through lung function testing to confirm deterioration in these parameters. Epoxy-based coatings may also cause dermatitis in exposed workers. Health surveillance for dermatitic substances consists of self reporting of relevant skin signs and symptoms and enquiry through a suitable questionnaire for these signs and symptoms.

57 Where either occupational asthma or dermatitis is suspected, the individual should be referred to an occupational health practitioner for further investigation to confirm or otherwise the diagnosis.

INFORMATION AND TRAINING

58 Before any persons start work in a tank, they should be informed about the hazards and risks involved in the work. They should be instructed on any special precautions to be observed including safe systems of work; this should include how to recognise changes in circumstances which could increase the risks to health and safety. They should be adequately trained in the use of work equipment and any personal protective equipment, including RPE. They should be trained on the emergency arrangements, including emergency rescue techniques.

59 All employees should be informed of the hazards from flammable liquids used and stored; of the need to exclude sources of ignition and heat away from spraying areas and the ancillary areas where ventilation equipment is located. Those involved in the use of coatings should also be given specific training to cover normal operating and emergency procedures.

60 The training should include:

(1) the type of substances in use, their properties and hazards;

(2) general procedures for safe handling of materials and operation of equipment;

(3) use of RPE and PPE;

(4) housekeeping, reporting of faults and incidents (including spills);

(5) emergency procedures including raising the alarm; and

(6) the use of appropriate fire-fighting equipment.

61 Information on the requirements for training related to work in confined spaces are given in the ACoP paragraphs 92 and 113-116. Advice on training with respect to RPE is given in HSG53.