GUIDANCE NOTE No. 62

PPE SELECTION FOR WORKING IN FLAMMABLE AREAS

Introduction

The Solvents Industry Association has issued this Guidance Note to outline some of the factors to be considered when selecting Personal Protective Equipment to be worn when working in environments that could contain a flammable atmosphere. This is not an alternative method for determining the PPE that should be worn in zoned areas, but is intended to provide some additional information on PPE selection criteria following a full risk assessment as required under DSEAR (Dangerous Substances and Explosive Atmospheres Regulations)[1]. A major hazard when handling solvents is the possibility of a fire or explosion due to the ignition of a flammable atmosphere, initiated by the release of static electricity. Carrying out a DSEAR Risk Assessment will have identified zoned areas where an ignition source has the potential to ignite flammable vapours. The DSEAR Regulations require a company to install intrinsically safe ATEX equipment and electrical systems within its zoned areas. (It should be noted that mechanical equipment also has the potential to create heat and sparks that could cause ignition of a flammable atmosphere).

(For an electrostatic ignition risk to occur, three things must be present: - a flammable/combustible material such as vapour or dust, air or some other oxidising agent and an electrostatic discharge that could have igniting power.)

This Guidance Note is primarily concerned with identifying the correct PPE for use in areas where a flammable atmosphere may be present, such as:-

Zone 0. An area in which a flammable vapour or gas is present continually or for long periods;

Zone 1. An area in which a flammable vapour or gas is likely to be present in normal operation;

Zone 2. An area in which a flammable vapour or gas is unlikely to be present in normal operation, but if it does occur may be present only for a short period.

However, it should be remembered that non-zoned areas can also contain flammable vapours due to damaged and leaking packaging. IBCs (Intermediate Bulk Containers containing ~1000 Litres) are designed for multi trip use and can develop leaking seals/valves during transit and storage which can produce a flammable atmosphere in poorly ventilated areas. Solvent vapours are generally heavier than air and will accumulate in low lying areas unless there is a good level of ventilation.

This Guidance Note details some of the considerations required when selecting PPE for use in areas that may have a flammable atmosphere. Further information may be obtained from the SIA's film

‘Solvents and Static Electricity’, and Guidance Note No 47 ‘Flammable Solvents and the Hazard of Static Electricity’. Both are available for download via the website www.solvents.org.uk

Some of the environmental factors that could exist in a workplace and should be considered when determining whether a static charge achieving the Minimum Ignition Energy (MIE) for ignition of a flammable atmosphere are highlighted in the following section.

Identifying Electrostatic Hazards

It is well known that when flammable liquid vapours are mixed with air or another oxidiser, a flammable atmosphere may arise that could then be ignited when an ignition source is present.
Static electricity can give rise to electrical discharges under some circumstances and therefore must be assessed as an ignition source in areas where flammable vapours may arise.
All materials fundamentally contain electrical charges (negative electrons and positive atomic nuclei) in their atomic structure. In an uncharged material these charges are present in equal numbers and their electrical effects are neutralised. When two material surfaces are close or touch, some charges always move from one material to the other. When the materials are separated, one material is left with a positive charge and the other has an equal negative charge. We say the materials have become charged, although in reality they have just accumulated a very small imbalance in their natural charge levels.
Like charges repel, and unlike charges attract so charges accumulated on one material will repel each other and attract opposite charges on a nearby material. If they are free to move, the charges will attempt to recombine or dissipate to earth. If they succeed, no static electrical effects will be noticed.

- **Conducting** materials allow such free charge movement if connected to earth.
- **Insulating** materials such as plastics and other composites often used in the manufacture of PPE do not allow free movement of charges, unless they have had conductive materials added.

The conductive material is often visible as a black striped or checked feature across the whole surface of the PPE to prevent the build-up of a static charge.
When a charge imbalance is created by surface contacts, the charge in a non-conducting material cannot quickly dissipate or recombine. If repeated contacts are made then more and more charge can build up on the material surface as static electricity. Any process that involves movement and contact between materials will necessarily cause charging of the materials. Processes that involve more movement typically can generate higher electrostatic charge levels.

Conductors such as metals can also accumulate charge if they are not provided with a conducting path to earth to allow the charges to dissipate. Such a path is often fortuitously present, but sometimes it must be provided deliberately in the form of a direct connection to earth. This is known as "grounding" or "earthing" the conductor. The ease with which a conductor can conduct charge is indicated by its resistance or resistivity. A high resistance (low conductivity) material may take some time to allow charge to move and dissipate.

Consideration should be given to the potential for a conductive substance to become isolated from earth and subsequently charged by induction or triboelectrification[2].

For ignition of a flammable atmosphere to occur, the energy in an electrostatic discharge must equal or exceed the Minimum Ignition Energy (MIE). Ignition from an electrostatic discharge from a conductor is the most incendive (i.e. it has the highest propensity to ignite a flammable atmosphere). This is because all of the stored charge on the conductive object is free to move quickly to contribute to the energy in the electrostatic discharge. Personnel not wearing conductive PPE may form a particular risk as they continually move and generate charge, and can store significant electrostatic charge before eventually coming into contact with a grounded conductor and causing an Electro Static Discharge (ESD) event.

An isolated conductor also poses a hidden risk. Even if the conductor is not itself charged, it can have a high voltage induced on it by the electrostatic field due to a nearby charged object. No contact is necessary to achieve this high voltage, but the part may easily become the source of an incendive ESD event.

Discharges from insulating surfaces ("brush" discharges) are less incendive than discharges between conductors, but can still be energetic enough to risk ignition of a flammable vapour.

Typically all the charge on the insulator cannot move quickly to contribute to the discharge.

Therefore, only a small part of the surface may act as the ESD source, leaving other areas of the object still charged for further ESD events. Insulating materials are commonplace as packaging and engineering materials in modern environments.

Site Operational Requirements

Premises storing flammable liquids in tanks and packages adopt a prescriptive approach to PPE to be worn when in operational and storage areas in order to ensure that a static spark cannot be initiated.

In general the following PPE requirements are mandated, and visitors will be checked on arrival:

- Hard Hat
- Safety Goggles or Spectacles
- Anti-static High visibility vest or clothing
- Anti-static flameproof overalls (For filling operations)
- Conductive or anti-static boots or shoes.

It is good practice for sites to pre-notify visitors and contractors of their PPE and safe operating instructions prior to their arrival. Non Contractors such as visiting drivers may be delayed and possibly refused entry if they do not possess the appropriate PPE.
Contractors will be required to provide method statements and risk assessments and also be subject to the site's Permit To Work (PTW) system where detailed information is generally exchanged.

PPE clothing suitable for use in flammable atmosphere areas

In general when handling Gas Class[3] Group IIA materials, the risk of incendive ignition from clothing is minimal, provided that the wearer is wearing conductive footwear, the clothing is reasonably close fitting and is not removed or unfastened within a Zone 0 or Zone 1 area. Explosive atmospheres and electrostatic hazard guidance has stated that "In spite of the fact that modern clothing, made from synthetic textiles, can readily become electrostatically charged it is not, in general, an ignition risk providing that the wearer is earthed by means of suitable footwear and flooring". If more sensitive materials with an MIE of less than 0.2 mJ are handled (Group IIB or IIC) then highly insulating clothing materials should not be worn. Outer clothing should be dissipative[4] with a surface resistivity of less than 5×10^{10} Ω.

Where PPE is issued it is necessary to ensure it is compliant with relevant electrostatic requirements for flammable atmosphere areas. There is concern that some high visibility clothing incorporating highly reflective strips have been found to charge highly in some cases and could give incendive discharges, especially to more sensitive Group IIB materials.
Clothing worn in areas that may contain a flammable atmosphere must comply with the relevant requirements of Directive 89/686/EEC which states that "PPE intended for use in explosive

atmospheres must be so designed and manufactured that it cannot be the source of an electric, electrostatic or impact-induced arc or spark likely to cause an explosive mixture to ignite."

Protective clothing issued for use in flammable atmosphere areas must comply with the relevant surface resistivity test methods detailed in:-

- EN1149-1: 2006; [5]
- EN 1149-2:1997; [6]
- EN1149-3:2004; [7]
- EN1149-5:2008. [8]

Footwear worn in hazardous areas should be static dissipative[4] or conductive. The DSEAR ACoP L138[9] requires that anti-static footwear and clothing should be provided when the risk assessment identifies that it is required. 401 and 403 of Regulation 7(3) and Schedule 4 are particularly relevant and the requirements may be interpreted as follows: anti-static footwear and flooring (e.g. concrete, metal grids) are generally sufficient for areas where there is a flammable gas or vapour risk; anti-static footwear is not generally required for dusts, since they are not easily ignited, but flooring must not be highly insulating. Such a summary must, however, not preclude consideration of specific high-risk gases or activities.

Footwear can become soiled and lose its conductivity and antistatic properties. There are a number of "boot checking" plates available for confirmation that footwear is conductive and these will require regular maintenance and calibration to ensure that they remain effective.

Gloves used in hazardous areas that are not made from dissipative materials have the innate possibility that a hand held metal item could be electrically isolated and become a possible source of electrostatic discharge.

Some flammable solvents can also be toxic by inhalation and additional consideration should be given to the selection of RPE (Respiratory Protection Equipment) and the potential for static discharges. Respiratory protective devices with powered filtering devices incorporating a helmet or a hood will be battery powered and must be checked for their suitability for use in potentially flammable atmospheres.

Additional Considerations

Whilst the selection of “anti-static” PPE should be fairly straightforward to organise and control, its effectiveness is subject to ever changing factors. Some of the factors that may lead to ineffective or incorrect PPE being worn in flammable areas are listed below:-

- People will always respond to an abnormal event and may stray into zoned areas whilst not wearing appropriate anti-static PPE;
- Visitors such as delivery drivers may not always have the appropriate PPE for the areas they may be accessing;
- The PPE is dirty or poorly maintained;
- PPE with anti-static or dissipative coatings can have its anti-static/conductive properties reduced during laundry or wear & tear;
- PPE is stated as being suitable for use in zoned areas but has not been manufactured in accordance with the relevant BS EN standards.

The above is not an exhaustive list but may provide some additional considerations when selecting PPE to be worn on a site that handles flammable solvents.

It is good practice to provide instructions to employees on the selection and purpose of the relevant PPE. The instructions should cover all aspects of maintaining the PPE and when it would be deemed unsuitable for use and need replacing.

Regulation 7 of the Personal Protective Equipment at Work Regulations[10] outlines the employer’s responsibilities to ensure the PPE provided continues to provide protection.

“An employer should ensure that PPE continues to provide protection and can do this by putting in place an effective maintenance system that should include the following:

a) *Examination – checking for faults, damage, wear and tear, dirt etc;*
b) *Testing – to ensure PPE is operating as intended;*
c) *Ready for use – for example if you’re working in hot environments the PPE may lose effectiveness if it’s wet internally from sweating either due to the temperature or the amount of activity or exertion; you may need to provide somewhere for drying the PPE so it retains its insulating properties;*
d) *Cleaning – including disinfection if appropriate;*
e) *Repair; and*
f) *Replacement.”*

PPE Manufacturers and wholesale providers will be able to provide some general advice on carrying out suitable and sufficient checks.

Information, instruction and training on PPE is covered by Regulation 9 of the regulations[10]:-

"Where an employer is required to ensure that personal protective equipment is provided to an employee, the employer shall also ensure that the employee is provided with such information, instruction and training as is adequate and appropriate to enable the employee to know –

a) The risk or risks which the personal protective equipment will avoid or limit;
b) The purpose for which and the manner in which personal protective equipment is to be used; and
c) Any action to be taken by the employee to ensure that the personal protective equipment remains in an efficient state, in efficient working order and in good repair as required by regulation 7(1),"

This Guidance Note has been issued to specifically detail some of the factors to be considered when selecting the appropriate PPE for use in flammable areas. Additional guidance on general PPE selection and use can be found in the HSE's Approved Code of Practice L25[11].

References

1 DSEAR (Dangerous Substances and Explosive Atmospheres Regulations) SI 2002/2776

2 The triboelectric effect is a type of contact electrification in which certain materials become electrically charged after they come into frictional contact with a different material. Rubbing glass with fur, or a comb through the hair, can build up triboelectricity. Most everyday static electricity is triboelectric. The polarity and strength of the charges produced differ according to the materials, surface roughness, temperature, strain, and other properties.

3 All surface industry gases/vapours are classed as Group II gases. Group II is divided into 3 sub-groups:

- IIA – High energy is required to ignite. Less intense explosion. (Propane)
- IIB – Less energy is required to ignite. More intense explosion. (Ethylene)
- IIC – Little energy is required to ignite. Most intense explosion. (Hydrogen).

4 **Dissipative (electrostatic dissipative)** an adjective describing a material incapable of retaining a significant amount of electrostatic charge when in contact with earth. These materials have a volume resistivity higher than 10^4 Ωm but equal to or lower than 10^9 Ωm, or a surface resistivity less than 10^{10} Ω (or surface resistance less than 10^9 Ω) measured at ambient temperature and 50% relative humidity.

5 EN1149-1:2006; Protective clothing. Electrostatic properties. Test Method for surface resistivity

6 EN1149-2:1997; Protective clothing. Electrostatic properties. Test method for measurement of the electrical resistance through a material (vertical resistance).

7 EN1149-3:2004; Protective clothing. Electrostatic properties. Test methods for measurement of charge decay.

8 EN1149-5:2008. Protective clothing. Electrostatic properties. Material performance and design requirements.

9 DSEAR ACoP L138 – 2nd edition 2013 ISBN 978 0 7176 2203 0

10 Personal Protective Equipment at Work Regulations - SI 1992/2966

11 HSE's Approved Code of Practice L25 - Personal protective equipment at work 3rd edition 2015

Other CENELEC - The European Committee for Electrotechnical Standardization - CLC/TR 60079-32-1: 2015 Explosive atmospheres. Electrostatic hazards, guidance.