January 2014

CBI/EIG

Guidance on Personal Protective Equipment (PPE)
for Explosives Operations

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Contents

Foreword

01 This publication on Personal Protective Equipment (PPE) has been produced by a working group of the Explosives Industry Group of the Confederation of British Industry (CBI) on behalf of the explosives industry. Its purpose is to provide information to help persons in the explosives industry comply with legal requirements applying to the selection, procurement, use and disposal of PPE provided for protection against hazards arising from activities involving explosives.

02 As part of the hierarchy of explosives hazard process control measures PPE comprises the final part of the overall hazards control system. This publication describes some examples of commonly followed practice regarding PPE within the explosives industry. It identifies that a systematic approach to the identification of hazards, the parts of the body that may be harmed, and the selection of PPE comprises industry good practice.

03 Nothing in this publication should be read as setting a higher standard than that required in existing guidance, for example HSE Guidance L25 on the Personal Protective Equipment at Work Regulations 1992 (as amended) (PPEWR) [1], and paragraphs 240-242 & 250-258 of the ACOP for the Manufacture and Storage of

Explosives Regulations 2005 (MSER). The information in this publication is intended to supplement this general advice, and includes advice on the selection of PPE for explosives operations as well as identifying the importance of 'fit' as part of the effective use of the PPE.

04 Relevant legislation and its context are included within this document. Whilst every effort has been made to cover appropriate legislation and relevant industry practice at the time of publication, neither the CBI nor its servants or agents can accept responsibility for, or liabilities incurred directly or indirectly as a result of, any errors or omissions within this document. Those persons involved in the explosives industry are responsible for taking their own legal and other advice as they see fit. Readers are strongly advised to check for any changes in legislation since publication.

05 Nor do the CBI, its servants and agents make any representation expressed or implied that the products and product ranges or the processes, equipment or materials referred to in this publication are suitable, satisfactory or appropriate for the purpose or purported purposes set out or referred to in this guide and the CBI, its servants and agents accept no responsibility or liability therefore.

SECTION 1 Aim and scope

1.1 Relevance of this publication

06 This document has been written to support the explosives industry in the selection, procurement, use and disposal of PPE intended for use in normal working practice utilized by those working in explosives facilities with Explosives, Propellants and Pyrotechnics; i.e. those materials that would fall within the definition of explosives contained in MSER. Whilst it does not specifically address PPE for those visiting explosives facilities, much of the advice will be pertinent, especially when active processes or demonstrations are taking place. It also considers other hazardous materials, or activity, that may affect the selection of PPE for explosives activities.

Typically the explosives activities or locations where PPE is required are:

- Processing/manufacture
- Storage
- Disposals (including the movement and disposal of firework carcases from a display)
- Laboratory
- Test, evaluation and commercial demonstration

- Environmental testing including conditioning (hot/cold)
- Setting up of displays and theatrical effects
- Plant/Equipment/Facilities maintenance
- Decontamination and/or decommissioning

07 Basic information on the relevance of PPE is present in the Approved Code of Practice for Regulation 4 of MSER [2] (see paragraphs 240 – 242 and 253 -258) with regards to protection from fire or explosion.

1.2 Intent of this publication

08 This publication identifies the parts of the body that can be protected by PPE and the type of hazard that could generate the need for PPE. It also provides advice for the user, including the importance of wearing PPE correctly. Three aspects of the life-cycle of PPE that are particularly important if safety is to be maintained are:

- Selection, procurement and management of PPE
- Use and maintenance of PPE
- Disposal of PPE

09 This publication can be used by many of those operating in the explosives industries and those people who may find this of value are:

- Occupational Health/Safety, Health and Environmental Advisors
- PPE Assessors
- Line Managers/Supervisors and operators
- PPE Manufacturers/Suppliers/Vendors
- Those providing training in the use of PPE
- Entertainment event Subject Matter Experts (SMEs)

1.3 Limitations of this publication

10 It is not intended to replicate advice that is available about the responsibilities and legislative requirements relating to PPE. This can be obtained from the HSE guidance on regulations L25 [1] and the documents that it references or recommends for further reading.

11 Amongst the activities not covered by this guidance are:

- Transport of explosives on the public road;

- Those not involving explosives, or exposure to explosive risk, that are carried out on an explosives licensed site.

SECTION 2 Background

12 Previously the CBI issued a number of guides on PPE for those operating in some fashion with explosives, pyrotechnics and propellants. These were on Head and Eye Protection (May 1999) [3], Hearing Protection (August 1997) [4], Fire protective clothing for pyrotechnics or propellants (Nov 1995) [5], and Protection against substances hazardous to health (March 2001) [6]. At a CBI/HSE review in 2011 it was agreed that these guides were significantly out of date and that a working group should be set up to create a new publication.

13 One of this working group's conclusions was that to identify specific PPE by manufacturer, type or BS EN was fraught with problems; if for no other reason than the information would probably be out-of-date soon after publication. The focus of the working group was therefore to consider more about the aspects of PPE that related to its use in the explosives environment and operations.

SECTION 3 Definition and identification of PPE

14 Having followed the hierarchy of explosives risk control measures and identified that PPE will be required as one of the control measures in the risk assessment, the protection of the primary person (involved in the activity) and the secondary person (people nearby within the hazard zone) needs to be considered. It is also important to identify which parts of the body require protection.

15 The main parts of the body that require protection are usually obvious but the working group's experience was that other parts can be overlooked and it was these that were usually injured.

> While the operator was standing against the granulator the pyrotechnical composition inside it ignited. The flame and hot gasses spread horizontally at table-level and reflected upwards from the floor between the trousers and the jacket of the PPE worn by the operator. As the operator turned to escape, the heat and flames continued to burn his stomach, side and back.

16 The following lists the body parts that could be affected during the normal circumstances of an explosives activity and/or an explosives incident that might occur during that activity. For each part of the body, typical examples of PPE that could provide protection are given, not forgetting that protection should overlap between the main body parts, to avoid gaps in protection at junctions between the different

components of a PPE system. Also included (as *italicised* text) are issues that may need consideration in the PPE selection process.

- **Head (including Neck)**
  - Bump caps, hard hats, balaclava, anti-flash, weather protection, woolly hats, 'hoody' as part of fire protective suit, chin guards;
  - *loss of situational awareness, heat illness;*
- **Hands and arms (including Wrists)**
  - Gloves (impact, abrasion, cuts, chemicals, hot, cold, flame resistant, puncture resistant, tear resistant), gauntlets, wrist guards, protective sleeves, elbow joint protectors, cotton-inners, pre-work skin creams,
  - *loss of dexterity*;
- **Feet and legs (including Ankles)**
  - Boots, Wellingtons, shoes, overshoes (clean side/dirty side), socks, ankle protectors, leg protectors, knee protectors, inner soles, anti-static, conducting, insulating, vapour permeable, water proofing, toe protectors (steel, composite), puncture resistant;
  - *loss of mobility, fatigue;*
- **Torso**
  - Coats (laboratory, warehouse, dust, vapours), jackets, suits, coveralls, aprons, anti-static or conducting, hi-visibility, fire resistant, T-shirts, trousers, long-johns, disposable suits (flame retardant, anti-static), cool vests,
  - *loss of mobility, heat illness*;
- **Eyes**
  - Goggles, spectacles (glasses), face visors (anti-static), shields, UV/IR tints, polarised, prescription, chemical, impact, dust, molten metals, anti-mist/fog, vapours, vented, full face mask,
  - *maintenance of hygiene*, *situational awareness;*
- **Ears**
  - Defenders, plugs, muffs (cold), peak/impulse pressure, attenuation, communications, helmet mounted;
  - *situational awareness;*
- **Skin**
  - All the above, barrier creams (pre-work), sun screen, cleansers (post work);
  - *possible problems with contact dermatitis, long-term skin allergies, fit (comfort), heat rash, hygiene, breathability;*
- **Lungs**

- Vapours, Hot Gases, RPE, face masks (particulates), chemical masks, positive and negative pressure systems, anti-static, breathing apparatus (self-contained);
- *correct use of protection factors (as described in HSG53 [7])*, *situational awareness, fatigue;*

• **Digestive system**

- Face masks (particulates), RPE, positive and negative pressure systems, breathing apparatus (self-contained), clothes changing and hygiene wash stations, vapours.

Hazard assessment template

17 Use of the following template will assist in capturing the potential explosives hazards that may arise during a particular activity and the parts of the body that they can affect or harm.

Protection area[a] / Hazard	Head and Neck	Hands and Arms	Feet and Legs	Torso	Eyes	Ears [c]	Skin	Lungs	Digestive system
Flying fragments (primary and secondary, e.g. metal, glass, ceramic, packaging) [a]									
Thrown burning debris, (firebrands, burning pyrotechnical composition) [b]									
Coarse dust									
Fine dust/smoke (incl. disposal ash)									
Splashes of hot liquids, molten materials									
Splashes of corrosive liquids									
Vapours, fumes and gases, lachrymatory, irritant, toxic									
Radiant heat, hot objects, equipment or surfaces									
Light (incl. UV flash, dazzle)									
Noise (intermittent, continuous)									
Fire/Flash/Flame									

Table 1 – Hazard and protection area requirement template

Template notes:

(a) When considering protection against flying fragments from the accidental initiation of an explosive, the fragments may have a velocity or energy in excess of the minimum performance specified in the relevant EN standard. They may also have a temperature, physical state or brightness that exceeds standards (e.g. molten metals/materials flash, etc.). In such cases, the performance of the PPE against the threat will therefore have to be assessed by type testing or theoretical calculations.

(b) Annex A to this guidance is a summary of current practices in the UK explosives industry for work involving pyrotechnics and propellants which may be helpful in the selection of PPE for activities involving those materials – however it is not a substitute for the systematic approach to the selection of PPE for the particular activity under consideration.

(c) HSG53 [7] provides further information that may be of assistance in the selection of ear (hearing) protection for activities involving explosives – however as before it is not a substitute for the systematic approach to the selection of hearing protection for a particular activity under consideration.

18 It is important to consider other potential hazards that may both affect the body directly and cause an unintended ignition of explosives during an explosives operation, for example:

- Electrostatic Discharge
- Vibration of hand held tools
- Work under hot conditions
- Work under cold conditions
- Falling objects or materials
- Releases of compressed gases, for example from air lines

Systematic Analysis

19 The idea of a systematic analysis is not new; there are many varied algorithms in existence that assign a score to characteristics of several similar options and rank them accordingly. When used in the selection of PPE a systematic approach can assure that the PPE is fit for purpose. Whatever systematic approach is adopted, it should:

- enable a judgment to be made where there are potentially competing requirements that need to be delivered by effective PPE, and also
- structure a judgement made on the balance of worth between the different aspects of the environment that the PPE is being used in.

20 An example of the systematic approaches that have found application within the explosives industry is the Figure of Merit approach, details of which can be found on the EIG webpage.

SECTION 4 Procurement and fitness for use

21 The following paragraphs provide information on aspects that need to be considered as part of the procurement process and also in any instructions on use.

4.1 Procurement issues

22 Once PPE required has been defined and identified, the next step is to procure the item. There are several issues to consider in order to ensure that the item will provide the expected, appropriate level of protection in actual use.

23 In order for PPE to adequately protect the wearer correctly sized items are required. Having a correctly sized item can also reduce discomfort in wearing and help to ensure that the item/garment is worn by the user.

As an example a flame retardant/resistant garment that is too tight on the wearer or fails to overlap adequately will not give the full protection intended (as the fit is different to that applied during the testing of the item).

24 Where will the PPE be purchased? To ensure that a genuine product is bought to the correct specification the supplier of the product needs to be considered. All PPE must be correctly tested and certified to meet an appropriate European Standard [8] where this is required to comply with The Personal Protective Equipment at Work Regulations 1992 (as amended) (PPEWR). A point to be aware of is that items are available that have not been appropriately certified and also counterfeit items are available. Advice and a checklist of good indicators to look for is available from BSIF.

25 It is important to make sure that where one or more British Standards (BS), or other recognised Standards is quoted, the protection level has been tested to the correct part of each Standard.

26 To try to ensure that an item is appropriately certified and not counterfeit there are a few things to consider;

- Where the item is to be purchased, choose a reputable supplier;
- Check labelling, it should be clear and legible with correct font for CE marking and at least 5mm high. Is the item marked to same standards as the advertised product specification?;
- Check documentation, PPEWR require clear instructions for use;
- Check certification, the supplier should be able to provide an EC declaration of conformity or an EC Type examination certificate.

27 In addition the following considerations for flame resistant / retardant garments are of particular importance for the explosives sector;

- Confirmation that manufacturers have used flame retardant cotton or inherently flame retardant thread to assemble the garment;
- It may be important to understand whether the BS, or other recognised Standards, tests were carried out on the fabric or on the garment as the results could affect the effectiveness of the protection (e.g. a fabric test may not identify if there are problems with fixings such as buttons);
- Garment manikin type testing against the maximum credible event, if not already completed by the manufacturer;
- Ensure the garment to be procured is suitable for all exposed hazardous substances present and does not present a risk of accidentally initiating any explosives (by for example electrostatic discharge);
- Consideration should be given to the garment being a different colour to the explosives substance as this enables any contamination to be quickly identified. Additionally, there may be a requirement to procure a disposable flame resistant / retardant garment (with antistatic properties if required) to be worn over the top of the other, reusable, flame protective garments for processes that are likely to increase powder / dust contamination (such as mixing, blending and drying);
- When there is a need to work with extremely sensitive explosives and other hazardous substances (ignition energy less than 1mJ), the procurement of clothing that will not generate electrostatic discharge (for example cotton), to be worn underneath the flame resistant / retardant garment should be considered.

A case example of the failure of a flame retardant garment during type testing can be found at Annex B.

4.2 Fitness for use

28 PPE is for personal use and should not be treated as a communal product – this is particularly important to recognise when ensuring that each item of PPE is correctly sized and/or adjusted for the individual who will be wearing it.

29 PPE is often specified as a system combining items designed to protect different parts of an individual against specific identified hazards; in the explosives industry this 'system' is often crucial in providing the defined level of protection and its effectiveness is often as much about what items of clothing are not worn (e.g. football shirts of man-made fibres, nylon/lycra leggings, etc.) as it is about wearing the particular items of specified PPE (e.g. cotton undergarments, flame resistant or retardant treated overalls, face guards, etc.). Therefore, it is essential that all these points are is adequately and regularly communicated to those required to wear PPE.

30 Having ensured that only appropriate items are worn a number of other critical points should be addressed/controlled:

- Where multiple items of PPE are required to be worn, vulnerable points where the various items meet (e.g. wrists, ankles, neck, etc.) need to be considered and it needs to be ensured that adequate protection is provided and can be maintained during the work activities (i.e. operative movements do not cause gaps to be created, etc.);
- All users must be adequately trained in how to check that their PPE is of the correct size and how to wear the PPE correctly to ensure the desired level of protection is afforded;
- Personalisation of PPE can adversely affect its effectiveness (e.g. company logo'ing, stickers, etc.) This must not be allowed unless it is undertaken as part of the manufacturing process for the items and is thus encompassed in the item's certification against a defined standard;
- Before use the condition of PPE must also be considered to ensure it has not aged or deteriorated in a way that compromises the protection level it was originally intended to have. Issues to consider include;
    - The degree of wear of an item can compromise its level of protection or user fit;
    - Contamination can compromise PPE; items of PPE should be kept in a clean state and replaced when excessively contaminated.

- Some items of PPE may require an acclimatisation period of time before they become effective (e.g. some items of conducting/anti-static clothing); manufacturers guidelines should be identified and followed in respect of this.

31 Users should be instructed not to adjust PPE in the work area, as this can lead to a loss or reduced level of protection. If PPE needs to be adjusted the user should vacate the work area and make the adjustment in a safe place.

SECTION 5 In-Use

32 PPE has to be worn correctly if it is to be effective at providing the expected level of protection.

The operator was wearing a flame retardant overall, balaclava, safety glasses, silver apron, silver sleeves and leather gloves) and was standing in front of the lead rolling machine feeding the composition filled (NEQ 15g) lead tube (through a series of apertures to reduce the diameter and increase the length of the tube) when the event occurred. The PPE protected the operator such that the only injury suffered was a small blister to the tip of the left hand middle finger.

Overalls will not provide protection if the top section of the overalls is tied around the waist and glasses provided are of no value if worn on top of the head. These may be simplistic examples but when observed they can highlight a poor safety culture, a lack of understanding of risk and/or a failure of management controls.

33 Care must be taken to prevent PPE migrating to tasks where it may not be appropriate for the activity being carried out (e.g. anti-static shoes being used when conductive shoes should be worn).

34 The protection afforded by the PPE should not be downgraded by individuals failing to use it properly or not using it at all, and the issues of weight and heat illness must be addressed though management controls. Examples of controls could include

adjusted working patterns, use of cool vests, shorter working times, and/or more frequent breaks.

5.1 Good practice in use:

35 PPE should be sized to fit the individual within the available size range, exceptional circumstances may require bespoke PPE for an individual where they are outside the available size range.

36 Sleeves/trouser legs should be rolled down and, if folded back, folded inside rather than outside (so as not to provide a 'pocket' for explosives to collect).

37 Overalls and coats should be fully fastened, including the neck area.

38 There should be no modification of PPE that defeats the planned protection (e.g. removing the fingers from under-gloves to aid manual dexterity, using non flame retardant thread for alterations or repairs).

39 Face-fit testing for RPE must be carried out (see HSE guidance).

5.2 Considerations for comfort:

40 Manage heat illness related issues – i.e. perspiration which will cause wetting of garments and undergarments which may increase the likelihood or extent of burns in the event of an ignition.

41 There are cool vests available which are made of flame retardant material which include gel packs (pre cooled), these are worn between layers of PPE. Before such vests are used, the overall effectiveness of the system should be reassessed to ensure that they do not interfere with the protection provided by the other elements of any multilayered approach. Consideration must also be given to the effects of the additional weight being carried by the wearer compared with the reduction in heat illnesses.

42 Provide a specified place where some layers of PPE e.g. a balaclava may be safely removed to assist in cooling off.

43 Consider the provision of drinking water in safe/refuge areas for rehydration.

SECTION 6 Maintenance

44 It is important to manage the shelf life of PPE in accordance with the manufacturer's 'use-before' dates, and this may require stock rotation.

45 The finite amount of life for items such as hard hats and RPE filters, as determined by the manufacturer, also needs to be managed.

46 It is important to understand how to identify when a garment is worn out or is worn out to a degree sufficient to reduce its protective properties significantly.

47 The manufacturer's instructions for the correct storage and maintenance of PPE must be adhered to throughout its serviceable life.

48 Consideration must be given to the following aspects of the laundering of PPE garments:

- in-house versus 3rd party
- contamination
- replacement periods for flame retardant treated materials
- waste water treatment, etc.
- caution regarding laundry aids causing dermatological problems, incompatibility of bleach or other cleaning agents
- decontamination prior to sending to an external laundry
- look at frequency of laundering and how to ensure that defined periods are adhered to (prevent excessive contamination – e.g. bar code control etc.)

49 It is important that repairs or alterations to garments are to the same standard as the original garment manufacture.

50 Management must ensure that time-expired, worn or defective PPE is withdrawn from the user.

SECTION 7 Disposal

51 An important consideration in deciding how PPE is to be disposed of is whether the level of the explosives contamination of the PPE is sufficient to represent a hazard or just low/trace. Where the PPE is sufficiently contaminated to represent a hazard the disposal of the PPE can present a problem, particularly for flame resistant or flame retardant materials. PPE that can be regarded as low/trace contaminated is either certified free from explosives hazard (CFFEH – low level contamination), or cleaned such that it can be certified free from explosive (CFFE).

52 For PPE that is sufficiently contaminated to represent a hazard, there are few disposal options available to most operators other than safely burning the PPE on-site. This should be undertaken as a single process and not included with other explosives wastes to reduce the risk of an enhanced effect overcoming the separation distances or other mitigatory controls applied. The disposal by burning of flame resistant clothing presents a specific problem due to its properties, this may require additional accelerants, higher temperature burning for longer times to achieve

complete disposal. Advice on this can be obtained in the CBI guidance for the safe management for the disposal of explosives [9].

53 The use of roadside/front of house/charity recycling disposal is not an option for explosively contaminated PPE.

54 When disposing of explosively contaminated PPE it is important to use appropriately licenced waste contractor who will provide the relevant document which must identify the relevant European Waste Catalogue (EWC) code. Contractors that are unable to provide this documentation may be involved in illegal fly tipping.

55 For low/trace contaminated PPE (either CFFE or CFFEH) the disposal route can be through contracted or council waste treatment routes in the same way other non-hazardous materials are disposed of. Where the site has an appropriate permit the PPE can be burned as fuel for the burning process.

56 Decontamination can be achieved through laundering of the PPE, followed by disposal via the non-hazardous route. However it should be recognised that the process of laundering the PPE may result in an explosively contaminated waste stream which will need treatment. Potentially this may require the laundering process to be in-house or by a contractor on-site.

57 Where flame retardant/resistant clothing can be decontaminated to a non-hazardous state then conventional disposal routes are an option.

58 The batteries in self-powered RPE can present a problem for safe disposal by burning if they become contaminated. Precautions should be taken prior to use to prevent the battery and/or the RPE from being explosively contaminated. For disposal follow the advice in HSG53 [7].

Glossary

Item	Description
Flame resistant	Inherent property of the material of manufacture. For further information please see (link).
Flame retardant	Wash or coating to provide a limited lifespan of protection. For further information please see (link)
Heat illness	Heat illness has traditionally been divided into heat exhaustion and heat stroke. In practice it is difficult to define the division

	between the two. For the purposes of this publication the term 'heat illness' is all embracing and applies to an individual who becomes incapacitated as a result of a rise in core body temperature.
Visitor	A person who visits a Company, but is not employed by or contracted to that Company for the purposes of carrying carry out work on the Company's site.

Abbreviations

BSIF	British Safety Industry Federation
CFFE	Certificated Free From Explosives
CFFEH	Certificated Free From Explosives Hazard
MSER	Manufacture and Storage of Explosives Regulations 2005
RPE	Respiratory Protective Equipment

References

1. Personal protective equipment at work (Second edition) – Personal Protective Equipment at Work Regulations 1992 (as amended); Guidance on Regulations L25 HSE Books 2005. ISBN 0 7176 6139 3
2. Manufacture and Storage of Explosives Regulations 2005, SI 2005/1082. The Stationery Office 2005. ISBN 0 11 072764 9. Guidance on Regulations L139, HSE Books 2005, ISBN 0 7176 2816 7
3. Head and Eye Protection – a guide for those that manufacture, test or use explosives May 1999. ISBN unknown
4. Hearing Protection – a guide for those that manufacture, test or use explosives August 1997. ISBN 0 85201 548 8
5. Fire Protective Clothing - a guide for those that manufacture or store pyrotechnics or propellants November 1995. ISBN 0 85201 513 5
6. Protection against substances hazardous to health – a guide for those that manufacture, test, supply or use explosives March 2001. ISBN unknown
7. Respiratory Protective Equipment at Work guidance. ISBN 978 0 7176 6454 2.

8. Commission communication in the framework of the implementation of the Council Directive 89/686/EEC of 21 December 1989 on the approximation of the laws of the Member States relating to personal protective equipment (link)

9. Guidance for the Safe Management of the Disposal of Explosives, ISBN 978-0-85201-655-8

Acknowledgements

The CBI Explosives Industry Group partnership working together through the Explosives Industry Forum wish to gratefully acknowledge the following organisations for their valuable efforts made in the preparation and production of this guidance:

AWE plc

BAE Systems, Munitions

Blackcat Fireworks

Chemring Countermeasures Ltd

Ministry of Defence

QinetiQ Ltd

Wallop Defence Systems Ltd

Annex A – PPE for Fire Protection

The following information is an extract from Reference [5], the information contained has not been reviewed or amended but is believed to represent current practice.

Factors to consider for work involving Pyrotechnics and Propellants

Pyrotechnics

Head/face protection is provided to:

(i) maintain cleanliness and reduce sensitisation

(ii) protect against heat/flash/fragments

Where cleanliness/sensitisation is the only issue a flame retardant cap and a Tyvek® hood are worn. The Tyvek hood is part of a Tyvek overall. Tyvek® overalls may be worn for cleanliness but only on top of fire protective clothing. (Tyvek® is typical of a range of disposable polyolefin overalls which are not commonly flame retardant).

Where the possibility of heat, flash or fragments exists a wide variety of practices are followed.

Selection of protective equipment within the range below is only made following a thorough assessment of the task in hand.

(i) no specific head/face protection

(ii) simple Flame Retardant cotton cap

(iii) simple Flame Retardant cotton cap with ear/neck flaps

(iv) Flame Resistant or Flame Retardant cotton balaclava

(v) balaclava, Flame Resistant hood and Tyvek® hood

(vi) rigid aluminised helmet with separate air supply and integral heat and chemical resistant visor.

As a guide, no head/face protection is worn when completed fireworks are being packed because the risk of ignition is considered minimal. The rigid aluminised hood is worn when large quantities of high thermal intensity compositions are being handled directly.

Where the headgear does not include eye and face protection, then safety spectacles (including prescription lenses), safety goggles or visors may be worn.

Torso

The basic level of protection worn throughout the industry is either a boiler-suit (coverall) or jacket and trousers made of either Flame Retardant cotton fabric or Flame Resistant fabric. Particular attention is paid to collars, cuffs and other entry points for flame.

The garments do not have external pockets or turn-ups, and buttons or fasteners are soft or concealed, whilst remaining secure. Extra, personal, clothing, e.g. scarves, if worn is not exposed.

In more specialised applications, particularly high thermal intensity compositions, extra layers of protection are worn over a Flame Resistant coverall. These include aluminised fabric and leather worn separately or in combination.

Hands/Arms

Any selection of hand protection must first address the balance between loss of dexterity and gain in protection. In many cases no gloves are worn. The lowest level of protection is provided by non-Flame Retardant cotton gloves, e.g. for packing or assembly of insensitive devices. Higher levels of protection using Flame Resistant gloves together with disposable plastic gloves and other specialised combinations including leather gloves are used in specific applications, e.g. direct handling of high energy compositions.

The area where hand protection and arm protection meet is given careful attention. This may be protected by a specific item, e.g. a gauntlet or by built-in overlaps between the glove and sleeve.

The arms are normally protected as a part of the torso garment. However certain applications may require separate leather or aluminised fabric sleeve coverings.

Legs

In almost all cases legs will be protected by either Flame Retardant or Flame Resistant material as a part of the torso protection. A small number of specialised applications involving high energy compositions require the use of aluminised fabric, in this case without leather.

Aprons, either pinafore type or waist downwards, made from either leather or aluminised fabric are worn in specialised applications.

The use of non-Flame Retardant cotton aprons is to be avoided.

Feet

In many applications no specific foot protection is provided, except the use of Corovin® (Corovin® is polypropylene fabric, weight 100 g/m^2, It is not Flame Retardant.*)* overshoes or similar type to minimise grit hazards.

Standard leather safety footwear is considered to provide sufficient foot protection and the authors are not aware of any pyrotechnics manufacturer who provides a higher level of protection. Such footwear may also have anti-static properties either by a conducting sole or earthing straps and may include covered steel toecaps.

The area between the trouser leg and footwear is also checked to ensure that no traps are provided for burning debris, and that the area not covered by the footwear or trouser leg is minimised.

Underwear

In the fireworks industry and much of the military and civil pyrotechnics area no particular underwear (including socks) is specified or provided.

When high energy compositions are being handled, cotton underwear is issued; this may or may not be Flame Retardant treated.

Where cotton socks are provided this is for anti-static purposes rather than fire protection.

Propellants

Comparison of the fire protective clothing worn in pyrotechnic and propellant areas showed many practices are common to both.

The basic level of protection for propellant workers is provided by Flame Retardant cotton or Flame Resistant material.

Some propellant manufacturing and processing sites stipulate the use of a lightweight Flame Retardant cotton shirt (175 g/m^2) or lightweight Flame Retardant cotton underwear (160 g/m^2).

Where a higher risk is perceived, e.g. propellant machining, some sites use garments made from aluminised fabric.

In the interests of brevity, the details of clothing already described in the pyrotechnics section are not repeated here. Manufacturers who work with propellants are advised to read the pyrotechnics section as well as the comments above.

Burning Grounds

Employers should recognise that burning grounds are areas where workers may deal with hazardous materials out-of-doors in inclement weather. It is important to ensure that the protection offered by fire-retardant indoor clothing is not negated by inappropriate outdoor clothing.

On certain burning grounds flammable liquids are used in the destruction process. Protective clothing worn in such areas is chosen to be resistant to these liquids and not to absorb them.

There are garments available which meet all the above requirements.

Annex B – Example of failure of flame retardant clothing during type testing

During type testing of a two piece Proban® system as flame retardant protection using ‘stick’ gun propellant the system failed when the tunic top was not tucked into trousers, The type testing was conducted using a fibreglass standard shop manikin and thermocouples underneath the garment and above the garment. Below are photographs of garments that were type tested. What can be seen is during the test the cotton undergarment ignited due to the gaseous nature of the propellant increasing the potential burn injuries and demonstrating why type testing of a system against the maximum credible event/hazard can be important.

Temperature Profiles –12KG Slotted Stick Propellant, Proban® garments