ICHCA International Limited

INTERNATIONAL SAFETY PANEL

RESEARCH PAPER # 9

PERSONAL PROTECTIVE EQUIPMENT

By

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ICHCA International Limited

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This publication is one of a series developed by the International Safety Panel ("Safety Panel") of ICHCA International Limited ("ICHCA"). The series is designed to inform those involved in the cargo-handling field of various practical health and safety issues. ICHCA aims to encourage port safety, the reduction of accidents in port work and the protection of port workers' health.

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ICHCA International Limited - INTERNATIONAL SAFETY PANEL

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Personal Protective Clothing

1. Introduction

1.1 Methods of general accident prevention may be divided into two types, 'safe place' and safe person'.

1.2 The safe place method is embodied in legislation that provides for such conditions as:

- Safe access and egress
- Safe premises
- Safe plant
- Safe processes
- Safe materials
- Safe systems of work
- Adequate supervision
- Competent and trained personnel

1.3 The safe person method is concerned with protecting the individual in specific situations where a safe place method may not be wholly appropriate or possible to implement. It always depends upon the individual conforming to certain prescribed standards. These may be classified as follows:

- Care of the vulnerable, eg. inexperienced workers, pregnant workers, disabled persons, those exposed to toxic substances or physical agents.
- Personal hygiene
- Conduct for the safety of the individual and others
- Caution towards danger ie. the identification and assessment of risks
- Personal protective equipment (PPE)

1.4 Wherever possible a safe place strategy is preferable to a safe person strategy. The provision of personal protection such as safety boots and ear defenders should be seen as an interim form of protection until the hazard can be eliminated at source or by the implementation of safe place, or as a last resort when all other measures have failed.

1.5 In performance based approaches to safety such as risk assessment, PPE is at the bottom of what is recognised as a hierarchy of protection in the reduction of risk.

1.6 As a form of protection, PPE obviously relies both on the individual wearing it when required, and wearing it correctly.

1.7 PPE can be uncomfortable or inconvenient to wear, especially over a long period. This can be minimised by careful selection of PPE.

1.8 In many ways, PPE is an imperfect solution. However, where total protection is impractical because of either the mobility of personnel or the particular hazards in the environment, PPE can still make a contribution towards the safety of the individual. This is particularly so in cargo handling work and is specifically recognised in the various national and international conventions, regulations and other legislation that are concerned with safety in docks.

1.9 Any country that has implemented the International Labour Organisation (ILO) Convention 152 - Occupational Safety and Health in Dock Work - should have enacted legislation that ensures workers are provided with PPE when protection cannot be provided by other means.

1.10 For example, the European Union Personal Protective Equipment Directive and the Use of Personal Protective Equipment Directive require employers to carry out an assessment of the need for PPE. If this shows that PPE is necessary, they must provide it free of charge and replace it if it becomes damaged or faulty. They must also ensure it is worn when the risk assessment so requires, and where required by national legislation. Employees must take care of the equipment and report any faults or damage that may develop. Similar legislation is in force within the USA at longshoring and marine terminals.

1.11 In certain cases where equipment is of a very personal nature, and is usable off the job, (ie. safety glasses, safety shoes and cold weather gear), the matter of payment will often be subject to management/union negotiations.

1.12 The users of PPE should be instructed as to why PPE is needed, the type of protection offered by it and the correct way to wear it. PPE should always be used in accordance with the manufacturers' instructions.

1.13 Users should be made aware that when hazards are assessed on a time-weighted average, eg. noise or fumes, the level of protection would be dramatically reduced if equipment is only worn for part of the exposure time.

1.14 It is possible to encourage workers to wear/use PPE by involving them in the choice of equipment, and by ensuring Managers lead by example.

1.15 When considering what sort and design of PPE to use, the following aspects must be considered:

- Suitability for the risk and for the task
- Comfort, ease of movement, convenience when putting on and removing PPE
- Compatibility with other PPE that may need to be worn at the same time.
- The number of personnel exposed.
- The safe limits of the hazard, eg. occupational exposure limits, noise levels.
- Specific statute law, rules or regulations in place.
- Other factors which might affect the wearer, eg. extremes of temperature, lighting levels, background noise, confined spaces etc.
- Ease of maintenance and cleaning.

1.16 There is a need to ensure that workers who use PPE are properly protected. Consideration of the factors in 1.15 in a systematic way will ensure that choice, introduction, and use, maintenance and monitoring of equipment is carried out effectively.

1.17 An effective maintenance system needs to ensure that routine repair and maintenance of PPE is carried out, particularly in the case of equipment such as breathing apparatus, and lifejackets. It should also ensure that a sanitising facility for some pieces of equipment, such as ear protectors, is available.

1.18 One important requirement for all Port workers is the provision of high visibility clothing in the form of a vest, jacket or overall that is in a highly visible colour and incorporates reflective materials.

1.19 PPE may be broadly divided as follows:

- Hearing protection
- Respiratory protection
- Head protection

- Eye and face protection
- Protective clothing
- Hand and arm protection
- Leg and foot protection
- Fall prevention and fall arrest equipment
- Flotation aids

1.20 The following sections of this booklet give more specific guidance about the selection, use and care of PPE for use in cargo handling operations.

2 Hearing protection

2.1 General

2.1.1 Many countries have legislation in place to protect workers against the risks associated with the exposure to excessive noise at work.

2.1.2 The use of ear protection is a last resort to control noise exposure. It should only be considered where exposure cannot be controlled by other means.

2.1.3 A rule of thumb is that if a worker is carrying out a job where he needs to shout to make someone standing 2 metres (6 feet) away hear, he should be wearing hearing protection. A proper noise assessment should then be carried out.

2.2 Types

2.2.1 There are many types of ear protector available. All types are capable of reducing noise exposure and sufficient technical data should be available to allow proper selection of a suitable type of protector. The type selected will depend on the frequency and intensity of the noise and the attenuation factor of the ear protector at that frequency. Irrespective of the type used, it will only operate effectively if it is kept in good condition, the correct size and worn properly.

2.2.2 The three principal types of ear protector are muffs, plugs and semi-inserts.

2.2.3 Each type should offer a similar level of noise reduction performance, although there will be advantages to each type in certain uses. Choice is likely to be based on the following factors:

- Personal preference
- Compatibility with other safety equipment
- Comfort
- Predicted noise reduction
- Need for communication
- Environmental factors - such as temperature or dust
- Cost of maintenance or replacement

2.2.4 Recent technical development have led to the production of a number of highly sophisticated ear protectors with additional noise control facilities, such as built in electronic systems. These include noise-level dependant protectors that protect against hazardous noise whilst permitting good communications in quieter areas. Active noise reduction ear protectors are also available. These incorporate an electronic sound cancelling system that is extremely effective at low frequencies (50 - 500 Hz).

2.3 Use

2.3.1 Ear muffs are easy to use and clearly visible so use can be easily monitored. The disadvantage of ear muffs is that they are not suited for use with safety glasses or some types of helmet, and may be uncomfortable in warm environments. There should be no interference with ear muff seals, anything between the seal and head is likely to reduce performance. This could include goggles, spectacles, beards, long hair and clothing which may all affect the performance of ear-muffs.

2.3.2 Some ear plugs are intended for use for an indefinite time, some only to be used a few times and others to be thrown away after single use. As ear-plugs fit into the ear canal, any user that suffers from ear problems should be referred to a doctor before using them. Ear-plugs will only be effective when fitted correctly. They need to be properly and securely inserted in the ear canal. Depending on their intended use, ear-plugs can be made from compressible foam/mineral down (disposable/reusable) or rubber/plastic (permanent). Custom moulded ear-plugs are also available. The advantage of plugs is that they may be used with safety glasses or helmets. However, they are not suitable where they are likely to be removed frequently.

2.3.3 Semi-inserts are pre-moulded plugs attached to a head band, which presses them into the entrance to the ear canal. This type of protector is useful for intermittent short periods of use in an ear protection zone.

2.3.4 Improved protection can be obtained by wearing a combination of ear muffs and ear-plugs. The amount of protection depends on the particular muff and plug combination.

In general the most useful combination is a high performance earplug and a moderate performance earmuff. An individual wearing such a combination will often experience half the exposure to noise of one wearing each item alone.

2.3.5 Port workers are often subject to variable noise exposures. The selection of good broad based (in frequency terms) ear protectors will provide adequate protection in most situations.

2.3.6 A thousand fold reduction (30DB) in actual noise exposure may be attainable if appropriate ear protectors are worn correctly for a full working day.

2.4 Training

2.4.1 Ear protectors are only effective when used properly. A person who has had appropriate training should fit them. Users should be instructed in their correct fitting and use. The characteristics of the noise should always be determined before selecting appropriate ear protectors.

3 Respiratory Protective Equipment (RPE)

3.1 General

3.1.1 Sometimes work must be undertaken in a space or area where the atmosphere is contaminated or deficient in oxygen (less than 18% v/v) or both.

3.1.2 The contamination may consist of substances, such as dust, fibres, fumes, vapour, gases, micro-organisms or radioactive particulates and gases which can cause

significant damage to health or even lead to death in extreme cases. In such cases Respiratory Protective Equipment will have to be worn.

3.2 Types

3.2.1 There are two main types of respiratory protected equipment.

- Respirators - designed to filter or clean contaminated air from the workplace before it is inhaled by the RPE wearer. This includes the powered filtration type respirator helmet. No respirator should be worn in atmospheres which are immediately dangerous to life or health, including those which are deficient in oxygen.

- Breathing Apparatus - delivers breathable air from either air cylinders included in the apparatus or free air from an air line. Breathing apparatus may be suitable for oxygen deficient atmospheres and other atmospheres that are immediately dangerous to life and health.

This section deals only with respirators, as the use of breathing apparatus involves specialised training. Its use is considered to be outside the scope of the regular activities of port workers.

3.3 Selection

3.3.1 In common with the other types of PPE, effective protection is only possible when the RPE is:

- Suitable for the hazard and the task
- Suited to the wearer and the environment
- In good condition
- Worn correctly by someone who has been trained to use it.

3.3.2 There are many types of RPE and care is needed to select the correct equipment for a particular situation.

3.3.3 Where there is any doubt over the selection of suitable RPE, the manufacturer or supplier should be consulted in order to confirm the suitability of the equipment for the task and conditions in which it is to be used.

The performance of a tight fitting face piece depends on a good contact between the user's skin and the face seal of the mask. For this type of equipment a fitting check needs to be carried out each time the RPE is put on. Loose fitting face pieces should never be used where the equipment relies on a user's lung power to draw in air.

3.3.4 Respirators may be used to provide protection against a variety of substances, broadly classified as follows:

- Dust
- Fibres

- Mists
- Fumes
- Micro-organisms
- Gases and vapours

3.3.5 There are many patterns of respirators available:

- Filtering half masks which are entirely or mainly made from filtering material. These are commonly known as disposables. They rely on the breathing action of the wearer to draw air through the filters.

- Half or full face masks with separate filters. These may include a battery powered filter unit to assist breathing.

- Hoods, helmets or visors used with a powered unit.

3.3.6 It is essential that respirators have the correct type of filter fitted for the substance against which protection is required. Particle filters will not remove gases and/or vapours; gas/vapour filters are not designed to remove particles.

3.3.7 Combination filters are available which remove both particles and gases/vapours. It is recommended that a combination filter be fitted to all emergency masks to increase flexibility and protection.

3.3.8 One particular danger with gas and vapour filter type respirators is that they fail to danger when the absorbent becomes saturated. They will, therefore, always have a limited working life. Reliance on the user's sense of smell to indicate breakthrough should never be permitted, by that time it may be too late. Many toxic gases and vapours have immediate and serious effects when inhaled, even at low concentrations. Filter type respirators should only be used in atmospheres containing low levels of contaminants.

3.3.9 Once the seal on a filter is broken, its shelf life is drastically reduced. Manufacturers' recommendations should be followed regarding use and replacement.

3.4 Use

All forms of RPE cause some discomfort and restrict the wearer. If RPE makes the job too difficult to perform, or is too uncomfortable, the wearer is unlikely to use it correctly, and they will not be properly protected.

3.4.2 Individual susceptibility to the stress of wearing RPE can vary, as can individual medical fitness.

3.4.3 Excess heat stress is also a factor to be considered when selecting RPE. Powered respirators may reduce overheating of the user. The establishment of a work system that allows adequate rest periods will help to alleviate discomfort from the use RPE.

3.5 Training

3.5.1 The best equipment is unlikely to provide protection if users do not know how to use it. Protection will also be affected if RPE is not maintained or stored properly. Training needs to be provided on how to use the equipment, as well as facilities for storage and maintenance.

3.5.2 Training needs to be tailored to the particular RPE and to the application to which it is to be put. It should cover both theory and practice, and be based on the recommendations and instructions supplied by the manufacturers. Many manufacturers provide training in the form of literature or video packages, or through formal courses.

Alternatively there may be suitably knowledgeable individuals who can provide the necessary training.

4. Head Protection

4.1 General

4.1.1 Head protection should be worn in any situation where there is a reasonably foreseeable risk to the head from either:

- moving or falling objects
- bruising or abrasion caused by contact with overhead obstructions.

Protection may be afforded by industrial safety helmets or industrial bump caps.

4.1.2 In many countries the use of head protection in such circumstances is either a general legal requirement, or a specific legal requirement in legislation based on ILO 152. In many countries head protection is provided by the employer free of charge and the employer must ensure it is worn, whilst in other countries employers are under no obligation to provide head protection, but must still ensure it is worn.

4.2 Selection

4.2.1 Comprehensive specifications exist in national and international standards for head protection. Employers should ensure that any head protection used complies with these standards or any equivalent.

4.2.2 Head protection should be as comfortable as possible, otherwise there will be resistance to its use.

4.2.3 To fit properly, the head protection must be of the right shell size for the user and have an adjustable headband, nape and chin strap. The range of adjustment should be sufficient to allow thermal liners to be used in cold weather. In addition the following factors will enhance comfort and user acceptance:

- A flexible headband shaped to fit the forehead
- An absorbent sweat band that is easily cleaned or replaced
- Textile cradle straps
- Chin-straps that are made from non-irritant materials, are compatible with other PPE and do not cross the ears.

4.2.4 It should always be confirmed that the head protection is appropriate for the task when assessing its suitability. For example, a safety helmet with a high crown may not be suitable for lashing vehicles on a Roll on/Roll off (RoR0) ferry, and a helmet with a pronounced peak may not be suitable for stevedores requiring unrestricted upward vision.

4.2.5 If other PPE, such as ear defenders or eye protection, is required, then the helmet must be designed to allow them to be used with the helmet safely and comfortably.

4.2.6 In some instances, such as RoRo operations, a bump cap might be more suitable if the vessel is handling only RoRo cargo. However, if the stevedores are also working on lift on-lift off (LoLo) operations on the same vessel, a safety helmet must be worn.

4.3 Maintenance

4.3.1 Damage to the shell of a safety helmet can occur when objects fall on it, it strikes against a fixed object or it is dropped or thrown.

4.3.2 Ships and ports are, by definition, a harsh working environment. Head protection should be visually inspected regularly for signs of damage or deterioration.

4.3.3 Safety helmets that are to be used by more than one person should be thoroughly cleaned before change of user. Chemical cleaning agents should not be used as they may affect the properties of the helmet. For a similar reason helmets should not painted. The safest and most effective cleaning agent is soap and water. The sweatband should always be cleaned or replaced.

4.3.4 Deterioration of the properties of the safety helmet will also occur due to ageing, which may be caused by heat, humidity, sunlight and rain.

In temperate climates, standard safety helmets have a life of approximately five years. However in all cases manufacturers' recommendations should be followed.

4.3.5 A safety helmet may also need to be replaced when the cradle strap is damaged and cannot be replaced, when the shell is damaged or it is suspected that its resistance to shock or piercing has been reduced. This can happen when the helmet has received a severe impact, is deeply scratched, or the shell is cracked.

5 Eye and face protection

5.1 General

5.1.1 Except for engineering applications or handling bulk liquid cargoes, eye protection in the port industry is generally only needed for tasks where debris, dust or cargo residues may get into eyes. This is particularly prevalent with solid bulk cargoes, when unstuffing containers or during break bulk operations. They would also be worn when cutting metal wires or straps around bales or packs.

5.1.2 As with other PPE, most countries have national standards or specifications for eye protection.

5.1.3 The selection of eye protection depends on hazard. However, comfort is always a factor in ensuring that such equipment is used when required.

5.2 Types

5.2.1 Eye and face protection may be divided into the following types:

- Safety spectacles
- Eye shields
- Safety goggles
- Face shields

5.2.2 Safety spectacles protect against impact. The lenses are made from tough optical quality plastic such as polycarbonate. Most manufacturers offer a range of prescription safety spectacles that are individually matched to the user.

5.2.3 Eyeshields are similar to safety spectacles but are made with a frameless one-piece moulded lens. Vision correction is not possible. However, some eyeshields can be worn over spectacles.

5.2.4 Safety goggles are probably the most suitable type of eye protection for those involved in cargo operations. They have an elastic headband and will stay on during violent movement or physical exertion. They afford the eyes total protection from all directions as the whole frame of the goggles is in contact with the face. Lenses of goggles may be made of toughened glass or plastic, depending on their use. However goggles are more prone to misting than glasses and this may cause problems. Direct ventilation goggles, double glazed goggles, or anti mist coatings may be effective where misting is a problem.

5.2.5 Face shields protect the face, but do not fully enclose the eyes and, therefore, do not protect against dust, mists or gases. They may, however, be more comfortable when worn with a safety helmet or adjustable head harness. They can also be worn over standard prescription spectacles.

5.3 Maintenance

5.3.1 Maintenance of eye protection is normally restricted to the simple but important task of cleaning. Lenses should be kept clean, as dirty lenses restrict vision, causing eye strain and so may lead to accidents.

5.3.2 The preferred method of cleaning is to thoroughly wet both sides of the lenses and dry them with a wet strength absorbent paper. If static or misting is a problem, anti-static and anti-fog lens cleaning fluid may be used, daily if necessary.

5.3.3 Plastic or polycarbonate lenses should not be cleaned dry as grit or dust in the cloth may scratch them.

5.3.4 Eye protection headbands should be replaced when worn out or damaged. Transparent face shields should be replaced when they are warped, scratched or become brittle.

6 Protective clothing

6.1 General

6.1.1 Protective clothing provides protection for the whole or main part of the body, whereas other personal protective equipment generally provides protection for particular parts of the body.

6.2 Types

6.2.1 Protective clothing may be divided into two types:

- Clothing worn to directly protect the body
- Clothing worn to otherwise protect the person

6.2.2 Examples of body protection include:

- Coveralls, overalls and aprons to protect against hazardous substances and dirty environments
- Clothing to protect against cold, heat and bad weather
- Clothing for use with certain machinery, such as chain saws

6.2.3 Examples of person protection include:

- High visibility (Hi-vis) clothing
- Buoyancy aids

6.2.4 In some countries the wearing of Hi-vis clothing is a legal requirement wherever vehicle movements are taking place. This is one of the most effective accident prevention measures that may be taken for port workers. Some factors to be considered when selecting protective clothing are discussed in the following sections. Buoyancy aids are the subject of a separate section later in this booklet.

6.3 Hi-vis clothing

6.3.1 Hi-vis clothing may take the form of overalls, jackets or vests that incorporate highly visible reflective materials.

6.3.2 Hi-vis clothing makes the user more visible in daylight by its use of high visibility fluorescent material and in the dark by use of reflective strips.

6.3.3 Particularly in Port operations, it is essential that workers on foot are conspicuous from above to drivers of large plant and cranes. All clothing that covers the upper body runs over the shoulders and all head protection should have reflective strips. Reflective strips applied as hoops around the lower leg give an additional safeguard against being struck by moving traffic.

6.3.4 National and international standards for 'Hi-vis' clothing specify the minimum performance of colour fast dayglow/fluorescent materials within specified photochromic limits. For example, on one-piece overalls, the upper body down to mid chest level and the upper arms are made of Hi-vis fabric.

6.3.5 Although belts and bands of reflective and fluorescent material are available as separate items, they are not adequate substitutes for 'Hi-Vis' clothing.

6.3.6 There are a number of different fabrics and materials available that are suitable for the manufacture of Hi-vis clothing.

6.4 Selection of fabrics

6.4.1 Some of the factors that have been found by experience to be the most relevant when selecting Hi-vis clothing are described below.

6.4.2 Day-glo material colour:

- Yellow is the most visible colour to the human eye and as such is the high visibility colour of choice and the most commonly used colour. The sheer quantity of material produced ensures that this is the cheapest. Most clothing suppliers do not offer any other choice for their off the shelf range. Yellow

does not perform well under orange high pressure sodium lighting because of diminished colour rendition; it appears a muddy, rather than a bright, yellow colour. Yellow shows soiling very quickly. It then looks scruffy and can prove difficult to keep clean.

- Orange does not perform quite as well as yellow in daytime but it is acceptable. Under high pressure sodium lighting the colour remains permanent, not suffering any colour change. It does not show the dirt so readily. Unfortunately, it is more expensive.

6.4.3 Coat fabric treatments:

- Fabric treatments should be colourfast to ultra-violet light and washing. Manufacturers of fabrics have interpreted this as being resistant to soiling and having reasonable washing capabilities to remove soiling. Fabric treatments can also improve durability, strength and waterproofness.

- Nylon is the cheapest material available. It will not pass the colourfast test as ultra-violet light attacks it. Fading can occur in weeks if left in bright sunlight. It needs to be coated on one side with a rubberised PVC or polyurethane membrane to make it waterproof.

- Polyurethane polyester has similar properties to nylon and is colourfast but more expensive. It can be coated depending on the degree of water resistance and breathability required.

- Nylon and polyurethane polyester materials cannot be dyed. Colour is added during the manufacture of the plastic that forms the fibres. For this reason colour choice is limited but it is available in the primary colours with a variation of shades.

- Polyester mixture fabrics are constructed of mixed fibres, to obtain different aesthetic finishes and if required may be further treated. Such mixtures can produce extremely durable fabrics and many colours. These fabrics are expensive and for Port purposes it is only the poly-cotton mixes, used in the manufacture of coveralls, drivers jackets and trousers that are of interest. A high cotton content in coveralls will keep costs to a minimum but the disadvantages are fading and slight shrinkage after washing.

6.4.4 Most garments can be manufactured in either breathable or non-breathable fabrics. Breathable materials are coated with a thin permeable micro-porous membrane, as opposed to a totally non-permeable membrane (non-breathable). Body heat will be dispersed through the membrane, but rain will be kept out because water molecules are too large to pass through the micro-pores.

` 6.4.5 Breathable fabrics cannot cope with excess body humidity. Condensation will form inside the garment in the same way as in a non-breathable garment. If the outer layer is covered with grease, oil or plastic badges, the pores are blocked and breathability is lost. Where constant movement takes place and the fabric is stretched (elbow and shoulder areas) the pores become stretched and so allow water to pass through. Where the membrane becomes chafed through constant contact with inner garments (in particular zips and buttons) waterproofing is also lost.

6.4.6 Garments can easily be designed to incorporate vents to alleviate condensation. Such venting consists of holes in the under arm and an overlap flap on the back. These vented breathable garments tend to have thicker inner membrane and, therefore, more resistance to chafing and stretch. As such they generally guarantee waterproofing.

6.4.7 Non-breathable fabrics are cheaper and can often be washed at slightly higher temperatures.

6.4.8 Breathable and non-breathable fabrics need to have all stitched seams hot sealed, (normally taped) to ensure garments are watertight.

6.4.9 Outer garments can be manufactured using a mixture of breathable and non-breathable fabrics, the body and sleeves being breathable, and the lower parts being non-breathable.

6.4.10 Cleaning may ensure Hi-vis clothing retains its visibility requirement and that its conspicuity remains effective.

6.4.11 As colourfastness is essential to the day-glo part of the garment, some fabric manufacturers have quoted a fabric life span, particularly for breathable fabrics. The number of washes that may be performed before the material loses its Hi-vis properties may be limited.

6.4.12 Garments constructed of fabric that utilises inner polyurethane or PVC membranes can only be washed at 40^{o} C. Controlled experiments have established that 40^{o} C does not remove heavy grease soiling, but a 50^{o} C wash appears fairly successful without apparent damage to the garment.

6.4.13 Poly-cotton materials used in coveralls, drivers' jackets and trousers should not be a problem. These fabrics, including the reflective strips, can be washed at 60^{o} C.

6.5 Protection against extremes of temperature and weather

6.5.1 Thermal protection necessary to ensure comfort and wellbeing is determined by both personal and environmental factors. Personal factors include body activity, clothing insulation worn and duration of exposure. Environmental factors include ambient temperature, wind velocity, radiant temperature etc.

6.5.2 Wind speed is one of the most important environmental factors to consider. Flesh exposed to a wind speed of 24 kph at 5^{o}C will experience an equivalent chilling temperature of - 6^{o} C. The colour of the garments worn will also affect the amount of heat absorbed from the environment. Up to 95% of incident radiant energy will be absorbed whilst wearing a black outer covering and as little as 30% when wearing a white garment.

6.5.3 An arbitrary unit of insulation, the 'clo' is used for assessing the insulation value of clothing. By definition 1.0 clo is the insulation provided by clothing sufficient to allow a person to be comfortable when sitting in still air at a temperature of 21^{o}C. A polar weather suit has a clo of 3 to 4. Two areas of artificially low temperatures in ports are cold stores and refrigerated vessels.

6.5.4 The normal operating temperature of a cold store is around - 20^{o} C. At this temperature, forklift drivers will require additional protection, over normal outdoor clothes after 30 minutes of work and manual workers after 60 minutes. Forklift drivers will require garments with an insulation factor of at least 8 clo, and manual workers 3 to 4 clo at these temperatures.

6.5.5 Avoidance of heat stress in port workers is normally controlled by limiting exposure rather than by protective clothing. However, there are various heat resistant clothing

combinations available for non-cargo handling applications. These include aluminised Kevlar/glass fibre clothing for firefighting, flame retardant clothing for welders (usually made in natural fibres such as wool or cotton). Chrome leather aprons are also used and flame-retardants are also available for cotton or cotton polyester fabrics. In the USA, threshold limits have been specified for the effects of heat.

6.5.6 Jackets, trousers and leggings made with PVC coated nylon or cotton will offer good protection against rain. These garments will be more comfortable if they are lined. These materials are also resistant to abrasions, cracking and tearing and protect against most oils, chemicals and acids. Breathable waterproof fabrics (see 6.4) will keep out water while allowing body perspiration to escape.

6.5.7 Where Hi-Vis clothing is a legal requirement, the wet weather clothing must be Hi-vis, or a Hi-vis vest worn over it.

7 Hand and Arm Protection

7.1 General

7.1.1 Most port workers are involved with some manual handling operations at some time. During these operations, hands may be pierced by abrasive, sharp or pointed objects or damaged by impact.

7.1.2 There are various types of gloves available to provide protection against a range of hazards that occur in cargo handling operations. These protect against mechanical injury (cuts and abrasions), skin irritation, dermatitis, extremes of temperature and contact with dangerous chemicals. The type and degree of protection depends on the glove material and its construction.

7.1.3 Gloves should not be used when working near moving machinery or power tools, except where specifically designed for the purpose, eg. chainsaws.

7.2 Selection

7.2.1 Gloves or other hand protection should be comfortable, fit properly and be capable of giving protection against the particular hazards associated with the work. In some cases where there is no risk of physical damage or chemical attack to the hands, barrier cream may be used.

7.2.2 The ability of gloves to restrict abrasion and other industrial wear and tear is important. Manufacturer's instructions should always be followed. Where gloves are required to give chemical protection, reference needs to be made to the chemical permeation and resistance data provided by manufacturers.

7.2.3 It is essential that all parts of the hand which come into contact with the hazard be protected. Fingertips are essential to secure handling but may be exposed to cuts and abrasions. The ball of the thumb and the palm of the hand come into contact with any object being handled. Gloves with reinforced and cushioned palms provide increased comfort and protection.

7.2.4 Rubber, plastic or knitted gloves are flexible, resist cuts and abrasions, repel liquids and offer a firm grip in water or wet conditions.

7.2.5 Traditionally, the port industry has used a cotton chrome leather combination glove for dry cargo work, because of their flexibility and hard wearing characteristics. However, they are not necessarily the best choice for work in wet weather or for dealing with mooring lines and ropes.

7.2.6 Depending on the weight and construction, Terry cloth gloves will provide protection against heat or cold. Gloves made from Kevlar glass fibre and leather can be used to provide protection at higher temperatures. PVC, nitrile rubber and natural rubber gloves may be used for handling bulk liquids or powders. Glove manufacturers should be consulted regarding suitability for specific operations and availability before specifying hand protection. Different types of gloves may be required for different operations.

7.3 Maintenance

7.3.1 As with all protective equipment, care should be taken in the wearing, use and storage of gloves.

7.3.2 Gloves should be checked regularly. They should fit the user properly, leaving no gap between the glove and the user's sleeve.

7.3.3 Gloves should be cleaned according to the manufacturer's instructions as they may have particular finishes which may make repeated washing inappropriate. There may also be a risk of cross contamination as chemical residues may remain even after washing.

7.3.4 Gloves that have become grossly contaminated by chemicals or grease, oil etc. should be discarded.

7.3.5 The inner surfaces of gloves will also become contaminated and smelly over a period of time owing to the perspiration and natural oils secreted by the user's skin. All gloves have a limited life span dictated by the frequency of use, the environmental conditions and the risk of developing dermatitis. Gloves should never be shared. All users should ensure that their hands are as clean as possible before putting on gloves. Gloves that have been contaminated on the inner surface should not be worn under any circumstances.

8 Foot and leg protection

8.1 General

8.1.1 ILO Guidance simply says that 'Dockworkers should, as far as practicable, wear safety footwear'. However, in many countries there is a legal requirement for employers to provide safety footwear where there is a danger of foot injuries.

8.1.2 The following are examples of safety footwear which are used in the port industry.

- Safety boots or shoes are the most common type of safety footwear. These normally have steel toecaps, but also have other important safety features such as slip resistant soles, steel midsoles and insulation against extremes of heat and cold.

- Clogs may also be used as safety footwear. They can be fitted with steel toe caps and thin rubber soles to increase their anti slip properties. They are usually made from beech wood, which is both a good insulator and shock absorber.

- 'Rubber boots' (gumboots) are usually made of rubber but are available in polyurethane and PVC which are warmer and have more chemical resistance. They may be obtained with corrosion resistant steel toe caps, rot proof insoles, steel midsoles, ankle bone padding and cotton linings.

- Anti-static footwear prevents the build up of static electricity on the user. It reduces the danger of igniting a flammable atmosphere and gives some protection against electric shock.

- Conductive footwear prevents the build up of static electricity. It is particularly suitable for handling sensitive explosive substances. It provides no protection against electric shock.

8.2 Selection

8.2.1 The selection of foot and leg protection will depend on the hazard, or combination of hazards involved. However, as with safety helmets comfort style and durability should also be considered, as must the needs of the user. There are numerous manufacturers offering many types of foot protection.

8.2.2 Safety footwear should absorb perspiration, be water resistant and be as flexible as possible. Inflexible footwear will result in tired feet and legs. Boots, not shoes should be worn when ankles need protection. If working in circumstances where entrapment of the foot is possible, non lace (riggers) boots may be preferable. The ability of the footwear to resist physical damage due to heat, abrasion and corrosion should also be considered:

- Soles are available in various combinations of polyurethane and nitrile rubbers to give oil, petrol, acid and alkali resistance. Nitrile rubber soles are best for abrasion and heat resistance but are not as comfortable as polyurethane soles. Soles should be adequately treaded to provide slip resistance. Footwear with steel mid-soles will protect against piercing by nails and similar objects.

- Steel toecaps should be capable of resisting a heavy/sharp object falling from a considerable height.

- Leather or other heat resistant uppers provide protection against heat sparks and molten metal. Rubber and PVC provide waterproof uppers, but they are not permeable and will cause perspiration, odour and foot infections. Similar

"breathable" materials to those used for body garments are available; these will allow air in and perspiration out but are waterproof. These are more hygienic and comfortable than leather or PVC but more expensive.

8.3 Maintenance

8.3.1 Safety footwear should be checked regularly for sole wear and materials lodged in the tread removed. The seams should be checked and laces replaced if necessary. Spraying the uppers of new footwear with a silicone spray or wax will give extra protection.

9 Fall prevention and fall arrest equipment

9.1 General

9.1.1 Fall prevention equipment will prevent a person falling over an open edge of a workplace while fall arrest equipment will stop the fall of a person who has fallen over an open edge. Fall prevention and fall arrest equipment consist of a harness or safety belt and a lifeline attached to a secure anchorage. The lifeline may be a simple fixed length lanyard or the self-retracting lifeline of a fall arrest block (FAB). Fall arrest blocks are sometimes referred to as self-retracting lifelines or SRLs.

9.1.2 In order to prevent serious injuries to the back and internal organs in the event of a fall, some countries prohibit the use of a simple waist belt with a lifeline more than 1.5 metres long. These short lifelines can limit the positions where a person can work. Europe, the US and some other countries require a full harness to be used with all fall arrest equipment.

9.2 Types

9.2.1 Simple 'economy' harnesses are available from several manufacturers. They are lightweight owing to the type of polyester fibre used. When they are correctly adjusted they need not be restrictive. In the event of a fall, the back panel action tightens the harness and the wearer falls in the upright 'self recovery' position. Such harnesses should only be used where assistance can be rendered very quickly in the event of a fall. They feature a standard rear 'D' ring and two front loops. These loops, when used together, are for front attachment and work positioning belts. The straps have wear indicators that assist in pre-use wearer inspection.

9.2.2 Full supporting harnesses have 'D' Rings at the back, each side and front. They tend to be used for engineering or plant inspection purposes. They have additional rings for work position belt attachment or rescue purposes. Full harnesses should be used where the wearer might not get immediate assistance in the event of a fall and may be left suspended for several minutes before rescue. By design, they can be restrictive and not so comfortable for everyday rigging purposes.

9.2.3 A fall arrest block locks when the lifeline in it is pulled sharply. If a user falls over an open edge during normal operation a speed sensing system in the block will activate, absorb the energy and stop the fall. A reserve lifeline system is incorporated in the block to reduce the shock of a fall arrest on the user if the fall occurs when the lifeline is almost fully extended.

9.2.4 Fall arrest blocks are available with 12 to 16 metre long self-retracting steel wires. They are ideal for permanent installation on spreader frames and container top safety cages or frames. The 'back pull' on a harness can be around 5 kg which workers may find inhibiting at first. In addition any sudden movement can trigger the arrest brake which can be a little unnerving when trying to step over a gap. However, this type of block and fall arrest system has become very popular in ports around the world, as little

training is required and work methods differ little from before but workers are attached to a lifeline.

9.2.5 Portable fall arrest blocks are also available with 7 metre long self-retracting polyester webbing. These 'go anywhere' blocks weigh only 5 to 10 kg, depending on specification, and are favoured by scaffolders and steel erectors. They consist of a polycarbonate shell and webbing lifeline. The 'back pull' on a harness is only around 2 kg, so they are less tiring to use than steel-wire fall arrest blocks. They have many uses on container tops, particularly where a short task is required and permanent fittings are not available. They are ideal for engineers and electricians working at height. They can be used from any:

- Lifting 'D' ring on the spreader frame
- Fixed point tested to 10 kN.
- ISO container corner casting
- ISO container vertical door bar (ISO standard is 20 kN, equivalent to 2 tonnes)
- Girder or structure with obvious strength.

9.2.6 Lanyards are short, fixed length lifelines that can be attached between a user's harness or belt and a secure anchorage. A short 230 mm lanyard may be attached to the 'D' ring at the rear of a full body harness to enable the harness wearer to hook and unhook from a lifeline without any assistance.

9.2.7 Work Position Belts are waist belts and are usually adjustable. As the name suggests, they are used in a fixed position for example the belts used by telephone linesmen. Once in position the belt should be attached and adjusted to remove any slack and to ensure the desired working position is maintained. Where a risk of falling is present during access and egress to the work position, the work position belt should be used in conjunction with a self retracting lifeline block or lanyard, preferably attached somewhere above the intended workplace.

9.2.8 In container operations, work position belts may be used to secure a stevedore in position on narrow hatch ledges or outboard lashing platforms, for the purpose of handling lashing poles. Work position belts may be attached to vertical container door bars (ISO tested to 20 kN); 'D' rings or corners castings, where possible.

9.2.9 As with any safety equipment, cumbersome and uncomfortable safety equipment will meet wearer resistance. Selection should be made in consultation with those who will be wearing the equipment in practice.

9.3 Anchorages

9.3.1 When lifelines are attached to anchorages, care should be taken to ensure that they cannot be accidentally disengaged. If karabiners are used, they should only be of the screw gate or 'snap-lock' type. 'Snap-close' karabiners, which are unlocked, should never be used.

9.3.2 Anchorage devices on blocks other than those supplied should not be used. Anchorage points should be of sufficient strength (tested to 3,600 lbs or 16 kN minimum) to offer support in the event of a fall. Ideally, anchorage points should be recognised, tested fittings, such as 'D' rings on the spreader frame, ISO corner castings or girders or supports of obvious strength. Handrails should never be used as an anchorage point.

9.3.3. Ideally the anchorage point should be above the wearer at not more than a 40^{o} angle to the vertical to minimise any pendulum swing if a fall occurs. However, as the fall

arrest system will function normally at any angle, the angle may exceed 40^{o} but the wearer needs to be aware of the potential consequences of a swing in the event of a fall.

9.4 Use

9.4.1 The harness and lifeline should always be checked for damage before use. The check should include tugging it to ensure that the locking device functions correctly. The harness and block should never be attached to another fall arrest block.

9.4.2 Some harnesses have wear indicator lines. If a cut or tear beyond this line is evident, the harness should never be used. In all other cases cuts or tears should not exceed 5 mm.

9.4.3 The maximum permissible load of a fall arrest block is normally 136 kg (3,000 lb or 21 stones).

9.4.4 Where lanyards are used and there is a risk of falling over an open edge, the lanyard should always incorporate a shock absorber.

9.4.5 Lanyards and work positioning belts should never be used to extend the reach of a fall arrest block, as this may affect the pre-set braking mechanism and so prevent the block acting as intended.

9.4.6 It is recommended that automatic 'snap-lock' karabiners are used with lanyards and work positioning belts rather than screw gate karabiners. This eliminates the risk of the user forgetting to secure the karabiner properly.

9.4.7 Fall arrest equipment should never be used to protect the wearer when working on soft or slowly shifting materials, such as sand or grain.

9.4.8 The lifeline should not be allowed to snap back fast into the block.

9.4.9 No attempt should be made to tamper with or repair equipment. It should be returned to the manufacturer or an authorised service engineer.

10. Flotation aids

10.1 General

10.1.1. Lifejackets or buoyancy aids should be worn when working on or near water if there is a foreseeable risk of drowning. Personnel working aboard small craft, such as mooring boats, and line handlers working within one metre of a quay or jetty face should wear flotation aids at all times.

10.2 Selection

10.2.1 Factors to be considered when selecting flotation aids include:

- Size/weight of the wearer
- Ability to swim
  Protective clothing being worn
- Water conditions
- Use of tool belts or other equipment

10.2.2 It is important to remember that buoyancy aids are considerably inferior to lifejackets and will only provide support to a conscious person who is able to swim and help themselves but lifejackets will support the wearer, particularly if that person is unable to swim or is injured, exhausted or unconscious.

10.2.3 Buoyancy may be provided in a number of ways. These may be by the use of inflatable chambers, permanently buoyant material or a combination of both.

10.2.4 Buoyancy aids should only be used in situations where a person falling into the water can be expected to be rescued in a short time.

10.2.5 Automatically inflated lifejackets are suitable for use by persons who are likely to fall into the water unexpectedly. A manually inflated lifejacket should only be used if the wearer will have time to fully inflate it before being immersed.

10.2.6 The final decision on the type and specification of flotation aids depends on the type of work being carried out, the water conditions and the risks involved in the operation. These aspects should be considered when selecting which manufacturers' products to purchase.

10.3 Use

10.3.1 Users of floatation aids should inspect and check them before use in accordance with the manufacturer's instructions. Any defects should be reported.

10.3.2 Ideally lifejackets should be issued to individual users. The individual can then be responsible for carrying out pre-use checks and reporting defects. A supervisor should also carry out periodic checks and keep records of them. In both cases, the persons carrying out these periodic inspections need to be trained and competent.

10.4 Maintenance

10.4.1 Lifejackets should be stored in suitable dry conditions to ensure that their performance and their useful life are not affected:

- If they are wet, they should be hung on a hanger and left to dry
- They should not be hung up with wet clothes
- They should not be stored above heat sources
- They should not be stored upside down
- There should be enough space around them to allow air to circulate

10.4.2 The obvious risks of flotation aids failing to operate correctly will be increased if they are not properly maintained. Procedures should always be in place to ensure proper use, maintenance and storage of the equipment.

10.4.3 The maintenance procedures for flotation aids will depend on the method used to achieve buoyancy and the conditions of use of the equipment. The procedures set up should always follow the manufacturer's recommendations.

10.4.4 Equipment that relies on permanently buoyant material will normally need only regular visual checks on the cover, buoyancy materials and fastenings.

10.4.5 There should be clear procedures for the inspection, use and storage of equipment that relies on inflation chambers, inflation mechanisms and gas cylinders.

10.4.6 A number of different types of automatic inflation system are in use but they all rely on a similar mechanism. This consists of an automatic firing capsule, a carbon dioxide gas cylinder and a fitting attached to the gas cylinder that holds these two in place. The spring-loaded piston within the capsule is held back by a device that degenerates on contact with water, eg. a 'salt' or 'paper ring'. When it is immersed in water, the device breaks down and releases the spring. The piston is forced forward and a sharp pin pierces the cap of the gas cylinder and the lifejacket inflates.

10.4.7 In addition to in-house inspections, the manufacturer should service lifejackets at the recommended intervals. In most cases this is at least every 2 years. However, where lifejackets are used more frequently, they should be serviced at shorter intervals. If they are used daily, they should be serviced every three months.

10.4.8 Repairs should only be carried out by persons or companies approved by the manufacturer.

10.5 Training

10.5.1 Training in the use of flotation aids should include an explanation of why the equipment is required, how it is operated and used, its performance and limitations, instruction and practice on pre-wear checks, inspection and storage.

Selected references

Legislation

European Union

EC PPE Directive - 89/686/EEC
EC Use of PPE Directive - 89/656/EEC
EC Directive - 86/188/EC (Noise)

United Kingdom

'Safety in Docks' - The Docks Regulations 1988
Safe Code of Practice and Guidance
Guidance on the Personal Protective Equipment at Work Regs 1992

USA

Occupational Safety & Health Administration OSHA 29 CFR Part 1918 Subpart J. PPE Longshoring and Marine Terminals

International

International Labour Organisation (ILO) Convention 152 - Occupational Safety & Health in Dock Work

Equipment Standards

Head Protection	USA	ANSI 2-89-1 1986
	EU	EN 397
Eye Protection	EU	BS EN 166, 167 and 168
	USA	ANSI 2-87, 1-89
Footwear	EU	BS EN 345
	US	ANSI 1-41 1991
Hi Vis Clothing	EU	BS EN 471

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The Ports' Safety Organisation Research and Information Paper No.1 Lifejackets and Personal Buoyancy Aids - **Ports Safety Organisation, Africa House, 64-78 Kingsway, London WC2 6AH, UK**

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