SIP 015 CONFINED SPACES IN PORTS

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Port Skills and Safety

Contents

1. INTRODUCTION

1.1. The Health and Safety Executive provided support to Port Skills and Safety in producing this guidance, which is aimed at improvements within the Ports industry. This guidance may go further than the minimum you need to do to comply with the law regarding health and safety.

1.2. It is for companies operating in the UK ports industry with responsibility for the safe design, construction, operation, management and maintenance of ports and terminal facilities and management of port and terminal activities. It will also be useful to employees and their representatives.

1.3. Following the guidance is not compulsory and you are free to take other action. But if you do follow the guidance, you will normally be doing enough to comply with the law. Health and safety inspectors seek to secure compliance with the law and may refer to this guidance. If the guidance goes beyond compliance, then this will be clearly identified.

1.4. Regulations in this document are referred to by title but not year, because they are amended from time to time and the reader should always seek the current version. Acts are given a year as they tend to change less frequently. The list of references at the end of this document however does include a year that was correct at the time of publication.

1.5. Many ports and their associated activities will invariably involve access to confined areas at some stage. It is the purpose of this document to offer some guidance in identifying confined spaces that are likely to be encountered in the port environment and offer some considerations as to the aspects that may need addressing when setting up a confined space work program, or task.

1.6. It is not intended that this document will offer all the solutions when setting up a confined space management system, as this will be determined via the local risk assessment and permit to work procedures (if the latter is chosen), but it will offer information way-marks and portray best practice for the reader to interpret and develop their own safe systems of work.

1.7. Employers need to consider the physical ability, pre-existing medical conditions, any personal protective equipment needs, etc. of persons entering confined spaces. Employers are required to provide such information, instruction, training, and supervision as is necessary to ensure the health and safety at work of employees. Specific training for work in confined spaces will depend on an individual's previous experience and the type of work they will be doing. It is likely that this training will need to cover:

1.7.1. an awareness of the Confined Spaces Regulations and in particular the need to avoid entry to a confined space, unless it is not reasonably practicable to do so, in accordance with regulation 4(1).

1.7.2. an understanding of the work to be undertaken, the hazards, and the necessary precautions;

1.7.3. an understanding of safe systems of work, with reference to 'permits-to-work' where appropriate.

1.7.4. how emergencies arise, the need to follow prepared emergency arrangements, and the dangers of not doing so

1.8. This guidance is aimed at routine operations and may not cover some of the specialised and high risk activities associated with chemical tank farms and underground sewer works etc. which may involve complex shut down operations and in-line, or self-contained breathing apparatus, albeit the assessment approach and control methodology will be similar

2. REGULATORY FRAMEWORK AND GUIDANCE

2.1. The two principal relevant pieces of law are the Health and Safety at Work etc. Act (HSWA) 1974, and the Management of Health and Safety at Work Regulations (MHSWR), which set out the basic requirements to ensure, so far as is reasonably practicable, the health, safety and welfare of all involved.

2.2. Port specific, Merchant Shipping and other legislation applies and should be referred to.

2.3. Approved Code of Practice (ACOP) L148 'Safety in Docks' was introduced on 6 April 2014: http://www.hse.gov.uk/pubns/books/l148.htm

2.4. The PSS/HSE Safety in Ports guidance suite, available from the PSS website at: https://www.portskillsandsafety.co.uk/resources is an important supplement to Safety in Docks ACOP L148.

2.5. The guidance is aimed at routine operations and does not cover some of the specialised and high risk activities associated with handling dangerous goods and hazardous cargoes, or major hazards sites which are subject to the Control of Major Accident Hazards Regulations for which specialist advice may be required.

2.6. Reference can also be made to the International Labour Organisation's (ILO) Code of Practice on Safety and Health in Ports (ILO 152): http://www.ilo.org/sector/activities/sectoral-meetings/WCMS_546257/lang--en/index.htm

2.7. Confined space activities are specifically covered by The Confined Space Regulations. These regulations, along with relevant guidance documents such as those referenced below, should be considered before starting work in a confined space as well as when developing a confined space safe system of work or management system. Information and guidance on these regulations can be found on the HSE Confined spaces web pages.

2.8. Further maritime Confined Space specific regulations and guidance include:

2.8.1. Merchant Shipping (Entry into Dangerous Spaces) Regulations

2.8.2. Enclosed Space Entry Procedures (Ship Owners Club Publication)

2.8.3. IMO Revised Recommendations for Entering Enclosed Spaces Aboard Ships

2.9. Where permits to work are to be used, advice on their design and implementation can be found in the HSE Permit To Work web pages

3. HEALTH

3.1. The wide range of activities in ports can give rise to health risks such as exposure to dusty cargoes; back injuries, sprains, and strains from lifting and handling, pushing, and pulling; noise and vibration. There is specific legislation including the Control of Substances Hazardous to Health Regulations, the Control of Noise at Work Regulations, the Manual Handling Operations Regulations and Personal Protective Equipment at Work Regulations.

3.2. While there is reference to some specific health risks in these guidance documents, it is not possible to cover all the issues. Further information and guidance on the identification, assessment and reduction or avoidance of such risks can be found on the HSE website at:

3.2.1. Ports web pages:
http://www.hse.gov.uk/ports/index.htm

3.2.2. Control of Substances Hazardous to Health:
http://www.hse.gov.uk/coshh/index.htm

3.2.3. HSE Whole Body Vibration in Ports Information Paper
http://www.hse.gov.uk/vibration/wbv/ports.pdf

3.2.4. Musculoskeletal disorders (MSDs)
http://www.hse.gov.uk/msd/index.htm

3.2.5. Noise at Work
http://www.hse.gov.uk/noise/

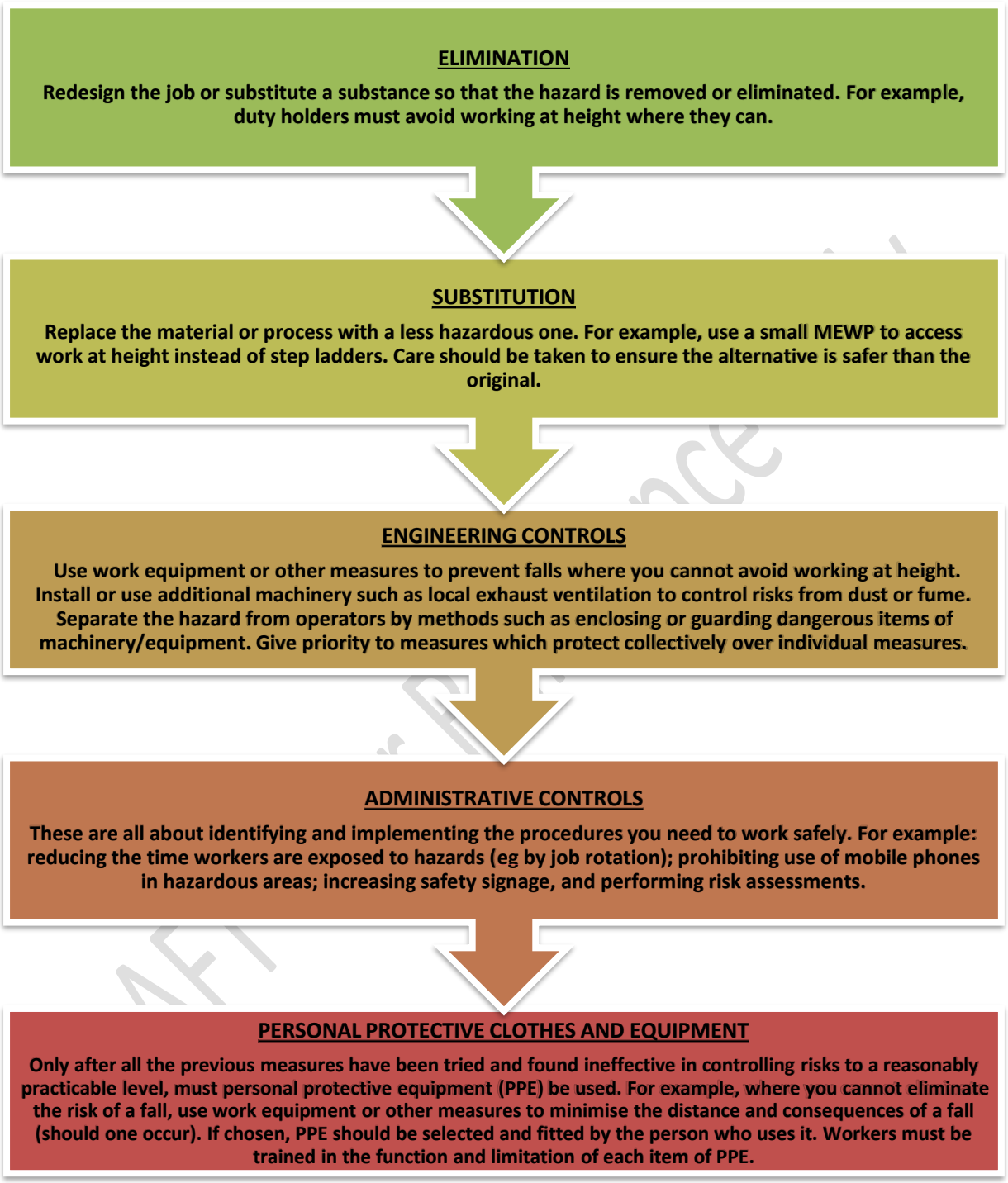
3.2.6. Personal Protective Equipment
http://www.hse.gov.uk/toolbox/ppe.htm

3.2.7. Vibration at Work
http://www.hse.gov.uk/vibration/

4. RISK ASSESSMENT

4.1. Risk Assessments must be undertaken in accordance with the Management of Health and Safety at Work Regulations. The risk assessment must consider the risks, not only to permanent employees but also to others including non-permanent employees (NPE's), ship's crew, passengers and visitors that may be affected by the activity. The appropriate control measures must be introduced and should consider collective measures ahead of personal or individual measures.

4.2. Risks should be reduced to as low as is reasonably practicable by taking preventative measures in order of priority below. The diagram below sets out an ideal order to follow when planning to reduce risk.



Reference: HSE Leadership and Worker Involvement Toolkit. Available at

http://www.hse.gov.uk/construction/lwit/assets/downloads/hierarchy-risk-controls.pdf

4.3. Risk assessments must be reviewed regularly and immediately after any incident or when there are significant changes to the operation. Most accidents and near misses can be avoided if the risks from the work are suitably and sufficiently assessed and appropriate control methods are adopted.

4.4. The risk assessment should record the significant hazards and the risks of the operation together with the relevant control measures. In port operations risk assessments should consider changes such as tidal changes, weather, trim, list, load/cargo, and vessel dynamics.

4.5. Planning and work execution is discussed in HS(G) 177, Managing Health and Safety in Dockwork: http://www.hse.gov.uk/pubns/books/hsg177.htm

4.6. The Health and Safety at Work Act 1974 applies on board a ship when shore based workers are engaged in cargo handling or other tasks on board. Cargo handling may include, but is not limited to, loading, unloading, stowing, unstowing, pouring, trimming, classifying, sizing, stacking, unstacking as well as composing and decomposing unit loads; and also, services in relation to cargo or goods such as tallying, weighing, measuring, cubing, checking, receiving, guarding, delivering, sampling and sealing, lashing and unlashing.

4.7. The Health and Safety at Work Act 1974 also applies to the Master and ship's crew when working with shore-based personnel on board ship.

4.8. Cooperation and coordination between shipside and landside employers is required. Employers must therefore carry out risk assessments and develop safe systems of work (in consultation with the workers involved) that all parties agree to, so that the respective employers can co-operate effectively with each other.

4.9. A signed agreement or an agreed and recorded system of work with the master of each vessel is recommended - this is not a legal requirement but may help to ensure effective co-ordination with other parties.

4.10. The regulations made under the Health and Safety at Work Act 1974; such as The Management of Health and Safety at Work Regulations; The Lifting Operations and Lifting Equipment Regulations and The Provision and Use of Work Equipment Regulations, do not apply to a master or crew of a ship, or any persons employing them, in relation to safe access, plant and equipment which remain on board the ship and for any undertakings or work which are carried out on board ship solely by the master and the crew. Instead, the Merchant Shipping Act 1894 and related Merchant Shipping Regulations impose similar duties on board ship in UK territorial waters.

4.11. A ship's master has duties under the Health and Safety at Work Act 1974 in relation to the ship's crew who are put ashore to perform their own tasks (for example loading ship's stores or carrying out maintenance work on their ship). Those duties also extend to plant and equipment (for example a forklift truck) which is under the master's control that is used ashore by ship's crew, or when used by shore-based workers ashore or on-board ship.

4.12. A signed agreement or an agreed and recorded system of work with the master of each vessel is recommended - this is not a legal requirement but may help to ensure effective coordination with other parties.

4.13. Because of the potential risks involved in confined space working the shoreside employer needs to consult with the master prior to any operation commencing. It is the vessel master's responsibility to ensure that all access ways and ship's working spaces are safe to enter. However, it is best practice that the port or terminal.

4.13.1. Obtain written confirmation that the gas and air quality testing has been performed.

4.13.2. Conducts their own checks prior to deploying labour on board the vessel.

5. CONSULTATION, COOPERATION AND COORDINATION

5.1. **Consultation**: Employers have a duty to consult with their employees, or their representatives, on health and safety matters. By gaining worker involvement on health and safety through two-way communication, concerns can be raised and solved together, and views and information can be sought and exchanged in a timely manner.

5.1.1. See: HSE pages: Consulting and involving your workers http://www.hse.gov.uk/involvement/index.htm

5.2. **Cooperation and Coordination**: Cooperation and coordination between shipside and landside employers is required. Employers must therefore carry out risk assessments and develop safe systems of work (in consultation with the workers involved) that all parties agree to, so that the respective employers can co-operate effectively with each other.

6. WHAT IS A CONFINED SPACE?

6.1. The Regulations define a confined space as "any space, including any chamber, ships hold, hold access way, stairwell, tank, container, vat, silo, pit, trench, pipe, sewer, flue, well or other similar space in which, by virtue of its enclosed nature, there arises a reasonably foreseeable specified risk."

6.2. Therefore, a space is not automatically classed as a confined space unless there is also one or more of the 'specified risks' present that could harm a person entering it. For example, a part loaded freight container may be enclosed but not be defined as a confined space itself. However, if its contents have been fumigated prior to or during shipment and dangerous residues are still present, or the toxic fumigant was absorbed into soft furnishings with the risk of its release if disturbed; this could now re-classify this container as a confined space under the Regulations.

6.3. A space can also become a confined space due to the work being done in it, for example cleaning an area with chemical cleaners can produce dangerous fumes, carrying out welding work in an enclosed space can reduce the oxygen concentration to hazardous levels, working on fire suppression systems that use stored gases (argon, inert gases, nitrogen etc.) to flood the area to put out a fire.

6.4. Under the Regulations a 'specified risk' is defined as:

(a) serious injury to any person at work arising from a fire or explosion.

(b) without prejudice to paragraph (a) –

(i) the loss of consciousness of any person at work arising from an increase in body temperature.

(ii) the loss of consciousness or asphyxiation of any person at work arising from gas, fume, vapour, or the lack of oxygen.

(c) the drowning of any person at work arising from an increase in the level of liquid; or

(d) the asphyxiation of any person at work arising from a free flowing solid or the inability to reach a respirable environment due to entrapment by a free flowing solid

6.5. In summary, a confined space will be somewhere that is enclosed (although not always entirely) and a place where there exists a reasonably foreseeable risk of serious injury arising from hazardous substances, or conditions that exist, or have the potential to exist whilst occupied by persons.

6.6. Regulation 4(1) requires that "No person at work shall enter a confined space to carry out work for any purpose unless it is not reasonably practicable to achieve that purpose without such entry". Consequently, where other options exist e.g., doing the work from outside or remotely, then they should be used.

6.7. The International Maritime Organisation does **not** use the term Confined Space. It uses the term Enclosed Space instead. For the purposes of managing risk, the term Confined Space may have the same meaning as Enclosed Space in this guidance.

7. CONFINED SPACE HAZARDS - INTRODUCTION

7.1. Confined Space fatalities continue to occur at sea and in ports.

Examples of Confined Space Fatal Incidents

Incident	Fatalities
2006 Saga Spray	1 crew
2007 Viking Islay	3 crew
2008 Sava Lake	2 crew
2008 Saga Rose	1 crew

Incident	Fatalities
2015 Suntis	3 crew
2015 Sally Ann C	2 crew
2015 Port of Antwerp	3 port workers
2018 Oxelösund, Sweden	1 port worker
2018 Martapura Baru, Indonesia	4 port workers, 1 paramedic
2018 Aracruz, Brazil	3 port workers

7.2. Confined Spaces can become hazardous in several ways including:

- oxygen deficiency
- build-up of flammable and/or explosive atmospheres e.g., oxygen enrichment
- build-up of toxic or corrosive gases and/or substances
- ingress of water or free flowing solids
- physical contact with plant and equipment
- environment becoming too hot or cold.

7.3. These hazards might be caused by:

7.3.1. **things in the space** (e.g., the cargo).

7.3.2. **the work being done** (e.g., welding)

7.3.3. **natural processes** (e.g., rusting)

8. HAZARDOUS ATMOSPHERES - ASPHYXIATION & OTHER NOXIOUS GAS EFFECTS

8.1. The very real risk of asphyxiation and history of fatal accidents make this a top priority for application of controls.

8.2. Oxygen is the only gas that supports life. The normal

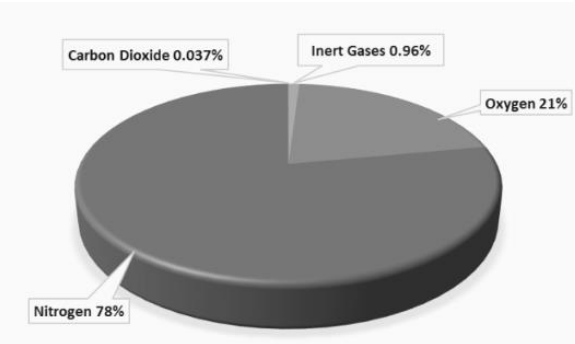


Figure 1: Relative composition of normal atmosphere

concentration of oxygen in the air is approximately 20.9%1.

8.3. A person's ability to concentrate, think and make decisions is impaired when the oxygen concentration falls only slightly below this (see table below). These effects are not noticeable to the affected individual.

8.4. If the oxygen concentration in air decreases or, if the concentration of any other gases increases, a situation is rapidly reached where the risks of asphyxiation are significant.

8.5. Oxygen depletion may be caused by the removal of oxygen from the air (for example absorption by timber products) or by the displacement of oxygen by other gases such as carbon dioxide.

8.6. The following table indicates approximate effects and symptoms, which may vary depending on the individual.

Oxygen	Effects and Symptoms
20.9%	The normal concentration in the air that we breathe
<21%	Any depletion of oxygen concentration below 21 % should be regarded with concern and fully investigated
19.5%	As a minimum the oxygen concentration in the workplace should be maintained above 19.5 %
<18%	Atmospheres containing less than 18 % oxygen are potentially dangerous and entry into such areas must be prohibited unless appropriate safety controls are adopted
<10%	The risk of unconsciousness followed by brain damage or death due to asphyxia is increased at oxygen concentrations below 10 %.
<6%	Immediate loss of consciousness occurs with less than 6 % of oxygen.
0%	Inhalation of only 2 breaths of nitrogen, or other inert gas containing no oxygen, causes immediate loss of consciousness and death within 2 minutes.

Source: British Compressed Gasses Association Guidance Note 11 Reduced Oxygen Atmospheres: The management of risk associated with reduced oxygen atmospheres resulting from the use of gases in the workplace.

[1] Safe work in confined spaces ACOP L101

8.7. **Oxygen deficiency** may result from, for example:

8.7.1. purging of the confined space with an inert gas to remove flammable or toxic gas, fume, vapour, or aerosols.

8.7.2. naturally occurring biological processes consuming oxygen, which can occur in sewers, storage tanks, storm water drains, wells etc. Similarly gases can be produced as a result of fermentation in sealed silos where crops have been or are being stored; in fermentation vessels; or in cargo holds caused by the carriage of timber or timber products, steel turnings or swarf, vegetable products, grain, biomass, coal etc.

8.7.3. leaving a vessel completely closed for some time (particularly one constructed of steel) since the process of rust formation on the inside surface consumes oxygen. Within ports low oxygen levels have been reported in the internal leg sections of ship to shore container cranes, storage tanks, floating barges and ships holds and likewise several deaths in port and port related activities have occurred. Newly fabricated or shot blasted carbon steel vessels are especially vulnerable to rusting, particularly those with a large surface area, for example, heat exchangers, separators, filters etc.

8.7.4. burning operations and work such as welding which consume oxygen

8.7.5. displacement of air during pipe freezing, for example, with liquid nitrogen

8.7.6. gradual depletion of oxygen where provision of replacement air is inadequate

8.8. **Oxygen enrichment** may occur for a number of reasons such as: leaks in equipment (e.g. welding equipment, whereby oxygen has leaked from the airlines), or deliberate release of oxygen to sweeten the air. Oxygen levels may also be affected by internal chemical reaction of cargoes, and/or cargo reaction with the environment.

8.9. Enriched oxygen will result in any fire burning more fiercely, or possibly cause an explosion and this scenario has caused multiple fatalities in ports and ship building yards in the past.

8.10. When welding, cutting or burning in confined spaces always ensure adequate ventilation and air movers are available as required. See http://www.hse.gov.uk/welding/confined-spaces.htm for more detail on welding.

8.11. **Carbon monoxide** is a colourless, odourless, highly toxic, flammable gas formed by incomplete combustion of carbon and is a common off-gassing product from some cargoes, such as biomass. Off-gassing effects must be controlled and minimised to protect workers from dangerous atmospheres, especially carbon monoxide.

8.12. When Carbon monoxide enters the body, it prevents the blood from bringing oxygen to cells, tissues, and organs. Early symptoms of Carbon monoxide poisoning can mimic many common ailments and may easily be confused with food poisoning, viral infections, flu or simple tiredness. Symptoms include: headaches or dizziness, breathlessness; nausea; loss of consciousness, tiredness, pains in the chest or stomach, erratic behaviour and visual problems.

8.13. Levels of just 1% carbon monoxide (10,000ppm) would be rapidly fatal to an exposed, unprotected individual and levels must be monitored closely with ventilation controls used to prevent toxic build-up of gas.

8.14. In a space such as an unventilated ship's hold or stairwell, increased carbon monoxide can lead to a potentially fatal reduction in the oxygen concentration as well as presenting toxic and fire risks. For example, carbon monoxide concentration of approximately 1% has been measured in a sealed cargo hold of a ship containing wood pellets some 18 days after the cargo was loaded. The oxygen concentration at this time was less than 1%. Since the cargo hold was enclosed and there was a clear specific risk of oxygen depletion and potential noxious fume, the hold in this example would constitute a *Confined Space*.

Carbon Monoxide		**Effects and Symptoms**
0.1%	100 ppm	Slight headache in 2-3 hours
0.2%	200 ppm	Slight headache within two to three hours; loss of judgment
0.4%	400 ppm	Frontal headache within one to two hours
0.8%	800 ppm	Dizziness, nausea, and convulsions within 45 min; insensible within 2 hours
0.16%	1,600 ppm	Headache, increased heart rate, dizziness, and nausea within 20 min; death in less than 2 hours
0.32%	3,200 ppm	Headache, dizziness, and nausea in five to ten minutes. Death within 30 minutes.
0.64%	6,400 ppm	Headache and dizziness in one to two minutes. Convulsions, respiratory arrest, and death in less than 20 minutes.
1.28%	12,800 ppm	Unconsciousness after 2–3 breaths. Death in less than three minutes.

Source: Goldstein M (December 2008). "Carbon monoxide poisoning". Journal of Emergency Nursing. 34 (6): 538–542.

8.15. At the time of publishing the workplace exposure limits in EH40 for carbon monoxide are:

8.15.1. Long-term exposure limit (8-hr reference period) of 30 ppm

8.15.2. Short-term exposure limit (15-minute reference period) of 200 ppm

8.16. **Carbon dioxide** is naturally present in the air at a concentration of about 0.037% (370 ppm) and is not harmful to health at low concentrations. At room temperature and atmospheric pressure carbon dioxide is a colourless and odourless gas and, because of this, people are unable to see it or smell it at elevated concentrations. It is not flammable and will not support combustion. As the concentration of carbon dioxide in air rises it can cause headaches, dizziness, confusion and loss of consciousness. Since it is heavier than air, fatalities from asphyxiation have occurred when, at high concentrations, it has entered spaces such as tanks, sumps or cellars and displaced oxygen. It is also possible for CO2 to accumulate in trenches or depressions outside following leaks and this is more likely to occur following a pressurised release where the released CO2 is colder than the surrounding air.

8.17. In Great Britain carbon dioxide is classed as a 'substance hazardous to health' under the Control of Substances Hazardous to Health Regulations 2002 (COSHH). The HSE publication 'EH40/2005 Workplace exposure limits' http://www.hse.gov.uk/pubns/books/eh40.htm provides exposure limits for airborne concentrations of hazardous substances in the workplace. Workplace exposure is calculated by taking an average over a specified period of time. At the time of publishing the workplace exposure limits for carbon dioxide are:

8.18. Long-term exposure limit (8-hr reference period) of 5000 ppm

8.19. Short-term exposure limit (15-minute reference period) of 15000 ppm

Carbon Dioxide		Effects and Symptoms
2-3%	20,000-30,000 ppm	Unnoticed at rest, but on exertion there may be marked shortness of breath
3%	30,000 ppm	Breathing becomes noticeably deeper and more frequent at rest
3-5%	30,000 – 50,000 ppm	Breathing rhythm accelerates. Repeated exposure provokes headaches
5%	50,000 ppm	Breathing becomes extremely laboured, headaches, sweating and bounding pulse
7.5%	75,000 ppm	Rapid breathing, increased heart rate, headaches, sweating, dizziness, shortness of breath, muscular weakness, loss of mental abilities, drowsiness, and ringing in the ears
8-15%	80,000 – 150,000 ppm	Headache, vertigo, vomiting, loss of consciousness and death if the patient is not immediately given oxygen

Carbon Dioxide		Effects and Symptoms
10%	100,000 ppm	Respiratory distress develops rapidly with loss of consciousness in 10-15 minutes
25%	250,000 ppm	Convulsions occur and rapid loss of consciousness ensues after a few breaths. Death will occur if level is maintained.

Source: Health effects of respiratory exposure to carbon dioxide, (Baxter, 2000; Faivre-Pierret and Le Guern, 1983)

8.20. Storage of some products (e.g., Biomass) in enclosed spaces may lead to an accumulation of noxious gases, organic residues and organic volatiles including Methane. Life threatening levels of gases have been demonstrated and fatalities have occurred amongst those working in these circumstances.

9. CONFINED SPACE SPECIFIC RISK ASSESSMENT

9.1. The first consideration is to determine if the work area in question is a confined space, under the regulations.

9.2. When considering a potential confined space, particular emphasis should be placed on the possible impact of residual fumigation products, the production of asphyxiates and or toxic gases, the cargo type (free flowing or not) with known health and safety issues or not, and the management of the work environment during loading /unloading operations. If conditions change e.g. if the hatch cover has been closed, the condition of the hold may change, and it could then become a confined space.

9.3. If it is determined that the area is not a confined space, then a risk assessment process must still be conducted for the work being undertaken.

9.4. If a 'confined space' is determined to exist, the first consideration is whether there is a need to work in the confined space at all. Ideally, the design of workplaces and all machinery should be as such that any functions within the area concerned can be undertaken without entry. This may mean the use of cameras or sensors; or inspection/maintenance hatches for the use of probes or pressure washing equipment; internal elements and devices that can be changed or maintained by direct access from outside tanks; remote control mechanisms and robotic equipment.

9.5. When conducting a risk assessment for confined space there are numerous aspects to be considered and much of this will depend on the complexity of the task and the space to be entered. In some vessels for example, void spaces below deck can be a warren of narrow passages and cavities, all subject to variable contaminations, rust and de-oxygenation. Any such entry will require a complex set of arrangements that include a multiple gas check; power and energy isolation; communications; air supply and a rescue team. Conversely a side entry water tank which has been purged and ventilated for some time may require less complex control measures, proportionate to the risk.

9.6. In general any assessment of any confined space must take into consideration of the following:

9.6.1. records or history pertaining to the space.

9.6.2. general condition

9.6.3. access and egress, physical dimensions and method

9.6.4. current and past contents

9.6.5. presence (and potential presence) of gases, hazardous substances and residues (scale, sludge, vapours etc.)

9.6.6. third party or external contamination ingress

9.6.7. oxygen levels (deficient or enriched)

9.6.8. internal structures and obstructions (baffle plates, isolated areas, pockets)

9.6.9. cleaning chemicals (to be used, or been used)

9.6.10. sources of ignition (flame, heat, static and electrical)

9.6.11. mechanical and electrical hazards

9.6.12. potential ingress, disturbance, deterioration, or reaction of substances

9.6.13. Hazards associated with the cargo or product.

9.6.14. hazards that may be created by the activity itself. For example welding in a confined space could lead to extreme temperatures, or leaking equipment could lead to over-oxygenation of the space, or the release of flammable gases

9.6.15. environmental hazards, such as tide or wind

9.6.16. emergency incident management and rescue

9.6.17. other relevant task or operational factors

9.7. As a guide the following table, identifies some confined spaces likely to be encountered in port work and the possible hazards that may arise.

9.8. Table 1- Common Confined Spaces Found in Ports - the following hazards and locations are for indication only and not exhaustive.

Location	Possible Hazards
Storage tanks – organic content	Bio-degradation and Hydrogen Sulphide; inhalation of pathogens or micro-organisms; de-oxygenation; physical contact with agitators or unguarded pumps; injury from heating/cooling elements; asphyxiation from filling or emptying; dust explosion.

Location	Possible Hazards
Storage tanks – inorganic content	Poisonous, toxic, corrosive, harmful, flammable or explosive substances; variable densities of toxic gases; de-oxygenation; physical contact with agitators or unguarded pumps; injury from heating/cooling elements; asphyxiation from filling or emptying; dust explosion.
Freight Containers	Fractured, leaking packages containing organic or inorganic substances (as above); cargo movement, particularly free surface movement substances (i.e. grain, liquids); de-oxygenation; fumigant gases; gas pockets; dangerous wildlife; spontaneous fire/explosion.
Cofferdams & Caissons	Structural failure; subsidence; loss of pneumatic pressure/reduced oxygen levels; ingress of water or other liquids; accidental debris falling or pumped in; slips, trips, and falls; poor underfoot conditions; low level climbing and working at height.
Silos (cement, grain etc.)	Explosive atmosphere (dust); de-oxygenation; physical contact with agitator drives or unguarded pumps, shifting materials (dry drowning)
Vessel holds, access way, tween decks and barges	Fractured, leaking containers/packages containing organic or inorganic substances (as above); gas pockets; insecure cargo; environment or cargo condition changes (bio-degradation, gas, mould spores etc); cargo movement; working at height; free surface movement substances (i.e. grain, coal, wood chippings); de-oxygenation; fumigant gases; dangerous wildlife; spontaneous fire/explosion; slips, trips and falls; poor underfoot conditions; low level climbing and working at height..

Location	Possible Hazards
Vessel bilges, tanks, and void spaces	Bio-degradation and Hydrogen Sulphide; Poisonous, toxic, corrosive, harmful, flammable or explosive substances; de-oxygenation; physical contact with agitator drives or unguarded pumps; injury from heating/cooling elements; electrocution; slips, trips and falls; poor underfoot conditions; low level climbing and working at height.
Machine spaces, pump rooms and maintenance pits	De-oxygenation; Carbon Monoxide; exhaust gases; fire suppressant physical contact with drives or unguarded machinery; surfaces with extreme temperatures; heating/cooling elements; electrocution; pressurised pipelines and systems, slips, trips and falls; poor underfoot conditions; low level climbing and working at height.
Sewers, trenches, service, and communication ducts	Bio-degradation and Hydrogen Sulphide; Poisonous, toxic, corrosive, harmful, flammable or explosive substances; de-oxygenation; physical contact with agitator drives or unguarded pumps; injury from heating/cooling elements; electrocution

10. CONFINED SPACE HAZARDS - MANAGEMENT CONTROLS

10.1. The main controls are:

- competent design
- operational planning and controlling access (such as use of Permit-to-Work)
- ventilation
- gas testing and monitoring
- Personal Protective Equipment
- emergency planning
- instruction, information, and training

11. COMPETENT DESIGN

11.1. Design and construction (e.g., of new infrastructure), should apply a Hierarchy of Controls, first aiming to eliminate confined spaces where practicable. Where it is not practicable to eliminate such spaces, the design should aim to eliminate the need for persons to access them by means such as remote working.

12. OPERATIONAL PLANNING AND ACCESS CONTROL INCLUDING PERMIT TO WORK

12.1. Ports by their nature can be extremely busy places with many activities occurring simultaneously. This will include the maintenance of plant and equipment, as well as repairs and maintenance to the port infrastructure. Repairs and routine maintenance activities may be conducted by any number of either in-house employees or external contractors and often while other activities take place.

12.2. It is imperative that whilst activities of this mix take place, the actions of one party do not give rise to unacceptable hazards and risks that may affect the health or safety of others.

12.3. Risk assessment will determine where such activities may interact and cause such risks, but it is foreseeable that the safety of confined space activities could be seriously jeopardised without the proper control of external influences. Such influences might be the reactivation of moving machinery, change of atmosphere (i.e. gases, fumes, extreme heat or cold), the entry of liquids or free-flowing substances, all of which could place those working in the confined space at risk.

12.4. Personnel must not enter a confined space without breathing apparatus unless atmospheric testing is undertaken and the atmosphere in all areas, including access ways, is declared safe by a competent person, both before entry and on a regular basis whilst personnel are in the space.

12.5. Where the atmosphere within a confined space has been declared safe, continued ventilation of the space must be considered. The properties of the pollutants (i.e. vapours lighter or heavier than air) and the layout of the space must be assessed and where necessary air movers deployed to ensure forced ventilation and the circulation of air is effective. However, ventilating flammable vapours and gases may bring them within their flammability ranges, as could the disturbance of flammable dust, so caution must be exercised.

12.6. Where a confined space has been tested and deemed safe and entry is to be made without breathing apparatus, the personal issue of short term emergency life support apparatus (ELSA) can be considered as a method of self-rescue. In the event of a gas monitor alarm or the presence of smoke, this equipment will give the wearer a specified number of minutes of breathable air, sufficient for emergency egress in most cases. ELSA equipment is not designed to be worn for normal work conditions, or to undertake rescue attempts, and is **only** for the 'self-rescue' of the wearer to affect escape in an emergency.

12.7. Safe access and egress to the confined space must be maintained.

12.8. When vertical access is used suitable equipment (such as suspended baskets, cages, retractable life-lines, safety harnesses) should be provided for all personnel who enter the confined space with, consideration given to their recovery. Any harness and line must be adjusted and worn so that the wearer can be safely drawn through any opening as may be necessary.

12.9. Adequate and suitable lighting must be provided. Equipment suitable for the hazardous environment (which may include intrinsically safe equipment) must be used unless the atmosphere in the confined space is declared free from explosive or flammable risks by a competent person.

12.10. The degree of supervision should be based on the findings of the risk assessment. Should the risk assessment identify a level of risk that requires the appointment of a competent person to supervise the work, they may need to remain present while the work is being undertaken. It will be the competent person's role to ensure that the permit-to-work system, where applicable, operates properly, the necessary safety precautions are taken, and that anyone who may be affected by the confined space working is informed of the work being done.

12.11. A competent person outside the confined space should be constantly available and within close proximity (as identified by risk assessment) in case of emergency. Suitable measures should be in place to enable those in the confined space to communicate to persons outside the space to initiate rescue procedures or summon help. The emergency can be communicated in a number of ways, for example by: the tug of a rope, radio or a 'lone worker' alarm. Whatever the system it should be reliable, take into account potential explosive atmospheres and be tested frequently. Exceptionally, if justified on grounds of risk or from knowledge of previous incidents involving similar work, suitably trained people in sufficient numbers, should be immediately available to effect a rescue.

12.12. Effective signage and area security is critical to prevent entry by untrained or unauthorised individuals into confined spaces. Taken from Biomass SiP022.

12.13. A suitable method of applying an additional level of control to such activities is the implementation of a permit to work system, whereby in addition to any prescribed safe systems of work, a final check-off is made prior to entry, communicated to all concerned and signed off by the competent persons in charge. Where work involves personnel from different employers, permits to work are a good communication tool to ensure work does not start until all the relevant controls, often being implemented by different employers, are all in place before hand and all involved are made aware of its details.

12.14. Permits to work should only be used where they will enhance safety standards and should not simply become a mundane administration process whereby several sheets of paper and numerous signatures are needed to complete a task. For more information of permits to work go to: http://www.hse.gov.uk/comah/sragtech/techmeaspermit.htm

12.15. The decision not to adopt a permit-to-work system should be taken by a competent person, where necessary following consultation with specialists, and bearing in mind the findings of the risk assessment and the need to ensure a safe system of work.

13. VENTILATION

13.1. It may be sufficient to ventilate spaces such as ship's holds by simply opening hatches and allowing time for the atmosphere to normalise. Similarly, a period with the doors open may provide sufficient ventilation for a shed, store or stairwell. In either case, measures should be put in place (such as setting a chain with flashing light across the shed entrance) to alert personnel and control access during venting.

13.2. If a ventilation regime is deemed necessary by risk assessment, then suitable and sufficient measurement of gases should take place before personnel can commence working.

13.3. If a space is closed off again during operations, for example to protect cargo from rain, additional ventilation and testing is likely to be required before work can re-commence. In some circumstances, adequate forced ventilation may be necessary.

14. ATMOSPHERIC TESTING AND MONITORING

14.1. Ports and Terminals should have in place appropriate gas testing, monitoring, and recording regimes as identified by risk assessment. Testing should cover all relevant areas, for example both the space and the access ways may need to be tested. The risk assessment should identify if testing needs to be carried out on each occasion that the confined space is re-entered, even where the atmosphere initially was found to be safe.

14.2. Regular monitoring of the atmosphere may also be necessary to check that there is no change in the atmosphere while the work is being carried out, particularly where the work activity or other factors could give rise to changes in the atmosphere.

14.3. Conditions should be continuously monitored when, for example, forced ventilation is being used.

14.4. Testing, retesting and monitoring requirements should be defined by a competent person within the safe system of work.

14.5. Gas testing on Board Vessels

14.5.1. When a vessel arrives, testing on board must cover all areas which personnel will access and may give rise to a hazardous atmosphere risk. This may mean that in addition to holds, access routes such as: trunks, corridors, stairways, ladders spaces and any other area, space or compartment required to be accessed by personnel needs to be assessed.

14.6. Gas free certificates

14.6.1. Gas free certificates are normally obtained via a competent third party when first opening vessel holds. The gas free certificate is only a snapshot at a moment in time. The port or terminal operator should bear in mind that *a range of factors may mean that the gas free certificate testing is not sufficiently dependable for safe operations*. For example: the range of gases tested may be limited and the test will no longer be valid if hatches are closed, then re-opened during operations because of potential re-build-up gases. Industry best practice at ports and terminals should be to undertake your own pre-start and continuous monitoring as well as access control (in line with your risk assessment).

14.7. Where any doubt exists as to the condition of the atmosphere, it should be tested.

14.8. It is recommended that multi-gas detection equipment is used to ensure atmospheres are safe. This can be deployed and used by suitably trained port staff or by professional marine chemists.

14.9. The Working Exposure Limit WEL and Short Term Exposure Limits for the gases generated by the products being handled should be known and understood by those concerned. EH40 available via the HSE website provides this information in the most up to date version.

14.10. Testing for safe levels of oxygen must be undertaken where there is a risk. Industry practice is that if levels fall below 20% entry should be prohibited until the situation improves. The area must be ventilated and retesting carried out to confirm oxygen levels are above 20% before re-entry.

14.11. Enclosed areas of conveyors and associated systems including tunnels, trunk-ways, access routes etc. must also be tested prior to entering.

15. METHODS OF ATMOSPHERIC TESTING

15.1. Testing to ensure the atmosphere is safe, including the existence of adequate oxygen to support life and to test for the presence of toxic or poisonous gases can mainly be achieved in three ways:

15.1.1. fixed installed monitors for foreseeable gases.

15.1.2. portable reactant tube aspirators

15.1.3. personal/portable gas detector monitors

15.2. **Fixed installation gas detector sensors** are often useful in confined space locations where constant or frequent chemical processes or storage take place. In many cases these will be a single detector sensor as the gas present, or the potential gas in the event of a malfunction for example, will be known. Such devices may also be found within ships to detect the ingress of gas or liquids into void spaces, bilges and holds. However, some caution must be exercised as although such detector sensors may indicate a particular toxic substance may not be present, it does not necessarily confirm that other toxic substances are not present, or oxygen of safe levels.

15.3. **Portable reactant tube aspirators** are available with manual operated or electro – mechanical pumps and they are an efficient method of detecting toxic gases in the atmosphere, particularly where the substance most likely to be present is known. Reactant tubes are available to detect certain categories of substances and not a specific gas or fume.

15.4. One of the disadvantages, particularly with the manually operated versions is a person needs to be present in the potentially hazardous atmosphere to operate it. However, most manufacturers provide extension tubes and lances to distance the operator from the sampling point. In addition, electro-mechanical versions can be left in-situ to take samples at pre-set intervals.

15.5. Reactant tube aspirators are a simple way of detecting cargo fumigants in freight containers and holds prior to entry and some ports have developed forty foot lances to extend the sampling point.

15.6. Again, some caution must be exercised as fumigant packages left in the hold or container may be disturbed and reactivate. Likewise, fumigant may have been absorbed into the cargo (such as grain, wood chip and soft furnishings), only to be emitted again when disturbed. Reactant tubes used in this scenario will not indicate oxygen levels; a separate reactant tube for oxygen levels may be required.

15.7. A further disadvantage is some reactant tubes get very hot (>100oC) and must not be used in flammable or explosive atmospheres. To ensure safe use, manufacturers advice on the type and the extent of the sampling required in any given atmosphere should be sought. Several manufacturers also offer training in the use of their equipment.

15.8. **Personal, portable gas detector monitors** are the most flexible and reliable of the detector sensor equipment available, as when worn in a confined space they are in constant presence and worn by the operator in a position within their breathing zone. Personal gas monitors are intrinsically safe. They can be multi-gas or single gas and may or may not include oxygen. Personal gas monitors should be selected for the expected gases that that might be present. Another advantage is that portable monitors will emit a visual and audible alarm when the Workplace Exposure Limit (WEL) has been reached and many will go into a heightened alarm condition, should conditions reach life threatening levels.

15.9. One disadvantage of electronic gas monitors is that sensors can be desensitised or may give false alarms due to cross sensitivity with other gases. However, gas detectors are designed to 'fail to safety' and will alarm if faulty. If an alarm sounds, all personnel must evacuate the space.

Remember, for all confined space work:

'IF IN DOUBT, GET OUT.'

15.10. Gas detectors should be maintained, calibrated and 'bump tested' according to manufacturer specifications. Operators may determine, subject to risk assessment, a more frequent bump test regime depending on use.

15.11. Portable gas monitors normally require calibration by the manufacturer or their service agent every six months.

15.12. Where confined space entry is irregular, the purchase and maintenance of electronic portable gas monitors may not be practical and hiring on a short-term basis or contracting out the testing, might be an option.

16. RESPIRATORY AND PERSONAL PROTECTIVE EQUIPMENT

16.1. Personal Protective Equipment (PPE) and Respiratory Protective Equipment (RPE) should only be used in addition to engineering controls and safe systems of work. Use of PPE and RPE is a last resort, with preference given first to controls that are higher up the Hierarchy of Controls.

16.2. The type of PPE and RPE provided will depend on the hazards identified, for example, safety lines, harnesses, and suitable breathing apparatus. The risk assessment should take account of foreseeable hazards that might arise, and the need for emergency evacuation/rescue. If deemed necessary the type of respiratory equipment and filters must be assessed against the foreseeable gases and fumes that might be or have the potential to be present.

16.3. Where PPE and RPE has been identified as necessary in the risk assessment, it should be:

16.3.1. provided

16.3.2. adequate – right for the hazard and reduce exposure to the level required to protect the wearer's health.

16.3.3. suitable – right for the wearer, task and environment, such that the wearer can work freely and without additional risks due to the RPE.

16.3.4. correctly fitting including face fit testing (where applicable)

16.3.5. used by those entering and working in confined spaces.

16.4. Any person, who is required to enter a confined space, must be trained in confined space entry, working, and associated emergency procedures. This will include training in the use of PPE and RPE where such equipment is required.

16.5. The need for respiratory protective equipment should be based on risk assessment.

16.5.1. HSE guidance: Selecting suitable respiratory protective equipment WIS14 (rev2)

16.5.2. HSE guidance: Respiratory protective equipment at work (HSG53)

16.6. Where Respiratory Protective Equipment is deemed appropriate it should be clear in the safe systems of work features such as: what type of equipment is necessary, what protection factor is required and where it is to be used. If it is tight-fitting, it must be "Fit Tested" prior to use and the operator trained in its care and use. Face fit testing is not required for positive pressure, loose-fitting units. The effectiveness of all Respiratory Protective Equipment will reduce with use and over time. Disposable devices must be treated as such, and re-usable devices must be well maintained and stored properly.

16.7. Dust masks, respirators and forced air helmets are designed to protect against breathing in airborne particles and are not a form of protection where the amount of oxygen in the air may be depleted or where toxic gases are present.

16.8. Selection, use and maintenance of Respiratory Protective Equipment should be undertaken with reference to the COSHH risk assessment, Health and Safety Executive published guidance, specialist expertise where appropriate and manufacturer's information.

16.9. There is only room to identify basic principles here because of the specialist, technical requirements of selection and use of Respiratory Protective Equipment. For guidance and further information on respiratory protection visit the HSE Respiratory protective equipment web pages and HSG53 Respiratory protective equipment at work: a practical guide

17. INSTRUCTION, INFORMATION AND TRAINING

17.1. Persons expected to work in Confined Spaces must be provided with appropriate training and information on the potential atmosphere hazards, the methods of controlling risks to respiration, the use of any personal protective equipment and how to respond in the event of alarms and emergencies.

18. EMERGENCY PLANNING, RESCUE AND FIRST AID

18.1. Arrangements for rescue of persons in the event of an emergency, are required under the Confined Spaces Regulations. Arrangements must be suitable and sufficient and, where appropriate, should include the necessary equipment to enable resuscitation procedures to be carried out. The arrangements should be in place before any person enters or works in a confined space.

18.2. Emergency procedures must be suitable for the risks, to ensure safe evacuation or rescue of persons from a confined space. The procedures must not solely rely on calling the emergency services. As many ports are unlikely to have rescue teams equipped with breathing apparatus on stand-by, alternative arrangements should be provided. It should be remembered that even the strongest person is unlikely to be able to lift or handle an unconscious person on their own using only a rope. It would be reasonable to consider the use of port lifting equipment, (such as a mobile crane) to facilitate rescue in many cases, but the use of such of equipment must be in compliance with the requirements of The Lifting Operations and Lifting Equipment Regulations with regards the lifting of persons.

18.3. Rescue equipment should be compatible with the space from which a person might need to be rescued, for example, ensuring that selected breathing apparatus is not too bulky to allow rescuers to get into the space.

18.4. First aiders should be trained to deal with foreseeable injuries; these will include immobilisation, resuscitation and other associated procedures. Training and refresher training are essential.

18.5. Ancillary equipment may be needed for oral resuscitation, to avoid direct contact between the mouths of the victim and rescuer, for example, by using special tubes and mouthpieces. However, if resuscitation is needed because of exposure to toxic gases, oral methods may not be appropriate as they could put the rescuer at risk. In some cases equipment for artificial respiration as a follow-up to, or in place of, oral resuscitation is appropriate. This equipment should only be operated by someone with the appropriate training and be available, properly maintained, on site for use by a person providing medical help.

18.6. Ports should practise their rescue and first aid procedures regularly to ensure all concerned are proficient in their roles and can facilitate an expedient rescue should the need arise

18.7. It is industry good practice to engage with stakeholders such as local fire and emergency services and to provide relevant information to them about any particular risks associated with Confined Space rescue (e.g. hazardous cargos, operational risks etc.).Biomass SiP 022

18.8. See also SiP 16 Emergencies

19. RELEVANT LEGISLATION AND GUIDANCE

19.1. Please note that the following are the correct versions at the time of publishing but the reader should always seek out the most current version.

19.2. The current versions of other PSS Safety in Ports Guidance documents can be found at: https://www.portskillsandsafety.co.uk/resources

19.3. Relevant legislation and guidance on Confined Spaces includes:

- Confined Spaces HSE web page www.hse.gov.uk/confinedspace/
- Confined spaces in ports HSE web page http://www.hse.gov.uk/ports/index.htm
- Confined spaces: A brief guide to working safely Leaflet INDG258(rev1): http://www.hse.gov.uk/pubns/indg258.pdf
- Merchant Shipping (Entry into Dangerous Spaces) Regulations 1988 www.legislation.gov.uk/uksi/1988/1638/contents/made
- Safe work in confined spaces - Confined Spaces Regulations 1997 and Approved Code of Practice: http://www.hse.gov.uk/pubns/books/l101.htm
- Staying Safe in Ports Confined Spaces PSS video: https://www.portskillsandsafety.co.uk/staying-safe-ports-confined-spaces

19.4. General legislation and guidance include:

- Biofuels/wood pellets http://www.hse.gov.uk/confinedspace/updates/wood-pellet-fuels.htm
- Consulting and involving your workers: http://www.hse.gov.uk/involvement/index.htm
- Control of Substances Hazardous to Health http://www.hse.gov.uk/coshh/index.htm
- Control of diesel engine exhaust emissions in the workplace HSG187 http://www.hse.gov.uk/pubns/books/hsg187.htm
- Dangerous Substances and Explosive Atmospheres Regulations (DSEAR) 2002 http://www.hse.gov.uk/fireandexplosion/dsear.htm
- Dangerous Goods in Harbour Areas Regulations 2016 http://www.hse.gov.uk/pubns/books/l155.htm
- The Electricity at Work Regulations 1989 and guidance on electrical safety http://www.hse.gov.uk/electricity/index.htm
- Health and Safety at Work Act (HSWA) 1974 http://www.hse.gov.uk/legislation/hswa.htm
- Health and Safety (Safety Signs and Signals) Regulations 1996; http://www.hse.gov.uk/pubns/books/l64.htm

- Fumigation: Health and safety guidance for employers and technicians carrying out fumigation operations HSG251 HSE Books 2005 www.hse.gov.uk/pubns/books/hsg251.htm
- Guidance on permit-to-work systems - A guide for the petroleum, chemical and allied industries http://www.hse.gov.uk/pubns/books/hsg250.htm
- HSE research on personal, portable and fixed gas monitors http://www.hse.gov.uk/research/rrpdf/rr973.pdf
- Management of Health and Safety at Work HSE web site http://www.hse.gov.uk/managing/index.htm
- Managing Health and Safety in Dockwork - HS(G) 177 http://www.hse.gov.uk/pubns/books/hsg177.htm
- Permits to work HSE web site http://www.hse.gov.uk/comah/sragtech/techmeaspermit.htm
- Personal Protective Equipment http://www.hse.gov.uk/toolbox/ppe.htm
- Ports web pages http://www.hse.gov.uk/ports/index.htm
- Provision and Use of Work Equipment Regulations (PUWER) 1998; http://www.hse.gov.uk/work-equipment-machinery/puwer.htm
- Respiratory protection HSE web site: http://www.hse.gov.uk/respiratory-protective-equipment/
- Respiratory protective equipment at work - A practical guide (HSG53) http://www.hse.gov.uk/pubns/priced/hsg53.pdf
- Safety in Docks ACOP L148 http://www.hse.gov.uk/pubns/books/l148.htm
- Saga Spray Fatal Accident report (Swedish Maritime Safety Inspectorate) http://www.transportstyrelsen.se/Global/Sjofart/English/Accident_investigation_reports/E_2006/2006_11_16_the_bulk_carrier_VRWW5_SAGA_SPRAY_fatal_accident.pdf
- Lifting Equipment at Work: http://www.hse.gov.uk/pubns/indg290.htm
- Lifting Operations and Lifting Equipment Regulations (LOLER) 1998; http://www.hse.gov.uk/work-equipment-machinery/loler.htm

- Work at Height Regulations 2005
  http://www.hse.gov.uk/work-at-height/index.htm

20. DOCUMENT AUTHORS

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