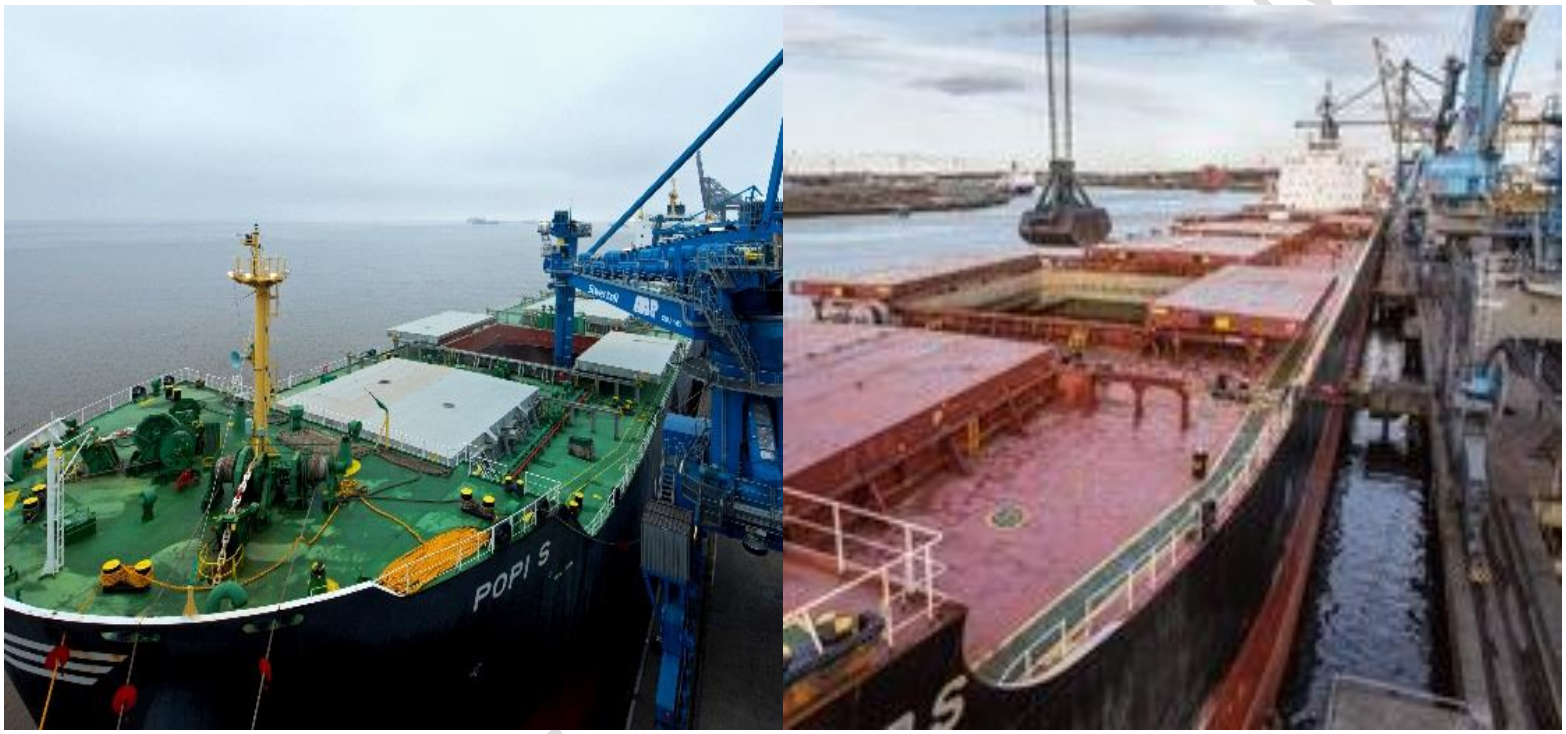
SIP022 – GUIDANCE ON

BIOMASS WOOD PELLET AND CHIP (VIRGIN AND RECYCLED)



HSE Health & Safety Executive

PSS Port Skills and Safety

unite the UNION

DISCLAIMER

It is Port Skills and Safety (PSS) policy to obtain permission to link to external web sites, and contextual links are provided to such sites where appropriate to the industries business. PSS is not responsible for, and cannot guarantee the accuracy of, information on sites that it does not manage; nor should the inclusion of a hyperlink be taken to mean endorsement by PSS of the site to which it points

DOCUMENT AUTHORS

This guidance document has been produced by Port Skills and Safety with assistance of the Health and Safety Executive and representatives of the UK ports industry

COPYRIGHT

Publication: February 2018 (original) – this Draft version is aesthetic only January 2023

Port photos courtesy of Associated British Ports and Port of Tyne

SIP022 - GUIDANCE ON BIOMASS WOOD PELLET AND CHIP (VIRGIN AND RECYCLED)

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 with regard to 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.

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

3. HEALTH

3.1. The wide range of activities in ports can give rise to possible 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:

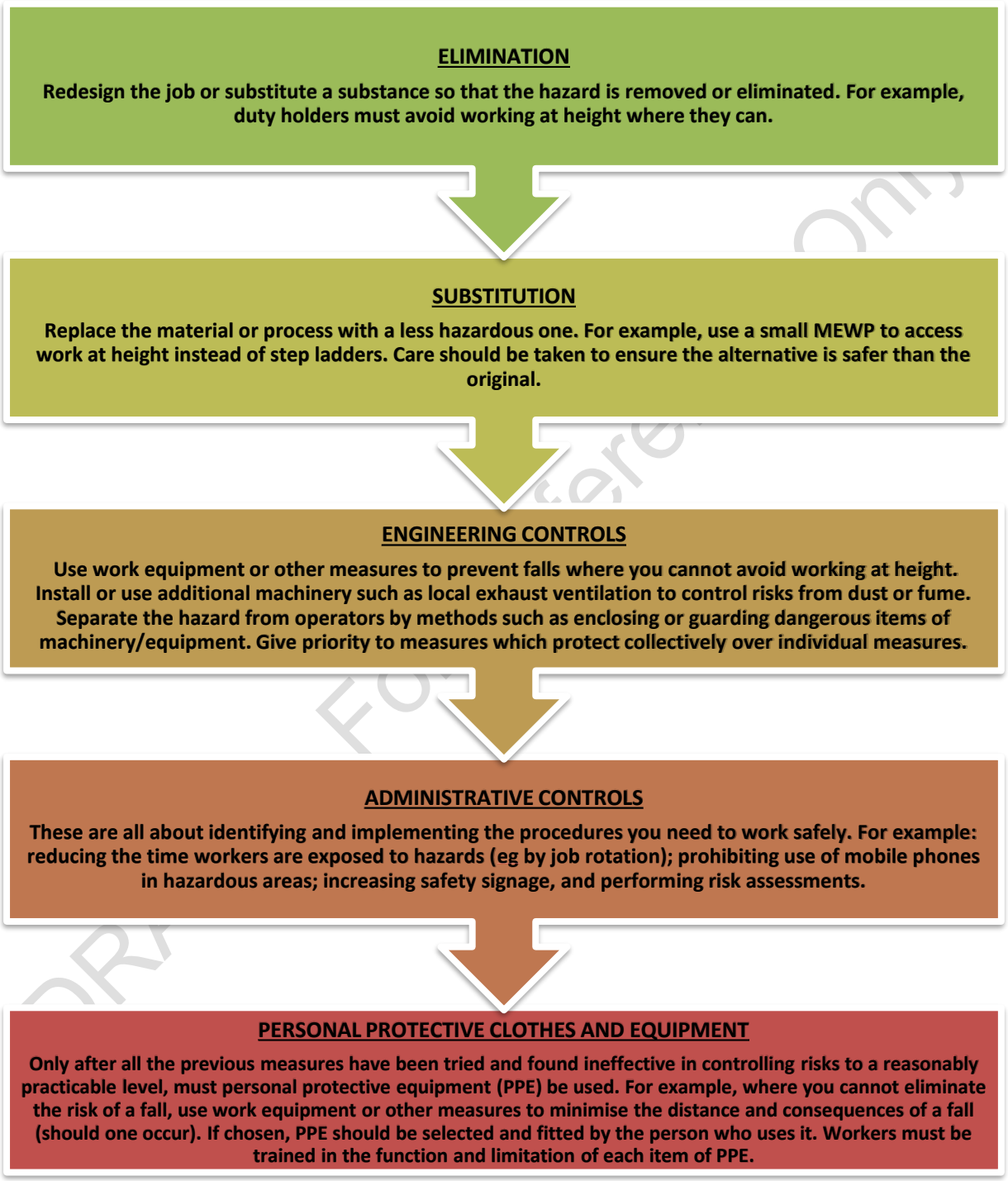
- Ports web pages
- Control of Substances Hazardous to Health
- HSE Whole Body Vibration in Ports Information Paper
- Musculoskeletal disorders
- Noise at Work
- Personal Protective Equipment
- Vibration at Work

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.

HIERACHY OF CONTROLS



Reference: HSE Leadership and Worker Involvement Toolkit. Available at
www.hse.gov.uk/construction/lwit/assets/downloads/hierarchy-risk-controls

4.3. Risk assessments must be reviewed:

- regularly
- immediately after any incident
- when there are significant changes to the operation

4.4. Most accidents and near misses can be avoided if the risks from the work are suitably and sufficiently assessed and appropriate control measures adopted.

4.5. A risk assessment should record the significant hazards and risks of an 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.

4.6. Planning and work execution are discussed in HS(G) 177, Managing Health and Safety in Dock work

4.7. 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
- composing and decomposing unit loads
- services in relation to cargo or goods such as tallying, weighing, measuring, cubing, checking, receiving, guarding, delivering, sampling and sealing, lashing and unlashing.

4.8. 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.

4.9. 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
- 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

- 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.

4.10. 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 extend to plant and equipment (for example a forklift truck) under the Master's control being used ashore by ship's crew, or when used by shore-based workers ashore or on-board ship.

4.11. This type of operation may require a specific manual handling assessment as part of the overall risk assessment process.

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.

- See HSE pages: Consulting and involving your workers

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. BIOMASS

6.1. Biomass, which is sometimes also referred to in the industry as biofuel, is a collective term for organic (plant and animal) non-fossil material normally used to generate energy. Biomass is a very resourceful material and can be used to produce heat and power (electricity). In the UK port sector there has been a significant change from coal to biofuel with Biomass being regularly handled and stored in recent years.

Types of Biomass

- Wood: Processed Wood Product (Pellet), Virgin wood, Round log, Recycled and reclaimed wood chip fuels.
- Energy Crops: Cynara cardunculus (Artichoke Thistle), Willow, Poplar, Miscanthus (grass)
- Waste: Oil, Vegetable, Fruit, Refuse Derived Fuel, Solid Recovered Fuel, processed sewage pellets
- Animal Feedstuff: where contaminated and unsuitable for animal consumption

7. DOCUMENT COVERAGE

7.1. By volume, Wood Pellet is the main biomass product handled by UK ports at present. This document addresses Wood Pellet and Wood Chip (virgin and recycled). It does not cover other forms of biomass. It does not address general port operations hazards such as manual and mechanical handling, workplace transport, safe access/egress, work at height etc. Which are considered in other Safety in Ports documents (such as SiP008 Storage of dry bulk cargo) which are available at: https://www.portskillsandsafety.co.uk/resources

7.2. Some biomass products require specialised licensing and environmental protection arrangements. Licencing and environmental arrangements are not addressed in this document.

7.3. Biomass is required to be stored differently depending on the type of product. Processed Wood Product (Pellet) and Virgin wood do not react well to external storage, so are stored undercover or in Silo. Whereas round logs, recycled and reclaimed wood chip fuels, can be stored externally as well as undercover.

8. CONFINED AND ENCLOSED SPACES IN PORTS

8.1. *Confined Space*[1] (on land) and *Enclosed Space* (at sea) have specific definitions and Regulations associated with them. They are broadly analogous and generally described as a place which is substantially enclosed (though not always entirely), and where serious injury can occur from hazardous substances or conditions within the space or nearby (e.g. lack of oxygen). This document only uses the terms *Confined Space* or *Enclosed Spaces* when referring to the legal definition.

[1] http://www.hse.gov.uk/confinedspace/

See also SiP015 Confined Spaces in Ports for further information on Confined Space safety.

8.2. The following are examples of some of the spaces found in ports that have the potential to become *Confined Spaces*, depending on circumstance: ships' holds and access stairwells, freight containers, storage tanks, cofferdams and caissons, silos, machine spaces and pump rooms, vessel bilges, tanks and void spaces, sewers and communication ducts, etc.

9. POTENTIAL HAZARDS ASSOCIATED WITH WOOD PELLET AND CHIP

9.1. The following table gives generic guidance only, operators should conduct their own risk assessment of products being handled in their specific circumstances, consult hazard data sheets and other relevant information and identify appropriate controls accordingly.

Product	*Potential Risks include:*			
	Hazardous Atmosphere	Fire/Self-Heating	Explosion	Occupational Health
Processed Wood Pellet	• Oxygen Depletion • Carbon Monoxide • Carbon Dioxide • Methane	• Yes	• Yes	• Respiratory Hazards • Carcinogens • Phytosanitary /Spores/Mould • Wood dust is a respiratory sensitiser • Skin irritant
• *Processed/ recycled Wood chip*	• Oxygen Depletion • Carbon Monoxide • Carbon Dioxide • Fumigants • Methane	• Yes	• Yes	• Respiratory Hazards • Carcinogens • Phytosanitary /Spores/Mould • Chemical contamination of recycled product • Wood dust is a respiratory sensitiser • Skin irritant

In the following sections, you will find each of • ***Hazardous Atmospheres***, • ***Fire/Self Heating***, • ***Explosion*** and • ***Occupational Health*** divided into two parts. The first part provides information about the hazard and risks, the second part discusses the management controls.

10. HAZARDOUS ATMOSPHERES - ASPHYXIATION AND OTHER NOXIOUS GASES ACUTE EFFECTS

10.1 Fatal accidents involving hazardous atmospheres

There have been a number of fatal accidents featuring hazardous atmospheres in Confined Spaces some of which involved the type of wood products covered by this document. The most frequently occurring hazard is oxygen depletion. Examples include:

Table 1 Examples of Fatalities Associated with Hazardous Atmospheres

Incident	*Main Hazard*	*Casualties*	*Product*	*Ref:*
MV Corina Hanstholm April 2015	Possibly Carbon Monoxide or Oxygen Depletion	One crew member fatality and three crew member injuries	Wood Pellet	No formal report available
MV Suntis Goole Docks May 2014	Oxygen Depletion	Three crew member fatalities	Timber	https://www.gov.uk/maib-reports/safety-warning-issued-after-entry-to-confined-space-on-general-cargo-vessel-suntis-results-in-loss-of-3-lives
Saga Spray Helsingborg Nov 2006	Oxygen Depletion	Crew member fatality Stevedore serious injury	Wood pellet	http://www.emsa.europa.eu/implementation-tasks/accident-investigation/221-occupational-accidents/1004-bulk-carrier-saga-spray-vrww5-fatal-accident.html

10.2 Oxygen Depletion

Oxygen depletion can occur within spaces used to store or transport biomass, creating an asphyxiation risk for those working in these spaces e.g. ships holds and access stair wells.

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

Oxygen is the only gas that supports life. The normal concentration of oxygen in the air is approximately 20.9%[2].

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.

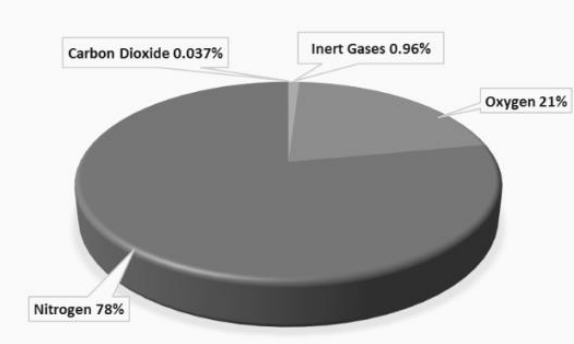


Figure 1: Relative composition of normal atmosphere

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.

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.

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

[2] Safe work in confined spaces ACOP L101

Oxygen	Effects and Symptoms
<10%	The risk of unconsciousness followed by brain damage or death due to asphyxia is greatly 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.

10.3 Carbon Monoxide

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

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.

Toxic gas exposure, such as carbon monoxide poisoning is one of the most serious risks associated with biomass.

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.

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.

See also the International Maritime Solid Bulk Cargoes (IMSBC) Code, for wood pellets and generation of carbon monoxide and risk assess for your particular biomass product.

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

- Long-term exposure limit (8-hr reference period) of 30 ppm
- Short-term exposure limit (15-minute reference period) of 200 ppm

10.4 Carbon Dioxide

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.

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 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:

- Long-term exposure limit (8-hr reference period) of 5000 ppm
- 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 possibly death if the patient is not immediately given oxygen
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: IVHHN – Volcanic Gases and Aerosols Guidelines pg 19. [Table of Health effects of respiratory exposure to carbon dioxide, (Baxter, 2000; Faivre-Pierret and Le Guern, 1983; NIOSH, 1981)]

10.5 Noxious gases, organic residues and organic volatiles including Methane

There is evidence from incidents and experimental research that storage of some biomass in enclosed spaces may lead to an accumulation of noxious gases and organic residues. Life threatening levels of gases have been demonstrated and fatalities have occurred amongst those working in these circumstances.

There is evidence of emissions of organic volatiles (methane, butane, ethylene, propylene etc.), carbon dioxide and carbon monoxide during bulk transport and storage. Levels of gases such as carbon dioxide have been determined to exceed occupational exposure limits in some scenarios. Potentially there could be risk of operator error since at lower concentration noxious gases and volatile organic constituents can rapidly disrupt brain function and hand-eye coordination.

Evidence of ill health associated with exposure to volatiles emitted from biomass is less strong and should be risk assessed and controlled on a case by case basis.

See Health Protection Agency guidance on Methane

11. HAZARDOUS ATMOSPHERES - MANAGEMENT CONTROLS

A build-up of carbon monoxide, carbon dioxide and/or a depletion in oxygen levels in an enclosed space has proved tragically fatal in the past. Organisations handling biomass must put measures in place to manage these respiratory risks.

The main controls are:

- Competent design of storage and handling installations
- Operational planning
- Ventilation
- Controlling access such as Permit-to-Work
- Gas testing and monitoring
- Personal Protective Equipment
- Emergency planning
- Instruction, Information and Training

11.1 Competent Design of storage and handling installations

Design and construction of storage and handling installations, including external storage areas, should be undertaken with competent advice and suitable risk review. Existing sheds and storage areas that were not purpose built for bulk storage of wood pellet and other Biomass will most likely need to be adapted before use. High carbon monoxide levels above the store are less likely if the area is well ventilated.

11.2 Controlling Access

Places where Biomass is handled, transported and stored should be risk assessed and appropriate controlled access put into place. This may include ships' holds and stairwells, flat stores, silos, hoppers, conveyor systems and transfer towers. Depending on the level of risk, designation of *Confined Spaces* (see also SiP015 *Confined Spaces* in Ports) and the use of Permit to Work systems may be appropriate. Effective signage and area security is critical to prevent entry by untrained or unauthorised individuals.

11.3 Ventilation

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.

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.

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.

11.4 Gas Testing and Monitoring

Ports and Terminals should have in place gas testing, monitoring and recording regimes to ensure the safety of all staff involved in handling biomass cargoes, that may give off hazardous gases. Industry good practice is not to rely on the ship carrying out this operation. The characteristic of the products being handled must be analysed and measures put in place to test for the gases likely to be encountered. This is likely to include a minimum of oxygen and carbon monoxide whenever biomass is stored in an enclosed space e.g. a ship's hold or flat floor store. No person should enter an enclosed place where wood pellet or other biomass is stored without suitable and sufficient gas testing having taken place.

11.5 Gas testing on Board Ship - Holds and Access

Where a vessel arrives with a cargo of biomass, testing on board ship 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 tested.

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.

If for any reason circumstances change, such as hatch lids being closed due to bad weather, prior to allowing personnel to re-enter any space of compartment the gas tests must be undertaken again to confirm the atmosphere remains safe. If it is not safe, then no one must enter until it is made safe.

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.

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.

Storage sheds and silos should also be checked, monitored and managed as described above. It is industry good practice to use a combination of personal, fixed and portable monitors. When using fixed monitors, the monitors should ideally be located above the stored materials.

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

11.6 Gas free certificates

Gas free certificates are normally obtained via a competent third party when first opening vessel holds on a vessel with a cargo of biomass. 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 reliable 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. 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).

11.7 Monitoring stored biomass

It is an industry recommendation that where no fixed gas detection is installed, monitoring should be regularly performed as determined by your risk assessment. This is particularly important in the case of carbon monoxide. Carbon monoxide off-gassing from some biomass products increases with higher ambient temperature so ambient temperature should also be recorded with each reading.

11.8 Personal Monitoring within potentially hazardous atmospheres

Staff working in and amongst biomass cargoes should wear personal gas detectors and be trained in their use, where the risk assessment has identified a risk of exposure to hazardous atmospheres. It is industry recommended practice that as a minimum, readings of oxygen and carbon monoxide, are taken to guard against the risk of non-breathable atmospheres.

Current industry practice is to use oxygen monitoring to also protect against carbon dioxide risk in personal monitoring. The % concentration at which CO2 becomes hazardous will have reduced oxygen levels sufficiently that oxygen monitors will have already alarmed. The decision on which gasses/substances to monitor, should be made following a risk assessment and taking into account requirements under COSHH and other relevant regulations.

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.

11.9 Respiratory Protective Equipment

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.

The need for respiratory protective equipment should be based on risk assessment. See the Occupational Health Management Controls section below.

- HSE Guidance - Selecting suitable respiratory protective equipment
- Respiratory protective equipment at work (HSG53)

11.10 Emergency Planning

Procedures in the event of an alarm or emergency situation should be in place and routinely tested e.g. by drill. These should include arrangements for safe evacuation in the event of a personal or area gas monitor alarm (including the use of escape sets where appropriate) and also for the safe recovery of casualties from the space.

Emergency planning applies to stores, holds, stairways and access etc. in addition to being a mandatory requirement for *Confined Space* access. 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 biomass.

11.11 Instruction, Information and Training

Persons expected to work with Biomass should 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.

12. FIRE AND SELF-HEATING

Biomass is both combustible and prone to self-heating. For wood pellets, it is important is to keep the stockpile dry. Exposure to rain, either directly or from leaking covers, or the formation of condensation, will encourage the growth of microorganisms and significantly accelerate heat production. Temperature rises of up to 2.4^{o}C per hour have been measured in silos containing wood pellets. Although biological heat will stop when microorganisms are killed by high temperature (in the range 70-80oC for thermophilic organisms), chemical oxidation can take over, accelerating the self-heating process towards spontaneous combustion in a greatly reduced timeframe.

12.1 Scenarios which could result in a fire

12.1.1 Ignition source from ship/discharge

There is a risk that an ignition source could be delivered into the store for example where there is offloading of high temperature fuel in the vicinity, exposed lights or smoking. A fire due to an external ignition source is most likely to occur shortly after the store has been filled. However there have also been incidents where fire has occurred later due to an external ignition source. For example, failure of conveying plant or equipment associated with the ship discharge has resulted in contact friction of parts leading to combustion of high dust deposits within the equipment. In this case there was significant loss of plant and equipment as a result of the fire.

12.1.2 Self-heating of the biomass leading to spontaneous combustion

Certain types of biomass have a propensity to degrade and generate heat. Spontaneous combustion becomes more likely to occur the longer the biomass has been in storage. It is essential that the quality of the biomass from the ship is closely monitored before it is delivered to the store to minimise spontaneous combustion risk. It is important to monitor the condition of the biomass in the store so that appropriate action can be taken for whatever reason a heating event occurs.

12.1.3 Exposure to moisture/water

Incidents have occurred where water has got into a ship's hold in transit through a non-watertight hatch. Parts of the cargo had crusted over, leading to a hot spot below. Exposure to moisture can also occur in non-watertight sheds or silos. Condensed water or steam on top of a wood chip/pellet heap is an indication of an exothermic reaction, Biological or chemical activity.

12.1.4 Equipment fires

Incidents have occurred on material handling equipment such as loading shovels and skid steer loaders. Typically, they occur when dust builds up in engine bays and around hot components such as exhausts, leading to ignition. These have led in some cases to equipment being written off. This in itself is serious, but the examples below show damage to cabs and emphasise that there was significant potential risk to the operator.

Figure 2 Examples of fire damaged handling plant

12.1.5 Fires involving waste wood chip

Waste wood chips show far more critical fire behaviour than other biomass such as wood pellets.

- Higher heat release rate of the wood chips (0.65 mW/g compared to about 0.09 mW/g for the wood pellets)
- Lower bulk density and the higher number of air enclosures in the bulk leading to convection.

- Fire development is always in the direction of the supply of fresh oxygen. Therefore, a mass store should be sealed as much as possible from both the bottom and the top to avoid any air ingress.

12.1.6 Methane

Methane may be given off by wood chip or pellet if it is allowed to decompose. Methane is an odourless, colourless flammable gas and can give rise to increased fire and explosion risk in air at levels as low as 5 percent (5000ppm).

13. FIRE PREVENTION - MANAGEMENT CONTROLS

To date, the main consequence of fires in biomass facilities has been in damage to structures, plant and equipment. These have a clear cost in loss of product, repair, replacement, down time, investigation and reputation. However, the potential is there for a biomass fire to cause injury, and controls are essential to protect personnel. The main fire prevention management control measures are:

- Competent Design of storage and handling installations
- Non-destructive handling
- Cleaning
- Temperature Monitoring and Thermal Imaging in the hold
- Storage and stack management
- Biomass Condition Monitoring in the store
- Plant and equipment design and operation
- Fire Fighting Systems
- Cleaning
- Control of ignition sources
- Ventilation of explosive/flammable gasses
- Emergency planning
- Non-destructive handling

Fire and explosion risks are interconnected. Many of the controls that are designed to prevent ignition are also applicable in prevention of explosions as discussed later in the document. Guidance on fire and explosion should be read in conjunction with one another to obtain a more complete understanding of the risks and controls.

13.1 Competent Design of storage and handling installations

Bespoke stores and silos should be designed to minimise flat surfaces and voids in the walls and roof structures where dust can accumulate. Dust build up can increase the risk and/or severity of fires.

It is a recommendation that transfer towers should not be fully enclosed/confined structures as this can lead to a build-up of dust.

13.2 Non-destructive handling of wood pellets

It is important to maintain the integrity of Wood Pellets during handling. Operational procedures and plant/equipment design should take in to account process to minimise handling and the resulting generation of dust. Degradation of the pellet causes additional dust, which then has to be controlled at every transfer point, chute, hopper, silo or store.

"Reduce the dust reduce the problem"

It is recommended that plant and equipment operators are trained in low impact handling techniques.

Other measures which may mitigate the generation of dust clouds around stockpiles include:

- restricted vehicle speeds in dust prone areas
- restricting discharge heights
- tipping on to other product rather than shed floors

Non-destructive handling and dust reduction will also be key to managing the explosion and respiratory risks addressed later in the document.

13.3 Cleaning

Cleaning regimes are an essential part of preventing the build-up of dust which can increase the risk and/or severity of fires. Cleaning is one of the most important controls for preventing fire as well as controlling respiratory and explosion risk. Simply put, it is an absolute must for ensuring safe operations and it should be an integral part of your risk management arrangements. See also Explosion management controls and respiratory protection below.

13.4 Temperature monitoring in the hold

Subject to local risk assessment and conditions it is a general industry good practice recommendation that ports identify a maximum temperature above which normal discharge should not take place without additional controls. Frequency of temperature monitoring should be determined according to risk assessment with identified trigger temperatures and temperature change rates. Plans should be agreed with the supply chain stakeholders in the event that issues with temperatures arise.

13.5 Storage and stack management

The longer that any biomass which is prone to combustion stays in a single place, the greater the risk of self-heating and ignition. Where practicable, such material should not be stored for long periods.

Biomass stocks are generally only stored for short periods due to the delivery programme and running regime of the power station being supplied. However, deliveries at the port should be monitored and any biomass deliveries which may show signs of self-heating dealt with appropriately.

As necessary, the material can be moved/rotated to prevent self-heating, though there may be a trade off with additional handling leading to greater dust production. In the event of heating, it may be possible to use movement and segregation of parts of the heap to bring the heating/fire under control but this should be part of a planned incident response.

13.6 Condition monitoring of biomass in undercover stores and silos

Monitoring and recording within a store is recommended where there is a risk of fire/self-heating. Different approaches may be appropriate according to the circumstances and may include:

- temperature probes, including checking for hot spots in silos
- sampling of gases that indicate early stages of combustion;
- visual checks of the stockpile in flat stores for evidence of “Damp Patches” that indicate possible condensed water; mould, smouldering or changes in physical characteristics
- Infrared detectors
- Closed Circuit TV

It is normal for wood pellets to release some carbon monoxide during storage, but the **level** and **rate** of increase of carbon monoxide will be much higher in the event of a fire. It is difficult to fix a specific carbon monoxide level to reliably alert the presence of fire, because the level in ppm is dependent on factors such as how much ambient air is entering the store and mixing with it (dilution effect). Carbon monoxide levels above 2000 ppm are a potential indicator but not a confirmation of a fire.

The rate of release of carbon monoxide can vary for different types of pellets, but is still considered a good indicator of whether carbon monoxide is being generated by normal off gassing or by a fire.

13.7 Condition monitoring of biomass in external storage

Consideration should be given, subject to risk assessments, to monitoring of biomass in external storage areas. Different approaches may be appropriate according to the circumstances and may include:

- temperature monitoring and recording
- visual checks for evidence of mould, smouldering or changes in physical characteristics
- Infrared detectors
- Closed Circuit TV
- Managing dwell times

13.8 Mobile Plant and equipment selection, design and operation

Factors that should be considered when: selecting or altering mobile plant and equipment for handling wood chip and pellet include but are not limited to:

- Dust control in the operator's cab
- Bio hazard inside the cab & air conditioning (Mould growth, etc.)
- Bio hazard to service staff. (Mould growth, etc.)
- Temperature control in: engine bay, transmission, hydraulic tank & pump area.
- Fuel tank location & construction material
- Diesel Particulate Filter (DPF) re-generation times, cycles, exhaust & body temperature
- Dust entry control to above
- Dust exit when in the above
- Engine Cooling pack design & location
- Engine Cooling Fan location
- Cooling air / dust route through engine bay, or cooling pack area
- Fire prevention, (Before it catches fire)
- Fire suppression and fire extinguisher systems (after it catches fire)
- Cleaning regime

- Sanitizing regime
- Timescale between thorough deep clean
- Use of compressed air for routine cleaning
- Use of water for routine cleaning

When using enclosed cabs on equipment to control dust exposure it is important to consider emergency escape in the event of a fire or mechanical failure. For example, a typical enclosed skid-steer type loader does not enable the operator to open the door if the bucket is raised. Where the primary means of egress might become unavailable, an alternative egress route such as an escape panel should be fitted.

If considering preparing plant and equipment for ATEX zoning, it is important to take into account the type of risk and protection required for the circumstances. For example, in the petro-chemical industry, protecting against gas and vapour is likely to be a priority whereas for wood pellet in ports the risks are more associated with flammable dusts. A suitable and sufficient risk assessment should be used to identify the risks to be controlled.

It is industry recommended good practice that the mobile plant is fitted with an automated fire suppression system.

13.9 Firefighting systems

Wood pellet fires in silos or stores tend to be slow/smouldering due to the lack of oxygen in the headspace. This typically gives the Incident Controller time to properly consider when to deploy the firefighting systems rather than triggering them when they are not required, which could also damage the associated plant.

Fire suppressant systems can use: foam, Nitrogen, carbon dioxide or water. Deluge systems such as water spray or ‘hydro-mist’ systems should be considered on conveyors and material transfer systems, subject to the assessed risk.

Fire emergency plans should be prepared. The importance of procedures, planning, periodic exercising and early communication with emergency services cannot be over emphasised.

The emergency fire plan should take into account the environmental impact of containment and run-off of firefighting mediums such as water or foam. The potential need for containment and subsequent disposal of contaminated water should be considered as part of the risk assessment along with clean-up resources, etc.

14. EXPLOSION

Biomass dust in certain conditions can explode. Different dust profiles present different hazards. Some dust accumulations may present more of a fire hazard than direct explosion hazard.

Figure 3 Explosion pentagon - conditions required for an explosion to take place

An explosion can start as a dust fire when it ignites finer dust that is dispersed into the air by some other mechanism.

Measurements of lower explosive limits of many materials are available. For many organic products the limit is in the range of 10-50g/m3. A dust cloud of this concentration resembles a very dense fog. See HSG 103 Safe handling of combustible dusts: Precautions against explosions

The secondary explosion following a primary explosion is where more fuel in the form of a dust cloud is thrown up into the atmosphere from the initial explosion and with an ignition source the results can be catastrophic.

- Explosion: a rapid increase in volume and release of energy in an extreme manner, usually with the generation of a high temperature
- Explosiveness: is a function of particle concentration, oxygen concentration and the energy of the ignition source or the temperature of the heat exerted by the wood pellet dust

Some biomass can give off explosive gasses e.g. decomposing organic materials can give rise to Methane.

15. PREVENTING EXPLOSIONS - MANAGEMENT CONTROLS

Management controls to prevent explosions include but are not limited to:

- Competent Design of storage and handling installations
- Spark detection within enclosed Conveyor Systems.
- Cleaning
- Zoning of plant and storage areas
- Dust suppression
- Enclosures and dust extraction
- Control of ignition sources
- Non-destructive handling
- Ventilation of explosive/flammable gasses
- Plant and equipment design and operation

15.1 Competent design of storage and handling installations

Installations should be competently designed and constructed. Attention should be paid to reducing or masking off surfaces where dust can accumulate and to access to surfaces for cleaning and dust removal. Where existing facilities are being used, places where dust will accumulate can be minimised by retrofitting angled surfaces and/or use of materials such as expanding foam to fill voids.

Accumulated dust may be an issue within buildings or covered areas associated with (un)loading equipment. For example, there is potential to accumulate biomass dust, particularly around the rails in railway loadout sheds.

Consideration should be given to installation of extract ventilation fans in bulk undercover storage facilities for removing gases, in particular carbon monoxide and Methane. Dust filters should be incorporated to catch dust fines during ventilation.

Where there is a risk from explosion within the process, a suitable and sufficient Explosion Venting System must be incorporated within the plant. The requirement for an Explosion Venting System should be identified during the pre-construction HAZOP Study and should comply with the Dangerous Substances and Explosive Atmosphere Regulations.

15.2 Cleaning

Cleaning is one of the most important controls for preventing explosions as well as controlling respiratory and fire risk. Simply put, it is an absolute must for ensuring safe operations and it should be an integral part of your risk management arrangements. Documented cleaning and housekeeping procedures should be in place; setting out cleaning and inspection frequency and variation in cleaning requirements for different areas of plant or equipment.

Cleaning regimes prevent areas of hazardous dust layers occurring. It is recommended that cleaning should be sufficient to generally avoid dust layers over 2mm thick and maintain widespread dust layers at less than 0.5mm thickness. Personnel should be trained and empowered to identify unacceptable dust layers, as indicated in defined cleaning standards.

Maintenance activity can lead to dust exposure. Using brushes and air lines to clean equipment will increase airborne dust levels and should be avoided within enclosed spaces where practicable. The use of vacuuming equipment is recommended for interior use. In new-build facilities, it is recommended that consideration be given to installing a suitable vacuum system with hose connection points throughout.

Spillages, for example from overloading on the belt or maintenance activities should be cleaned away promptly.

Spraying equipment such as appropriately chosen water spray atomisers can be used to spray water during operations to supress fugitive emissions from grabs, vehicles or ships holds etc.

Regular cleaning/inspection of handling equipment may be necessary; in some facilities this may be as often as every one to two hours for some pieces of equipment such as shovel loaders. Some operators have retro-fitted cleaning features such as piping, to make it easier to clean down less accessible parts of the engine. Thorough deep cleaning should be scheduled into the maintenance programme for plant and equipment.

Steam cleaning equipment may be used, however this may be better done over longer intervals as it is a wet operation and dust will stick to wet surfaces and often harden in place.

Compressors may be used outside of enclosed storage areas to blow dust clear of machinery, surfaces and engine parts. However, blowing dust is likely to increase potential respiratory risk to operators and suitable and sufficient controls should be put in place when using such equipment.

15.3 Zoning of undercover biomass storage

Areas should be assessed by a competent person and zoned according to risk with suitable and sufficient controls put into place. The ATEX directives specify zoning of dusts as follows:

- **Zone 20** A place in which an explosive atmosphere in the form of a cloud of combustible dust in air is present continuously, for long periods or frequently
- **Zone 21** A place in which an explosive atmosphere in the form of a cloud of combustible dust in air is likely to occur in normal operation occasionally
- **Zone 22** A place where an explosive atmosphere in the form of a cloud of combustible dust in air is not likely to occur in normal operation but, if it does occur it will persist for a short period only

Zoning can be part of controls for wood pellet dust. However, wood chip can normally be safely stored outside and would therefore not necessarily require Dangerous Substances in Explosive Atmospheres Regulations zoning.

15.4 Enclosures and dust extraction

For internal storage, dust control equipment, usually fitted to transfer towers, hoppers and conveyors is designed to minimise dust concentrations/levels during transfer and handling.

A number of ports have introduced specialised hoppers and other dust containment methods to manage the dust during discharge. Features such as: non-return valves, negative pressure, dust extraction and positive pressure operator cabs have been introduced in the hopper design. Existing port hoppers designed for other products may lack suitable dust suppression and if used may require additional dust controls. Such features should have robust, documented, inspection and maintenance regimes in place. For example Local Exhaust Ventilation requires statutory through examination & testing.

Loaded bulk shunt vehicles should be sheeted when moving around the port, regardless of the distance.

Use of automatic doors and sheeting features on Heavy Goods Vehicles can also reduce dust dispersal and should be considered when sourcing HGV provision. Such automated equipment reduces the need for drivers to move around operational areas on foot and climb in and out of vehicles.

15.5 Spark detection within enclosed conveyor systems

It is recommended that a suitable and sufficient spark detection system is installed at suitable points in the system as identified by risk assessment. Extinguishing systems should be installed where appropriate to prevent the sparks from igniting the collected material within the system.

15.6 Emergency planning

It is essential that suitable and sufficient Emergency Plans are in place for vessels, handling areas and stores.

Stores should be designed with sufficient access for:

- personnel evacuation
- accessing “Hot Spot” locations so that hot biomass can be dug out and suitably cooled by spreading out at a very low height.

Emergency plans should include but not be limited to factors such as:

- Physical aspects and layout of the space/area for safe access/egress and emergency response, casualty evacuation and clean-up
- Communications arrangements
- Provision of rescue and response equipment
- Trained emergency response personnel
- Incident management
- Practice/drill arrangements

See SiP016 Emergency Planning in Ports for further details

15.7 Control of ignition sources

Controls may include:

- specialised plant and equipment (for example ATEX rated)
- intrinsically safe, low temperature lighting and other electrical equipment including portable electrical equipment
- means of capturing ‘tramp’ metal such as magnets, metal detection, screening etc. that could create sparks
- maintenance regimes

- lagging or other means of controlling heat sources such as pipework or engine components
- prohibition of smoking and e-cigarettes

16. OCCUPATIONAL HEALTH

16.1 Respiratory Hazards

Exposure to dust is a risk for development of respiratory impairment and respiratory allergy. Exposure to wood dust may increase the risk for work related asthma by up to 50%. Wood residues such as terpenes, abietic acid and plicatic acid have also been implicated as respiratory allergens. Whilst Hardwood dust has been internationally recognised as a Group 1 human carcinogen, it is suspected that softwood is also a carcinogen. Therefore it is industry good practice to treat all wood dust as a carcinogen. Where there is such a risk to port operators, regular medical surveillance is required.

Under the current version of Control of Substances Hazardous to Health Regulations (COSHH) both hard and soft woods have been given UK workplace exposure limits of 5mg/m^3 (8-hour time weighted average of total inhalable dust). As a recognised asthmagen & potential carcinogen, control is only deemed adequate when exposures are reduced as low as is reasonably practicable (ALARP). See EH40 for current limits

It should be noted that whilst workplace exposure limits exist, the duty under law is to reduce exposure to as low as reasonably practicable. Organisations should have robust monitoring and control in place to keep exposure well below occupational exposure limits.

16.2 Diesel Engine Exhaust Emissions

Consideration should be given to potential respiratory risks from plant and equipment used in wood chip/pellet operations, for example potential exposure to diesel exhaust emissions.

16.3 Toxins Phytosanitary/Spores/Mould issues (farmer's lung)

Toxic activity in wood is specific to the species so knowing the exact species is important in establishing what the potential toxic effects may be. The hazardous forms of wood that are most likely to cause health risks are: dust; sap, latex or the lichens associated with a wood. Recycled wood may contain contaminants

If biomass becomes damp it is likely support the growth of microorganisms and the production of spores. Naturally occurring bacteria and fungi on damp biomass can rapidly grow within the material during storage, especially if the product becomes

increasingly damp due to poor ventilation, rain water ingress or similar. The spores produced then become part of the organic dust released during any subsequent disturbance of the material e.g. front loading shovel operation and shifting of material. Exposure to these spores can cause rhinitis, itchy eyes, breathing difficulties and even skin problems. If exposure to airborne spores is repeated and prolonged, those exposed may develop chronic and debilitating lung conditions including asthma or extrinsic allergic alveolitis. Where biomass is stored externally, these risks are also relevant.

16.4 Dermatitis

Allergic contact dermatitis may be experienced through handling some biomass products.

17. OCCUPATIONAL HEALTH - MANAGEMENT CONTROLS

17.1 Respiratory hazards

Respiratory risks to personnel must be identified through COSHH risk assessments and appropriate methods of control implemented. The approach must be to work from the top of the hierarchy of controls to eliminate the hazard where practicable.

The dust management arrangements discussed earlier in the document including: non-destructive handling, cleaning, controlling access, monitoring (e.g. dust level measurement, medical surveillance, checking filters etc.), low impact handling, water spray atomisers, air filtered cabs, hopper design etc. will also be part of the controls applied to minimise the risk to personnel from respiratory hazards.

In addition to such measures that are higher up the hierarchy of controls, personal protective equipment will be required. Subject to local risk assessment and conditions, Personal Protective Equipment when working with Biomass may comprise: head protection, safety shoes, coveralls (e.g. to prevent skin exposure) and high visibility clothing, gloves, eye protection and respiratory protective equipment. Additional equipment may be appropriate according to local conditions.

Personal Protective Equipment requirements should be written into procedures, signposted at entrances to facilities and enforced. Personal Protective Equipment, must be appropriate to the risk and must be maintained. Due to the risk of contamination, appropriate hygiene facilities should be provided for workers. Facilities should also be provided for cleaning, storing and disposal of Personal Protective Equipment.

17.2 Respiratory Protective Equipment

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.

Respiratory Protective Equipment must be

- Adequate – right for the hazard and reduces exposure to the level required to protect the wearer's health
- Suitable – right for the wearer, task and environment, such that the wearer can work freely and without additional risks due to the RPE.

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.

There is only room to identify basic principles here because of the specialist, technical requirements of selection and use of Respiratory Protective Equipment. Further guidance is available at: HSG53 Respiratory Protective Equipment at Work

This and other appropriate sources should be consulted prior to the introduction of respiratory protective controls in the workplace.

17.3 Toxins Phytosanitary/Spores/Mould issues (farmer's lung)

If dry wood pellet or chip is allowed to get wet and is left for a period of time, it decomposes and mould can form. Stock management and housekeeping are a primary control. Workers should also be trained to understand the risks. Mouldy wood chip/pellet is likely to smell which may help to indicate risk. There is the potential for mould/spores to occur in filtration systems in work areas such as plant air conditioning equipment, changing facilities, etc. These may require enhanced cleaning and replacement regimes.

If there is a requirement to handle mouldy material, a COSHH assessment should be conducted and suitable controls put in place which may include respiratory protection.

17.4 Dermatitis and contact risk

With dermatitis, the primary controls are around provision of personal protective equipment, adequate personal washing facilities and training of operatives in appropriate hygiene controls. Risk assessment should be used to determine the type and extent of facilities required.

Arrangements should be put in place to adequately wash and/or safely dispose/exchange dirty workwear where there is an identified risk. Workwear should be adequate for the hazards, for example covering arms and legs where there is a potential contact hazard.

17.5 Medical surveillance

A risk assessment should be undertaken for personnel who will handle biomass to identify if Medical Surveillance should be put into place. Where surveillance is deemed appropriate, a two-stage surveillance process for exposure to dust should be implemented: (1) medical questionnaire then (2) lung function test if deemed necessary by an Occupational Health professional. The type and frequency of ongoing health surveillance and respiratory testing will be dependent on the exposure levels and advice from an Occupational Health professional.

Pre-employment medicals should identify any vulnerability or allergy to wood pellet dust and it is recommended that this includes a prestart lung function test.

For further information, see also:

- Safe Wood Working documents
- HSG173 Monitoring strategies for toxic substances
- SiP011 Sources of occupational health information

18. TRAINING

All persons engaged in working with biomass should have site induction and any additional training required of them to undertake their duties on site. Risk Assessments, Method Statements and Operating Instructions should be prepared for all potentially hazardous tasks and be addressed in the training. Persons responsible for operating or maintaining plant and process equipment must be trained to perform their tasks safely. Shipside personnel, in addition to normal operator training, should be given extra training based on the Safe Loading and Unloading of Bulk Carriers Regulations 2003 (IMO Blu Code) and other relevant codes/regulations. Toolbox talks/safety briefings should be part of the information, instruction and training regime.

One of the specialised training issues with biomass is that plant operators have appropriate instruction on non-destructive handling to reduce dust production.

19. CONVEYOR SYSTEMS

Conveyor systems are used in some locations for handling biomass cargoes. Conveyor systems must be fit for purpose, properly designed and installed, regularly inspected and maintained. The Provision and Use of Work Equipment Regulations 1998 will apply to conveyor systems. In addition, in some case the Lifting Operations and Lifting Equipment Regulations 1992 may also apply.

General plant and machinery safety is addressed in other Safety in Ports guidance documents such as SiP002 Guidance on General Cargo

19.1 Dangers with conveyors

The main Dangers to personnel from conveyor plant and associated machinery arise from:

- Being trapped or struck by the machinery, for example by in-running nips between pulleys and belts
- Being buried in or struck by the materials being handled
- Falling, for example from the conveyor or into the chute

Aspects of conveyor safety should include but not be limited to:

- Safety features must be included in the design. Guards must be fitted in all areas where trap, entanglement hazards exist
- Permit systems must be in place including appropriate isolation procedures as necessary to ensure that the system can be safely maintained and operated
- Staff operating and maintaining conveyors must be competent and had suitable training
- Cleaning regimes need to be in place to regularly clean any conveyor system. Build-up of any product can result in fires and or explosions
- Regular checks must also be made to ensure conveyors are clear of obstructions and that belts do not rub against other objects; the friction generated may be sufficient to create enough heat to initiate fires and explosions
- Access control systems should be in place to ensure no unauthorised access to conveyors and any associated equipment

- Fire and explosion dampening systems should be considered and fitted if practicable to areas of conveyor systems where they may be of benefit
- Guarding, with appropriate safety interlocks checked and in place around moving parts before operation
- Local rules such as: persons must not ride on belts, persons must not step on to a conveyor table or cross a conveyor, except by walkways or other designated means etc.

20. ANNEX 1 - EXAMPLE CHECKLIST FOR PLANNING VESSEL ARRIVAL AND DISCHARGE

20.1. The following points are a guide only and are not exhaustive, they should be adapted to fit the hazards and risks as assessed by those in control of the operation.

20.2. Ports/Terminals should have robust procedures in place to safely manage the cargo handling procedure and safe departure of the vessel. The Marine elements of arrival and departure will be covered by Port Marine Safety Code compliance. However stevedoring operations must be in accordance with the Safe Loading and Unloading of Bulk Carriers Regulations 2003 (and also the IMO Blu Code). These requirements include but are not limited to:

- Nominating a terminal representative
- Providing terminal information
- Agreeing with the Master a loading/unloading plan
- Completing a ship/shore safety checklist
- The terminal operating an approved Quality Management System

20.3. Ship/shore information exchange must include any hazards, obstructions, unusual access arrangements on the ship identified to enable shore staff to be informed

20.4. Any shore-side related matters, hazards or issues to be agreed and understood by the ship to enable all crew to be informed

20.5. Vessel acceptance arrangements, this can include more than just normal published port entry requirements like draught and dimensions; and may include items such as hold access arrangements, type of hatch lids, cargo handling restrictions/arrangements and other operational matters

20.6. Atmospheric testing of cargo holds and access routes when discharging a vessel

20.7. Temperature monitoring of the cargo whilst in the ship and storage areas

20.8. Characteristics of the particular cargo being handled, including Safety Data Sheets (SDS)

20.9. Confirming that all plant and equipment is in a safe condition and ready to be used for the cargo handling operations, including pre-use checks, statutory inspections, appropriately cleaned, maintenance regimes, training records, storage facilities, monitoring equipment calibrated

20.10. Establishing that the vessel has a safe berth, including safe access arrangements

20.11. Making all required facilities available e.g. water, bunkers, waste disposal and reception facilities available as required

20.12. Arrangements for providing suitable cargo handling personnel, appropriately trained and competent with suitable supervision

20.13. Plant and equipment operators to understand dust minimisation techniques to be adopted

20.14. Any required dust monitoring arrangements are in place, ready to be used and calibrated

20.15. Any required dust control measures are in place which may include but not be limited to water curtain sprays/jets, hoppers, dust extraction systems

20.16. Plant & equipment cleaning procedures are in place and staff trained in cleaning techniques

20.17. Storage facilities are available and cleaned as required to ensure dust levels acceptable and ready to accept the cargo

20.18. If shunt vehicles are to be used to move product, they should be fit for purpose, with suitable drivers. Traffics routes should be explained, sheeting requirements agreed and dust minimisation methods understood

20.19. Stores such as bulk sheds must have had any required atmospheric testing undertaken prior to personnel enter unless fixed gas detection systems are installed. In which case gas levels are to be established and confirmed safe prior to entry

20.20. Conveyor system and any other specialist plant must be fit for purpose and ready in all respects to allow the cargo to be safely handled.

20.21. Conveyor guarding should all be in place and all safety systems ready, working and tested. Emergency stop arrangements must be in place

21. REFERENCES AND FURTHER READING

21.1. Relevant legislation and guidance includes the following. Please note that these are the correct versions at the time of publishing but the reader should always seek out the most current version.

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

21.3. Safe Loading and Unloading of Bulk Carriers Regulations 2003 and also the IMO Blu Code.

21.4. Confined Spaces HSE web pages

21.5. Consulting and involving your workers

21.6. Control of Major Accident Hazards Regulations (COMAH) 2015

21.7. Control of Substances Hazardous to Health Regulations (COSHH) 2002

21.8. Workplace exposure limits (EH40)

21.9. Dangerous Goods in Harbour Area Regulations 2016

21.10. Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR)

21.11. ATEX Directives and further information (workers potentially at risk from explosive atmospheres)

21.12. Electricity at Work Regulations 1989 and guidance on electrical safety

21.13. Health and Safety at Work etc. Act (HSWA) 1974

21.14. Health and Safety (Safety Signs and Signals) Regulations 1996

21.15. International Labour Organisation's (ILO) Code of Practice on Safety and Health in Ports (ILO 152)

21.16. International Maritime Dangerous Goods Code (IMDG)

21.17. International Maritime Solid Bulk Cargoes (IMSBC) Code

21.18. Management of Health and Safety at Work Regulations 1999

21.19. Managing Health and Safety in Dock work HS(G) 177

21.20. Monitoring strategies for toxic substances (HSG173)

21.21. Personal Protective Equipment HSE web pages

21.22. Provision and Use of Work Equipment Regulations (PUWER) 1998

21.23. Respiratory Protective Equipment HSE web pages

21.24. Safe handling of combustible dusts (HSG 103): Precautions against explosions

21.25. Safety in Docks ACOP L148

21.26. Selecting suitable respiratory protective equipment WIS14

21.27. Safe Wood Working documents

21.28. See also British Standards: http://shop.bsigroup.com/

- BS EN 1755:2000+A1:2009 – Safety of Industrial Trucks – Operation in potentially explosive atmospheres – Use in flammable gas, vapour, mist and dust.
- BS EN 1834-3:2000 – Reciprocating internal combustion engines – Safety requirements for design and construction of engines for use in potentially explosive atmospheres. Part 3: Group II engines for use in flammable dust atmospheres

22. DOCUMENT AUTHORS

This guidance document has been produced by Port Skills and Safety with the assistance of the Health and Safety Executive and representatives of the UK ports industry.

23. FURTHER INFORMATION

For further information, please contact:

Port Skills and Safety, 30 Park Street, London SE1 9EQ

Email: info@portskillsandsafety.co.uk

24. COPYRIGHT