CHAPTER 4

Managing Hazards and Risks for Ship and Terminal

4.1 Management system

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This chapter sets out a general risk management process and then identifies general hazards and their mitigating measures for both tankers and terminals. Risk management processes for specific operations, e.g. cargo handling, are covered in the other chapters.

4.1 Management system

A management system is a defined method to ensure that stated objectives are achieved. The system is documented and includes the following key elements:

- Scope and objectives.
- Procedures.
- Resources responsible and accountable for implementation and execution.

- A verification and measurement process to determine whether the desired results are being achieved.
- A feedback mechanism to provide a basis for further improvement.

4.2 Risk management

4.2.1 General

Tankers and terminals should have a risk management process. It should include procedures to identify hazards, assess associated risks and ensure risks are either eliminated or reduced to ALARP through preventative and mitigating measures or controls.

All activities, including those of contractors, should be included in the risk management process.

4.2.2 Risk assessment

A key tool used by the industry, and a function of all SMSs for managing risks, is the process of a risk assessment. A risk assessment can identify potential hazards, i.e. anything that may cause harm, and analyse the likelihood and severity of a hazard arising and the consequence of it happening. A risk assessment is, typically, a five step process, the results of which may be expressed in a quantitative or qualitative fashion:

1. Identify the hazards.
2. Decide who might be harmed and how.
3. Evaluate the risks and decide on preventative and mitigating measures or controls.
4. Record significant findings.
5. Review the assessment and update following the *International Safety Management (ISM) Code* or the operator's SMS.

Risk assessments should provide the basis for developing policies and procedures that cover all tanker and terminal operations.

All new or non-routine activities not covered by existing procedures should be risk assessed before starting, e.g. emergency repairs.

Risk assessments should consider the possibility of human error introducing a hazard or a control failure. In this situation, Safety Critical Task Analysis (SCTA) (see chapter 7) may be used to help prevent, detect or respond to human error.

To ensure all hazards are identified, risk assessments should be completed by a team of suitably trained and experienced personnel. They should, preferably, not be completed by a single person.

4.2.3 Hierarchy of controls

Table 4.1 provides a recommended order of priority for selecting preventative measures or controls. This is known as the hierarchy of controls.

1. Elimination	Remove the cause of the hazard completely, e.g. by not performing a proposed operation.
2. Substitution	Replace the proposed procedure with a less hazardous one.
3. Engineering controls	Separate personnel from the hazard by physical means, e.g. fitting guards at dangerous items of equipment, rigging barriers around open hatchways or using Lock-out/Tag-out (LO/TO) equipment.
4. Administration controls	Use procedures to perform tasks safely, e.g. hot work permits, enclosed space entry permits, hazard identification tools, risk assessments and duty rosters to minimise exposure to hazards.
5. PPE	Use PPE to protect the person carrying out the operation, e.g. safety glasses. PPE should only be considered when all the above measures have been found to be ineffective at controlling the risks to a reasonable practical level. Select PPE to mitigate against the identified hazard. Train personnel how to use it correctly, including how to check it is still fit for the intended purpose.

Table 4.1: Risk assessment hierarchy of controls

4.2.4 Marine interface risks

Activities at the marine interface that should be risk assessed include:

- Mooring and berthing operations.
- Cargo transfer operations.
- Double banking operations (including multiple banking).
- Discharging or loading over the tide.
- Tug and towing operations.
- Non-cargo related operations, including tank cleaning, bunkering, storing, hot work and repairs while alongside the berth.
- Tank measurement and sampling.

Risk assessments can also be used to develop the following:

- Security plans.
- Emergency response plans.
- Oil spill response plans.
- Terminal safety exclusion zones.
- Non-standard terminal firefighting and protection arrangements.
- Critical equipment and systems identification.

Regularly review existing risk assessments and associated controls to make sure they are still valid. A periodic inspection procedure should be in place for both tanker and terminal facilities and operations. This should be used to identify new hazards and to decide whether a revised risk assessment is needed.

4.2.5 Management of Change

The risk management process should include a Management of Change (MOC) procedure.

MOC is the process of bringing controlled and planned change, either temporary or permanent, to operations, procedures, equipment or personnel to meet a defined goal.

The MOC procedure should ensure that safety and/or environmental standards are not compromised after the change.

MOC should be documented and supported by risk assessment, following on from any initial risk assessments where available.

Changes that might need an MOC procedure include:

- Changes to standard operating procedures in the SMS, e.g. because of changes in regulations and standards.
- Modifications to existing equipment.
- Installation of new equipment.
- Changes to tanker or terminal manning arrangements.
- New cargo products being handled.
- A different type or size of tanker calling at a terminal.

4.3 Stop Work Authority

It is recommended that tanker and terminal SMSs include a Stop Work Authority (SWA) policy and procedure. The SWA gives employees and contractors the responsibility and obligation to intervene and stop work if they see something unsafe that may cause an accident (see section 7.7).

A typical SWA procedure includes five steps:

1. Stop the unsafe activity.
2. Tell the Person In Charge (PIC) so the issue can be addressed.
3. Discuss the concerns with those involved and correct the issue as necessary.
4. Start the activity again.
5. Share what has been learned with other employees and contractors who might be affected.

4.4 Lock-out/Tag-out

Specially designed LO/TO equipment is widely available that provides a system for preventing a valve or device being operated until the lock or tag has been removed, usually under a documented system of safe management control. Uses vary but could include the isolation of overboard sea valves and tanks during tank entry.

Hazardous energy control procedures (see section 4.5) may also include a LO/TO system that places a lock and/or tag on an energy isolating device, e.g. a valve or breaker. This stops the energy isolating device being operated until the lock or tag has been removed.

Training should be provided to all personnel involved in using the LO/TO system and this training should include all associated equipment and the procedures to which the system is being deployed. Training should be extended to contractors who are also required to work with a system that may be specific to the ship or terminal.

4.5 Control of hazardous energy

4.5.1 Hazardous energy

Hazardous energy is any electrical, mechanical, hydraulic, pneumatic, chemical, nuclear, thermal, gravitational, sound, motion, biological or other energy that can harm personnel. Examples of hazardous energy include:

- Pressure in a cargo pipeline due to stored pressure.
- Pressure in a cargo pipeline section due to temperature variations.
- Gas pressure in an IG line.
- Air pressure in reservoirs.
- Stored electrical energy in electrical switchboards.
- Hydrostatic pressure on ship side valves.

4.5.2 Hazardous energy controls

A hazardous energy control procedure should be developed to identify and control hazardous energy. An example five step procedure is given below:

1. Gather information.
2. Perform SCTA.
3. Perform a risk assessment.
4. Implement controls.
5. Communicate and train.

When implemented these should prevent:

- Injuries by an initial uncontrolled release of hazardous energy.
- Injuries by residual energy remaining in a system after shutdown.
- Release of a pollutant to air, the sea, the ground or on deck.
- Uncontrolled sea water entering machinery or other spaces.

Procedures should aim to establish that a zero energy state has been achieved and independently verified before work starts. If this zero energy state cannot be established, work should not start until more risk assessment and control measures are established. Procedures should identify the steps to be followed when a zero energy state cannot be established. Figure 4.1 provides a flowchart setting out the recommended steps to control hazardous energy.

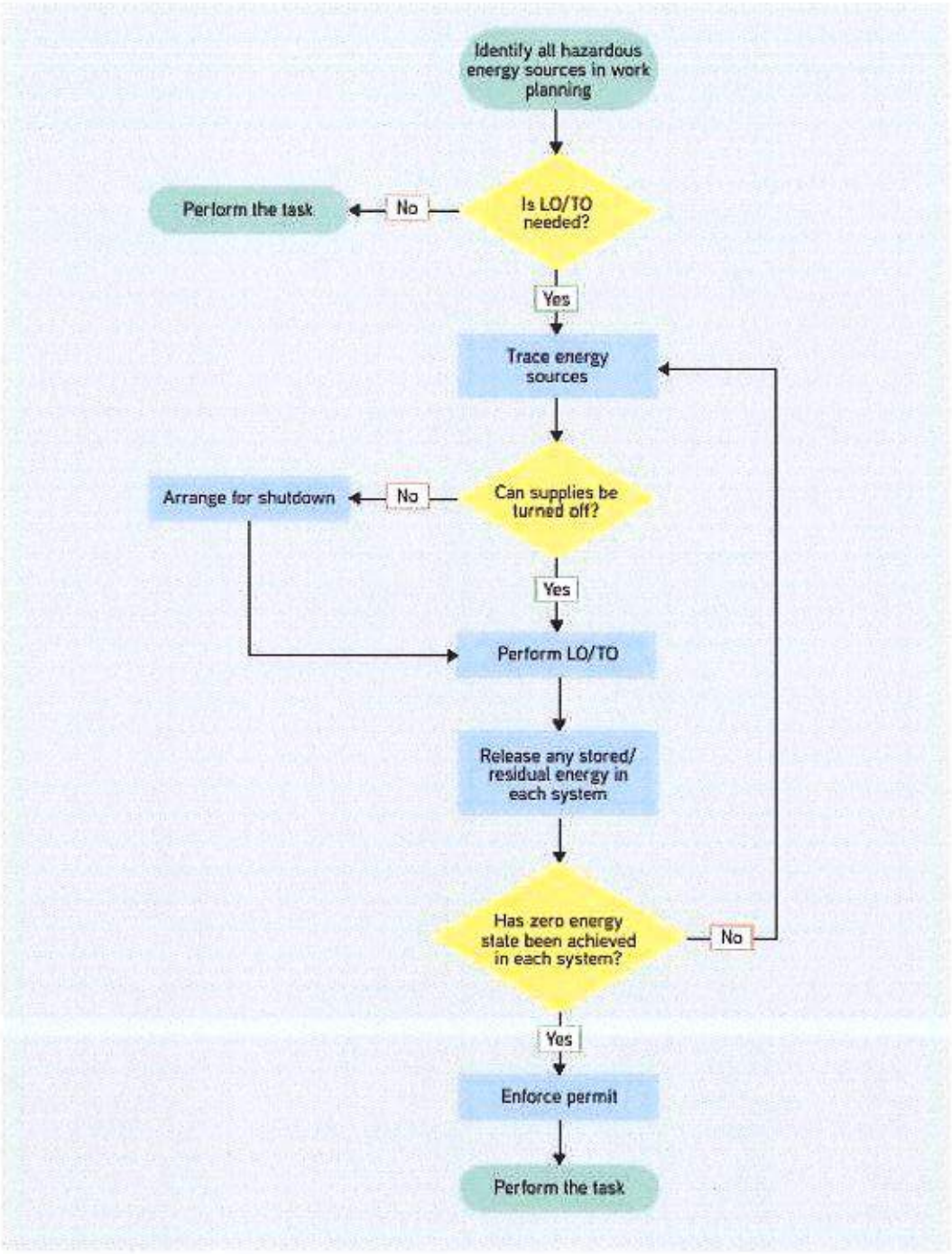

Figure 4.1: Control of hazardous energy flowchart

4.6 Simultaneous Operations

4.6.1 General

Simultaneous Operations (SIMOPS) are activities that take place at the same time in the same area or that could directly or indirectly affect the safety of any other activity on the ship or at the terminal (see figure 4.2).

SIMOPS should be identified at an early stage so that the risk assessment can include the individual risks of each operation and the risks from their interaction. If the operations are only risk assessed individually, additional risks might not be identified.

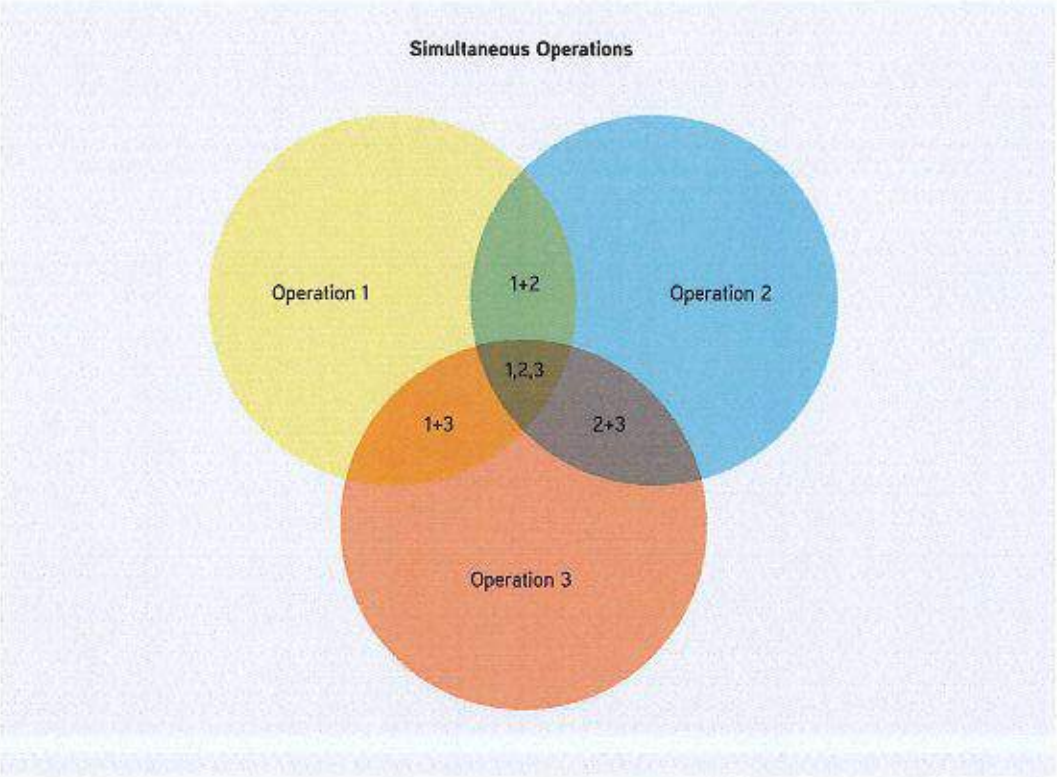

Figure 4.2: Interaction of SIMOPS

4.6.2 Managing Simultaneous Operations

4.6.2.1 Simultaneous Operations risk assessment

Avoid SIMOPS whenever practicable. If this cannot be avoided, then SIMOPS should be carefully managed through risk assessment, toolbox talks and work practices.

A SIMOPS risk assessment should study the intended operations and identify any additional hazards introduced by undertaking the activities simultaneously. The risk assessment should consider factors such as:

- Approval level: in accordance with company procedures and SMS requirements.
- Schedule and workload clashes.
- Resources: there should be enough personnel to safely complete each operation within the anticipated timeframe and enough to assign personnel to individual tasks.
- Supervision: each operation should be adequately supervised.

- Distraction: operations should be controlled from a common location, e.g. single control room for engine or cargo operations.
- Communications: there should be enough communications equipment with separate channels for each operation and contingency arrangements agreed.
- Knowledge and skills: personnel undertaking the tasks should be sufficiently trained and experienced to safely complete the assigned tasks.
- Fatigue: work and rest hour requirements should not be compromised by the demands of the SIMOPS.
- Critical tasks.
- Maintenance activities.
- Contingency plans.

Using the factors identified the level of risk should be assessed and risk reduction measures evaluated. Hierarchy of controls principles should be used to prioritise those measures and to further identify any additional safety barriers required. Additional hazards introduced by the SIMOPS should also be highlighted and further reviewed during the assessment.

4.6.2.2 Simultaneous Operations plan

This will enable a SIMOPS plan/interface document to be prepared, which will outline planned controls to be confirmed as in place to ensure the operation is managed effectively and risks reduced to an acceptable level.

The plan may vary in scope from a simple pre-job meeting to a detailed interface document that considers some or all the following, depending on the complexity and scale of the operation, the number of different activities and the personnel involved:

- Purpose of the operation and identified SIMOPS.
- Risks and their mitigations, along with control measures and safe operating procedures.
- Reporting lines and overall control authority.
- Communications and contingency plans.
- MOC requirements.

4.6.2.3 Simultaneous Operations preparation

Toolbox talks should then be used to review the SIMOPS plan and these should include discussion on the implementation of the control measures and any potential conflicts or challenges.

Examples of SIMOPS include:

- Bunkering or storing operations at the same time as cargo operations.
- Maintenance operations at the same time as bunkering or cargo operations.
- Testing equipment at the same time as bunkering or cargo operations.
- Enclosed space entries at the same time as cargo operations.
- Emergency exercises at the same time as cargo operations.
- Diving operations at the same time as cargo operations.
- Inspections, e.g. Port State Control (PSC), Flag State or the Ship Inspection Report Programme (SIRE), at the same time as cargo operations.
- Ship to Ship (STS) transfer operations. Bridge watchkeeping at the same time as cargo watchkeeping.

4.6.3 Decision matrix

It is recommended that SIMOPS procedures include a decision matrix to help identify the level at which approval is required within the organisation.

4.6.4 Matrix of permitted operations

Procedures may include a matrix of permitted operations. This provides a visual guide to the level of risk identified in SIMOPS. The matrix will identify activities that are:

- Permitted to occur simultaneously without restriction.
- Permitted with restrictions.
- Not permitted at all.

Figure 4.3 provides recommended steps for a SIMOPS procedure.

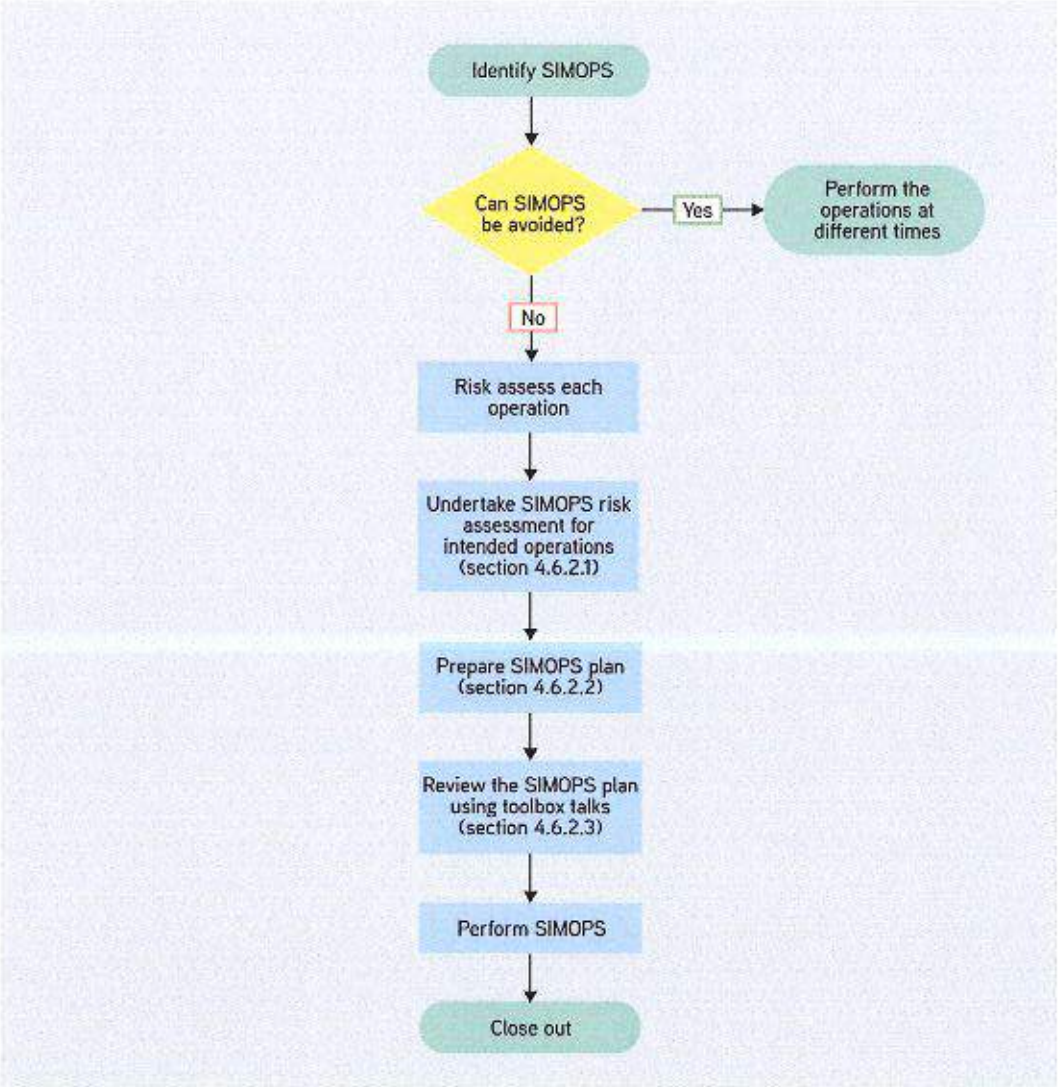

Figure 4.3: SIMOPS control procedures flowchart

4.7 Permit to work systems

4.7.1 General

While tanker and terminal operators will develop their own procedures for managing all aspects of operations and tasks, many choose to incorporate a permit to work system into their SMS in order to manage hazardous tasks.

A permit to work system is a formal written system that controls certain types of work. It delivers a risk-based approach to safety management and requires personnel to undertake and record risk assessments in the development of a safe system of work.

A number of publications issued by industry organisations and national safety bodies contain guidance for establishing a permit to work system.

The permit to work system may include one or more of the following management tools to control hazardous activities:

- Work instruction.
- Maintenance procedure.
- Local procedure.
- Operational procedure.
- Checklist.
- Permit.

The measures used when carrying out a particular task are determined by a risk assessment and recorded in the permit to work.

4.7.2 Permit to work systems – structure

The structure of the system and its processes are very important in ensuring that the system delivers the necessary level of safety and operational integrity.

The permit to work system should define:

- Operator responsibility.
- Responsibilities for all personnel operating the system.
- Training in the use of the system.
- A measure of the competency of personnel.
- Types of permit and their application.
- Levels of authority.
- Isolation processes.
- Permit issuing procedures.
- Permit cancelling procedures.
- Associated permits to be reviewed.
- Emergency actions.
- Record-keeping.
- Auditing.
- System updating.

The system will determine the proper controls to manage the risk associated with each task and the right management tool to manage the task, as listed in section 4.7.1.

The system need not require all tasks to be done under the control of a formal permit. However, it is important that the work instruction, procedure or permit used for managing a task is

appropriate to the work being carried out and that the process is effective at identifying and managing the risks.

4.7.3 Permit to work systems – principles of operation

A permit to work system should comprise the following steps:

- Identify the task and location.
- Identify the hazards and assess the risks.
- Ensure appropriate competency of personnel who will carry out the work.
- Define the risk control measures – state the precautions and PPE needed.
- Set out communication procedures.
- Identify a procedure and initiate a permit to work.
- Obtain formal approval to perform the work.
- Carry out a pre-work briefing.
- Prepare the work.
- Carry out the work to completion.
- Return the work site to a safe condition.
- Complete the process, keeping records for audit purposes.

4.7.4 Permit to work forms

The permit to work form is designed to lead the operator through an appropriate process in a logical, detailed and responsible manner. The permit is produced as a joint effort between those authorising the work and those doing the work. The permit should ensure that all safety concerns are fully addressed.

The structure and content of permit to work forms will be determined by the specific individual requirement of an operator's SMS, but are typically as follows:

- Type of permit.
- Permit number.
- Supporting documents, e.g. details of isolations, gas test results.
- Location of work.
- Description of work.
- Hazard identification.
- Precautions necessary.
- Protective equipment to be used.
- Period of validity.
- Authorisation for the work, including duration and endorsement by the Master or department head.
- Acceptance by those performing the work.
- Management of changes to workforce or conditions.
- Declaration of completion.
- Cancellation.

A permit does not, by itself, make a job safe.

Complying with the requirements of the permit, and identifying any deviations from the specified controls or expected conditions, are essential parts of completing the task safely. The system should also identify any conflicts with other tasks being carried out on board at the same time.

4.7.5 Work planning meetings

Work planning meetings should be held to ensure that operations and maintenance tasks are correctly planned and managed, with the aim of completing all tasks safely and efficiently. These meetings may include discussion of:

- Risk assessments.
- Work permits.
- Isolation and tagging requirements.
- The need for safety briefings, toolbox talks and correct procedures.

The format and frequency of work planning meetings should be in line with the requirements of the operator's SMS and will be determined by the tanker or terminal's activities.

It may be appropriate to have two levels of meeting – one for management and another for the practical issues related to specific tasks.

4.7.6 Toolbox talks

A toolbox talk is a discussion between all workers, including contractors, about the hazards of the planned task.

A toolbox talk is required for all tasks. The PIC of the task should hold a toolbox talk at the worksite with everyone involved before the task begins. Toolbox talks should include:

- Critical job steps, including roles and responsibilities.
- Job hazards and additional safeguards, including PPE.
- Specialised work permits, where applicable.
- Communication plan.
- SWA triggers.

If only one person is needed to perform the task, that person should review the above list before starting.

If the worksite is noisy, identify the hazards at the worksite, then move somewhere quieter to finish the toolbox talk.

4.8 Personal safety

4.8.1 Personal Protective Equipment

Identify what protective clothing and equipment is needed in a risk assessment. PPE should be of an approved standard and should be worn by all personnel engaged in operations. This should include protection for:

- Body.
- Hands and feet.
- Face and eyes.
- Ears.
- Head.

Avoid using synthetic material for tasks involving flames or heat, because it can melt and severely damage skin. Personnel at risk of falling into the water should wear life jackets or approved Personal Flotation Devices (PFDs). Personnel working at a height of 1.8m or more should wear approved fall protection. See the *Code of Safe Working Practices for Merchant Seafarers (COSWP)* and OCIMF/CDI's *Recommendations for Oil and Chemical Tanker Manifolds and Associated Equipment*.

Storage places for PPE, including RPE, should be protected from the weather and clearly marked.

Training on how to use PPE and RPE correctly should be provided.

PPE requirements for visitors should be established.

Inspection and maintenance procedures should be available for PPE and RPE.

4.8.2 Slip, trip and fall hazards

Slips, trips and falls are a common cause of accidents on tankers and in terminals. Management and personnel should pay attention to anything that may cause these accidents, including changing conditions.

Non-skid coatings or gratings should be provided in working areas and on walkways. These areas should be clearly marked so that personnel are aware of their existence and extent. Areas for consideration include:

- Mooring areas.
- Manifold areas.
- Dipping and sampling locations.
- Access walkways.
- Pipeline step-overs.
- External stairways.

Terminals should establish requirements for personnel passing through the terminal. A clearly marked safe route and/or safe transport through the terminal should be provided.

All personnel, including visitors, should use the marked access routes. The routes should be kept well lit, clear and free of spillages.

The risk of slips, trips and falls is significantly higher when using access ladders and companionways. Good design and construction will help prevent these accidents. Trip hazards, e.g. high plate edges at the top of ladders and unevenly spaced steps, should be avoided. Where the design cannot be modified, trip hazards should be clearly marked or highlighted with contrasting paint.

4.8.3 Asbestos

The disturbance or removal of asbestos should be carried out by specialist contractors. If the crew need to make urgent repairs at sea, measures should be in place to ensure they are adequately protected from asbestos. MSC/Circ.1045 *Guidelines for Maintenance and Monitoring of On-Board Materials Containing Asbestos* provides guidance on how to handle asbestos safely on board tankers. A detailed risk assessment should be conducted before starting any urgent repairs that might involve asbestos.

4.8.4 Personal hygiene

Prolonged contact with oil can be dangerous. Avoid direct skin contact with oil or with oily clothing wherever possible.

4.9 Preventing fire and explosion

To prevent the risk of fire and explosion, a source of ignition and a flammable atmosphere should not be in the same place at the same time. Precautions should be taken to exclude or control either the source or the atmosphere. Flammable gases can be expected in the hazardous zones of tankers and terminals. All possible sources of ignition should be removed.

Oil spillage and leakage present a fire hazard and should be avoided. If they occur, the leak should be stopped immediately and the spill should be cleaned.

Flammable gases and ignition sources can be safely controlled in control rooms, workshops, storerooms, etc. if they are properly designed, operated and maintained.

In a tanker's accommodation block, sources of ignition should be limited or controlled, e.g. by designating a smoking area.

It is essential that flammable gas is not able to enter the accommodation block. Settings on air conditioning systems should ensure the pressure inside the accommodation is greater than the external atmosphere, e.g. do not set to 100% recirculation.

In engine and boiler rooms, ignition sources cannot be avoided (see also section 4.10). Flammable gases should be prevented from entering the engine and boiler rooms. Bunker fuels, including residual fuel oils, may present a flammability hazard (see section 1.6), so bunker spaces should be checked regularly.

4.10 Control of potential ignition sources

4.10.1 Naked lights

Naked lights should be prohibited on the tanker deck, in the terminal and in any other place where flammable gas may be present.

4.10.2 Smoking

Smoking presents significant risks on board all tankers and requires careful management. Controls can be established through SMS requirements and design, e.g. dedicated smoking rooms on tankers. Controls for smoking should also be applied to any other products that are burned, e.g. incense sticks. Any smouldering, smoke-producing product should never be left unattended or allowed near bedding or other combustible materials.

4.10.3 Smoking at sea

While a tanker is at sea, smoking should be permitted only at times and in places specified by the Master. Personnel on board tankers should only smoke in the dedicated smoking room, if one is available. Smoking should be prohibited on the tanker deck or any other place where flammable gas may be present. Criteria that should be considered when determining the location of designated smoking places are listed in section 4.10.5.

4.10.4 Smoking in port and controlled smoking

Smoking should be prohibited in the restricted area around all tankers and berths and on board any tanker while at a berth, except in designated smoking places.

Smoking in port should only be permitted under controlled conditions and in designated smoking areas.

Smoking on board barges and other small craft should be prohibited while they are alongside the tanker or terminal.

4.10.5 Location of designated smoking places

Designated smoking places on a tanker or onshore should be agreed in writing between the Responsible Officer and the Terminal Representative at the pre-transfer conference before operations start (see chapter 24). The Responsible Officer should make sure everyone on the tanker has been told where the designated smoking places are and that suitable notices are posted.

During operations, designated smoking areas should only be allowed:

- In the accommodation area.
- In a room that does not have any doors or ports that open directly on to decks.

Operations include:

- Any handling of petroleum cargoes.
- Stern loading/discharge.
- Ballasting into cargo tanks that are not gas free.
- Purging with IG.
- Gas freeing.
- Tank cleaning.

In the designated smoking area, all portholes should be kept closed and all doors should be kept closed unless in use.

Before or after operations, while the tanker is still at the terminal, designated smoking areas should be selected to take account of any hazardous conditions, e.g. unusually high flammable gas concentrations, particularly when there is no wind, and tanker operations on adjacent berths.

Smoking can only be allowed in other areas if the Master and Terminal Representative have agreed to it in writing. When stern loading/discharge connections are being used, particular care should be taken to ensure that no smoking is allowed in any accommodation or space where the door or portholes open onto the deck where the stern loading/discharge manifold is located.

4.10.6 Matches and cigarette lighters

Safety matches or fixed (car type) electrical cigarette lighters should be provided in designated smoking areas.

All matches used on board tankers should be safety matches. The use of matches and cigarette lighters should be banned outside the accommodation, except in designated smoking areas. Matches should not be carried on the tank deck or in any other place where flammable gas may be present.

The use of all mechanical lighters and portable lighters with electrical ignition sources should be prohibited on board tankers.

Disposable lighters present a significant risk because their spark producing mechanism is unprotected, which means they can be accidentally activated.

The carriage of matches and lighters through terminals should be prohibited and severe penalties may be levied under local regulations for non-compliance.

4.10.7 Electronic or e-cigarettes

The existing smoking rules also apply to the use of electronic or e-cigarettes.

4.10.8 Notices

Portable and permanent notices prohibiting smoking and the use of naked lights should be displayed clearly at the access points to the tanker and at the exits from the accommodation area. In the accommodation area, instructions about smoking should be clearly displayed.

4.10.9 Galley stoves and cooking appliances

The use of galley stoves and other cooking appliances that employ naked flames should be prohibited while a tanker is at a petroleum berth.

Galley personnel should be instructed on how to safely operate galley equipment. Unauthorised and inexperienced persons should not be allowed to use galley equipment.

Fires are often caused by unburnt fuel or fatty deposits that have collected in galley ranges, flue pipes and filters. These areas should be regularly inspected to make sure they are clean. Oil and deep fat fryers should be fitted with thermostats to cut off electrical power and prevent accidental fires.

Galley staff should be trained how to handle fires and how to respond appropriately. Training should include how to operate fixed fire-extinguishing systems fitted to galley equipment. Appropriate fire extinguishers and fire blankets should be available.

The use of portable stoves and cooking appliances on board tankers should be controlled and, when in port, their use should be prohibited.

Steam cookers and other equipment heated by steam can be used at any time.

4.10.10 Funnel emissions

To prevent funnel fires and sparks, burners, tubes, uptakes, exhaust manifolds and spark arresters should be kept in good working condition. If a funnel fire happens at sea, or sparks are emitted from the funnel, the tanker should consider altering course as soon as possible to avoid sparks falling on the tank deck. Cargo, ballasting or tank cleaning operations should be stopped and all tank openings closed.

Boiler tubes should not be soot blown when the tanker is in port. At sea, the officer on bridge watch should be consulted before the operation starts and the tanker's course should be altered if necessary.

4.10.11 Spontaneous combustion

Some materials ignite when they are damp or soaked with oil, especially vegetable oil, without the external application of heat. This is called spontaneous combustion and it happens because the material gradually heats by oxidation (see section 13.4).

The risk of spontaneous combustion is smaller with petroleum oils than with vegetable oils, but it can still happen, particularly if the material is kept warm, e.g. because it is close to a hot pipe or surface.

Cotton waste, rags, canvas, bedding, jute sacking, sawdust or any similar absorbent material should not be stowed in the same compartment as oil, paint, etc. They should also not be left lying on the jetty, on decks, on equipment, on or adjacent to pipelines, etc. Damp materials should be dried before they are stowed. Oil soaked materials should be cleaned or destroyed.

Some chemicals used for boiler treatment are also oxidising agents and can spontaneously combust if they have evaporated. These chemicals should be stored in a safe and secure location.

4.10.12 Auto-ignition

Petroleum liquids ignite without the application of a naked flame when heated sufficiently. Auto-ignition is most common when fuel or lubricating oil under pressure sprays onto a hot surface. It also happens when oil spills onto lagging, vaporises and bursts into flame. Both instances have been responsible for serious fires.

Oil feeder lines require attention to avoid oil being sprayed from leaks. Pipelines carrying fuel and lubricating oil under pressure should be assessed and provided with necessary protection. Oil saturated lagging should be removed and personnel protected from any ignition or re-ignition of vapours during the process.

4.10.13 Equipment made of aluminium

Aluminium equipment should not be dragged or rubbed across steel. It can leave a smear that can cause an incendive spark if it is struck by a hammer or falling object. It is recommended that the underside of aluminium gangways and other heavy portable aluminium structures are protected with a hard plastic or wooden strip to stop smears being transferred to steel surfaces.

The use of other aluminium equipment in cargo tanks and on cargo decks should be subjected to a risk assessment and, where necessary, carefully controlled.

4.10.14 Cathodic protection anodes in cargo tanks

Various materials are used for cathodic protection, including magnesium, aluminium and zinc.

Magnesium anodes are very likely to cause an incendive spark if they strike rusty steel, so they should not be fitted in tanks that may contain flammable gases.

Aluminium anodes spark when they are hit hard. They should only be installed at approved locations in cargo tanks and should never be moved to another location without proper supervision. Because aluminium anodes can easily be mistaken for zinc anodes, they can accidentally be installed in hazardous locations. It is recommended that only aluminium anodes are used in permanent ballast tanks.

Zinc anodes do not generate an incendive spark if they strike rusty steel and are not subject to the above restrictions.

The location, securing and type of anode installed in cargo tanks are subject to approval by the appropriate authorities. Their recommendations should be observed and inspections made as often as possible to check the anodes and mountings are secured. Anodes are easily damaged by high capacity tank washing machines.

4.11 Electrical equipment and installations in hazardous areas

4.11.1 General

This section describes the classification of hazardous areas for electrical installations and equipment on board tankers and in terminals. It also gives general guidance on safety precautions during maintenance and repair of electrical equipment.

4.11.2 Hazardous areas

Hazardous areas may contain a flammable atmosphere during normal operations. They are sometimes called dangerous areas.

Hazardous areas are normally subdivided into zones according to the likelihood of a flammable atmosphere being present, as shown in table 4.2.

The extent of hazardous areas can be determined by reference to Class rules and industry standards.

Zone	Likelihood of flammable atmosphere
Zone 0	A place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapour or mist is present continuously or for long periods
Zone 1	A place where an explosive atmosphere consisting of a mixture with air or flammable substances in the form of gas, vapour or mist is likely to occur in normal operation conditions
Zone 2	A place where an explosive atmosphere consisting of a mixture with air or flammable substances in the form of gas, vapour or mist is not likely to occur in normal operation but, if it does occur, will only persist for a short period

Table 4.2: Hazardous area zones

4.11.3 Hazardous areas on a tanker

On tankers, hazardous areas are sometimes described as dangerous areas.

The arrangement of equipment is defined as required by Class rules.

Typically, the designation of the zones is aligned with IEC 60092-502 *Electrical installations in ships – Part 502: Tankers – Special features*.

Certain spaces, e.g. battery lockers and paint stores, are not described as hazardous areas but there are prescriptive requirements in Class rules for the types of electrical equipment and ventilation fans fitted in these spaces.

4.11.4 Hazardous areas at a terminal

At a terminal, hazardous areas and zones are based on national standards. These are aligned with industry standards, e.g. those of the IEC or the Energy Institute.

When a tanker is at a terminal, a tanker safe area may be in a terminal hazardous area. Any unapproved equipment on the tanker that is in the terminal hazardous area may need to be isolated when the tanker is at the terminal.

4.11.5 Sources of ignition from electrical equipment

Potential sources of ignition from electrical equipment include:

- Electric sparks.
- Arcs and flashes.
- Electrostatic discharges.
- Electromagnetic waves.
- Hot surfaces.
- Flames and hot gases.
- Mechanically generated sparks.
- Chemical reaction.

4.11.6 Standards of electrical equipment for use in hazardous areas

To avoid the risk of ignition, electrical equipment in hazardous areas needs to be specially designed and constructed. The most rigorous standards are needed in areas where the likelihood of a flammable atmosphere is highest.

Electrical equipment used in hazardous areas is subject to different regulations and standards depending on the geographical location where the certification is recognised and accepted. Different standards apply in different parts of the world, including the International Electrotechnical Commission System for Certification to Standards Relating to Equipment for Use in Explosive Atmospheres (IECEx), ATEX and the National Electrical Code (NEC).

Electrical equipment must be certified for use by a recognised certification body. Different certification bodies require different markings on equipment, which may cause confusion. Electrical equipment needs to be selected and installed carefully, and inspected and maintained regularly, to make sure it continues to comply with the selected standard.

4.11.7 Inspection, maintenance and testing of electrical equipment

All equipment, systems and installations, including cables, conduits, glands and similar equipment, should be inspected and maintained.

Continuing functional operation does not assure compliance with the required standards of safety, unless correct maintenance procedures have been followed.

4.11.7.1 Inspection and checks

Typical inspections should include checking:

- Cracks in metal casings or covers, cracked or broken glass, or failure of cement around glass in flame-proof or explosion-proof enclosures.
- Covers of flame-proof enclosures, to ensure that they are tight, that no bolts are missing and that no gaskets are present between mating metal surfaces.
- Each connection to ensure that it is properly connected.
- Possible slackness of joints in conduit runs and fittings.
- Clamping of cable armouring.
- Stresses on cables that might cause fracture.

Inspection routines and check sheets for hazardous areas are described in the IEC 60079-17 *Explosive atmospheres – Part 17: Electrical installations inspection and maintenance.*

When a tanker is at a berth, equipment in hazardous areas should not be serviced without prior agreement between the tanker's Responsible Officer and the Terminal Representative.

4.11.7.2 Maintenance

Incorrect maintenance procedures can compromise the safety of electrical equipment. Even simple repairs and maintenance can compromise safety, e.g. paint covering safety features such as relief holes, passages, etc. Changing a lightbulb could damage explosion-proof lights if the cover is closed incorrectly.

All repairs and maintenance should comply with the manufacturer's instructions and only qualified and competent electrical personnel should work on critical safety equipment, e.g. explosion-proof fittings.

Repair methods for electrical equipment in hazardous areas are described in the IEC 60079-19 *Explosive atmospheres – Part 19: Equipment repair, overhaul and reclamation.*

4.11.7.3 Insulation testing

Insulation testing should only be carried out when no flammable gas is present.

4.11.8 Changes to electrical equipment and systems

If the hazardous area classification or the characteristic of the flammable material changes, check to make sure the electrical equipment:

- Is the correct group.
- Is the correct temperature class.
- Complies with the new area classification.

Any change should be performed under an MOC process.

Approved equipment, systems or installations should not be modified, added to or removed without permission from the appropriate authority.

Safety features of equipment that rely on segregation, pressurisation, purging or other methods to ensure safety should not be modified.

If electrical equipment is removed from the hazardous zone, make sure any associated wiring is also removed or terminated in an appropriate enclosure. Electrical equipment should not be recommissioned until it meets the requirements of the SMS. The cable cores of intrinsically safe circuits should be either insulated from each other or bonded together and insulated from earth.

4.11.9 Electrical repairs, maintenance and testing at terminals

4.11.9.1 General

All maintenance work on electrical equipment should be undertaken under the control of a permit or an equivalent SMS procedure, with procedures to effectively manage electrical and mechanical isolations.

The use of mechanical LO/TO is recommended.

4.11.9.2 Cold work

Cold work means any work that cannot create a source of ignition. Electrical power should be cut off from equipment or wiring at source before:

- Carrying out cold work.
- Opening enclosures to non-intrinsically safe equipment.
- Disabling any special safety features.

Electrical power should not be restored until after the cold work has been completed, the enclosures to non-intrinsically safe equipment have been closed again and the special safety features have been re-enabled.

Cold work, including changing lamps, should only be done by an authorised person.

4.11.9.3 Hot work

Hot work means any work that involves sources of ignition or temperatures high enough to ignite a flammable gas mixture. This includes, but is not limited to:

- Welding (electric arc or gas).
- Cutting, burning, gouging (electric or gas).
- Heating (blow torch or heat gun).
- Soldering (electric or blow torch).

Use of the following temporary/portable equipment in a hazardous area should be classed as hot work:

- Power tools (electric or spark generating pneumatic).
- Electronic equipment that is not intrinsically safe.
- Internal combustion engines (driving air compressors, pumps, pressure washers, etc.).

The Terminal Representative and Responsible Officer will need to reach a joint agreement and issue a hot work permit before any hot work is conducted on:

- A berth with a tanker alongside.
- A tanker at a berth.

Also see section 9.4 before starting any hot work.

4.12 Portable electrical and electronic equipment

4.12.1 General

Portable and fixed electrical and electronic equipment present similar ignition hazards. The electrical energy is, typically, lower in portable equipment, but there are more risks from the use of batteries and an increased likelihood of equipment or cable damage.

Portable electrical and electronic devices should not be brought into a potentially flammable atmosphere unless they are certified as suitable. Certification should be checked for:

- Method of protection.
- Gas group.
- Temperature class.
- Zone.
- Special conditions – marked with an X at the end of the certificate number.

Selected general purpose Portable Electronic Product (PEP) can only be used in hazardous areas if:

- It is intended to be worn directly or supported by a person's body, or handheld, i.e. supported by one hand during normal use.
- It is battery powered or photovoltaic powered.
- It has been approved for use by both the owner/operator of the hazardous area and the authority having jurisdiction over site.

Some PEPs can be used in hazardous areas without meeting the above requirements, as long as they are incapable of causing an ignition under normal conditions and are used for their intended purpose. Examples include electronic wrist watches and hearing aids. However, this exception does not extend to more sophisticated electronic devices, e.g. rechargeable fitness wristbands and smart watches, as they are typically powered by higher risk lithium ion cells that have a greater risk of becoming an ignition source (see section 4.12.8).

More guidance on PEP and the requirements for suitability assessment and classification in hazardous locations, as well as the standard criteria for equipment to meet for acceptance, can be found in the American National Standards Institute (ANSI)/ISA 12.12.03 *Standard for Portable Electronic Products Suitable for Use in Class I and II, Division 2, Class I Zone 2 and Class III, Division 1 and 2 Hazardous (Classified) Locations.*

Portable and battery powered equipment frequently undergo in-service product upgrades, resulting in potential changes in operating parameters that could affect any prior testing and approval.

Testing of equipment for classification in hazardous environments is time consuming, resulting in a limited range of equipment that can be certified and labelled for use in hazardous environments and may periodically require re-testing to maintain certification.

ISGOTT does not recommend the use of PEP in hazardous locations except under strictly controlled and normal operating conditions as described in this section. This will often require PEP to be used only under the conditions of a gas free or hot work permit under the control of the owner/operator of the site.

Before use, portable equipment should be inspected for possible defects, e.g. damaged casings and cables, and to make sure cables are securely attached and will stay attached throughout the work. Special care should be taken to prevent any mechanical damage to flexible cables.

Inspection and maintenance of all portable electrical equipment should be included in the Planned Maintenance System (PMS).

4.12.2 Electrical equipment on flexible cables

The use of portable electrical equipment on flexible cables (also known as wandering leads) on tankers and in terminals should be controlled under the SMS.

On board tankers, electrical equipment on flexible cables can only be used in cargo tanks and over the tank deck if the areas are safe for hot work (see section 9.4).

Adjacent spaces should also be at least one of the following:

- Safe for hot work.
- Purged of hydrocarbon gas to less than 2% by volume and inerted.
- Completely filled with ballast water.

If the adjacent spaces to cargo tanks have not met the above criteria, electrical equipment on flexible cables can only be used if at least one of the following applies:

- All tank openings to the adjacent space are closed throughout the operation.
- Electrical equipment, including the flexible cables, is intrinsically safe.
- Electrical equipment is in an approved explosion-proof housing and the flexible cables are:
  - Approved for extra hard usage.
  - Have an earth conductor.
  - Permanently attached to the explosion-proof housing.

Certain types of equipment are approved for use over the tank deck only.

The above does not apply to flexible cables used with signal or navigation lights or to approved types of telephones if they are used correctly.

4.12.3 Air-driven lamps

Approved air-driven lamps can be used in hazardous areas if the:

- Air supply is fitted with a water trap.
- Supply hoses are low electrical resistance.

This will stop static electricity building up.

Permanently installed units should be earthed.

4.12.4 Torches, lamps and portable battery powered equipment

To stop potentially flammable atmospheres igniting, portable battery equipment should be designed and constructed to the same standards as electrical equipment and should be certified as safe for the area it is being used in. For example:

- Only torches (flashlights) that have been approved by a competent authority for use in flammable atmospheres may be used on board tankers.
- Handheld Very High Frequency/Ultra High Frequency (VHF/UHF) portable transceivers should be intrinsically safe.
- Tri-mode gauging tapes are battery operated electronic units and should be certified as being suitable for use in flammable atmospheres.

Small, battery powered, personal medical items, e.g. miniature hearing aids and heart pacemakers, are not considered significant ignition sources and can be used without certification in some hazardous areas subject to national standards and risk assessment.

4.12.5 Mobile telephones and pagers

Most mobile telephones and pagers are not intrinsically safe and are only considered safe for use in non-hazardous areas. They should be restricted to designated areas of the accommodation space where they are unlikely to interfere with the tanker's equipment. Mobile telephones should only be used on board a tanker or in the terminal as permitted by the applicable SMS. Details on restrictions on the use of mobile telephones should be prominently displayed at main access locations.

Mobile telephones and pagers should be switched off when carried onto a tanker or into a terminal and only switched back on again in a non-hazardous area. The batteries can cause an incendive spark if they are damaged and then activated by a call. Intrinsically safe mobile telephones and pagers are available and these may be used in hazardous areas. They should be clearly identified as being intrinsically safe for all aspects of their operation. Terminal staff going on board a tanker, and tanker staff going into the terminal, should be able to prove their mobile telephones and pagers are intrinsically safe. Visitors to the tanker or terminal should not use mobile telephones or pagers unless prior permission has been received from the tanker or terminal, as appropriate.

4.12.6 Cameras

The following general guidelines should be considered when deciding whether it is safe to use a camera. This guidance refers only to ignition hazards and does not consider security concerns that may require other restrictions on the use of cameras in some ports. Camera equipment that contains battery or power operated parts may produce an incendive spark, e.g. from a flash or aperture control. This equipment should not be used in a hazardous area unless it is certified as being suitable for use in a hazardous area. Disposable cameras with a built-in flash should not be used in hazardous areas.

Camera equipment without any battery or power operated parts, e.g. non-flash disposable cameras and clockwork mechanism cameras, can be considered safe for use in hazardous areas. An approved intrinsically safe camera can be used in a gas hazardous zone.

4.12.7 Other portable electrical equipment

Any other electrical or electronic equipment of non-approved type, whether mains or battery powered, should not be active, switched on or used in hazardous areas. This includes:

- Radios.
- Calculators.
- Games consoles.

- Laptop and handheld computers.
- Smart watches.
- Fitness wristbands.
- E-cigarettes.
- Remote controlled devices, e.g. drones.
- CD and DVD players, tape recorders and digital music players.
- Any other portable or wearable technology that is electrically powered but not approved for operation in hazardous areas.

The same measures to prevent use of this equipment in hazardous areas can be used as for other types of electrical equipment, e.g. mobile phones. Personnel should be told what non-approved equipment is banned.

Terminals should have a policy for telling visitors about the hazards of using portable electrical equipment. Terminals should reserve the right to make visitors leave any non-approved electrical equipment at an appropriate place, e.g. at the entrance to the terminal.

4.12.8 Lithium batteries

Lithium batteries are used in a wide variety of industrial and personal electrical equipment. There are two main types of lithium battery: primary (non-rechargeable) and secondary (rechargeable). All lithium batteries are high energy power sources. They can cause fire or explode, especially if they are damaged, exposed to fire, short circuited, overcharged or exposed to water. Used lithium batteries should be stored separately in dry conditions until landed for formal disposal.

The following precautions should be taken:

- Only use lithium batteries that are designed for the equipment being charged, incorporate the necessary safety features and are lithium ion.
- Do not crush, break open or damage lithium batteries or the equipment that contains them.
- Avoid short circuiting. For example, take care when moving the lithium batteries from an air-conditioned environment to a warm moist area, which may cause internal condensation leading to a short circuit.

4.13 Communications equipment

4.13.1 General

Communications equipment on a tanker should not be used, connected or disconnected in a terminal's hazardous area unless it has been certified as intrinsically safe or is an approved design.

Communications equipment may include:

- Telephones.
- Talk-back systems.
- Signalling lamps.
- Search lights.
- Loud hailers.
- Closed circuit television.
- Electrical controls for tanker whistles.

4.13.2 Ship's radio equipment

The use of a tanker's radio equipment during cargo or ballast handling operations is potentially dangerous.

4.13.2.1 Medium and high frequency radio transmissions

Significant energy is radiated during medium and high frequency radio transmission (300KHz–30MHz). This energy can travel 500m from the transmitting antenna and can induce an electrical potential in unearthed equipment, e.g. cranes, derricks, rigging, mast stays, etc., that can produce an incendive spark. Transmissions can also cause arcing over the surface of antenna insulators when they have a surface coating of salt, dirt or water.

It is recommended:

- All cranes, derricks, rigging and mast stays should be earthed.
- Transmissions should not be allowed when flammable gas is likely in the region of the transmitting antenna or if the antenna comes within the terminal hazardous area.
- Main transmitting antennae should be earthed or isolated when the tanker is alongside the berth.

If the tanker's radio transmitter needs to be operated in port for servicing, the tanker and terminal should agree on procedures to ensure safety in the pre-transfer conference (see chapter 24). Precautions might include operating at low power or using a dummy antenna load to eliminate all radio transmissions to atmosphere. A safe system of work should be agreed and implemented before turning the equipment on.

4.13.2.2 Very High Frequency/Ultra High Frequency equipment

Permanently and correctly installed VHF and UHF equipment are safe to use when the tanker is at the terminal, but it is recommended that the transmission is set to low power (one watt or less). The use of portable VHF/UHF radios in a terminal or on board a tanker presents no hazards if the equipment is certified and kept intrinsically safe and the power output is one watt or less.

The use of VHF/UHF radio equipment as a means of communication between tanker and terminal personnel is recommended.

4.13.2.3 Satellite communications equipment

Satellite communications equipment normally operates at 1.6GHz and the power generated is not enough to present an ignition hazard. Satellite communications equipment may be used to transmit and receive messages while the tanker is in port.

Long Range Identification and Tracking (LRIT) systems are normally integrated into satellite communication systems and also do not present an ignition hazard.

4.13.3 Tanker radar equipment

Marine radar systems operate in the Radio Frequency (RF) and microwave range. Radiation from the scanner fans out in an almost horizontal, narrow beam as the scanner rotates. In port, it will pick up cranes, loading arm gantries and other such structures, but it will not normally spread down to the tanker's deck or jetty.

Radar sets, operating on 3cm and 10cm wavelengths, are designed with a peak power output of 30kW. If they are properly sited, they do not present a radio ignition hazard due to induced currents.

Radar radiation does not penetrate the human body, but at short ranges (up to 10m) can heat skin or eyes. Assuming sensible precautions are taken, e.g. not looking directly into the scanner at close range, there is no significant health risk from marine radar emissions.

Radar scanner motors are not rated for use in hazardous areas but are usually positioned above terminal hazardous zones, apart from on smaller vessels. It is, therefore, safe to test radars when alongside. However, it is good practice to switch the radar off or place it on standby when alongside a terminal and to consult with the terminal before testing radar equipment during cargo operations.

4.13.4 Automatic Identification Systems

The Automatic Identification System (AIS) is required to operate while a tanker is underway and at anchor. Some port authorities may ask for the AIS to be kept on when a tanker is alongside. The AIS operates on a VHF frequency and transmits and receives information automatically, and the output power ranges between 2.0W and 12.5W. Automatic polling by another station, e.g. by port authority equipment or another tanker, could cause equipment to transmit at the higher (12.5W) level, even when it is set to low power (typically 2.0W).

When alongside a terminal or port area where hydrocarbon gases may be present, either the AIS should be switched off or the aerial isolated and the AIS given a dummy load. Isolating the aerial preserves manually inputted data that may be lost if the AIS is switched off. If necessary, the port authority should be informed.

When alongside a terminal or port area where no hydrocarbon gases are likely to be present, and if the unit has the facility, the AIS should be switched to low power.

At a Single Point Mooring (SPM) or Multi Buoy Mooring (MBM) terminal, the AIS may be kept on, if requested by the terminal, at an adequate power level to transmit information to the terminal safety monitoring system. Tanker and terminal representatives should agree on the AIS settings.

If the AIS is switched off or isolated while alongside, it must be reactivated on leaving the berth.

The use of AIS equipment may affect the security of the tanker or the terminal at which it is berthed. The use of AIS may be determined by the port authority, depending on the security level in the port.

4.13.5 Landline telephones

Telephone cables connecting the tanker and terminal should be routed outside the hazardous area. When this is not possible, the telephone cable should be routed and fixed in position by qualified terminal personnel and should be protected against mechanical damage so that no danger can arise from its use.

4.14 Tools

4.14.1 General

All tools should be used for the purpose that they were designed for, inspected before use and confirmed in good condition.

4.14.2 Hand tools

Hand tools, e.g. chipping hammers and scrapers for steel preparation and maintenance, may be allowed without a hot work permit.

The work area should be gas free and clear of combustible materials. The tanker should not be engaged in any cargo, bunker, ballasting, tank cleaning, gas freeing, purging or inerting operations.

Non-ferrous (also called non-sparking) tools are not recommended. They are softer (and less efficient) than ferrous tools and only slightly less likely to cause an incendive spark. Particles of concrete, sand or other rock-like substances are also likely to get embedded in the working face or

edge of non-ferrous tools, which can then cause incendive sparks when they impact with ferrous or other hard metals.

4.14.3 Electrical tools

Inspection and maintenance of all electrical tools should be included in the PMS. The use of electrical tools in hazardous zones should be managed through a permit to work system. Battery powered hand tools should be considered electrical tools. These include:

- Portable drills.
- Angle grinders.
- Sanders.
- Nibblers.
- Heat shrink guns.
- Impact wrenches.

4.14.4 Mechanically powered tools and grit blasting

Mechanically powered tools, e.g. chisels, needle guns, angle grinders, cup brushes and grit blasters, have a significant potential for producing sparks and should be used under the control of a permit to work and the SMS.

The following precautions should be taken:

- There should be no cargo, bunkering, tank cleaning, gas freeing, purging or inerting operations in progress.
- The work area should not be subject to vapour release, or a concentration of flammable vapours, and should be free of combustible material.
- The area should be gas free and tests with a combustible gas detector should give a reading of not more than 1% LFL.
- Adequate firefighting equipment should be laid out and ready for immediate use.
- Mechanical tools should not be used when a tanker is alongside a terminal, unless the Master and the Terminal Representative have given express permission.

The hopper and hose nozzle of a grit blasting machine should be electrically bonded and earthed to the deck, or fitting being worked on, to avoid risk of static discharge.

Pipelines can be perforated during grit blasting or chipping, so great care should be taken when planning such work. Similar precautions should be adopted for IG and COW lines.

4.14.5 Hydroblasting (high pressure water washing)

Hydroblasting (and slurry blasting) are hazardous activities and should be controlled through the SMS and permit to work process. There should be no cargo, bunkering, tank cleaning, gas freeing, purging or inerting operations in progress.

High Pressure (HP) washing uses pressures of between 700–1,700 bar. Above 1,700 bar is considered Ultra High Pressure (UHP) washing.

Hydroblasting presents two main hazards: personal injury and static electricity. The most common injuries are wounds caused by the water jet, musculoskeletal injury from use of the equipment and inhalation of harmful substances disturbed by the jet. Wounds caused by the water jet can have serious consequences and have been compared to gunshot wounds. Immediate medical attention is required.

Procedures should ensure that operators are suitably trained and provided with the correct PPE.

Because of the risk of static discharge from the nozzle, hydroblasting equipment should never be used where a flammable atmosphere is possible. Hydroblasting equipment should be electrically continuously conductive and earthed to the tanker structure or grounding point.

The area should be gas free and tests with a combustible gas detector should give a reading of not more than 1% LFL.