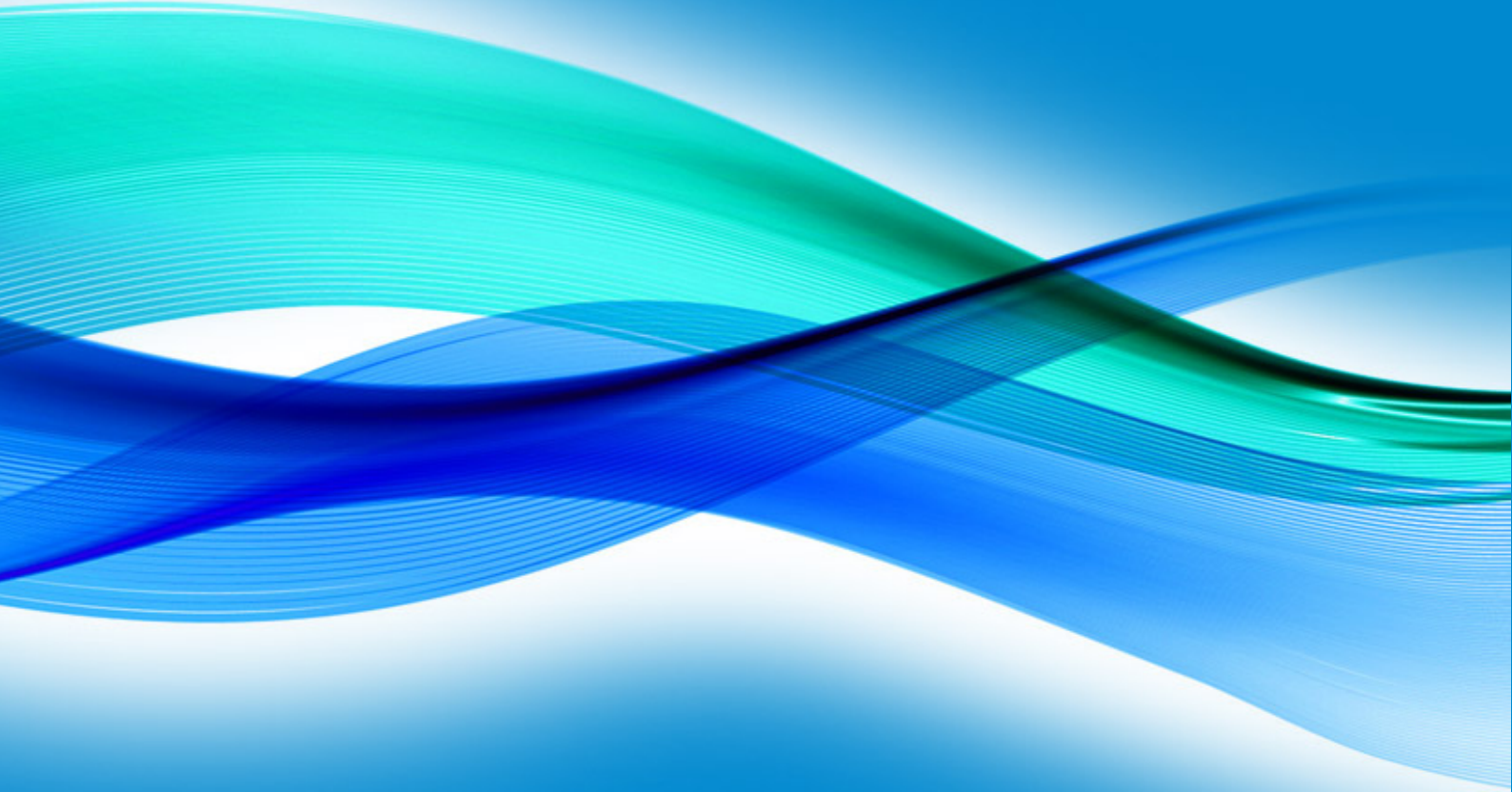


Safe use of machines on ships

General guidelines on machinery hazards and
risks, safe operation and maintenance

An abstract graphic consisting of several overlapping, wavy lines in shades of blue and green. The lines flow from the left side towards the right, creating a sense of movement and depth. The colors transition from a deep blue on the left to a vibrant green on the right, with some lines appearing more translucent than others.

Safe use of machines on ships

Last updated: 5 October 2017

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What this guide contains

Crew on ships get seriously injured and even killed working with machines.

This guide provides general advice on safe machine set-up, safe operating procedures and safe machine maintenance. Together these form the 'safe machine triangle'. The advice is general because a guide like this cannot address all risks and hazards for all of the different machines on New Zealand ships. People using this guide will still need to do their own assessment of the particular risks that machines pose in their operation.

The checklists summarise the guidance, and are designed to be used as a tool for operators and workers when buying, operating and maintaining machinery. Users of the guide should add to or delete items from the checklists to suit their particular operation.

Legislation

Maritime operators have duties under both the Maritime Rules (the Rules) and the Health and Safety at Work Act 2015 (HSWA). Sometimes these requirements can overlap.

Maritime Rules

The requirements of the Rules can depend on the type of vessel and type of machine involved.

Rules Part 40D.67 sets specific requirements for winches and other lifting equipment on fishing ships.

Rules Part 49 sets specific requirements for lifting appliances on other ships (i.e. that are not fishing ships). Both Rules include the requirement to have lifting appliances and associated gear periodically checked by a competent person.

Most commercial maritime operations have a maritime operator safety system under Rules Part 19 (MOSS). Under MOSS lifting appliances and associated gear must be fit for its intended use and operating limits and meet all applicable maritime rules.

Health and Safety at Work Act 2015 (HSWA)

HSWA contains a number of requirements that a person conducting a business or undertaking (PCBU) must meet.

PCBU duties in regard to machinery include a general duty (so far as is reasonably practicable) to eliminate or minimise all risks, ensure the health and safety of workers, ensure that machinery provided by the PCBU is safe, and ensure that workers are trained and supervised. A maritime operator is a PCBU.

Maritime operators need to:







- identify machinery hazards in their operation
- assess the risks posed by machine hazards (i.e. how severe the harm could be and how likely an accident is to occur)
- manage those risks by applying the best practicable control measures to eliminate the risks, or (if this is not practicable) minimise the risks
- give workers information about machines and their hazards
- train workers to safely use and maintain machinery
- supervise workers when they are using and maintaining machines.

1. Safe machine set-up – hazards

The first part of the ‘safe machine triangle’ is eliminating or minimising machine hazards. Machine hazards are found where:

- energy is moving from the motor to the part of the machine doing the work – for example by pulleys, chains, sprockets, gears, shafts, belts
- the machine is doing work – for example by hauling, lifting, feeding, stripping and cutting.

Common machine hazards to be aware of

Getting trapped and crushed between moving parts	<p>For example</p> <ul style="list-style-type: none"> • line hauler jockey wheels, winch capstans or any machine that pulls or winds rope • any type of nip, running belt, notched intermittent feed device or moving weight. 	
Being cut or grazed by machinery	For example an abrasive wheel.	
Being hit by or getting caught in a machine	For example revolving shaft or spindle such as a transfer auger or winch drum.	
Being hit, cut or wounded by material thrown out of a machine when it is operating or if it breaks	<p>For example:</p> <ul style="list-style-type: none"> • breakage of a high-speed cutting tool • swarf generation • gripper or clamp failure 	
Being burnt by hot machinery	<p>For example:</p> <ul style="list-style-type: none"> • hot engines • ovens, fryers. 	
Machinery, or piping systems that suddenly start up or release stored energy (hazardous energy)	<p>For example:</p> <ul style="list-style-type: none"> • springs or wires under tension • pneumatic or hydraulic pressure • parts that could rotate • parts that could descend, slide or fall. 	
Noise	Hearing loss due to sustained exposure to loud noise.	

What to look for in a safe machine

Location

- Where possible the machine should be set up away from other work-stations so that other workers are not exposed to risk.
- The machine operator should be able to see what is going on in the workplace.
- The area should be well lit so the operator can see what they are doing.

Design

- Machines should be stable - usually this means fixed to the deck or structure.
- The machine should not be able to move unexpectedly after being switched off or suddenly start and injure people (hazardous energy).
- It should be possible to disengage the machine and rescue a person who gets trapped.
- It should not be possible to restart the machine after a stoppage by resetting a device such as an interlock guard or trip bar.
- It should be possible to clean and maintain the machine safely. Interlock guards are ideal.

Controls

- Controls should be located away from the danger area and be easily reached by workers.
- Controls should be easy to see and clearly labelled to show what they do.
- Start buttons and pedals should have shrouds or other devices to prevent the machine being started by accident.
- The emergency stop function (such as a mushroom-head push button, bar or foot pedals) should override all other functions. It should be installed in addition to and not instead of other safety measures.

Where practicable, the machine should have a 'dead man' switch. When the operator lets go of the controls or leaves the area with the machine running the dead man or 'return to neutral lever' stops the machine or disconnects the power.

Controls should be tamper proof. Use routine checks to make sure controls haven't been tampered with or pinned or locked in the 'on' position (refer to 'Safe Operating Procedures' later in this guide).

Depending on the machine, it should have a lock and/or warning tag that must be removed before use. These measures are known as 'lock out/tag out'. Lock-out is one way to control hazardous energy, by physically locking the machine in a safe mode.

Tag-out is normally used when lockout is required. A label is attached to the machine stating why it has been tagged (e.g. repair, maintenance), when it was tagged, and the name of the authorised person who attached the tag. Only an authorised person is allowed to remove the tag.

Lock-out and tag-out processes should be set out in a safe operating procedure (SOP).

Signs / labels / warnings

Signs, labels and warnings should:

- be located where workers can easily see them (i.e. in the workers' field of vision)
- use bright and contrasting colours so they are easy to see
- be clear and easy to understand.

Where practicable, use international signage. This helps where language is a barrier.

If a sound is used (e.g. a beep, bell, whistle or siren) it should be easy to recognise and loud without being painful.

Guards

Moving parts of machines should have guards on all sides (i.e. be completely enclosed).

Machine guarding

Guarding is a common method of reducing machinery risk.

Guards should completely restrict access to moving parts - many workers are injured on partially guarded machines.

The guard should prevent an operator from reaching:

- into the machine
- upwards into a hazard, or
- over, under, around or along the guard.

Mesh size should be small enough to restrict access to moving parts. Refer to the 'Safe mesh guard openings and distances' chart later in this guide.

Some typical guards are described below.

Fixed guard

The safest way to enclose the dangerous parts of a machine is to install a guard secured with (for example) screws or nuts and bolts. A fixed guard is usually preferable to all other types of guard because it is simple and permanent.

A fixed guard should be:

- constructed to prevent anyone from reaching the dangerous parts
- a permanent part of the machine
- fastened securely so that tools are needed to remove it
- simple – so that it doesn't rely on other things to work
- made from sturdy material.

Interlocked guard

If fixed guards are not practicable, look for an interlock system. This means the machine cannot start until the guard is closed; and the guard cannot be opened when the machine is moving.

An interlock guard has these key features:

- the tripping mechanism and/or power automatically shut off or disengage when the guard is opened or removed
- the machine cannot be started until the guard is back in place
- the machine must be set up so that it does not automatically restart when the guard is closed after being opened
- the machine requires planned maintenance and checks so that it does not fail or get tampered with.

Adjustable guard

- allows flexibility – the machine can work with objects of different sizes
- should be used with safe operating procedures to ensure that the guard is always adjusted safely.

Self-adjusting guard

- the openings of these guards are determined by the movement of the object being worked on
- the guard is pushed away as the object moves into the danger area, so the opening is only large enough to admit the object
- the guard returns to the rest position after the object is removed.

Trip guard

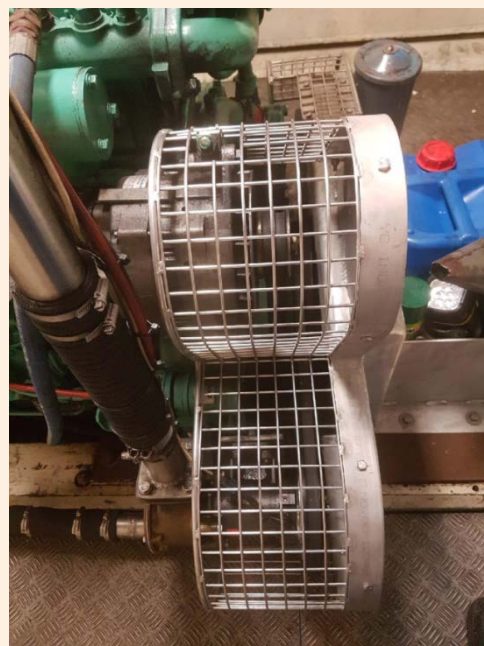
- Designed to shut down a machine or prevent it from starting if a person reaches into the machine.

Example – guarding the power take-off

The main motor has a power take-off that drives other machines on the vessel.

The operator (PCBU) asks the local engineering firm to make a guard to cover the drive pulleys and belt.

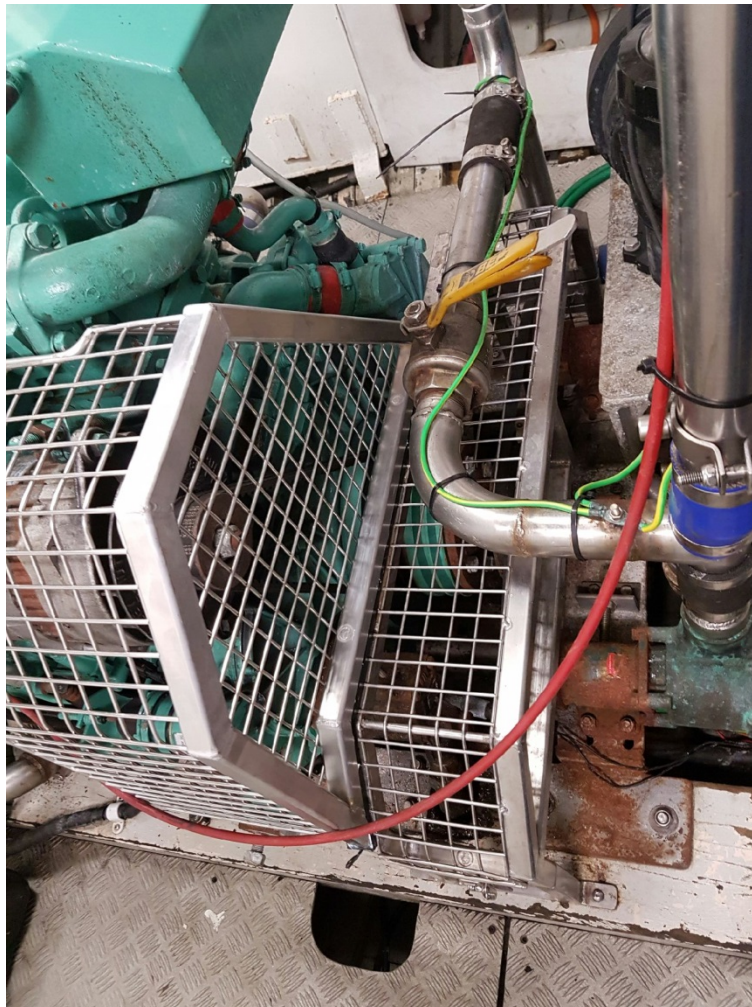
The guard is strong (steel frame and mesh), fixed in place, and the mesh size is small enough to stop a hand or finger accidentally getting caught by moving parts (see page 8).



Other controls

The controls below should be supported by safe operating procedures to ensure that they provide good protection.

Safe by position	The dangerous parts of the machine are made inaccessible.
Two-handed controls	A device that requires both hands to be on the controls before the machine will operate.
Pressure sensitive mats	Anyone accessing a dangerous part of a machine has to stand on a pressure-sensitive mat that disconnects the machine's power source, preventing it from running or starting.
Locked guards and gates	Used when other alternatives are not available. Isolate by fencing off machinery and locking the gate.
Adjustable guards	A fixed guard with an adjustable element that can be positioned to suit each operation.



Safe mesh guard openings and distances



Construct wire mesh barriers and guards so that crew cannot reach through and touch moving parts.

The chart below provides gives safe distances between a slot, square or circle and the moving part. The larger the opening, the further away the moving part needs to be.

Opening in guard - mm	Safe distances from openings in guards – mm		
	Slot	Square	circle
6	25	25	25
13	50	50	50
15	100	100	100
20	140	100	100
25	190	100	100
30	240	100	100
38	320	100	100
39	330	330	152
40	340	340	152
45	390	390	152
50	440	440	152
55	490	490	490
60	540	540	540
75	690	690	690
81	750	750	750
82	840	840	840
100	840	840	840
125	840	840	840
150	840	840	840
152	840	840	840
155	Reasonable reach over barriers		

Source: Ergonomics of machine guarding guide. Courtesy of WorkSafe New Zealand

2. Safe operating procedures (SOPs)

Safe Operating Procedures (SOPs) form the second part of the 'safe machine triangle', by describing how to use the machines on board safely. SOPs are used when risks cannot be minimised in other ways (e.g. by substitution or isolation) and some risk remains.

The operator should work with the master and crew to identify machine hazards on the ship and develop SOPs.

SOPs should be reviewed periodically to make sure they are still working effectively.

How to develop SOPs

- Look carefully at a task and identify the hazards involved.
- Assess the risks (How likely is it that the hazard will hurt someone? If they are hurt, how badly will they be hurt?)
- Identify and apply controls to minimise the risk (eg by doing the task a different way or isolating the task from other parts of the workplace).
- Consider the risk that remains after the controls have been applied.
- Identify administrative controls to minimise the remaining risk.
- Set a date to review the procedure.

Example – operating the winch

The operator (PCBU) has controls in place to manage the gear. These include an emergency stop button, winch drum brake, automatic guide-on gear, guards on the side of the winch, and a non-slip working surface on the deck.

The operator, master and crew meet to talk about what other steps they can take to reduce the risk. They decide on the following safe operating procedures:

- daily checks of the winch controls, wire rope, rigging blocks and swivels, and the working area surface
- daily greasing of the winch gear and rigging blocks
- monthly thorough check of the wire rope for defects
- every two years a competent person will check the winch and working gear
- working area surface kept tidy at all times and cleaned daily
- a dedicated crew member will operate the winch. They won't do other duties while they are operating the winch
- everyone will use agreed hand signals when the winch is being used
- while the winch is being used all crew working nearby will keep to a safe working zone
- everyone will wear gloves, safety shoes and a hard hat when the winch is being used
- they will review the procedures in 18 months or sooner if the procedures are not working

Training

Always train workers before they use a machine. Supervise workers who are not experienced.

Training should cover:

- the things about the machine that are dangerous (hazards)
- SOPs, including the safe use of guards, isolation, and lockout procedures
- procedures for cleaning, maintenance and repairs
- the roles each crew member has.

Use pictures, diagrams, and straightforward language to train workers. Ask workers who have been trained to show you what they have been taught – this will make it clear whether they understand their training.

Training should be reviewed when parts of the equipment are changed or if the present training is not working.

SOPs and the Maritime Transport Operator Plan

Most commercial maritime operations operate under MOSS, which is the maritime operator safety system introduced under Rules Part 19.

Commercial maritime operators in MOSS must have a Maritime Transport Operator Plan (MTOPlan) that details how they manage the safety of the operation. Rules Part 19 requires operators to include SOPs in their plan. If an SOP is updated after a review, the Rule requires the MTOPlan to be updated as well.



Examples of where a safe operating procedure might be required

Procedure	Things a procedure might cover
Routine checks before using the machine	<ul style="list-style-type: none"> • Checking that the machine is well maintained and working properly. • Checking that the safety measures are in place – guards, isolators, locking mechanisms, emergency off switches etc.
Routine safe practice around the machine	<ul style="list-style-type: none"> • Always standing clear of rigging blocks when the wire passing through them is under a load. • Always standing in a designated safe zone when fishing trawl gear is being payed out or hauled in. • Always standing clear in a specified or marked safety zone when the ship's crane is operating. • Never overloading the machine. • Always using jigs, holders, push sticks where the guard does not provide full protection.
Dress / personal grooming when using a machine	<ul style="list-style-type: none"> • Always wearing the right PPE e.g. gloves, hard hat, hearing protection and safety boots. • Making sure that PPE fits properly – not too loose or too tight. • Not wearing loose clothing or things that could get caught up in moving parts – e.g. dangling straps. • Tying up long hair or wearing a cap.
Operating the machine	<ul style="list-style-type: none"> • Always using a dedicated person to operate the machine. • The person operating the machine always stays at the controls while it is running. • Fellow workers avoid distracting the person operating the machine while it is running. • Everyone knows what to do if something goes wrong.
Hazardous energy controls (Lock-Out/Tag-Out)	<ul style="list-style-type: none"> • Machinery or moving parts that may unexpectedly start-up and injure workers are de-energised and locked out or tagged out. • Workers are trained to use the procedures.
Faults and maintenance	<ul style="list-style-type: none"> • Workers who operate machines identify and report faults and issues. • Machine faults and problems are logged. • The fault log is routinely checked and any problems addressed.

3. Machine maintenance

The third part of the 'safe machine triangle' is good machine maintenance. This is about keeping machines running safely and clearing, cleaning and doing repairs and maintenance in a safe way.

Risks

Unreliable or faulty machines can injure or kill when they suddenly break or stop.

Workers are more likely to take risks when the machine is not running well.

Workers doing maintenance, clearing blockages and cleaning can be injured or killed if the machine they are working on moves or starts unexpectedly.

See examples below.

Recommendations

Effective maintenance reduces risk because faults are identified and fixed at an early stage. Workers are not tempted to take risks when the machine is running well.

Have procedures in place so that the crew can report damaged or faulty equipment. Make equipment checks part of the daily routine.

Identify the hazards that could be present when maintenance is being done. Think about the risks these hazards pose and develop SOPs to manage the risks involved.

Include these procedures in the MTOP.

Real machine accidents

- **Winch guide-on gear not working properly.** While the winch is running a worker uses a bar to re-align the wire cable. The bar is snagged between the cable and the winch drum, moves rapidly like a scissor and cuts off the workers fingers.
- **Fish mincing machine jams.** While the machine is running a worker inserts a metal tray rod into the machine to try and clear the blockage. The machine grabbed and pulled the metal rod in a scissoring action that cut off the workers two middle fingers at the middle knuckles.
- **Worker cleaning out a mussel declumper.** The machine was normally disabled while it was being cleaned, but on this occasion the power source wasn't isolated. As the worker reached in to remove debris, he inadvertently pushed down on the control lever. The machine started rotating and severely injured his arm.

Other guidance available

Guidance on the safe use of particular types of machines is available. For example, the advice in crane-specific guidelines can be applied to the maritime sector because the principles of safe crane operation are essentially the same everywhere.

General guidance on the safe use of machinery is also available on the WorkSafe New Zealand website, including the 'Safe Use of Machinery. Best Practice Guideline' and the 'Ergonomics of Machine Guarding'. These and other guides are excellent resources, although they are not maritime-specific.

Standards in the series 'AS/NZS 4024 Safety of Machinery' are described by WorkSafe New Zealand as providing the current state of knowledge for the safeguarding of machinery and plant. These Standards are quite technical in nature, but should be regarded as the benchmark by designers, manufacturers and consultants.

Detailed information on the safe use of a specific machine should be provided by the manufacturer or supplier of that machine.

Safe machine checklist

Safe machine check	NA	✓	X
Is the machine located so that other workers are not exposed to risk?			
Does the worker at the controls have a view of the work area?			
Is there enough light for the machine operator and crew to see what they are doing?			
Is the machine stable / fixed down?			
Is the machine designed so that that it doesn't store 'hazardous energy' after being switched off?			
Can the machine be disengaged to free people who get trapped?			
Are controls in a safe place? Are the controls at a safe distance from the danger area? Can workers easily reach the controls?			
Are controls visible and clearly labelled to show what they do?			
Are controls protected so that they can't be activated by accident?			
Do the controls have a lock-out/tag-out facility?			
Is there an emergency stop function? <ul style="list-style-type: none"> • Is it easy to reach and activate? • Does it override all other functions? 			
Is there a 'dead man' switch?			
Are the controls tamper-proof?			
Are signs / labels / warnings: <ul style="list-style-type: none"> • located where they can be easily seen i.e. in the field of vision? • visible - suitable brightness and colour contrast? • easily understood: Acoustic signals should be easily recognisable and loud without being painful? 			
Does the guard completely enclose the moving part by guarding it on all sides?			
Are fixed guards secured with (for example) screws or nuts and bolts?			
For interlock guards: <ul style="list-style-type: none"> • Is the machine prevented from starting when the guard is open? • Is the guard prevented from opening when the machine is moving? 			
Is the guard mesh size small enough to restrict access to moving parts?			
Does the guard prevent an operator from reaching upwards into a hazard; into the machine; or over, around or along the guard?			
Is the guard designed to allow the machine to be cleaned and maintained safely?			

Machine maintenance checklist

Machine maintenance - safe operating procedures	NA	✓	X
Is the area around the machine safe to work in for the person doing maintenance?			
Do other workers nearby know that maintenance work is being done?			
Is the machine disconnected from the power supply, locked off and isolated from pipelines containing pressured fluid, gas, steam or hazardous material?			
Has the machine stopped moving?			
Has stored energy (e.g. compressed air, hydraulic pressure, wires under tension) been released?			
Have parts of the machine that could fall been supported?			
Have hot components been given time to cool?			
Are the manufacturer's maintenance instructions (if there are any) being followed?			
Does the person doing maintenance have the skills, knowledge and experience to work safely?			
Do maintenance workers have the right equipment (including PPE)?			

Winch, tackle and hoisting gear checklist

Winch, tackle and hoisting gear machinery check	NA	✓	X
Have winches, tackle and hoisting gear been properly installed and are they suitable for the way that the vessel is being used?			
Has a competent person certified that hoisting gear is suitable for the load being lifted?			
Does the hauling and hoisting gear have appropriate safety devices for emergencies, including emergency stop facilities?			
Have shields, barriers or guards been installed to minimise contact with bare ropes, warps and moving parts?			
Are winches guarded (where possible)?			
Are controls located in an area large enough for the operator to work in unhindered?			
Does the machinery operator have a clear view of the equipment and any crew member working near it (either by direct line-of-sight or by a suitable device)?			
Does the deck around the winch operation area have a non-slip surface and provide solid footing for the person working the winch?			

Winch, tackle and hoisting gear safe operating checklist

Winch, tackle and hoisting gear - safe operating procedures	NA	✓	X
Has the hauling and hoisting gear been inspected at regular intervals?			
Is the hauling and hoisting gear well maintained and in good working order?			
Have brakes, levers and safety devices been regularly checked and confirmed as being operational?			
Is the deck around the winch operation area clean, tidy and free of obstructions?			
Has the crew been trained to operate the machinery safely? Includes: <ul style="list-style-type: none"> • how to work around the winch safely • the effect on stability when winching in heavy seas or when gear is fast on the bottom • where to stand safely • being aware of where the wires or ropes are • using hand signals. 			
Does a dedicated crew member always operate the machinery?			
Is the operator <u>only</u> operating the machine (ie and not doing other tasks) while they operate the machine?			
Is a reliable communications system being used between the wheelhouse and the working deck?			
Capstans and surge drums <ul style="list-style-type: none"> • Is the rope 'flaked out' and clear of the working area before being worked onto the drum end?* • Is slack being taken up before taking the required number of turns around the drum end? ** • Is excessive surging on the drum end being avoided? • Do joins and splices have neat and tidy ends? *** 			

* The rope is laid out in a way that avoids causing tangles.

** This is to avoid riding turns on the drum. There should be no more than three turns around the drum end.

*** This avoids 'overwind'. A loose tussle end that gets trapped under the next turn.

Lifting appliance checklist passenger / non-passenger vessels

Lifting appliance in passenger / non-passenger vessels and fishing vessels if the appliance is used to lift general cargo	NA	✓	X
Was the appliance and loose cargo gear tested by a competent person before it was brought into service or after it has undergone any substantial repairs?			
Has the appliance and loose cargo gear been examined by a competent person at least every 12 months?			
Does the appliance and loose cargo gear have a valid certificate of test?			
Is the appliance and loose cargo gear permanently and clearly marked with its safe working load for each operating condition?			
Does the operation have a register of the lifting appliances and loose cargo gear it uses?			
For a ship fitted with a derrick or crane, is there a detailed rigging plan on board?			
Is the appliance covered in the maintenance plan? Is the maintenance plan being followed?			
Has a risk assessment been done? Is the risk assessment periodically reviewed?			
Have SOPs been developed for the use of the appliance? Are the SOPs being followed?			
Are workers aware of the risks of standing or working in the path of travel of the appliance or a load? For example: <ul style="list-style-type: none"> • Being crushed between the appliance and the ship or the load and the ship • Being struck by the appliance or a load • Being hit by a load that falls 			

Lifting appliance checklist for fishing vessels

Lifting appliance in fishing vessels where the appliance is used to handle and discharge the fish catch of that ship	NA	✓	X
Was the appliance and associated working gear tested by a competent person before it was brought into service or after it has undergone any substantial repairs?			
Is the appliance and associated working gear permanently and clearly marked with its safe working load for each operating condition?			
Is the appliance and associated working gear being maintained in good order?			
Is the appliance covered in the maintenance plan? Is the maintenance plan being followed?			
Has a risk assessment been done? Is the risk assessment periodically reviewed?			
Have SOPs been developed for the use of the appliance? Are the SOPs being followed?			
Are workers aware of the risks of standing or working in the path of travel of the appliance or a load? For example: <ul style="list-style-type: none"> • Being crushed between the appliance and the ship or the load and the ship • Being struck by the appliance or a load • Being hit by a load that falls 			