OCIMF

Safety Critical Equipment and Spare Parts Guidance

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OCIMF
OCIMF is a membership organisation that brings the maritime energy industry together around a shared commitment to safety. It was formed in 1970 following incidents, including Torrey Canyon in 1967, to address the need to better understand and manage maritime risk.

OCIMF's vision is: *A global marine industry that causes no harm to people or the environment.*

It promotes the safe and environmentally responsible transportation and handling of oil, petrochemicals, gas and emerging fuels, and expects the same standard in related offshore marine operations.

OCIMF is *United in purpose, to drive maritime safety in the energy sector* and works with its members and industry partners to manage today's operational hazards while helping industry prepare for emerging risks and future threats.

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Introduction

Safety critical equipment is an individual piece of equipment, a control system or an individual protection device which, in the event of a single point failure, may result in a hazardous situation, cause an accident or change the status of duplicated equipment and reduce the system redundancy. Safety critical spare parts are those components associated with the maintenance and repair of safety critical equipment.

The purpose of this information paper is to provide guidance on safety critical equipment and associated spare parts for companies to consider when preparing a Safety Management System (SMS) in alignment with the IMO's International Safety Management (ISM) Code. This paper outlines a proactive risk-based approach to identify, document, and maintain safety critical equipment and associated safety critical spare parts.

1.1 Scope

The ISM Code applies to all ships greater than 500 GMT, including self-propelled Mobile Offshore Drilling Units (MODUs) and some offshore vessels. Additionally, flag states may choose to apply the ISM Code to other ship types and sizes. This paper highlights considerations for oil and chemical tankers, but it is equally applicable to companies managing any type of ship or floating structure.

The terms company, ship operator, and owner are often used interchangeably; in the context of this paper the term company is used, meaning the body whose SMS applies to the ship(s).

1.2 Key industry requirements and practices

This section explores current industry regulations, how they deal with safety critical equipment and associated spare parts and highlights the need for clarity when developing an SMS.

At a minimum, companies must develop an SMS that fulfils the requirements defined by the ISM Code. Section 1.2.2 of the ISM Code states that the safety management objectives of the company must assess all identified risks to its ships, personnel and the environment and establish appropriate safeguards. Further, section 8 of the ISM Code outlines requirements for onboard emergency preparedness. The identification of safety critical equipment and use of safety critical spare parts are key steps in meeting these requirements.

Section 10 of the ISM Code establishes minimum standards for the maintenance of the ship and equipment, including the requirement to identify equipment and technical systems of which the sudden operational failure may result in hazardous situations. While the code does not specifically state the terms 'critical' or 'safety critical', the industry generally accepts 'safety critical' as the term used to describe such equipment. Section 10 also prescribes an SMS that promotes reliability of the identified equipment through design, planned maintenance, inspection and testing.

The role of Classification Societies on spare parts has changed in recent years. Previous Class requirements for specific spares, based on International Association of Classification Societies (IACS) recommendations, have been replaced by guidance. It is important to note that the Class guidelines are generic and may not cover all risks.

OCIMF addresses risk management and hazard identification in the Management and Self Assessment (MSA) Guidance, Element 4: Vessel Reliability and Maintenance including Critical Equipment, with individual publications for Tanker Management and Self Assessment (TMSA) and Offshore Vessel Management and Self Assessment (OVMSA). The company should have a risk management strategy that is designed to identify potential hazards and exposures, manage operational risks relating to Health, Safety, Security and the Environment (HSSE), and comply with ISM requirements.

The ISM auditors, MSA reviewers, regulatory or class inspectors and OCIMF inspectors play a key role in ensuring that companies apply the appropriate procedures, but it is generally difficult for an auditor to assess if a company considers safety critical equipment at the right level of detail. What they can assess is the company's consistent application of appropriate procedures in line with the ISM code and industry best practices.

Simply following existing industry codes and practices may not address all risks. Following an incident, legal challenges may arise where it is alleged that the absence of appropriate onboard spares contributed to the incident or impaired the ship's ability to respond effectively. Companies may wish to seek legal advice on this matter, which can be fed into their strategy for maintaining safety critical equipment and application of safety critical spare parts.

2
Defining safety critical spare parts

This section proposes some definitions and boundary limits to consider when evaluating the need for, and effectiveness of, safety critical spare parts.

2.1 Single point failures

A single point failure is any single component failure that could lead to a hazardous situation or an accident. The risk of single point failures exists because of generally predictable acts or events such as the inherent ship design, incorrect installation, lack of planned maintenance, or mis-operation. They may also occur due to unpredictable failures resulting from inherent manufacturing defects.

A single point failure may cause immediate risk of major accident or put the ship at risk of experiencing a direct accident such as a grounding, collision or allision.

Before a company can start to identify safety critical equipment and assess the need for the carriage of safety critical spare parts, they need to understand and document which single point failures may occur. This allows the criticality of each failure to be assessed at a later stage during the hazard identification and risk assessment process. Recognising that risk assessments rely on available knowledge, experience and operational context, the company should consider all systems, sub-systems, equipment and components which, in the event of a single point failure, could lead to a hazardous situation.

Many of the high-level decisions on risk management are made for companies by industry trends and industry regulations (e.g. single main engines, redundancy in fire pumps or power generation). Therefore, an industry-standard ship design could be used as the basis for a single point failure analysis in most cases.

A suggested starting point is to refer to system single line diagrams as the basis for identifying single point failures.

The evaluation could be tabulated using a logic flowchart to identify the potential outcome of each single point failure. The company may develop a bespoke flowchart and worksheet to meet the needs of the business and incorporate it into the SMS. A simplified example is provided in appendix A.

2.2 Safety critical equipment and spare parts

Safety critical equipment is an individual piece of equipment, a control system, or an individual protection device which in the event of a single point failure may:

- Result in a hazardous situation which could lead to an accident.
- Directly cause an accident that results in harm to people or the environment.
- Change the status of duplicated equipment and reduce the system redundancy.

At the highest level, the company may consider loss of key ship safety critical functions, which may include (but are not limited to) the following:

- Propulsion.
- Steering.
- Dead-ship recovery.
- Bilge management.
- Power generation and distribution.
- Power management.
- Automatic, integrated control and monitoring.
- Gas detection, oil mist detection, temperature monitoring.
- Emergency Communication Key emergency response capability (including shutdown and firefighting).
- Life-saving appliances.
- Onboard loading computer and damaged stability computer.
- Cargo management (safety systems and for emergency response).
- Inert Gas (IG).
- Ballast management for emergency response.
- Navigation equipment.

Further levels of detail should be considered where the single line diagram for the system under consideration does not provide sufficient detail for the company to make an appropriate decision. If available, the company may refer to HAZID and HAZOP studies used during the ship design.

Safety critical spare parts are the spare components associated with the maintenance and repair of safety critical equipment.

3
Risk management strategy and Safety Management Systems

Hazardous situations are avoided by appropriate ship design and equipment, and the application of safe working practices, such as those required by SOLAS and the ISM Code. It is recommended that a proactive risk-based approach to the identification of safety critical equipment and carriage of safety critical spare parts is taken for the management of hazardous situations. Companies should apply this approach to both new-builds and to existing ships. This approach may need to be above and beyond minimum regulatory requirements.

3.1 Hazard identification and risk assessment

Key elements of an SMS that facilitate the identification and implementation of safety critical equipment and safety critical spare parts should be embedded in a company's risk management framework and include hazard identification and risk assessment. The identification of safety critical equipment and establishing the need for safety critical spare parts can only take place after a methodical hazard identification has been carried out.

High-potential situations which could cause harm to people and extensive damage to the environment should be specifically highlighted as part of this process. For example, this may include risks related to navigation, cargo handling systems, or any other high-potential risks as determined by the company.

The final output from the hazard identification and risk assessment process should demonstrate that each risk has been reduced to an acceptable level by applying appropriate control measures. Resulting design mitigations should be considered and added to the ship specification, or procedural mitigations incorporated into the SMS where it is not possible or reasonable to add a design mitigation.

In addition, a company should document which systems are deemed safety critical, and how these support risk mitigation. Following this, requirements around the maintenance of safety critical equipment should be defined, including provisions for safety critical spare parts (covering carriage, procurement, use, and inventory). Appendix A provides a simplified table for the identification of hazardous situations, associated critical systems or equipment, and potential mitigations or alternative controls.

The risk assessments for individual ships and company fleets should be reviewed and updated on a periodic basis. Reviews should also be undertaken if circumstances change in ways that could introduce new risks or elevate consequences; these may include:

- Changes to the company's operations.
- Company or operational experiences.
- Learnings from near miss or incident reporting.
- Change in ship trading patterns.
- OEM's service experience or availability.
- When new ships or classes of ships are brought into the fleet.
- When new equipment is added or replaces obsolete equipment.

3.2 Controls

The hierarchy of controls, a recommended order of priority for selecting preventative measures or controls, should be defined within the company's SMS and applied in the process of managing identified risks and, consequently, determining safety critical equipment and required safety critical spares.

In a situation where safety critical spare parts can reasonably be employed in a timely manner, failure may be tolerated for a limited period. This will require a proactive planned maintenance system and the development of safe operating procedures as an alternative or back-up to design controls.

Alternative controls allow a ship to operate in a degraded operational status, temporarily, when repairs to safety critical equipment cannot be affected in a limited period. Alternative controls should be risk assessed and documented. Contingency plans can be a form of alternative controls. Temporary repairs combined with alternative controls may allow the ship to continue operations and reach a safe port of refuge for permanent repairs.

4

Application of safety critical equipment within Safety Management Systems

Following the hazard identification and risk assessment process, safety critical systems should be identified, documented, and incorporated into the ship's SMS and further identified onboard in a documented maintenance strategy.

4.1 Identifying safety critical equipment

The identification of safety critical equipment and establishing the need for safety critical spare parts can only take place after a methodical hazard identification has been carried out. A multi-disciplinary team should carry out this work (e.g. including engineers, naval architects, electrical specialists, ship superintendents). The hazard identification and risk assessment process should strive to answer the following questions:

- Which hazardous situations may occur on the ship and trade under consideration?
- What could cause the situation to occur?
- What could cause the situation to escalate?
- What is the likelihood of the situation occurring?
- What are the potential consequences when a hazardous situation is not controlled?
  - Are the consequences tolerable in all operational scenarios?
  - If not, how can the situations be prevented from occurring?
  - If they cannot be prevented, how can they be managed?

The hazard identification and risk assessment process should also consider:

- The ship type.
- The ship operating profile/trade route for each type of ship.
- Operational procedures.
- The inherent ship design (system redundancy and segregation).
- Original Equipment Manufacturers (OEM) advice.
- Industry experience or fleet experience of equipment.
- Mean Time Between Failures (MTBF).
- Use of alternative fuels and/or new technologies.

4.2 Additional assessment considerations

4.2.1 Redundant or alternative equipment

Regulations for machinery installations under SOLAS Chapter II-1 stipulate minimum design and construction requirements, but also reliability of essential propulsion and auxiliaries. Individual classification societies implement statutory and supplementary requirements for relevant machinery and equipment through their own rules and regulations, including those relating to redundancy in case of single-failure, or alternative equivalent to redundant systems.

Redundant or evaluated and approved alternative equivalent equipment and systems allow for a single point of failure while maintaining operational readiness and may therefore serve as an effective means of risk mitigation.

Consideration should be given to ensuring that stand-by and alternative equipment always remains fit for purpose through regular inspection, maintenance, and testing.

4.2.2 Segregation of equipment

Physical and/or system segregation can be used to mitigate the risk of damage to safety critical equipment. If all equipment and supporting auxiliaries are in one space, and that space suffers from a major fire, explosion, or flood, equipment redundancy in that space is ineffective and safety critical spare parts may not be effective to reactively manage the incident.

For fully segregated systems, safety critical spare parts remain a key part of the planned maintenance process. The segregation of redundant critical units suggests an increased priority on immediate availability of the equipment.

4.2.3 Reliability-centred approach

A reliability-centred approach involves the strategic installation and maintenance of high reliability equipment for specific safety critical equipment (such as a single main engine) as part of the risk management process.

4.3 Process to identify critical spare parts within a piece of safety critical equipment

Following the identification of safety critical equipment and systems, evaluations can be completed to identify the specific spare parts that should be carried onboard to support the effective reliability of the equipment.

Evaluation of each piece of equipment and associated maintenance schedule will determine the appropriate components and quantities to be maintained in the ship inventory. Considerations of critical spare components may include (but are not limited to):

- Original Equipment Manufacturer (OEM) lists of recommended spares.
- Recommended spares listed on Type approval documentation.
- Duplicate or redundant equipment installed.
- Additional components to support multi-fuel installations.
- Relevant equipment service history and MTBF data.
- Spare PLC and electronic components (including appropriate software updates).
- Emission control/monitoring equipment that may prevent engine operation.
- Carriage of a complete spare unit for small or high criticality equipment.

For most large components (e.g. engine crankshaft, propeller, etc.) it is recognised that the company may not consider it reasonable for each ship to carry and employ spares. However, such decisions should be justified and documented through the hazard identification and risk assessment. Fleets may choose to maintain larger spare components in a centrally located shore-based warehouse.

4.4 Management of Change

Safety critical equipment and spare parts should be included in the company's Management of Change (MOC) procedures. Any changes to safety critical equipment or spare parts, including carriage, procurement, use or inventory, should be documented and supported by a new risk assessment to ensure there are no hazard escalations or additional hazards introduced by the change. Additionally, any changes to ship operating parameters (trading patterns, staffing management, procurement policies, etc.) should be assessed for impact to safety critical equipment and critical spares.

5

Application of safety critical equipment and spare parts onboard

To manage the risks associated with safety critical equipment, the inspection, testing and maintenance procedures for such equipment should be prioritised over all other maintenance. The procedures should include the use of safety critical spare parts in addition to materials and consumables required to execute a repair.

5.1 Practical application of safety critical spare parts

As unplanned maintenance may occur in deep sea with no other means of timely assistance available, it is recommended that an appropriate inventory of safety critical spare parts is always carried aboard the ship. However, it is recognised that there are limitations to the usefulness of safety critical spare parts in case of catastrophic failure events.

Safety critical spares that are carried on board can be used in two ways:

Proactively: Used on board during planned maintenance to ensure the reliability of the safety critical equipment to mitigate the occurrence of hazardous situations.

Reactively: Used on board during unplanned, corrective maintenance to repair damaged safety critical equipment to prevent a hazardous situation from escalating to a more serious uncontrolled incident.

In general, application of safety critical spare parts should help the ship's personnel to:

- Avoid premature failure of safety critical equipment by carrying out planned maintenance.
- Recover from the Safety of Life at Sea (SOLAS) dead-ship condition.
- Prevent a hazardous situation from escalating.
- Allow the ship wherever possible, to reach a safe port of refuge so permanent repairs can be carried out.

The ship's personnel should be able to deploy safety critical spare parts in a timely manner, taking into account operational conditions, workload, available tools, and crew competence to manage the immediate risks. The company should consider defining what they understand to be a timely manner (appropriate for the type of ships operated and the ship trade routes) as part of the risk management process.

There are cases when it may not be reasonable to expect the crew to be able to achieve the goals above by employing safety critical spare parts. For example:

- After catastrophic failure events where large pieces of equipment are damaged beyond repair (e.g. high energy failures that result in explosions, fires and flooding).
- After catastrophic failure events where extensive damage occurs to the ship infrastructure.
- During heavy weather or due to other conditions where it is not possible to affect a timely repair (this should not be assumed to be the base case for the safety critical spare parts policy).

The company should document a safety critical spare parts strategy, outlining the intent and limitations of their application. This may be generic for a fleet with specific requirements for a Class of ships or one on a particularly sensitive trade.

5.2 General considerations for Planned Maintenance Systems

Planned Maintenance Systems (PMS) are the part(s) of the company's SMS that address inspection, maintenance, testing, and repair of the ship. Specific provisions should be included in the PMS to enable ship's personnel to carry out safety critical equipment maintenance.

An effective PMS should have provisions specific to safety critical equipment including:

- Clear identification of the equipment within the PMS.
- Specific procedures for safety critical equipment and the use of safety critical spare parts.
- Prioritised inspection, maintenance and testing, over all other routine maintenance.
- Required risk assessments for all safety critical maintenance tasks.
- Inspection, maintenance and testing in accordance with manufacturer's recommendations and applicable legislation.
- Procedures defining minimum personnel competency, availability, experience, and training requirements for each task.
- Maintenance and documentation instructions for ship's personnel.
- Guidance for the use of specialist or OEM support (including remote diagnostics where applicable).
- Minimum inventory requirements for safety critical spare parts, consumables and materials.
- Guidance for ship's personnel on acceptable temporary repairs.
- Requirements ensuring correct tools, manuals and drawings are available on board.
- Procedures for reporting and addressing non-conformities
- Planned maintenance deferment protocols based on documented risk-assessments, including time limitations and additional HSSE controls to mitigate the risk.
- Planned maintenance deferment approval only by shore personnel for a finite period with repeat deferment requests being escalated to an appropriate higher level of shore management.

- Safety critical equipment failure investigations by subject matter experts and the OEM.
- Safety critical equipment failures are highlighted in the incident reporting system for high visibility to management.

5.3 Identification of safety critical equipment and critical spare parts within the Planned Maintenance System

The identification of safety critical equipment should be in an easy-to-understand format. A summary of all safety critical equipment should be available in a list or matrix format. In a computerised PMS, safety critical equipment and associated spare parts should be provided with computer-searchable tags. Information provided in the PMS could be as follows:

- Safety critical equipment reference number/code.
- Description of the safety critical equipment.
- Explanation of its function in the risk management strategy.
- Information on the principal equipment and components.
- Established minimum inventory quantities for identified critical spares.
- References to procedures and special instructions.

5.4 Materials management

The management of safety critical spare parts on board a ship needs to be carefully controlled to ensure that the spares are ready for use at any time. This includes inventory management, enabling materials and procurement controls that prioritise the replacement of consumed safety critical spare parts.

5.4.1 Inventory management

The ship should have any materials required to deploy the safety critical spare parts, including tools, drawings, manuals and materials, readily available at all times.

The company should proactively and as far as reasonably practicable, ensure that the onboard inventory of safety critical spare parts does not drop below the minimum-specified quantities at any time. However, it is understood that if safety critical spare parts are used for unplanned maintenance, there may be some periods when those spares are not carried on board while replacements are procured. Inventory management procedures should include, but are not limited to, the following:

- Periodic inspection and stock-checking of the safety critical spare parts inventory.
- Ensuring that the shelf-life of components is addressed.
- Addressing the preservation and safe storage of spares.
- Programming and update requirements for electronic spares.
- The potential obsolescence of spares.
- Lead times for inventory replenishment.

Electronic components such as programmable logic controllers (PLCs) may require firmware updates, where recommended by the manufacturer, on a periodic basis to ensure that they are ready for service at any time. It is recommended that the component supplier presents to the company an agreed plan on how requirements for software updates are communicated to the company and subsequently executed on board. Records of updates should be maintained.

The company should carefully consider the implications of lead time in their inventory management procedures, particularly when safety critical spare parts are used for unplanned maintenance. Some long lead time spares may need to be held centrally in a fleet store where dispatch to ships can be made promptly.

5.4.2 Additional safety critical spare parts consideration

The term ‘spare parts’ is usually understood to mean the physical components of a piece of equipment (or system). However, spare and perishable materials may also be needed and essential to enable the use of safety critical spare parts in the event of a material failure or the return to service of the equipment being maintained.

Additional materials may include, but are not limited to, the following:

- Lube oils.
- Plates.
- Pipes.
- Blanks.
- Plugs.
- Clamps, nuts, bolts.
- Fillers, welding consumables.
- Gasket materials.
- Sealants, epoxies, resins, etc.

The company should ensure that an inventory of such items is maintained onboard.

5.4.3 Temporary repair materials

Temporary repair materials may be identified during the hazard assessment and carried as part of a ship’s inventory for emergency situations.

Temporary repair materials should not be carried with the intention of making repairs instead of employing appropriate safety critical spare parts, when the parts are readily available, or in place of systems redundancy.

The company may wish to develop guidance on what type of temporary repairs are permitted.

5.4.4 Procurement and quality control

The company should follow a clearly defined policy for the procurement of safety critical spare parts to ensure that appropriate, safety critical spare parts of a verifiable quality are procured. The policy should clearly state requirements for the use of OEM safety critical spare parts, OEM-licensed spare parts and after-market spare parts, where applicable.

The need for and procurement of safety critical spare parts should be addressed in all new-build spares inventories.

5.5 Vendor support

As modern ships increasingly rely upon automation, many systems are operated by proprietary control systems which the ship's personnel cannot interrogate or repair. The need for remote diagnosis and repair of electronic systems is increasing. A vendor support/emergency response contract may be needed as part of the safety critical equipment planned and unplanned maintenance strategy. Consideration should be given to the company's cyber risk management procedures, which may restrict or prevent ship-to-vendor connectivity.

Remote support should only be a back-up to appropriate ship design and operational procedures, including the use of physical spares. Remote assistance may not always be available for technical reasons. This highlights the importance of the reliability of the broadband communication systems on ships where remote support may be of benefit and part of the operational strategy.

6 Additional equipment and spares considerations

This section offers guidance on the use of additional spare part categories companies may wish to consider when looking more broadly at the overall classification of equipment and spare parts within their organisation and PMS.

6.1 Equipment that may not meet ISM 10.3 criteria

Although this document considers safety critical equipment and spare parts, companies should establish procedures to ensure that all equipment and systems onboard comply with relevant rules and regulations. Companies may choose to consider including systems beyond the scope of ISM 10.3 within their SMS and identifying them separately within their PMS.

During the risk assessment, where equipment is identified as safety critical in addition to business and/or environmentally essential (see sections 6.2 and 6.3), the inspection, maintenance, and testing protocols should default to the designation of safety critical.

6.2 Definition and considerations for business essential equipment and spare parts

Business essential equipment and business essential spare parts refers to the equipment and spare parts carried to ensure ship reliability from a business delivery perspective.

The process for considering business essential equipment and business essential spare parts may be common with the process of defining safety critical equipment and safety critical spare parts. In the case of business essential equipment failure, the risks would be recorded as business risks, rather than safety risks.

Examples of business essential equipment may include (but are not limited to) the following:

- Cargo hose handling cranes.
- Cargo pumps.
- Cargo transfer equipment.
- Cargo heating equipment.
- Oil Detection and Monitoring Equipment (ODME).
- Stripping pumps.
- Tank cleaning equipment.

6.3 Definition and considerations for environmentally essential equipment and spare parts

Environmentally essential equipment and spare sparts refers to equipment and spare parts carried to ensure the ship remains in compliance with relevant environmental regulations.

The process for considering environmentally essential equipment and environmentally essential spare parts may be common with the process of defining safety critical equipment and safety critical spare parts. In the case of environmentally essential equipment failure, the risks would be recorded as environmental risks.

Examples of environmentally essential equipment may include (but are not limited to) the following:

- Oily water separator and monitor.
- Ballast water treatment system.
- Incinerators.
- Selective Catalytic Reduction Units (SCRUs).
- Exhaust gas scrubbers.
- Carbon Capture and Storage (CCS) systems.
- Stern tube seals.
- Emissions monitoring equipment.

7 Conclusion

The identification of safety critical equipment and the need for safety critical spare parts to be made available to those onboard is self-explanatory. It is, however, acknowledged that it is a complicated subject, can be subjective and there is no one-size-fits-all solution. Use of this guidance in conjunction with completion of the risk assessment process should provide clarity when meeting ISM requirements.

Appendix A

Considerations for identification of hazardous situations

Hazardous situation	Potential accident	Consequences	Associated system failure (main and auxiliary)	Mitigation/system redundancy	Alternative controls
Loss of power	Collision, allision, grounding, explosion, fire, flood	Harm to the environment Harm to people	Generator engines	Multiple Diesel Generator Engines (DGEs), emergency DGE	Use fully redundant DGE
			Generators	Multiple gensets, emergency genset	Use fully redundant DGE
			Switchboards	Split switchboards	Degraded operation
			Fuel supply system	Yes – multiple systems	Heavy Fuel Oil (HFO) and Marine Gas Oil (MGO) fuel systems
			Power management system	Yes – full redundancy	Use redundant power management system
			Engine Control System	Yes – full redundancy	Use redundant Engine Control System
Loss of propulsion	Collision, allision, grounding, explosion, fire, flood	Harm to the environment Harm to people	Main propulsion system	Single point failure	Third-party intervention
			Fuel supply system	Yes – multiple systems	Spares/use alternative fuel systems
			Power management system	Yes – full redundancy	Spares/remote diagnostics
			Engine Control System	Yes – full redundancy	Spares/manual, local control
			Start air system	Partial system redundancy	Spares
			Stern tube cooling/lubrication	Single point failure	Spares/third-party intervention
Loss of steering	Collision, allision, grounding, explosion, fire, flood	Harm to the environment Harm to people	Steering gear	Single point failure	Third-party intervention
			Hydraulic system	Yes – redundant pumps	Spare hydraulic pumps
			Helm/autopilot	Yes – redundant control	Local manual control
Loss of Inert Gas (IG) system	Explosion	Harm to the environment Harm to people	Fuel supply system	Partial redundancy	Yes
			IG generator (boiler)	Partial redundancy (boilers)	Degraded capacity (IG generator)
			IG supply system	Partial redundancy	None
			IG control system	Single point failure	Spares/remote diagnostics
Loss of gas monitoring system	Explosion Suffocation	Harm to the environment Harm to people	Fixed gas monitoring and alarm system	Partial redundancy	Spares/portable gas monitoring
Failure of cargo/ ballasting monitoring equipment	Loss of containment	Harm to the environment Harm to people	Level alarms	Safety policies	Manual observations
			Gas detectors	Safety policies	Manual observations
Loss of mooring	Collision, allision	Harm to the environment Harm to people Harm to infrastructure	Mooring equipment	Equipment redundancy	Spares

Glossary

Best practice
OCIMF views this as a method of working or procedure to aspire to as part of continuous improvement.

Business essential equipment/spare parts
The equipment and spare parts carried to ensure ship reliability from a business delivery perspective.

Company
The owner of the ship, or any other organisation such as a ship manager or bareboat charterer that has assumed responsibility for the operation of the ship from the owner of the ship, including the duties and responsibilities imposed by the International Safety Management (ISM) Code. May also be referred to as operator.

Environmentally essential equipment/spare parts
Equipment and spare parts carried to ensure ship reliability from an environmental compliance perspective.

Guidance
Provision of advice or information by OCIMF.

Hazard
A source or a situation with the potential to cause harm, including human injury or ill health, damage to property, damage to the environment, or a combination of these.

Hazard Identification Study (HAZID)
A structured, team-based approach to identify hazards, their potential consequences, and requirements for risk reduction.

Hazard and Operability Study (HAZOP)
A structured, team-based approach to investigate how a system or plant in operation deviates from the design intent and creates risk for personnel and equipment and results in operability issues.

Management of Change
The process of bringing controlled and planned change, either temporary or permanent, to operations, procedures, equipment or personnel to meet a defined goal.

Planned Maintenance System
The part(s) of the company's SMS that address inspection, maintenance, testing and repair of the ship.

Risk management
The process of identifying hazards, assessing risk, taking action to eliminate or reduce risk, and monitoring and reviewing results.

Risk management strategy
Company's structured approach to risk management.

Safety Critical Equipment
An individual piece of equipment, a control system or an individual protection device which in the event of a single point failure may:

- Result in a hazardous situation which could lead to an accident,
- Directly cause an accident that results in harm to people or the environment, or
- Change the status of duplicated equipment and reduce the system redundancy.

Safety critical spare parts
The spare components associated with the maintenance and repair of safety critical equipment.

Safety Management System
A formal, documented system required by the ISM Code, compliance with which should ensure that all operations and activities on board a ship are carried out in a safe manner.

Single point failures
A single point failure is any single component failure that could lead to a hazardous situation or an accident.

Abbreviations

CCS	Carbon Capture and Storage
DGE	Diesel Generator Engine
GMT	Gross Metric Tonnes
HAZID	Hazard Identification
HAZOP	Hazard and Operability
HFO	Heavy Fuel Oil
HSSE	Health Safety Security and Environment
IACS	International Association of Classification Societies
IG	Inert Gas
IMO	International Maritime Organization
ISM	International Safety Management Code
MGO	Marine Gas Oil
MOC	Management of Change
MODU	Mobile Offshore Drilling Unit
MSA	Management and Self Assessment
MTBF	Mean Time Between Failures
ODME	Oil Detection and Monitoring Equipment
OEM	Original Equipment Manufacturer
OVMSA	Offshore Vessel Management and Self-Assessment
PLC	Programmable Logic Controllers
PMS	Planned Maintenance System
SCRU	Selective Catalytic Reduction Unit
SMS	Safety Management System
SOLAS	International Convention for the Safety of Life at Sea
TMSA	Tanker Management and Self-Assessment

Bibliography

International Safety Management (ISM) Code (IMO)
Offshore Vessel Management and Self Assessment (OVMSA) (OCIMF)
Tanker Management and Self Assessment (TMSA) (OCIMF)

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