

ISM Risk Management

Introduction

Although it is not often referred to as such, the development and implementation of a documented safety management system is an exercise in risk management. The drafting or amendment of written procedures involves looking at the company's activities and operations, identifying what could go wrong, and deciding what should be done to try to prevent it. The documented procedures are the means by which the controls are applied.

The implementation of a risk assessment process in the context of ship and fleet management generally will include a definition of processes, as well as hazard identification, including a risk assessment.

The underlying philosophy is to help develop an effective safety culture in companies and on board ship, where the human element is given regular and effective consideration. Its purpose is to facilitate and embed a culture of continuous improvement in safety performance without the requirement for additional regulation.

A Company will need to apply the process of hazard identification and risk assessment to determine the controls that are necessary to reduce the risks of incidents. The overall purpose of the risk assessment process is to recognize and understand the hazards that might arise in the course of the organization's activities and ensure that the risks to people arising from these hazards are assessed, prioritized and controlled to a level that is acceptable (requirements are included in different standards like ISM Code, ISO-9001:2008, ISO 14001:2004, OHSAS 18001:2007, MLC 2006 ...).

The idea of operational risk assessment had always been alluded to in the ISM Code but the original language had stopped short of marking this a formal requirement of the Code. The amendments on 1st July, 2010 get much closer and do make it clear that there is an expectation that the Company will adopt a risk based approach to managing safety. Whereas the ISM Code provides in 1.2 Objectives - the requirements for risk assessment and these are distributed throughout several chapters.

1.2.2. Safety management objectives of the Company should, inter alia:
 .2 assess all risks to its ships, personnel and the environment
 and establish appropriate safeguards.

This includes also the basic elements of occupational health and safety, to identify any hazards, to provide measures to avoid or minimize hazards and to monitor the effectiveness of these measures.

The focus of this Guideline is therefore on the application of the risk management process for assessing and improving ship operation with respect to the reduction of fatalities, damage and environmental damage.

Companies holding a DOC will need appropriate procedures to fulfil the requirements of the ISM-Code.

1. General

1.1 Risk assessment and management of change

Hazard identification and risk assessment methodologies vary greatly across maritime industries, ranging from simple assessments to complex quantitative analyses with extensive documentation. Individual hazards can require that different methods be used, e.g. an assessment of long term exposure to asbestos can need a different method than that taken for equipment safety or for assessing an office workstation.

Each organization should choose approaches that are appropriate to its scope, nature and size, and which meet its needs in terms of detail, complexity, time, cost and availability of reliable data. In combination, the chosen approaches should result in an inclusive methodology for the ongoing evaluation of all the company's risks.

The management of change needs to be considered for changes in assessed risks, determination of controls, or the implementation of controls. Management review should be used to determine whether changes to the methodology are needed overall.

To be effective, the organization's procedures for hazard identification and risk assessment should take account of the following:

- hazards,
- risks,
- controls,
- management of change,
- documentation,
- ongoing review.

1.2. Why use Risk Assessment

Risk assessment techniques can be applied in almost all areas of maritime industries. Ship owners know that to be successful they must have a good understanding of their risks and how risks impact the people associated with their operations, their financial performance and corporate reputation.

These objective values might be used in an optimisation process to

- achieve a reduced level of risk with a prescribed amount of money,
- reduce the costs that are required to achieve a target risk level.

Furthermore, compared with traditional root cause analysis approaches, risk analysis or risk assessment is **pro-active**. Pro-active means that hazards are identified before the un-wanted event occurs. In that sense risk analysis helps to avoid fatalities, environmental pollution and economic losses.

1.3 Background to Risk Assessment

Safety barriers and controls

One of the fundamentals of all safety systems is the understanding of the safety barrier principle. Whenever we design safety critical systems we provide them with a certain recovery potential. We do not want that safety

critical systems fail because of single and simple mistakes. This is why we integrate certain safety barriers and controls in our systems. If a hazard occurs it might not affect the system because of pre-installed safety barriers.

These barriers do not have to be a physical protection, such as safety boots or gloves. They can also be of organisational nature etc. An overview is given below.

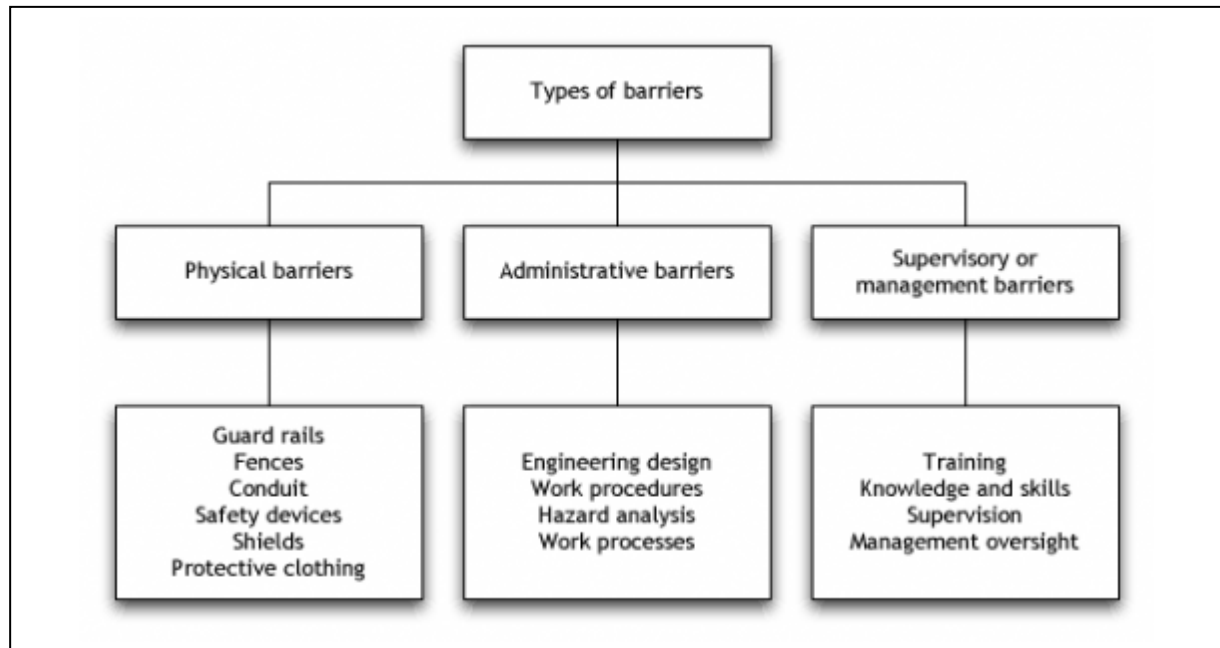


Fig. 1.3-1: Overview about measures to safeguard safety in shipping

When barriers are designed and integrated in the systems one has to pay specific attention to the nature of the target of a hazard: the ship, the cargo, the crew or other humans involved, external targets (e.g. port facilities, other ships etc.), the environment. Different hazards and targets require different barriers.

Safety management is therefore a continuous process of assessment of safety barriers. The existing barriers are monitored constantly. In addition our safety critical system is monitored, too. The focus is here on missing barriers resulting from insufficient risk assessment or changes in the systems.

After accidents an analysis of the function of our pre-installed safety barriers is carried out. These barriers were not always installed based on previous experience. They can also be installed based on personal judgement etc. It is therefore vital to analyse if the safety barriers in each system have the right dimensions. Accidents, unfortunately, are practical tests for our barriers. If they did not function, we have to improve them.

2. Introduction to the Risk Assessment Process

Before we install safety barriers we assess our systems. Risk management is a complex process. It consists of the following phases:

- Risk analysis and estimation
- Risk assessment
- Risk management and control

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During the analysis the vital components of technical/operational systems and potential hazards endangering the functionality of these systems are identified.

The next step is concerned with the estimation of frequencies of the appearance of these hazards and the resulting consequences. During risk assessment suitable Risk Control Options (RCOs) are identified, evaluated, and the most appropriate Risk Control Measure (RCM) selected. The selected RCMs are the barriers that should prevent a hazard from hampering the vital components in our technical/operational systems.

ISM requires proactive and reactive measures. Element 10 "Maintenance of the ship and equipment" requires the identification of critical equipment and systems (10.3). This is a proactive measure. A similar requirement is the risk assessment for routine planned maintenance of critical equipment before the equipment is shut down. During these considerations safety barriers will be integrated in the systems intended to mitigate accidents. During accident investigation (Element 9) the functionality of these safety barriers will be analysed and the barriers have to be adapted where required.

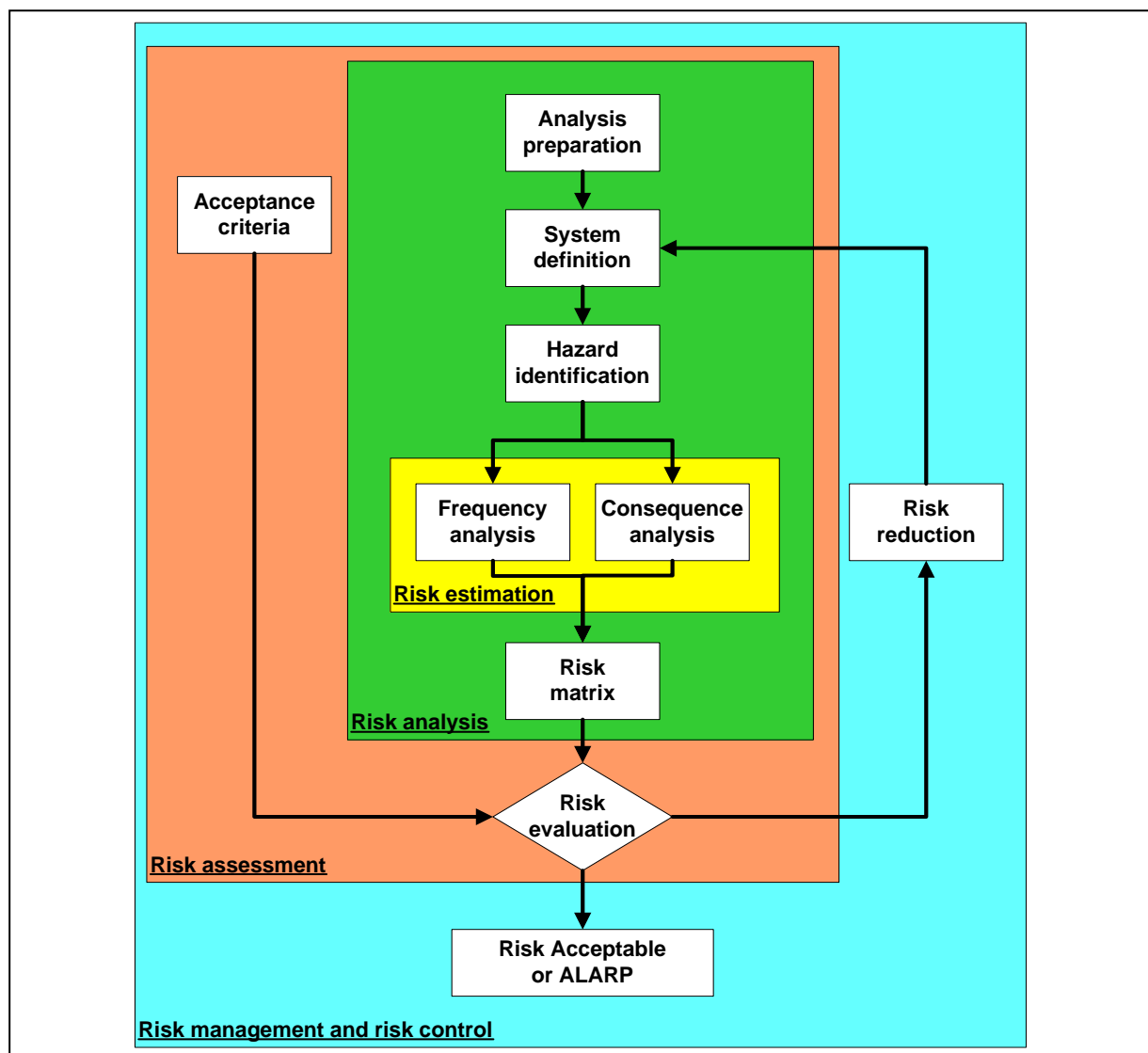


Fig. 2-1: Risk management process

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Risk analysis - is a decision-making aid (How safe?). It can be of great help in considering alternatives, but it fails if it is not known which questions have to be answered. The main advantage of a risk analysis is that it provides a structured access or identification to the hazards combined with a system or a process and thus providing a decreasing quantity of not realised hazards.

Risk analysis is followed by the **Risk Assessment (How safe is safe enough?).** The main task of the risk assessment is the risk evaluation, i.e. to decide if the estimated risk is acceptable. The usual procedure in risk calculation involves addition or multiplication of the parameters "frequency" and "severity". The (qualitative) results are then presented in a risk matrix. The evaluation requires an acceptance criterion.

Risk management and control (How to achieve an adequate level of safety?) Risk management as the whole process, which includes the risk evaluation - the judgement whether a risk is acceptable or not. Risk management is the process whereby decisions are made to accept a known or assessed risk and/or the implementation of action to reduce the consequences or probability of occurrence.

The hazard identification and risk evaluation are key elements of the risk assessment. In this context the terms acceptable and unacceptable risk are important. Between these two regions the ALARP (As Low As Reasonable Practicable) region is defended. In order to demonstrate that a specific risk is ALARP so-called risk control measures are analysed. Risk control measures are introduced to reduce the risk to an acceptable level

2.1 Methods of Hazard Identification and Risk Assessment

In Figure 2.1-1 an overview and a classification of the different methods for hazard identification and risk assessment are shown.

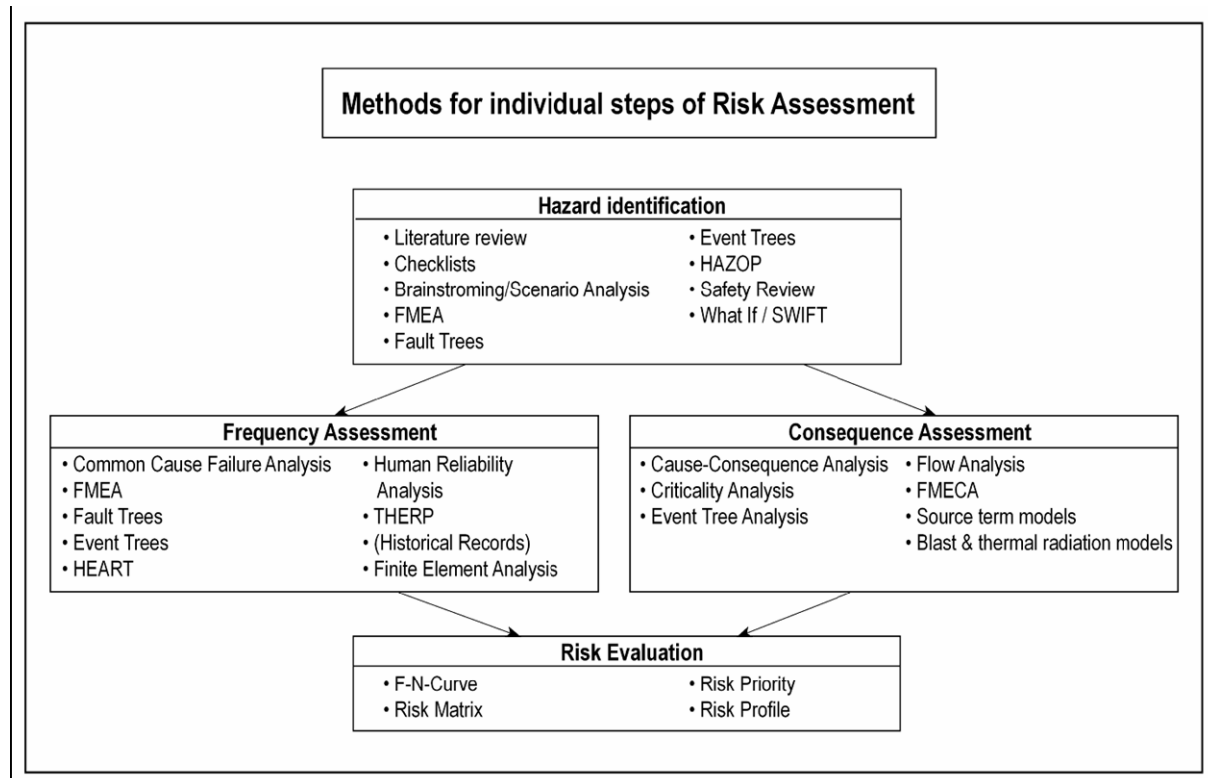


Figure 2.1-1: Overview of risk assessment methods

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The “typical methods” are to be understood as practical risk assessment instruments. In general, the methods are based on checklists and primarily permit qualitative risk identification. They are commonly applied in practice for applications in diverse sectors. It should be noted that, while the designations and implementation of individual methods may vary, the fundamental principles remain unchanged.

The hazard identification may be performed, dealing with the question “What can go wrong?” Hazard or Danger is posed by a situation in which there is an actual or potential threat for the crew, the ship or the environment.

For any practical approach, the identification of hazards is the first and most important step in risk estimation.

The question “when is the risk small enough to be ignored?” can really only be answered by your conscience. Nonetheless, a distinction must be made between unknown risks and those which are accepted for reasons of expense. Due to the pressure of cost and time, many unknown risks remain unspecified.

Incidents and accidents are reality. Incident investigations provide important information of significant risk contributors. Appropriate methods are include

- Analysis (statistical) of historical data
- Root-cause-analysis.

A simple example using a few of these terms regarding risks associated with an electrical power supply line:

Hazard >> High voltage

Incident >> Wire gets exposed

Accident >> Personal contact resulting in shock

Consequence >> Burns / electrocution

2.2 Risk Assessment in practice

Risk Assessment and control is a continual process. Hence, written risk assessments should be subject to periodic formal reviews to confirm the validity of the assessment and whether the risk controls are still effective and adequate (e.g. relating to type of ship, the nature of operations and the type and extent of the hazards and risks).

The focus of this risk assessment is on the

- implications to the existing system
- interrelation to other changes and development

Assuming that a complete risk assessment exists we re-assess

- how the likelihood is affected
- how the consequences change
- how existing barriers are affected

Otherwise, a complete risk assessment has to be conducted.

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This risk assessment should follow the guidance given in ANNEX-A in the step-by step guideline, i.e. by conducting these steps:

1. Classify work activities
2. Identification of hazards (based on work activities)
3. Identification of existing RCMs (controls in place)
4. Estimate Risk (severity and frequency of harm, risk factor)
5. Risk acceptable?
6. Risk control action plan (action to be taken following the assessment)
7. Review adequacy of action plan
8. Ensure risk assessment and risk control measures are effective and up-to-date

When identification of hazards it should be taken into account that the change measures might affect existing safety barriers.

What should be assessed?

The assessment should cover the risks arising from the work activities on the ship. The assessment is not expected to cover risks which are not reasonably foreseeable.

Employers are advised to record the significant findings of their risk assessment. Risks which are found to be trivial, and where no further precautions are required, need not be recorded.

The process of risk assessment should be carried out by suitably experienced personnel, using specialist advice if appropriate. Risk assessment should be seen as a continuous process. In practice, the risks in the workplace should be assessed before work begins on any task for which no valid risk assessment exists.

This risk assessment has to be documented; the form or checklist for risk assessment may be used and has to be filed. The risk mitigation measures resulting from the risk assessment have to be taken up in the records.

The tables below are shown in the form of risk matrix in which they most commonly appear, but they are not mandatory. The risk matrix may be expanded or reduced rows and columns, depending on how finely the company wishes to distinguish the categories. The terms used for frequency (likelihood) and consequence (severity) may be changed to assist understanding.

For example, frequency (likelihood) may be expressed in terms of "once per trip", "once per ship year" or "once per fleet year", and consequence may be made more specific by the use of "first aid injury", "serious injury" or "death", not forgetting the consequences for property and the environment.

Risk - the combination of the frequency and severity of the consequence.

RISK = FREQUENCY X CONSEQUENCE

Frequency - The number of occurrences per time unit (e.g. "per year" or "once per trip" or "once per ship year"...)

Consequence - The outcome of an accident (quantified by some measure of severity)

In other words, risk has two components: likelihood of occurrence and severity of the consequences. And thus risk is always expressed with a time dependent dimension.

The risk matrix (table 1) shows a simple method for estimating risks according to the potential severity of and the likelihood, as described above.

The next step is to decide which risks are acceptable, tolerable or unacceptable. In making decisions as to whether the risk is tolerable the work force should be consulted.

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Having determined the significant risks, the next step is to decide what action should be taken to improve safety, taking account of precautions and controls already in place.

The outcome of a risk assessment should be an inventory of actions. Any action plan should be reviewed before implementation, if the revised controls lead to tolerable risk level.

Risk Assessment and control is a continual process. Hence, written risk assessments should be subject to periodic formal reviews to confirm the validity of the assessment and whether the risk controls are still effective and adequate.

Table 1 Risk matrix for determination of the Risk Priority Number (RPN)

Risk Matrix

↑ Consequence Severity	4 catastrophic	medium	high-medium	high-medium	high
	3 severe	medium-low	medium	high-medium	high-medium
	2 significant	low	medium-low	medium	high-medium
	1 minor	low	low	medium-low	medium
		extremely remote 1	remote 2	reasonably probable 3	frequent 4
		Occurrence frequency →			

Note: Low risk here means that the risk has been reduced to the lowest level that is reasonably practicable

Risk Level Acceptable	Risk Level Tolerable <small>(Existing risk control measures to be reviewed to ensure ALARP level)</small>	Risk Level is not Tolerable <small>(RCMs to be modified and/or additional risk control measures to be implemented)</small>
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Table 2 Rating Scale – severity

SI	Severity	Effects on human safety	Effects on ship	Effects on environment
1	Minor	Single or minor injuries	Local equipment / structural damage	Non-significant spill up to a few barrels of pollution to sea
2	Significant	Multiple or severe injuries	Non-severe ship damage	A few tonnes of pollution to sea. Situation is manageable
3	Severe	Single fatality or multiple severe injuries	Severe damage	Significant pollution demanding urgent measures for the control of the situation and/or the cleaning of affected areas
4	Catastrophic	Multiple fatalities	Total loss	Major pollution with difficult control of situation and/or difficult cleaning to affected areas

Table 3 Rating scale – frequency occurrence (IACS)

FI	Frequency	Definition
4	Frequent	Likely to occur once per month on one ship
3	Reasonably probable	Likely to occur once per year in a fleet of 10 ships, a few times in a ship life
2	Remote	Likely to occur once per year in a fleet of 1000 ships, once in the total life of several similar ships
1	Extremely remote	Likely to occur once in 10 years in a fleet of 10000 ships

3. Change Management and Control

It is recommended that the Company should manage and control any changes that can affect or impact its hazards and risks. This includes changes to the organization's structure, personnel, management system, processes, activities, use of materials, etc. Such changes should be evaluated through hazard identification and risk assessment prior to their introduction.

The Company should consider hazards and potential risks associated with new processes or operations at the design stage as well as changes in the organization, existing operations, products, services or suppliers.

The following are examples of conditions that should initiate a management of change process:

- new or modified technology (including software), equipment, facilities, or work environment,
- new or revised procedures, work practices, designs, specifications or standards,
- different types or grades of materials, cargo etc.
- significant changes to the site's organizational structure and staffing, including the use of contractors,
- modifications of health and safety devices and equipment or controls.

3.1 Determining the need for controls

Having completed a risk assessment and having taken account of existing controls, the organization should be able to determine whether existing controls are adequate or need improving, or if new controls are required.

If new or improved controls are required, their selection should be determined by the principle of the hierarchy of controls, i.e. the elimination of hazards where practicable, followed in turn by risk reduction (either by reducing the likelihood of occurrence or potential severity of injury or harm), with the adoption of personal protective equipment (PPE) as a last resort.

The following provides examples of implementing the hierarchy of controls:

- Elimination – modify a design to eliminate the hazard, e.g. introduce mechanical lifting devices to eliminate the manual handling hazard;
- Substitution – substitute a less hazardous material or reduce the system energy (e.g. lower the force, amperage, pressure, temperature, etc.);
- Engineering controls – install ventilation systems, machine guarding, interlocks, sound enclosures, etc.;
- Signage, warnings, and/or administrative controls – safety signs, hazardous area marking, photo luminescent signs, markings for pedestrian walkways, warning sirens/lights, alarms, safety
- procedures, equipment inspections, access controls, safe systems of working, tagging and work permits, etc.;
- Personal protective equipment (PPE) – safety glasses, hearing protection, face shields, safety harnesses and lanyards, respirators and gloves.

In applying the hierarchy consideration should be given to the relative costs, risk reduction benefits, and reliability of the available options.

3.2 Recording and documenting the results of changes

The process for such change management shall be documented in a formal documented procedure. Risk assessment is a part of the change process and therefore has to be documented, too.

As a consequence of this, the verification of the change management process must be part of the ISM certification (during document verification, office audit and shipboard audits).

The organization should document and keep the results of hazard identification, risk assessments and determined controls. The following types of information should be recorded:

- identification of hazards,
- determination of the risks associated with the identified hazards,
- indication of the levels of the risks related to the hazards,
- description of, or reference to, the measures to be taken to
- control the risks,
- determination of the competency requirements for implementing
- the controls .

When existing or intended controls are used in determining risks, these measures should be clearly documented so that the basis of the assessment will be clear when it is reviewed at a later date.

The description of measures to monitor and control risks can be included within operational control procedures. The determination of competency requirements can be included within training procedures.

In order to control all documents and to trace the history, it is necessary to file all of the previous releases of the data on a separate medium or computer. It has to be made sure that these obsolete data are not considered as being current, by error.

4. Ongoing review

It is a requirement that hazard identification and risk assessment be ongoing. This requires the company to consider the timing and frequency of such reviews.

Periodic reviews can help ensure consistency across risk assessments carried out by different people at different times. Where conditions have changed and/or better risk management technologies have become available, improvements should be made as necessary.

It is not necessary to perform new risk assessments when a review can show that the existing or planned controls remain valid.

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ANNEX – A

Risk guide - a practical step by step approach to risk and change management

Step 1 - Classify work activities

Investigation about hazards, key process, detailed task, subtask

Step 2 - Identify hazards for the work activity.

Consider different scenarios under different conditions e.g. new crew, darkness, stormy weather, rain. Development of hazard prompt list for your operation activities including equipment and machinery which is used; shipboard hazards to personnel, hazards to the vessel hazardous, substances used on board; physical, chemical, biological hazards or psychosocial hazards, other have to be observed... .

Step 3 - Identify risk controls

safeguards against risk, safe working practices, procedures and instruction, familiarization, use of PPE

Step 4 - Determine risk. Assess likelihood and potential consequences of the scenarios.

determine the potential severity of harm and the likelihood that harm will occur, apply the IACS rating scale for severity, scale for frequency to decide on likelihood ...

Step 5 - Decide if risk is tolerable

calculate the Risk Priority Number-RPN by use of risk matrix, evaluate the risk and decide on further action ...

Step 6 - Prepare a risk control action plan to improve risk controls as necessary

Develop additional Risk Control Options-RCO, list measures to implement changes, ensure that risk is reduced to ALARP [As Low As Reasonable Practicable] level.

Step 7 - Review adequacy of action plan, confirm whether risk are now acceptable or tolerable

Investigate the effect of the additional Risk Control Measures-RCM, compare the benefits with time and efforts.

Step 8 - Ensure risk assessments and risk control measures are effective and up to date

Monitor implementation, review change, regular review the adequacy and effectiveness of the risk controls

ANNEX - B

Hazard Prompt List (Example)

The Hazard Prompt List may help with the identification of hazards for work activities. The list is not exhaustive but conversely companies will not encounter all the hazards shown below. The list should be updated as soon as hazards have been identified which are not on the list.

1. List of hazards for ship operation

1.1 Human-related hazards

.1 Personal factors

- reduced ability, e.g. reduced vision or hearing
- lack of motivation, e.g. because of a lack of incentives to perform well
- lack of ability, e.g. lack of seamanship, unfamiliarity with vessel, lack of fluency of the language used onboard
- fatigue, e.g. because of lack of sleep or rest, irregular meals
- stress

.2 Organizational and leadership factors

- Inadequate vessel management, e.g. inadequate supervision of work, lack of coordination of work, lack of leadership
- Inadequate ship owner management, e.g. inadequate routines and procedures, lack of resources for maintenance, lack of resources for safe operation, inadequate follow-up of vessel organization
- Inadequate manning, e.g. too few crew, untrained crew
- Inadequate routines, e.g. for navigation, engine room operations, cargo handling, maintenance, emergency preparedness

.3 Task features

- task complexity and task load, i.e. too high to be done comfortably or too low causing boredom
- unfamiliarity of the task
- ambiguity of the task goal
- different tasks competing for attention

.4 Onboard working conditions

- physical stress from, e.g. noise, vibration, sea motion, climate, temperature, toxic substances, extreme environmental loads, night-watch
- ergonomic conditions, e.g. inadequate tools, inadequate illumination, inadequate or ambiguous information, badly-designed human-machine interface
- social climate, e.g. inadequate communication, lack of co-operation
- environmental conditions, e.g. restricted visibility, high traffic density, restricted fairway

1.2 Shipboard hazards to personnel

- inhalation of harmful substances (e.g.toxic gases)
- burns from substances like acids
- electric shock
- person falls from height or slips
- person falls overboard
- other injuries, etc.

1.3 Hazards to the vessel

.1 Loss Of Watertight Integrity (LOWI)

- contact or collision
- explosion
- fire
- flooding
- grounding or stranding
- loss of hull integrity, structural failure

.2 Hazards external to the ship

- storms
- lightning
- uncharted submerged objects
- other ships
- attacks (pirates, terrorists)
- war

1.4 Hazardous substances on board ship

.1 Accommodation areas

- combustible furnishings
- cleaning materials in stores
- oil/fat in galley equipment

.2 Deck Areas

- cargo
- paint, oils, greases etc. in deck stores

.3 Machinery spaces

- cabling
- fuel and diesel oil for engines, boilers and incinerators
- fuel, lubricating and hydraulic oil in bilges, save ails, etc.
- residual oils
- refrigerants
- thermal heating fluid systems

1.5 Potential sources of ignition

.1 General

- electrical arc
- friction
- hot surface
- incendiary spark
- naked flame
- radio waves

.2 Deck areas:

- deck lighting
- funnel exhaust emissions
- hot work sparking

.3 Machinery spaces:

- air compressor units
- engine exhaust manifold

2. Additional hazards for cargo operation

2.1 Hazards of cargo

- flammability
- toxicity
- density
- Corrosion
- ...

2.2 Operational Hazards

- pollution
- static electricity
- smoking
- naked lights
- use of electrical equipment
- use of tools
- use of communication equipment
- spontaneous combustion
- enclosed spaces
- etc.

Source: ISGOTT, IMO FSA MSC/Circ. 1023