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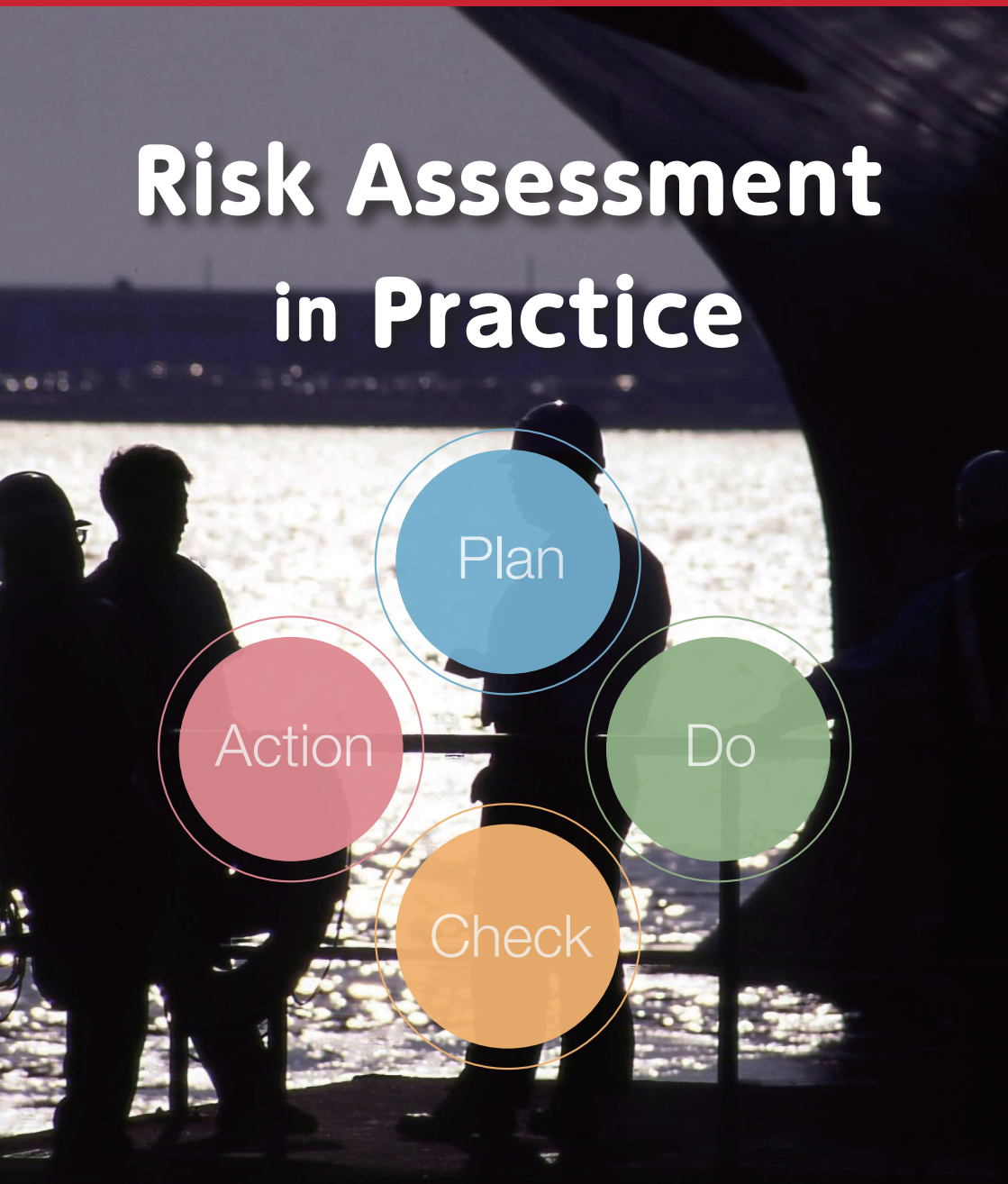
P&I Loss Prevention Bulletin

The Japan Ship Owners' Mutual Protection & Indemnity Association Loss Prevention and Ship Inspection Department

Risk Assessment in Practice



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§ 1 Introduction

In the seminars that we conducted and in the Loss Prevention Bulletins, we have stated that "the root cause behind marine casualties is approximately 90% the result of a chain of human errors." However, unfortunately, it is not possible to eliminate the occurrence of human error, thus in order to prevent maritime accidents, it is important to "break the chain of sequential errors".

When considering measures to prevent maritime accidents, we have shown that these can be chiefly classified into three specific methods (shown in Fig. 1) that are an effective means of preventing further accidents.

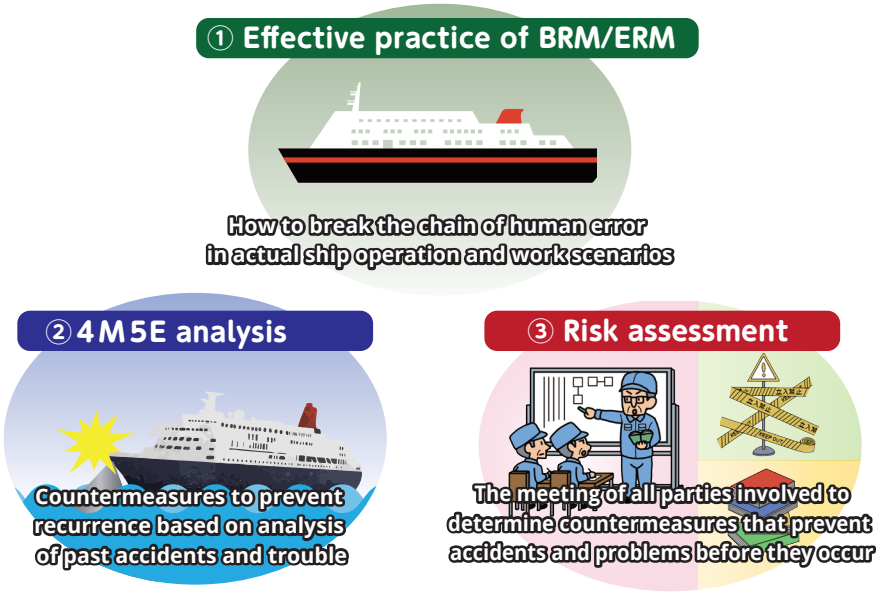


Fig. 1 Three maritime accident prevention measures

① Effective implementation of BRM/ERM (Bridge/Engine Room Resource Management)

This is a method that breaks the chain of human errors on the spot. Even experienced Masters and Chief Engineers (C/E) can make mistakes because they are human beings. Thus, BRM/ERM is a system that supports the duties of those involved in a cohesive manner so that one person's mistake does not cause a dangerous situation whereby team members and resources around him/her can quickly recognize and correct the mistake in time.

"Communication between each resource" serves as the basis of this and is illustrated in the M-SHELL Model (Fig. 2) below.

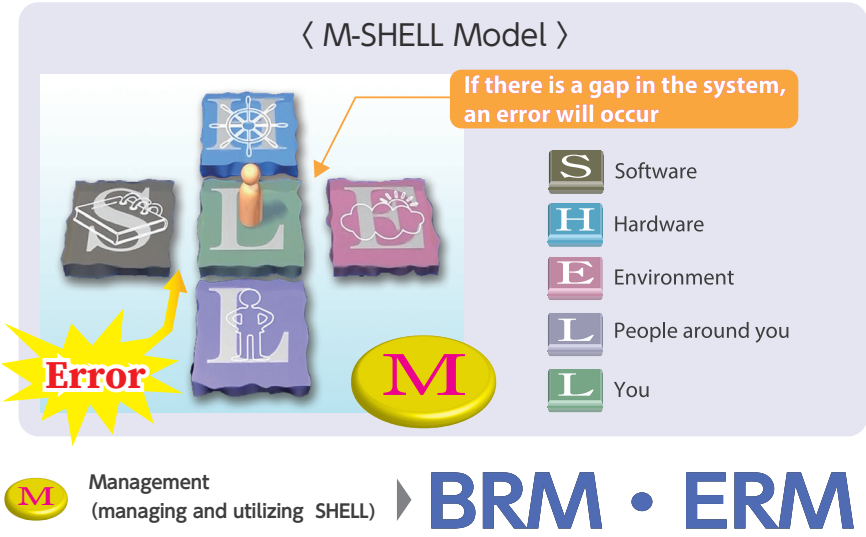


Fig. 2 M-SHELL Model

② Planning of measures that prevent maritime accidents through 4M5E analysis

In the event of a maritime accident occurring, in addition to the analysis from a physicall point of view, there is a method of developing countermeasures to prevent the same type of accident from occurring again by (1) identifying the event from the point of view of the "4Ms" of failures, i.e. Man, Machine, Media (working environment) and

Management, (2) analysing the result of (1) in terms of why the “Unsafe conditions” and “Unsafe behaviour” (Fig. 3) occurred, and (3), based on the results of (2) analysis, formulating countermeasures for each of the “5Es”, i.e. Education, Engineering, Enforcement, Example and Environment. This method has been developed and adopted by NASA (National Aeronautics and Space Administration) for accident investigation.

Although this method has been commonly used in the manufacturing industry, it is not widely spread in the marine industry: because it is originally less familiar, and, unlike in the manufacturing industry, accident causes are to be often found in human nature following a deeper analysis, which is where problems arise. For more details, please refer to the Loss Prevention Bulletin Vol.50.

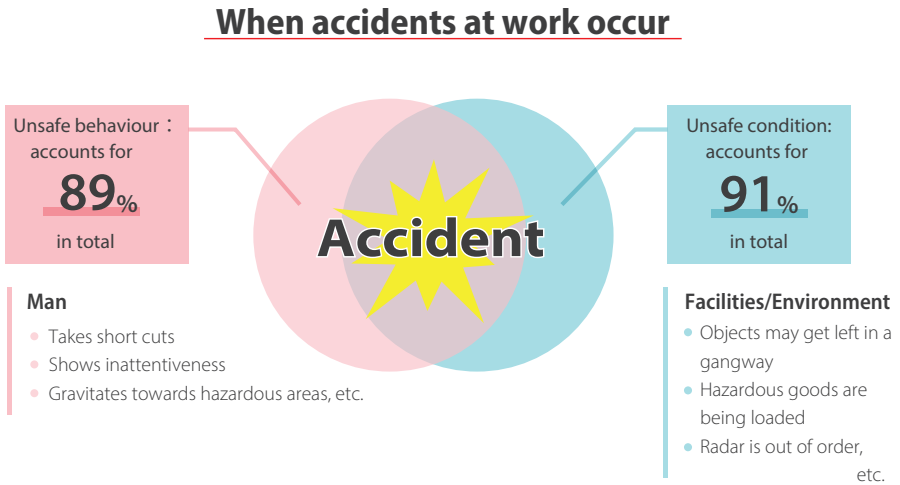


Fig. 3 Unsafe conditions and Unsafe behaviour

Source: Japan Industrial Safety & Health Association,“Seminar on Case Studies:Accident Analysis and Countermeasures”

③ Devise countermeasures that prevent maritime accidents through risk assessment

Risk assessment is the method designed for crew to examine the risks involved in their duties on board the vessel, especially when carrying out irregular work, and to develop countermeasures in advance. The idea is to share this information with all parties involved, including other management personnel at the shore catering department such as the shipowner, ship management company, charterer and so on in order to prevent accidents before they occur.

In 1999, in the manufacturing industry on land, Guidelines on Occupational Safety and Health Management Systems (Note 1) was introduced along with the Industrial Safety and Health Act (Act No. 57, 1972) and Risk management legislation.

However, later during 2010, the International Maritime Organization (IMO) created the ISM Code (International Management Code for the Safe Operation of Ships and Pollution Prevention). When this Code was revised, many companies were recommended to introduce a Risk management approach and incorporate it into their Safety Management System (SMS) and Safety Management Code, however, these are yet to be implemented successfully.

Note 1: OSHMS stands for Occupational Safety Health Management System.
(Ministry of Labour Notification No. 53, April 30, 1999 (Guidelines on Occupational Safety and Health Management Systems)

In terms of ship operations, based on a full understanding of the above proposed approach to prevent disasters (accidents) “ ② 4M5E analysis” and “ ③ Risk assessment”, it is a requirement that related parties be aware of “ ① BRM/ERM” while putting these into practice in the field. This time, the author will describe what is entailed in Risk Assessment.

§ 2 Risk Management

2-1 What is risk?

According to "Risk management principles and guidelines" of JIS Q 31000, risk is defined as follows:

Definition of risk: the effect of uncertainty on objectives

On the other hand, the International Safety Standards ISO/IEC Guide 51 defines "risk" as a "combination of the probability of occurrence of harm and the severity of that harm" and that "the probability of occurrence includes the exposure to a hazardous situation, the occurrence of a hazardous event and the possibility to avoid or limit the harm." Also, in IMO, risk is defined as the combination of the frequency and the severity in MSC-MEPC.2/Circ.12/Rev.2 (Annex, page 4).

In accordance with Japan's Industrial Safety and Health Act, the Ministry of Health, Labour and Welfare (MHLW) has established "Guidelines on Occupational Safety and Health Management Systems" (Ministry of Labour Notification No. 53, April 30, 1999), which was partially amended by the Ministry of Health, Labour and Welfare Notification No. 54 on July 1, 2019. In section 3 (implementation details), risks are defined as follows:

Risk: Severity of the injury or illness that may result from the danger (hazard) or harm and the degree of likelihood or possibility of its occurrence. (Provisional translation)

It is necessary to understand that "crisis" means an intense difficult and dangerous situation that has already occurred, and that risk is not the same thing.

"RISK" ≠ "hazard" or "crisis"

As mentioned above, "risk" is considered to be "something uncertain that has not yet occurred" and can be expressed as a function of the degree and probability (frequency) of adverse effects resulting from the presence of a "hazard" lurking in the course of carrying out work on board: dangers that are not present now, but which can be foreseen to occur in the future.

"Risk" = "degree of impact" × "frequency"

This will be further described in chapter 3.

2-2 Risk management

The ISM Code contains the following provisions relating to risk management: Quoted from ClassNK's amendments to the International Safety Management (ISM) Code. (The amendments entered into force on 1 January 2015.)

1.2 Objectives

1.2.2 Safety-management objectives of the Company should, inter alia:

.1 provide for safe practices in ship operation and a safe working environment;

.2 assess all identified risks to its ships, personnel and the environment and establish appropriate safeguards; and

.3 continuously improve safety-management skills of personnel ashore and aboard ships including preparing for emergencies related both to safety and environmental protection

The ISM Code refers to risk as: “We do not prescribe any particular method of risk management and it is for the company to choose the appropriate method for its organisation, its vessels possessed and its routes.” (Provisional translation). Let us examine this in detail.

2-2-1 The need for risk management

With the collaboration of the shipowner, ship management company and crew, by specifying the series of processes of the PDCA cycle: (P: Plan)→(D: Do)→(C: Check)→(A: Action)and by promoting continuously and proactively safety management activities, the aim of risk management is to reduce the potential hazards that can cause accidents and disasters and create a comfortable working environment on board, at the same time.

The absolute number of accidents has decreased since the ISM Code and the Safety Management Code was introduced, however recently that rate of decrease has slowed down. There is a decrease in the number of experienced crew who have accumulated safety management know-how. Also, because it is common to have mixed boarding of foreign crew on ocean going vessels, there is a differences in culture and customs for each country. As a result, safety management know-how on board is not sufficiently passed on, leading to the fear that this may not be passed on to the next generation, which could cause further accidents.

Under these circumstances, without leaving operational safety measures to the vessel only, it is required that the shipowner and the ship management company also be responsible for establishing a system of safety management to be implemented “systematically” and “continuously”, and for it to be planned and used in an integrated and appropriate manner.

2-2-2 What is risk management?

As mentioned above, risk management is the process of systematically managing risks to avoid or mitigate losses.

In addition, a risk management structure mainly consists of “risk assessment” and “risk management (risk response)”. Moreover, it consists of “risk identification” and “risk analysis”, and “risk analysis” consists of “risk evaluation”, “risk management” and “communicathion”.

Risk management has been introduced as a business management technique to effectively deal with unforeseen losses caused by various hazards at minimum cost. The background to this is that, with the enforcement of the Companies Act in 2006, it became necessary for joint-stock companies to establish a “system for the management of the risk of loss”. In addition, the Japanese version of Sarbanes-Oxley (SOX) Act (Financial Instruments and Exchange Act) came into force in 2008, requiring the development of a “financial risk management system”.

As a result, it has been said that we have moved from an era of compliance to an era of risk management, and in recent years, risk management has been in the spotlight in business management, also.

Until now, it seems that risk management was implicit in the decision-making process of any company, but with the introduction of new legislation and increased awareness of risk management, risk management has moved from being implicit to being explicit (visible).

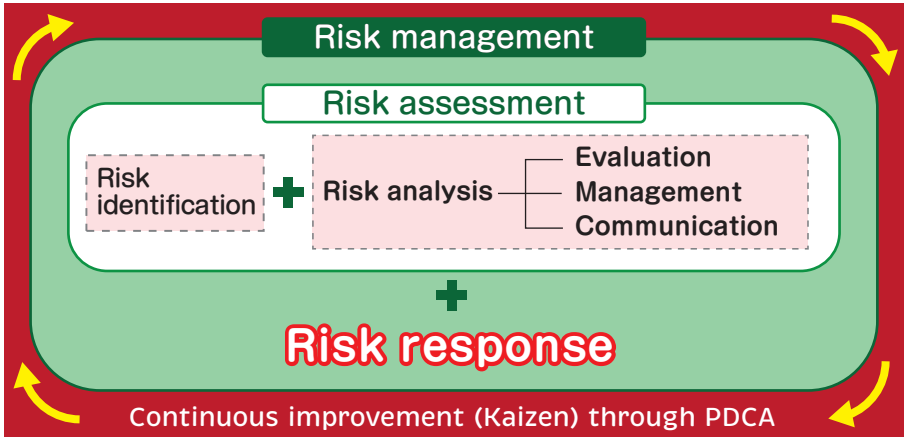


Fig. 4 Risk management conceptual diagram

§ 3 Risk Assessment

3-1 Fundamentals of risk assessment

Risk assessment is to ensure the safety of the vessel and crew's good health, and such days when people used to say, "We simply need to comply with the law," are gone. Now, the shipowner and ship management company are also expected to take all possible measures to ensure the safety of the ship and the well-being of the crew and not leave the burden of safe operation at sea entirely to the vessel.

Therefore, shipowners and ship management companies need to ensure that their ship management incorporates "methods that maximise health and safety standards wherever possible", and one of the most effective ways to achieve this is through risk assessment.

In recent years, many shipping companies have developed and set up their own crisis management and specialised risk management departments. Meanwhile, internal audits, potential accident reports and risk prediction (KY: Kiken Yochi) activities have been commonly used to identify the risks existing on board and to establish safety measures in advance.

In a broad sense, these activities are part of risk assessment. However, risk assessment is, in addition to these empirical activities, characterised **by a systematic and logical approach to the development of safety measures.**

3-2 Why risk assessment is necessary

In the past, the basic approach to prevent a disaster (accident) on board was to investigate the cause of an accident, formulate measures to prevent recurrence of similar accidents, and ensure that all ships were aware of these countermeasures. This was a so-called "responsible pursuit type" measure or a "grave-post type" measure in which the person involved in the accident was punished, the relevant parties briefed on the accident and then the case closed. (For details, please see "Thinking Safety", Loss Prevention Bulletin Vol. 35).

However, it has been recognised that learning from past disasters (accidents) is not enough when it comes to formulating recurrence preventive countermeasures.

When a crew member, who is a professional operator of the vessel, causes an accident despite being aware of the potential danger, the preventive measure is to ask "Why did the crew member behave in such an "unsafe" way? Based on the fact that 90% of the root causes of marine accidents are a chain of human errors, we have "identified technicians' common characteristics", "human characteristics", "psychological factors" and "human brain capacity" that may cause human errors. Therefore, it has become necessary to analyse the causes of accidents in terms of such factors which cause human errors, and carry out "preventive countermeasures" to find out what can be done to avoid such situations. Thus, the need for "preventive countermeasures" has increased.

It is therefore necessary to introduce a risk assessment approach that pays attention to potential hazards and one that takes proactive countermeasures, in order to eliminate or reduce the risks that exist on board, and to further promote fundamental safety on board, thereby improving safety standards. Figure 5 illustrates this.

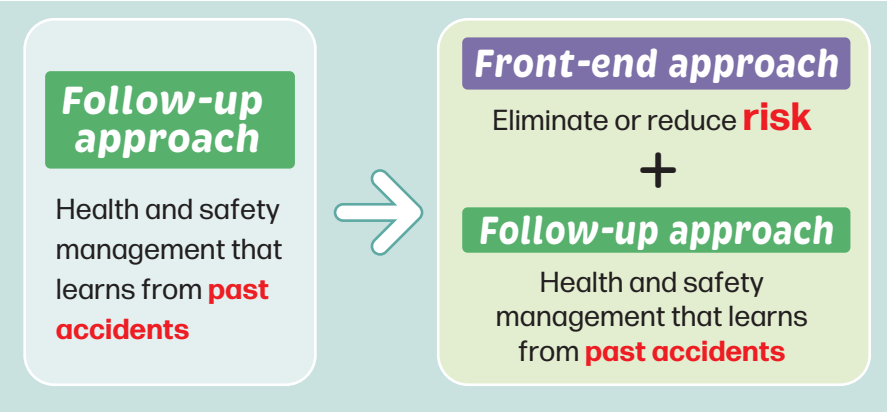


Fig. 5 From Follow-up approach to Front-end approach Source: Risk Assessment Training Materials by Japan Industrial Safety and Health Association (JISHA)

In addition, in Article 5 of the Labour Contracts Act (Consideration to the Safety of a Worker), the duty of care for safety is set out in the following.

= The Labour Contracts Act (Article 5) =

In association with a labour contract, an Employer is to give the necessary consideration to allow a Worker to work while ensuring the employee's physical safety.

That is to say that, as mentioned above, in recent years we have moved from an era of "compliance" to an era of "risk management". Figure 6 illustrates this.

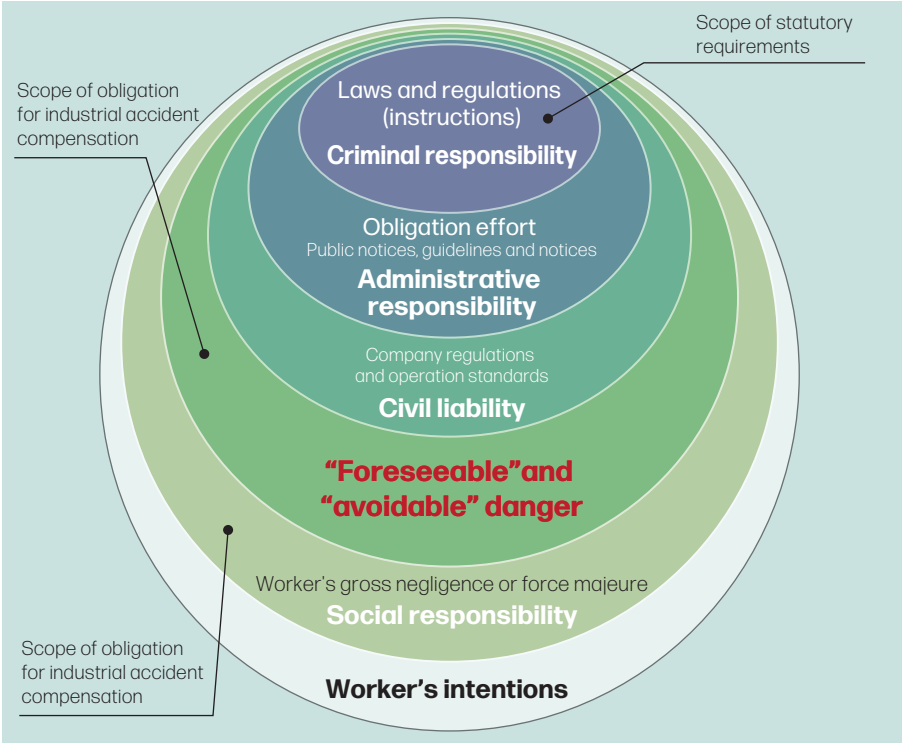


Fig. 6 Source: Scope of the duty of care for safety from "Practice of duty of care for safety from court cases" (Provisional translation). From the Japan Industrial Safety and Health Association (JISHA), ed.

In other words, the following two duties are needed in order to fulfil the duty of care to maintain safety:

1 Duty to warn Worker of any danger

To foresee hazards on board, especially potential hazards around the crew.

2 Duty to avoid foreseeable consequences

Risks to be eliminated or isolated/mitigated. Or, for "residual risks" that still remain, the crew needs be aware of their existence in order to take countermeasures in "daily shipboard health and safety" to prevent accidents from occurring.

3-3 Effectiveness of risk assessment

By carrying out a risk assessment, we can expect the following benefits:

1 Not only crew but also shipowner and ship management company can share their "perception" of risk

By carrying out a risk assessment on board and reporting it to the shipowner or ship management company, there is a common understanding of the risks existing on board.

2 Increased sensitivity to risks

This increases the sensitivity of everyone involved to better understand risk, and enables them to deal with risks that might otherwise have been overlooked.

3 Enable physical countermeasures to be taken with a focus on fundamental safety

By sharing safety measures that were previously left to the vessel or on-board, it will be possible to establish safety measures in advance that correspond to the risk level. In particular, it will enable the promotion of physical countermeasures that focus on fundamental safety (see below⑤).

4 Reasonable prioritisation of safety measures

Countermeasures taken to eliminate, reduce or isolate risks to below an acceptable level of risk, and the results of the risk assessment etc. can also determine the order of priority.

5 Reasonable countermeasures taken in terms of cost-effectiveness

In the event of ③ taking any physical countermeasures as in the above cases, costs will also be incurred. By specifically considering the urgency and funding of each risk countermeasure, it will also be possible to select those that are reasonable from a cost-benefit perspective.

6 The reasons from a "management approach: what to follow, etc." are clear for residual risks

Residual risk inevitably remains, even after elimination, reduction or isolation. In such cases, the response must be left to the ship's crew, with the necessary management measures put in place. If the crew is involved from the beginning, as they will understand the reasons, such as why they have to work with care, what needs to be followed will be observed.

3-4 Risk assessment structure

Risk assessment starts with identifying hazards (harmful events) and then analysing the risks identified. The analysis is then assessed, the frequency of occurrence (probability) and the impact of risks (severity), and measures (controls) are then put in place according to the required level of risk, which is the product of frequency of occurrence and impact. It is a series of processes comprising of the effective communication of these measures to relevant parties. (See Fig. 7)

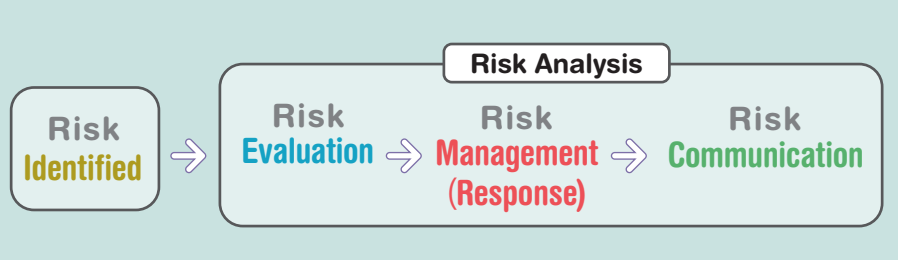


Fig. 7 Risk assessment process

3-4-1 Identifying hazards

The first step in risk assessment is to identify the hazard and the source of the hazard of the machinery, equipment, work activities and environment in question (work activities, work location, etc.) This is the most important task in carrying out a risk assessment.

Knowing the differences between hazards and risks

It is important to distinguish the difference between hazards and risks. A "**hazard**" can be defined **as "anything that has the potential to cause injury or trouble"**. This includes not only the ship's equipment and machinery, but also environmental and human factors. However, no matter how many of these hazards exist on board the vessel, no injury or trouble should occur. It is only when the crew are exposed to these hazards that the possibility of trouble or an accident involving people arises. This "combination of the severity of an accident caused by the hazard and the likelihood of it occurring" is called the "risk". Therefore, even if the hazard exists, if the crew or operator is not present, or if the crew or operator is not involved in the operation, then the risk does not exist.

Process leading to personal injury or trouble

The process leading to personal injury or trouble is shown in the Figure 8. Personal injury or trouble occurs when the Hazard and Man or Machinery (the vessel's equipment etc.) meet. This type of thinking is also used in risk prediction (KY) activities to assess the current situation.

A "dangerous situation" occurs when a person or piece of equipment is exposed to (or approaches) a hazard, and a hazardous event occurs when safety measures are insufficient/inappropriate/faulty. And, when hazardous events occur and "avoidance" fails, trouble or an accident involving people occurs. As you can see from this process, there are four possible ways to prevent trouble and accidents involving people. For details, please see P.24 3-4-2 (2) Risk management (response), to be described later.

- Eliminate the hazard
- Ensure that man and machinery (ship's equipment) are not exposed to (or approach) the hazard
- Have appropriate and sufficient safety measures in place
- That the "hazardous event" is successfully avoided when it occurs

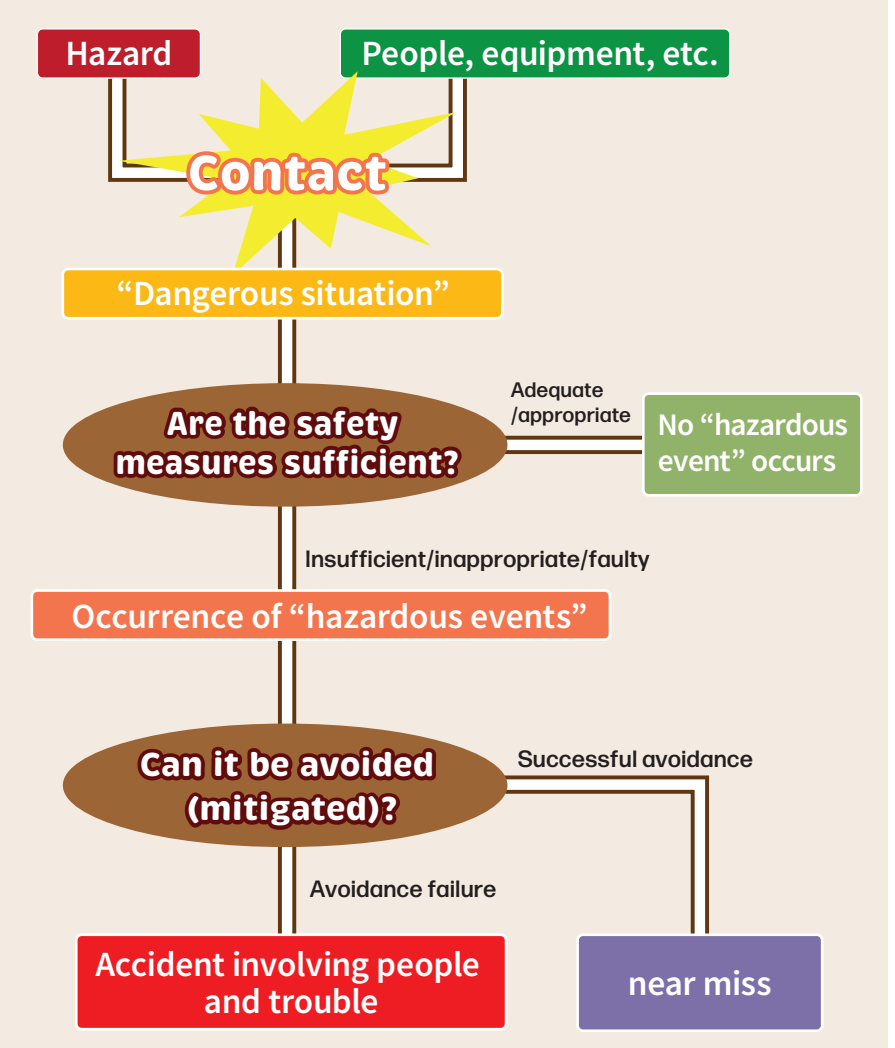


Fig. 8 Process leading to personal injury or trouble

Some remarks when identifying hazards on a vessel

Risk assessment begins with identifying the hazard. The following points should be taken into account when identifying hazards on the vessel.

Hazards are to be identified among all related persons

The more familiar experienced operators are with their duties, the more difficult it is to identify hazards. It is also necessary to involve the senior officers (Master/Chief Engineer and Chief Officer/First Engineer) and the crew who will be doing the work, rather than having only the crew, who will be doing the work, perform hazard identification.

In addition, the identification of hazards from the point of view of inexperienced crew members is often a blind spot for experienced personnel. It is therefore also important to check the work site with all concerned before starting the risk assessment meeting.

Collecting information

Wherever possible, reference information should be obtained from the ship management company or other sources, such as risk assessment reports, accident reports and potential accidents on other ships.

Review of legislation and company rules

Grasp the relevant laws and regulations, safety management codes and SMS manuals etc., and start work on the basis of them until covering all manner of work, even if there are no procedures available (inc. irregular work).

Prioritisation

Where there is more than one task or process, the plan should be developed sequentially, starting with those that are considered to pose the greatest risk.

Although collecting information is an important part of the above work, it should be noted that the crew changes every few months. Therefore, it is imperative that information gets passed on, since risk assessment tends to be based on the discretion and knowledge/experience of individual crew members, and becomes ad hoc.

It is necessary not to collect information only when the risk assessment is conducted, but to organize it on a daily basis, considering it to be useful as a material for conducting risk assessment, and to prepare a list of materials so that appropriate information can be provided promptly when the risk assessment is actually conducted. It is also necessary to prepare a list of materials so that appropriate information can be provided promptly at the stage of risk assessment and handed over to the successor. For example, one way to sharpen keen insight and observation will be through daily near misses. The ship management company is also expected to compile information on each vessel and provide it to the vessel on a regular basis.

3-4-2 Risk analysis

A "risk analysis" related to safety on a vessel is a framework for preventing the occurrence or minimising the risk of an accident occurring, rather than cleaning up after the accident, where the ship's operations or crew may be adversely affected by a "hazard" on board or during operations.

This means that all crew members involved in the various operations to be carried out on board the vessel will hold a briefing before starting work to identify the hazards that can be expected during the operation, and the kinds of accidents involving people or trouble that may occur.

Risk analysis consists of three elements: Risk evaluation, Risk management (response), and Risk communication, which interact to improve the results of risk analysis.

Remarks: website of the Ministry of Health, Labour and Welfare.

1 Risk assessment

The risk assessment assesses the impact of risk posed by a potential hazard on board or at work, in terms of what type of personal injury or trouble is likely to occur and at what rate (likelihood or degree of likelihood), and if they do occur, how serious are they likely to be (severity or degree of seriousness). Then, based on the magnitude of the assessed risk, determine the priority of reducing the risk and take measures to eliminate or reduce the risk according to that priority.

Risk is a combination of the probability and severity of a hazard causing personal injury or trouble. Then, in order to effectively utilize a risk assessment for it to lead to the elimination of risks and reduction measures, it is necessary to determine the criteria for the "degree of likelihood" and "impact of severity" of risks in the assessment, which are then divided into several levels.

Moreover, depending on the extent of the likelihood and severity categories obtained from the risk assessment, the impact of the risk (risk level) posed by the hazard is determined. The higher the likelihood and the greater the severity, the higher the risk level. We then set "priorities for reducing the risk", starting with those with the highest level of risk.

Risk assessment setting methods

For classifying the elements of risk, there are largely two main methods in order to assess risk and set priorities: the **non-quantified method and the quantified method**.

1) Non-quantified method

This is a matrix of severity and probability, and is widely used as an evaluation method when establishing prevention countermeasures against accidents involving people in the manufacturing industry on land. Examples are shown in Tables 9-1 and 9-2.

Non-quantified assessment and priority setting criteria

Likelihood \ Severity	Significance	Severely injured	Minor injury
Highly likely	Ⅳ	Ⅲ	Ⅱ
Likely	Ⅳ	Ⅲ	Ⅰ
Not very likely	Ⅲ	Ⅱ	Ⅰ

Table 9-1 Example of non-quantified assessment and priority setting criteria

Non-quantified risk level and how to proceed with countermeasures

Risk level	Risk	Approach for risk mitigation
Ⅳ	There is a serious health and safety issue	Immediate risk reduction measures Stop work until action is taken (Note 1)
Ⅲ	There is a health and safety issue	Prompt risk reduction measures
Ⅱ	There are some health and safety issues	Systematic risk reduction measures
Ⅰ	There are only a few health and safety issues	Risk reduction measures where necessary (Note 2)

(Note 1) Risk level IV is a risk level that is unacceptable for the workplace
(Note 2) Risk level I is a level that is broadly acceptable for the workplace

Table 9-2 Non-quantified risk level and how to proceed with countermeasures
Extract from the Japan Industrial Safety and Health Association (JISHA)

2) Quantified method (Attachments 1, 2 and 3)

This method of numerically assessing risk in terms of two factors, "likelihood/frequency of occurrence" and "severity", has been widely adopted in safety management codes and SMS manuals in the shipping industry.

The likelihood and frequency of occurrence are taken into account comprehensively and are often classified into three to five levels. The severity of the hazard is usually categorized into one to four levels in order to understand the severity (impact) of the personal injury or trouble that is expected to occur as a result of the hazard.

A risk assessment is made by multiplying the values obtained from the "Probability and Frequency of occurrence" and "Severity" assessments. The risk level is then assessed

on a scale of 5 levels: LL (very low risk) ～ HH (very high risk), and each onboard operation is identified as belonging to one of the risk categories. Finally, the assessment as to whether or not work can be carried out is based on a comparison of the risk level reduction between "Before" and "After" measures are implemented. Examples are shown in Tables 10-1, 10-2 and 10-3.

Quantified risk assessment index guidelines (criteria)

【Frequency of occurrence evaluation criteria】 Attachment 1

Frequency of occurrence	Nominal frequency of occurrence	Probability of occurrence
5	Level of repeated encounters in a lifetime (occurring in less than 3 to 6 months)	3/10
4	A level that has more than one encounter in a lifetime (occurring about once every six months to a year)	3/100
3	A level that has several encounters in a lifetime (occurring in less than 3 to 5 years)	3/1,000
2	A level that has very few encounters in a lifetime (occurring about once every 5-20 years)	3/10,000
1	A level that is close to zero encounters in a lifetime (occurring once in more than 20 years)	3/100,000

Table 10-1 Example of criteria for setting a quantified assessment (frequency of occurrence)

Quantified risk assessment index guidelines (criteria)

【Severity evaluation criteria】 Attachment 2

Level	Health and safety	Public concern	Environment impact	Economic loss	Management system
4	Death/public impact	Worldwide media coverage	Large-scale and long-term pollution	100 mm yen above	Complete shutdown
3	Serious injury or illness, limited public impact	National press coverage	Serious pollution	10 - 100 mm yen	Possible shutdown
2	Minor injury, small impact on public	Reported in local press	Medium-sized pollution of medium duration in a limited area	5 mm - 10 mm yen	Affected
1	Minor injury/ no public impact	Rarely broadcasted	Minor pollution or no pollution	Less than 5 mm yen	No impact

Table 10-2 Example of criteria for setting a quantified assessment (severity)

Risk assessment Risk index (criteria)

【Risk severity assessment classification】 Attachment 3

Risk severity assessment	Level	Region	Assessment as to whether or not work can be carried out
1	LL	Very low risk	[Region of safety]	[Work possible] Ensure that risk mitigation measures are implemented and that work is carried out in line with this
2				
3				
4	L	Low risk		
5	M	Medium risk	[Region of uncertainty] (Permissible and ALARP region) ※	
6				
7				
8				
9				
10	H	High risk	[Hazardous region] (Region whereby permission is not allowed)	[Work not possible] Where it is necessary to carry out work in order to respond to an emergency or for other reasons, the work must not be carried out without the permission of the manager, notwithstanding the safety management regulations.
11				
12				
13				
14				
15				
16	HH	Extremely high risk		
17				
18				
19				
20				

※ ALARP AREA : As low as Reasonably Practicable

Table 10-3 Example of criteria for setting a quantified risk level assessment

2 Risk management (response)

Following a risk assessment of the work on board, proactive countermeasures are put in place for each task. There are chiefly five risk countermeasures: Risk Aversion, Risk Reduction, Risk Sharing, Risk Isolation and Risk Holding and so on.

1 Risk Aversion (Fundamental Safety)

This is a method to avoid the risk itself. It means to eliminate the causes of risks.

2 Risk Reduction (Functional Safety)

This is a method to minimize the frequency of occurrences and the impact of damage.

3 Risk Sharing

Sharing the risk with organisations other than the vessel (e.g. ship management companies, shipowners, charterers etc.)
Risk transference and dispersion are two methods of sharing risk. It is important to prepare for compensation of loss, when a risk becomes apparent as this is an effective countermeasure when insuring. In this case, it is also referred to as the transference of risk to an insurance company.

4 Risk Isolation (Physical Countermeasures)

A method that does nothing about the risk itself, but rather isolates it with protective measures.

5 Risk Holding

There is no countermeasure against risk.
This can be said to be accepting the risk, and is used for risks that occur infrequently and causing little damage, but on the vessel, it is necessary to share risk information among the crew.

Figure 11 illustrates the relationship between these measures. The graph shows the probability of a risk occurring on the vertical axis and the severity of the risk on the horizontal axis; by placing each measure in the graph it is possible to observe any response method tendencies.

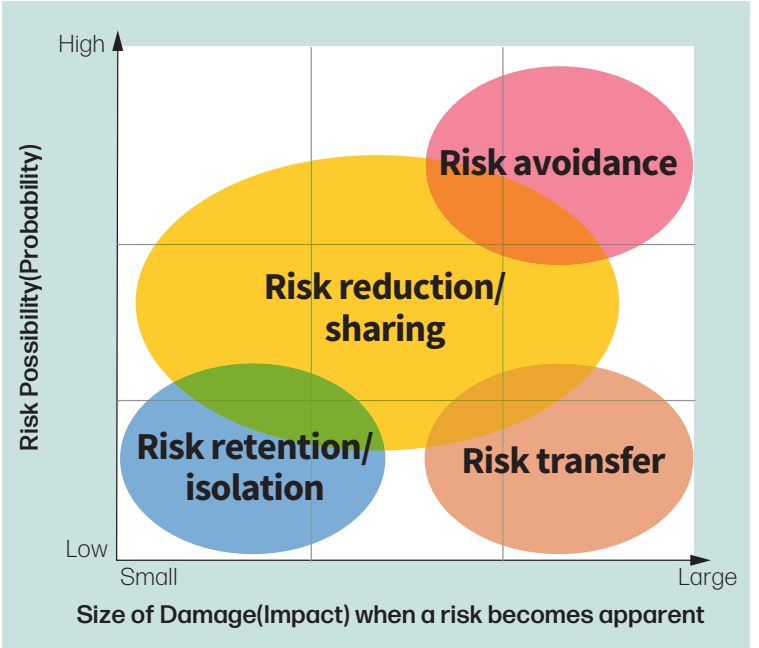


Fig. 11 Risk management correlation diagram
Source: Information security management and the PDCA cycle : Information-technology Promotion Agency, Japan (IPA)

An illustration of the existing risks when carrying out work on board is shown in Figure 12.

In this example, the diagram on the left shows that there are five risks on board. Then, a risk assessment was implemented on board before the start of operation, and as a result of the above mentioned countermeasure in place, three risks remained on board, as shown in the below diagram.

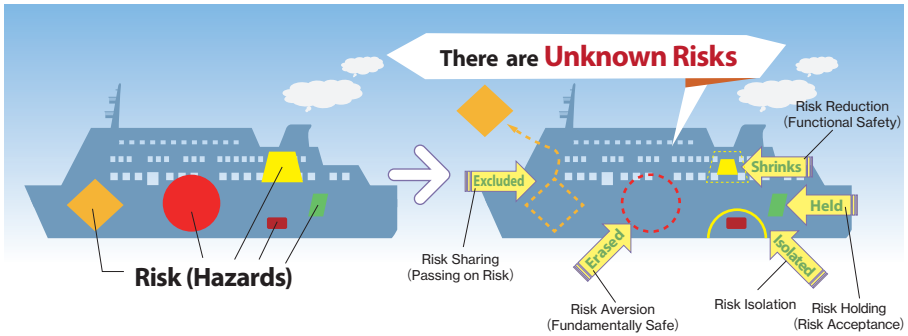


Fig. 12 Diagram of risk management

However, the reality is that it is difficult to eliminate or remove risks in actual on board operations. Therefore, it seems that most of the countermeasures are "managing residual risk", such as reduction, and risk holding by sharing information among the crew, or isolating it by means of shipboard work. However, even with these countermeasures in place, it is a must to be aware that there is still a potential unknown risk that none of the crew will be aware of. These countermeasures can be prioritised as shown in Figure 15.

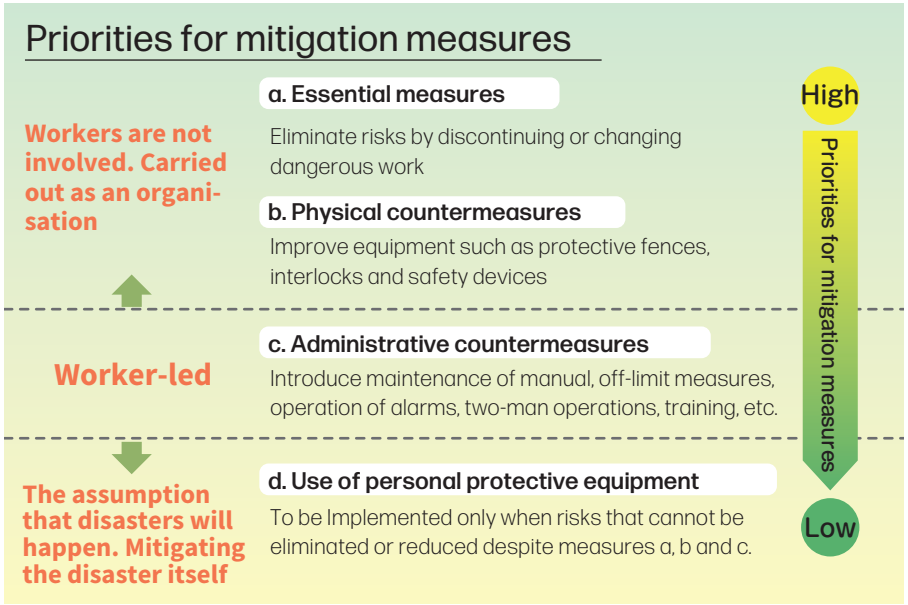


Fig. 13 Priorities for reduction measures

In Figure 13, "a. Essential measures" refers to the measures mentioned in Figure 12, such as removing or eliminating the risk. If these measures are implemented, the risk itself will disappear from the vessel and safety will be maintained instead.

In addition, "b. Physical countermeasures", also shown in Figure 12, is a measure such as isolation, which can be simply dealt with by shipboard work, but it is often difficult to implement on board in practice because of the cost.
Therefore, these two countermeasures require a response from the company, with little or no crew involvement.

On the other hand, countermeasures "c. Administrative countermeasures" and "d. Use of personal protective equipment" refer to the reduction and holding of risks in Figure 14, which shows the above mentioned "managing residual risk". In "c. Administrative countermeasures", these are to be considered by both the ship management company or shipowner and the crew and, possibly incorporated into the safety management code and SMS manual. However, these countermeasures do not eliminate the risk from the vessel.

In addition, countermeasure "d. Use of personal protective equipment" is only applicable if the risk level is low and the risk held is determined as is. This is a reactive measure, which assumes that a disaster will occur and mitigates the damage.
Obviously, the priority is higher for "a. Essential measures", but from the crew's point of view, the idea of differentiating risk levels in this way has never been applicable before, and they may not be accustomed to the idea of prioritisation per se either.

Residual risk management

Residual risk is defined in the ISO/IEC Guide 51 as "risk (3.9) remaining after risk reduction measures (3.13) have been implemented".

As mentioned above, the limited and special working environment of a ship makes it

difficult to take essential and physical countermeasures. For residual risks, the concept of "ALARP" as described below is less familiar to the vessel. However, the vessel and the shipowner and ship management company must be fully aware of these residual risks.

ALARP

ALARP: As Low As Reasonably Practicable
As explained in 10(2) of the "Guidelines and Commentary on the Investigation of Danger or Hazards, etc." (provisional translation) by the Safety Division of the Industrial Safety and Health Department, Ministry of Health, Labour and Welfare (MHLW) in 1999, risk is the "concept of reducing risk appropriately to as low a level as is reasonably practicable (ALARP) by implementing higher priority risk reduction measures as far as reasonably practicable." (Provisional translation)

Risk can be divided into the following three areas:(Figure 14)

(a) An area of risk where the risk is too great to be tolerated at all (Intolerable).
(b) An area where the risk is considered to be small or too small. A generally acceptable risk (Broadly acceptable).
(c) Area between (a) and (b), and it is required to be reduced to a level that is realistic, taking into account both benefits of accepting that risk level and the costs of further reducing it (ALARP region).

There are a large number of explanations regarding the ALARP region, but it has not (and cannot) been defined as to what risk level reduction is acceptable, as it varies from case to case.

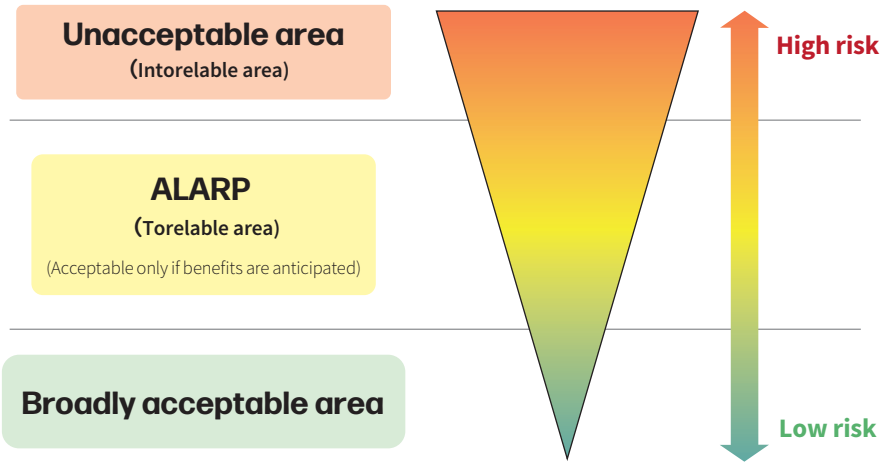


Fig. 14 ALARP region

Please note that the acceptable risk level is not future-proof, but constantly changing, as it is determined by the below factors:

- The values of today's society
- The search for the best balance between the ideal of absolute safety and what can be achieved
- Requirements/specifications that are compatible with the task (system)
- Optimality factors for objectives and cost effectiveness

Remarks on risk management(countermeasures for risk reduction)

The following points should be noted when considering and implementing countermeasures for risk reduction.

When formulating

- This is to be carried out mainly by supervisors such as the Master/Chief Engineer and Chief Officer/First Engineer. If necessary, a draft proposal

is drawn up, with advice from the ship management company and other experts.

- It is important that a broad range of risks is extracted. The first step in this process is to specify the differences between “direct and deliberate actions and reasonably foreseeable misbehaviours or error in operation”. Then, based on the purpose of the work and the environmental conditions of the workplace, the work process then needs to be clarified. At the same time, naturally assuming that “people make mistakes and errors”, we need to be able to anticipate the kinds of mistakes and errors that people will make, to get a full picture of these and to identify weaknesses in advance.
- It is important to check if the draft conforms with the standard of laws and ordinances, safety management codes and SMS manuals.
- In addition, any mitigation measures that have been formulated need to be checked that they have not created any new risks.
- The possibility of transferring the risk through Essential or Physical countermeasures is to be also considered.
- The mitigation measures (a draft proposal) prepared by the supervisors such as Master/Chief Engineer or Chief Officer/First Engineer are to be explained to the crew and all ideas that can be put forward are discussed and refined. The final risk reduction measures are then shared with the shipowner and ship management company.
- The shipowner and ship management company should re-evaluate the risk reduction measures developed by the vessel and feed back the results to the vessel.
- No mitigation measures should be taken that intentionally (or arbitrarily) reduce the risk level. Also, verify which risk factors (hazards) are affected by the mitigation measures to be implemented.
- Countermeasures that rely on Man/People (crew here) do not, in principle, reduce the risk level.
- We have to think more on the safe side, bearing in mind that skill levels vary from person to person.

While working

- A supervisor must be present during the work to oversee its implementation. A record, including photographs, must be kept. It is also a recommendable idea to create a format for the report form.
- Regarding operations in the context of risk reduction and holding, it is possible that some of the mitigation measures developed cannot be implemented immediately, or may not function effectively. In this case, either provisional measures (obviously more safety-oriented) must be implemented on board with the approval of the supervisor, or the work must be terminated. In the event of any provisional measures taken or work terminated, it is a requirement that it be reported immediately to the shipowner or ship management company to receive advice as well.

After completing the operation

- It is important to have a Review Meeting every time to check that there was no trouble.
- The results should be shared with the crew and a record made and reported to the shipowner and ship management company. The reports from each ship are accumulated as company know-how and become a technical resource for the creation of a strong workplace on board.

The company’s management of the database enables it to provide information to each ship and workplace on board in a timely manner.

3 Risk communication

The definition of risk communication is given in “Efforts for risk communication concerning food safety” in the Ministry of Health, Labour and Welfare’s homepage.

Definition of risk communication

Risk communication is the mutual exchange of information and opinions between risk assessors, risk managers, consumers, operators, researchers and other interested parties during the entire risk analysis process. It includes an explanation of the results of the risk assessment and of the risk management decisions.

- “Sense of security”, which is present progressive [continuous] in form, is placed on top of “safety”, consisting of a sequence of events in the past (including risks acceptable according to science, technology and technicians). (Fig. 15)
- Regarding the structure of risk communication, “safety” is formed by science, technology and technicians; the next level consists of “risk assessment” and “risk management” , then on top of that comes risk communication supporting the “sense of security” in the shape of two “wedges” which mean trust.
- The vessel, the ship management company and the shipowner are all interchangeable. It is important to reassure clients (owner and charterer) through risk communication about the “safety measures” that have been established.
- In the case of actual work on board, the crew must be able to carry out their work with a “sense of security” .

In other words, it is not possible to maintain safety if the Master/Chief Engineer or Chief Officer/First Engineer is left holding on to the prevention countermeasures, against accidents, that have taken so much effort and time to be established, and it is not possible for the crew to carry out the work with a sense of security.

Therefore, we must communicate the countermeasures we have developed to all parties involved, and that the risks which are shared, reassurance, and a sense of security supported by mutual trust, are firmly established. Risk communication is the method to achieve this.

Fig. 15 Risk communication connecting safety and sense of security

Figure 12 on P.26 shows five risk countermeasures on board. Inevitably, with on board operation, it is difficult to take essential countermeasures that exclude or erase risks; we can only reduce or hold the residual risks that remain. In addition, there are unknown risks that no one on board will be aware of, and it is in these fluctuating conditions that the safety of the ship is maintained. This means that shipowners, ship management companies and charterers etc. have to be prepared for any possible trouble that may occur on board at any time.

It is necessary to make these risk measures (reduced or held) visible and to share information between crew members and between the ship and the shipowner or ship

management company, in order to support each other through mutual trust via risk communication.

But is there still a lack of risk communication within the vessel and between the shipowner and the ship management company?

The approach of increasing the level of safety through risk communication is known as the Johari Window. By analysing information about the self as seen by the self and the self as seen by others, we can understand the self in the following four ways.

The Johari Window model

1. Personality known by the person as well as by others (Public : Open window)
2. Personality known about the person by a group that the person is unaware of (Blind spot window)
3. Personality that a person knows about themselves that is kept unknown to others (Hidden window)
4. Personality that is unknown by the person about themselves that is also unknown by others (Unknown window)

Let us consider how this might apply to risk assessment. When blind spots, hidden, and unknown areas are reduced and risks that are existing are shared via risk communication, the public (Open window) area is expanded. And by reducing these unknown risks as much as possible, the safety level is steadily increased. (See Figure 16)

In other words, the Open area specifies that all members within the range of activity, including the vessel and its land management department (shipowner and ship management company), are equally aware of the danger, thus proactive measures can be taken.

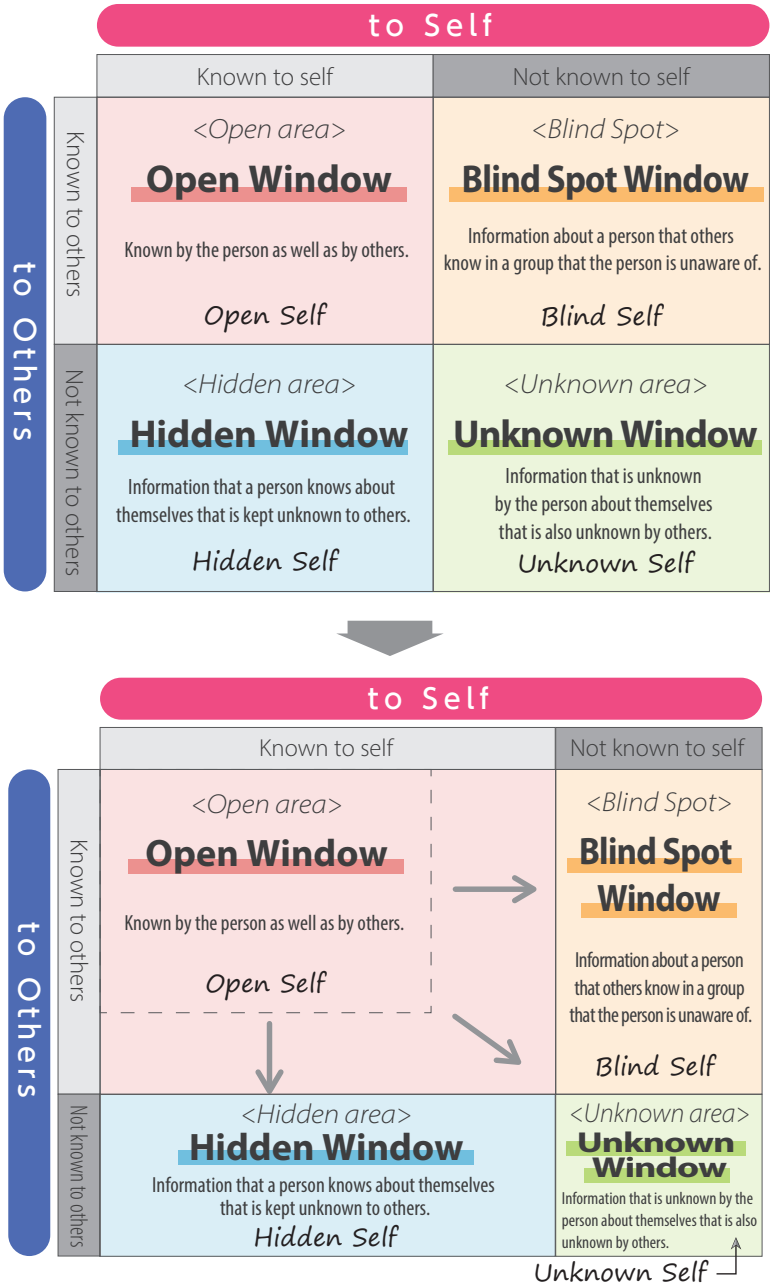


Fig. 16 Johari Window

3-5 Why is risk assessment not effectively utilized on a vessel and/or by ship management companies? = Problem areas =

Problem areas

As described above, it is understood that the combination of risk assessment and BRM/ERM described at the beginning of this guide is an effective means of prevention (through countermeasures) against accidents, especially when carrying out any unusual (unfamiliar) work on board. Therefore, why are we not able to carry it out effectively, despite the fact that we are aware of this?

Seemingly, there are mainly four reasons why risk assessment is not effectively utilized on a vessel and/or by ship management companies:

- It is not easily incorporated on board
- Psychological factors
- The ambiguity between safety and danger
- Human resource problem: The need to train personnel who can identify risks

The combined effect of these four factors is that risk communication, which is based on trust among crew members and between ship and shore, does not work effectively and becomes more difficult to carry out.

3-5-1 The difficulty of incorporating risk assessment on board a vessel

In the first place, risk assessment is one management tool used in corporate management such as compliance and fraud prevention.

As shown in Figures 6 (on P.13) and 17, the social context in which companies operate has since changed dramatically that corporate social responsibility is now no longer just lip service. Compliance with the law and regulations is of course a given, and even if not legally punishable, companies with poor awareness of compliance, environment and safety can be seen by public opinion as “below investment grade” which may seriously damage the business’ reputation and ability to operate. In fact, this has actually happened in the past. And since the measures established by risk assessment are costly, they are operated based on the concept of “visualisation: a numerical understanding” of cost-effectiveness through an index of frequency of occurrence.

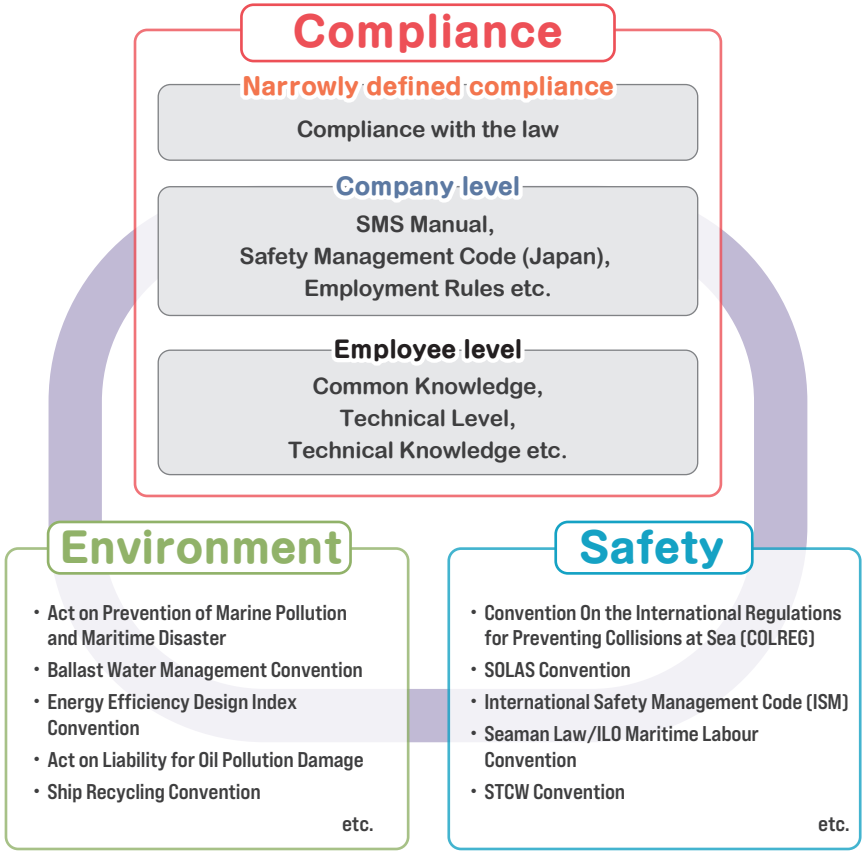


Fig. 17 Compliance in a broad sense

On the other hand, a ship is required to "operate with 100% safety". This means that safety measures must be implemented regardless of the frequency or severity of incident occurrence. In other words, neglecting a risk that is close to zero in frequency on the vessel would be unthinkable. There was no idea that the crew, as technicians, would be expected to accept the aforementioned "risk prioritisation" and "ALARP region" requirement.

Based on this awareness and concept, the results of the risk assessment practised on the vessel are reported to the ship management company. However, if the managing departments (managers) are instructed to "take no positive action despite the high severity of the index due to the cost involved" and feed this back to the ship, those on board may find this difficult to accept, which may result in a loss of trust between ship and shore.

In particular, when people in higher positions (such as the management layer of a management company or the Master of a ship) are two-faced, it only causes confusion among their subordinates. As a result, on board the vessel as a workplace, they will only follow instructions from the company and will not "question" a decision.

This may be one of the reasons why risk assessments are not so familiar on board a ship, owing to the difficulty of incorporating risk assessments.

3-5-2 Inability to utilize psychological factors effectively

There are psychological factors that prevent risk assessment from being utilized effectively. This can make risk communication difficult, which in turn makes risk assessment difficult to practice. There are two main psychological factors here.

Fig. 18 Factors that make Risk communication difficult

Perception gap for risks

There is a gap between "actual risk" and "perceived risk".

- **Hazard perceived to be greater than the actual risk**
  This is amplified when faced with unknown risks, little information, or hazards that we do not understand well or have no control over.
- **Hazards perceived to be smaller than the actual risk**
  We have a tendency to believe that it is smaller because of the clear convenient or beneficial factors, when we attempt to play the hazard down by ourselves. This is where "Normalcy Bias" ("I'm special, nothing can hurt me!) or Confirmation Bias" ("Stop exaggerating!") come to the fore.

Assumptions about safety

If, in the 12 Human characteristics that we all have, "⑨ Human beings sometimes make assumptions" comes to the fore, and Normalcy Bias (this is when people believe, "I'm special, nothing can hurt me") is triggered making us assume that this is correct, it will be more difficult for us to change this way of thinking.(See figure 52)

For example, when on board, are not the following assumed?

- Ships are built to be safe.
- In the periodic maintenance of the equipment in the engine room, it is not yet time for open maintenance, because it is within the manufacturer's

recommended operating time.

- We pass this sea area all the time and there are not many fishing vessels today, so it will be safe to leave the bridge watch shift to the duty officer only.
- This is what we have been doing all along, and we've never had any problems before, so there's no risk involved. We really do not need to practice a risk assessment of anything.

And so on...

3-5-3 The blurring line between safety and danger

As explained in 3-5-1, unlike the manufacturing industry on land, the environment on board a vessel does not have the concept of risk prioritisation or ALARP regions. In addition, the concept of risk did not exist in the Japanese language, but when the method of risk assessment was introduced here, it could be said that the crew felt uneasy about the middle ground between danger and safety (Fig. 19).

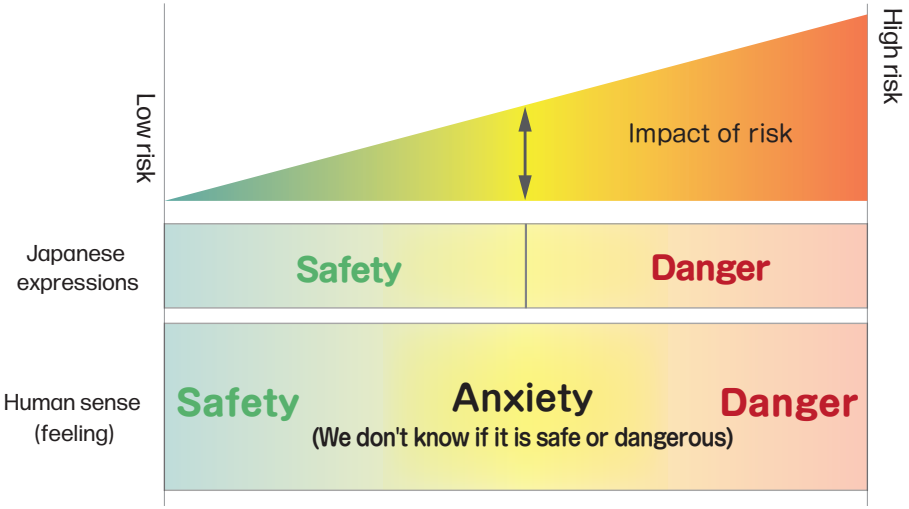


Fig. 19 The blurring line between safety and danger

It is easy for crew or a technician to distinguish the difference between risks that are, by anyone's reckoning, "major and unacceptable", and risks that are "minor and generally acceptable". However, if we do not properly use risk communication for the risks that lie in between, and fail to connect safety which is supported by the science, physics, technology and engineers that we have developed, with the sense of security which is supported by trust that is built on top of it, the result will be the very opposite of security. This may be one of the reasons why risk assessment has not been successfully implemented on board.

This is especially true in the case of vessel operations, where the severity of the risk may be minor, but if it leads to absence from work, it can have a direct impact on other vessel operations as replacements cannot be arranged immediately. In addition, when shipowners, ship management companies and other shore based management departments suggest an "interim response: ALARP", the common nature of technicians (see Loss Prevention Bulletin Vol.50 for more details) means that they have no choice but to follow the instructions, despite their opposition, which may make them even more anxious.

3-5-4 An absence of human resource development to identify risks

It has only been around a decade since risk assessment was introduced to the maritime industry, this is partly due to a lack of familiarity with the concept of risk assessment on board ships and in the land management department, and partly due to a lack of trained personnel to lead risk assessments. It is quite common in the manufacturing industry on land, and various training courses are offered, so it is a good idea to participate in them for our human resource development.

§ 4 How to Handle Risk Assessment

4-1 Fundamental countermeasures

4-1-1 On the vessel

The purpose of risk assessment is to prevent any accidents occurring by communicating and sharing information about risks such as blind spots, hidden and unknown areas among crew members, or between the vessel and management at the shore catering department such as the shipowner and ship management company, in the event of carrying out various risky operations.

It is therefore important that the briefing includes all of those involved in the operation and that the results be announced to the crew and shore management, rather than it being carried out by the Master/Chief Engineer or Chief Officer/First Engineer only at a desk.

In order for risk assessments to be effective, the following must be taken into account:

- The vessel must also be cost conscious. Please note that our top priorities are "safe operations" and "safety first".
- What is important in risk assessment is to clarify 5W1H plus 2F1H (For what, For whom and How much (cost conscious) before starting any work, and to study countermeasures by identifying "what risks" are involved on board from an "objective and bird's eye view" and to consider countermeasures. In particular, it is strictly forbidden to deliberately underestimate the "assessment of severity" .
- The Master/Chief Engineer or Chief Officer/First Engineer should also carefully consider and quantify the "Frequency" to determine the risk level. In particular, measures to further reduce the risk level must be considered for those judged to have a medium, high or very high risk level.
- Report to the person in charge of the company once the pre-operational risk assessment of the vessel has been completed. In this case, for those with a medium, high or very high level of risk, further explanation will need to be provided as to "why the level of risk could not be reduced to low or very low and the kind of work necessary" when planning countermeasures.

4-1-2 Management at the shore catering department : shipowner and ship management company

Once the results of the pre-operational risk assessment of the vessel have been received, the ship's superintendent should not carry out the assessment by him or herself as a management representative, but should ensure that the contents of the report from the vessel are reviewed by several parties, including the risk manager. Management at the shore catering department such as the shipowner and ship management company should note the following points when assessing the report from the vessel.

- For those with a medium risk level (region of uncertainty) or low risk level (region of safety), the content should be examined and additional advice given as necessary.
- For "high/very high" risk levels reported as hazardous areas, measures should be considered with a view to on shore support.
- The results of the evaluation and feasibility of the work determined by the land management department must be fed back to the vessel prior to the planned start of operation. This must always include the following information. Without such an explanation, trust between ship and shore will erode.
  - Company is to decide on whether or not work can be carried out based on the results
  - Additional countermeasures to be taken by the company to reduce the level of risk
  - Clear instructions on the timing and location (port) of implementation
  - If not implemented, a reasonable reason for not doing so, is to be provided,

etc.

Fig. 20 The importance of mutual trust

More importantly, if top management does not implement the countermeasures taken both on board and on land, their existence will quickly become meaningless. It is no exaggeration to say that "awareness raising" at management level is key to the continuation of risk assessment.

Fig. 21 Top management practice

4-2 Risk assessment in practice

4-2-1 Practice

As explained in §3 3-5, Why is risk assessment not effectively utilized on a vessel and/or by ship management companies? "=Problem areas=", we understand that risk assessment is an effective accident prevention measure, but know also that it is not yet at a practical level to be easily carried out. However, there is no need to dwell on this too much, because it will be incorporated more easily if we think of it as simply making something that has been done implicitly on board the ship "Visualization" by using a risk assessment table.

Unlike land-based industries, including manufacturing, where crews change every few months and are far removed from management, a risk assessment can increase the level of safety.

- In particular, before carrying out any unusual (unfamiliar) work (e.g. tank inspections, open maintenance or repair of critical equipment, work on board while in dock)
- For routine tasks such as weighing the anchor, entering or leaving port, etc. when the crew changes

4-2-2 Functional sustainability

In order for risk assessment to be functional, it is necessary to have a predetermined system of organisation and review procedures. It is therefore essential to regularly review and improve the organisational systems that enable risk assessment to take place. The key elements of a risk assessment are:

- Creating a risk assessment system
- By enabling the organisation to be capable of utilizing risk assessment effectively

- Specific rules are needed such as “At what stage, who by, and when is it to be conducted?” and “How will the results be utilized?”
- Regular risk assessment reviews are also important (To be aware of the need to respond in a timely manner to changes in society’s tolerance levels)
- Practise as early in the process as possible (phases of design and planning)
- Risk assessments should be repeated for “designs with changing tasks or objectives” and for “new or revised critical processes that have been planned”
- Practise from a variety of perspectives, including with multiple personnel members
- Consider all processes in the operation procedure
- Information should be collected at the earliest opportunity in order to evaluate, review and take action
- The results of the review should be stored in a database and used when planning subsequent new work or work that needs to be redone
- Human resource development to identify risks
- Continue to gather, review, evaluate data and consider public information in the search for the best solution after the work has been carried out

4-3 Risk assessment procedures

4-3-1 From the perspective of frequency, likelihood (probability) and severity

As we have seen in detail in Chapter 3, if we now summarise the processes leading to personal injury and trouble in terms of “frequency, likelihood and severity”, we can see the relevance, as shown in Figure 22.

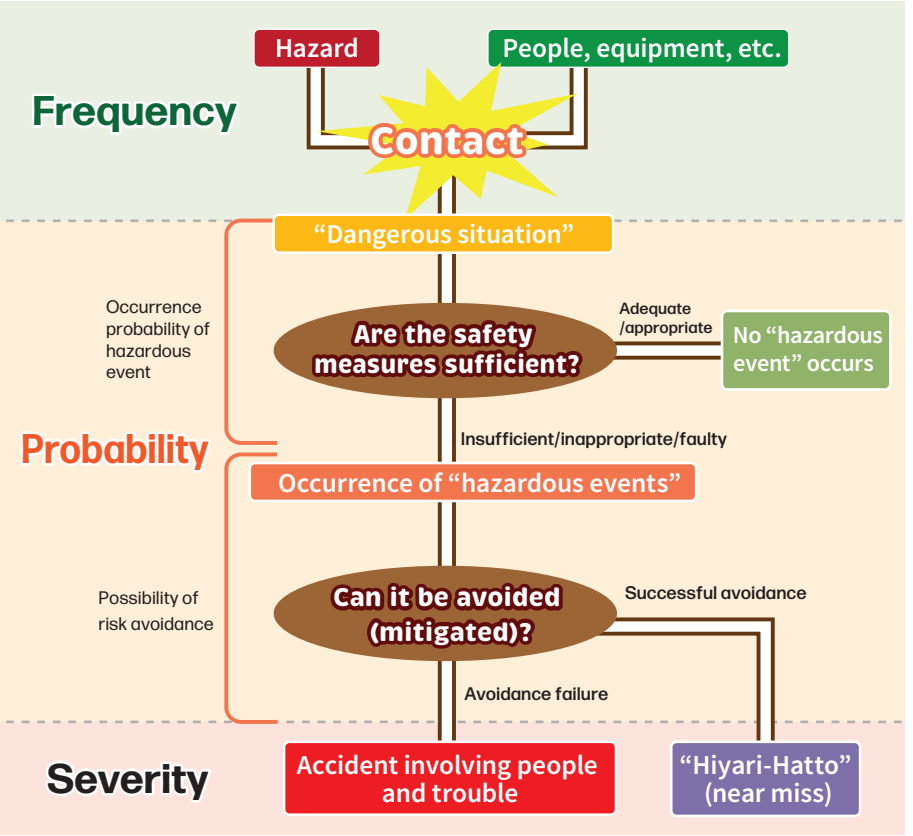


Fig. 22 Process leading to personal injury or trouble and its relationship with frequency/probability/severity

Identify the frequency of dangerous situations, examine the occurrence probability of hazardous event avoidance, and assess the severity of personal injury and trouble if risk avoidance fails.

4-3-2 Procedure (Example) (Fig. 23 and 24 Attachments 4 and 5)

Pre-work assessment table (Fig. 23) and Risk assessment table (Fig. 24) are to be used here.

On the Vessel

A risk assessment meeting is to be held with the related crew members regarding the work to be carried out.

- Identify possible risks and hazards where possible and determine the level of risk using the Pre-work assessment table.
- For each of the risks identified, measures are considered and changes in the risk level are assessed.
- This is then compiled and reported to the management department responsible such as the shipowner or ship management company on shore.

Management at the shore catering department : shipowner and ship management company

A risk assessment meeting is to be held with the relevant parties.

- For each risk listed in the Pre-work assessment table submitted by the vessel, it is to be assessed by the managing shore catering department.
- In addition, the results are transferred to a risk assessment table and a decision is taken on whether to carry out medium or high level risk work, which is then fed back to the vessel.

Attachment 4

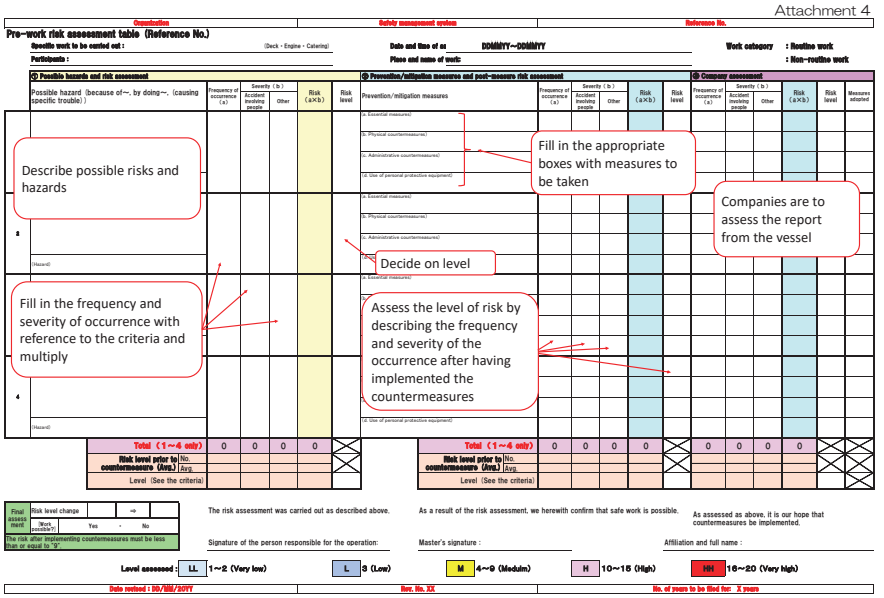


Fig. 23 How to fill in the Pre-work risk assessment table

Attachment 5

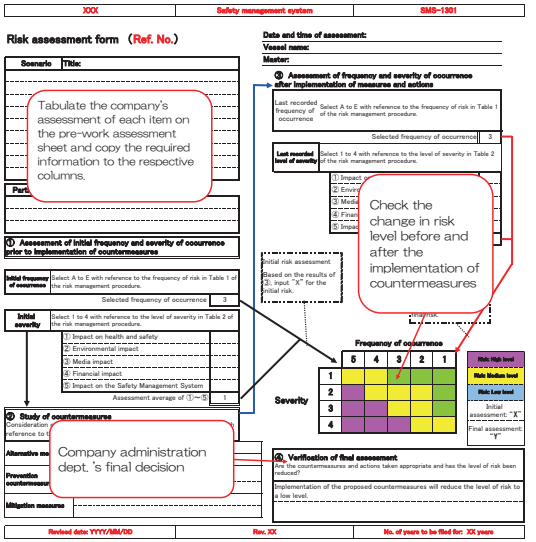


Fig. 24 Risk assessment table by management department on land

4-3-3 Risk assessment example = rough weather preparation =

As an example, the risk assessment will cover the Deck department, the Engine department and the Catering department assuming rough weather preparation for a typhoon forecast from dawn the next day. Please refer to Attachments 6 to 14 for the Pre-work assessment tables of each department.

① Deck department (Figs. 25,26,27, and 28 Attachments 6, 7 and 8)

A total of eight risks were identified on the vessel and the results are summarised as below.

- Mean value in Frequency of occurrence : 3
- Mean value in Severity (Personal injury) : 4
- Mean value in Severity (Non-personal injury) : 4
- Risk level (Applied both Personal injury and Non-personal injury) : 12 (H)

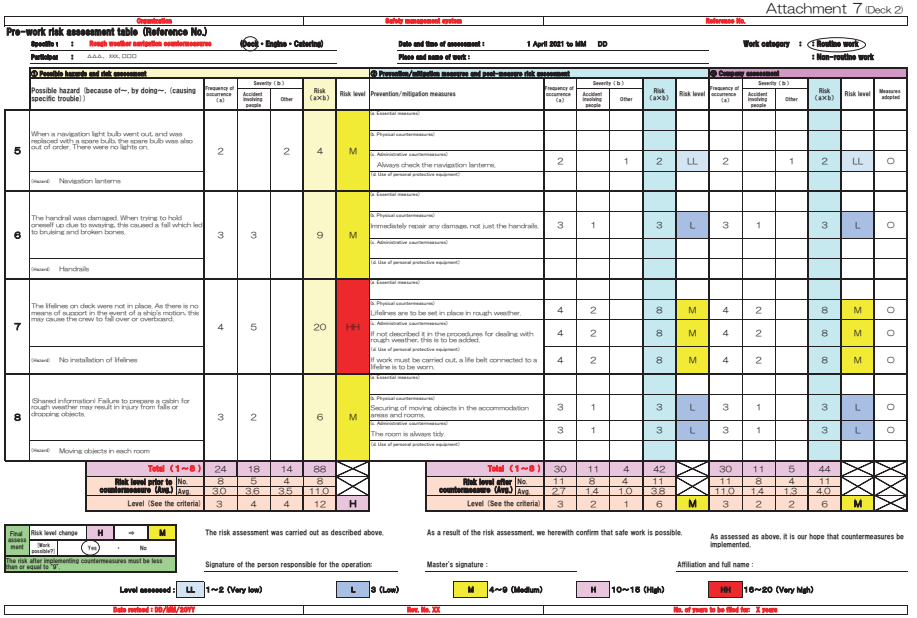
For the risks identified above, the following countermeasures were established. The risk level is the product of frequency of occurrence and severity.

- Mean value in Frequency of occurrence : 3
- Mean value in Severity (Personal injury) : 2
- Mean value in Severity (Non-personal injury) : 1
- Risk level (Personal injury) : 6 (M)
- Risk level (Non-personal injury) : 3 (L)

By preparing for rough weather on the deck, Accidents involving people has dropped from (H) to (M) and Non-personal injury from (H) to (L). Accordingly, in this example, the higher overall risk level of 6 (M) for personal injury has been adopted.

Attachment 7

Attachment 7 (Deck ②)



Pre-work risk assessment table (Reference No.)

Operation : Rough weather navigation countermeasures (Deck · Engine · Catering)

Particulars : AAA, XXX, DDD

Safety management system

Reference No.

Date and time of assessment : 1 April 2021 to MM DD

Place and name of work :

Work category : (Routine work) / Non-routine work

	① Possible hazards and risk assessment						② Prevention/mitigation measures and post-measure risk assessment							③ Conveyor assessment					
	Possible hazard (because of~, by doing~, (causing specific trouble:)	Frequency of occurrence (a)	Severity (b) Accident involving people	Severity (b) Other	Risk (a×b)	Risk level	Prevention/mitigation measures	Frequency of occurrence (a)	Severity (b) Accident involving people	Severity (b) Other	Risk (a×b)	Risk level	Measures adopted	Frequency of occurrence (a)	Severity (b) Accident involving people	Severity (b) Other	Risk (a×b)	Risk level	Measures adopted
5	When a navigation light bulb went out, and was replaced with a spare bulb, the spare bulb was also out of order. There were no lights on. (Hazard) Navigation lanterns	2		2	4	M	A. Essential measure(s): B. Physical countermeasure(s): C. Administrative countermeasure(s): Always check the navigation lanterns. D. Use of personal protective equipment:	2		1	2	LL		2		1	2	LL	○
6	The handrail was damaged. When trying to hold oneself up due to swaying, this caused a fall which led to bruising and broken bones. (Hazard) Handrails	3	3		9	M	A. Essential measure(s): B. Physical countermeasure(s): Immediately repair any damage, not just the handrails. C. Administrative countermeasure(s): D. Use of personal protective equipment:	3	1		3	L		3	1		3	L	○
7	The lifelines on deck were not in place. As there is no means of support in the event of a ship's motion, this may cause the crew to fall over or overboard. (Hazard) No installation of lifelines	4	5		20	HH	A. Essential measure(s): B. Physical countermeasure(s): Lifelines are to be set in place in rough weather. C. Administrative countermeasure(s): If not described it in the procedures for dealing with rough weather, this is to be added. D. Use of personal protective equipment: If work must be carried out, a life belt connected to a lifeline is to be worn.	4 4 4	2 2 2		8 8 8	M M M		4 4 4	2 2 2		8 8 8	M M M	○ ○ ○
8	(Shared information) Failure to prepare a cabin for rough weather may result in injury from falls or dropping objects. (Hazard) Moving objects in each room	3	2		6	M	A. Essential measure(s): B. Physical countermeasure(s): Securing of moving objects in the accommodation areas and rooms. C. Administrative countermeasure(s): The room is always tidy. D. Use of personal protective equipment:	3 3	1 1		3 3	L L		3 3	1 1		3 3	L L	○ ○
	Total (1~8)	24	18	14	88			30	11	4	42			30	11	5	44		
	Risk level prior to countermeasure (Ave.)	No. 8	5	4	8		Risk level after countermeasure (Ave.)	No. 11	8	4	11			11	8	4	11		
		Avg. 3.0	3.6	3.5	11.0			Avg. 2.7	1.4	1.0	3.8			11.0	1.4	1.3	4.0		
	Level (See the criteria)	3	4	4	12	H	Level (See the criteria)	3	2	1	6	M		3	2	2	6	M	

Final assessment — Risk level change H ⇒ M; Work possible? (Yes) / No

The risk after implementing countermeasures must be less than or equal to "9".

The risk assessment was carried out as described above.

Signature of the person responsible for the operation:

As a result of the risk assessment, we herewith confirm that safe work is possible.

Master's signature :

As assessed as above, it is our hope that countermeasures be implemented.

Affiliation and full name :

Level assessed : LL 1~2 (Very low) L 3 (Low) M 4~9 (Medium) H 10~15 (High) HH 16~20 (Very high)

Date revised : DD/MM/20YY Rev. No. XX No. of years to be filed for: X years

Fig. 25 Pre-work risk assessment table : Deck (Attachment 7)

In the example, eight risks have been identified, and we will now compare two of them with a significantly lower risk level.

If there is no countermeasure:

① Possible hazards and risk assessment

	Possible hazard (because of~, by doing~, (causing specific trouble))	Frequency of occurrence (a)	Severity (b)		Risk (a×b)	Risk Level
			Accident involving people	Other		
1	Failure to plan for evacuation in a rough sea area, and failure to inform relevant parties of estimated arrival delays, resulting in confusion in rescheduling	2	–	4	8	M
	(Hazard) No review of the voyage plan					

With an email or telephone call:

② Prevention/mitigation measures and post-measure risk assessment

	Prevention/mitigation measures	Frequency of occurrence (a)	Severity (b)		Risk (a×b)	Risk Level
			Accident involving people	Other		
1	(a. Essential measures)					
	(b. Physical countermeasures)					
	(c. Administrative countermeasures) If there is a significant change in estimated time of arrival, this is to be reported immediately	2	–	1	2	LL
	(d. Use of personal protective equipment)					

Fig. 26 Risk assessment regarding countermeasures for rough weather on Deck (Example 1) (Extracted from Attachment 6 and 7)

Failure to plan for evacuation in a rough sea area, when the vessel actually enters a rough sea area, causing a significant delay to the estimated time of arrival (ETA), or where the vessel has made an evacuation plan but has not informed the related parties such as charterers etc. of the revised ETA, its failure to share information can cause confusion on shore, because it is assumed that the vessel will arrive as originally scheduled, and arrangements are made for entering port and cargo handling.

This may result in Off Hire Cases. If this were left as it is, the ship would need to be contacted, so this is rated under Frequency as "2: infrequent", and Severity as "4" as it would interfere with the ship's operations. Multiplied by this, the risk level becomes 8:M. If this is communicated by email or phone call, the shore side will know what is going on and will be able to plan countermeasures in advance. This has been assessed as a reduction in severity to "2" with a risk level of 2 : LL. It shows the importance of communication between ship and shore.

If there is no countermeasure:

① Possible hazards and risk assessment

	Possible hazard (because of~, by doing~, (causing specific trouble))	Frequency of occurrence (a)	Severity (b)		Risk (a×b)	Risk Level
			Accident involving people	Other		
4	Failure to close watertight doors, through which water can enter and cause wet damage. or, fractures caused from being caught in a watertight door.	4	5	4	20	HH
	(Hazard) Watertight doors					

With just a simple effort:

② Prevention/mitigation measures and post-measure risk assessment

	Prevention/mitigation measures	Frequency of occurrence (a)	Severity (b)		Risk (a×b)	Risk Level
			Accident involving people	Other		
4	(a. Essential measures)					
	(b. Physical countermeasures) Watertight doors are always to be securely closed and, if necessary, locked	2	1	1	2	LL
	(c. Administrative countermeasures)					
	(d. Use of personal protective equipment)					

Fig. 27 Risk assessment regarding countermeasures for rough weather on Deck (Example 2) (Extracted from attachment 7)

Also, if the watertight doors at the entrance to the accommodation area are left open (or not closed properly), there is a possibility that water will enter through them. It is also possible that a person could get caught in a door and break a bone in the rush to close it in rough weather.

By identifying these risks, it is possible to avoid inadvertent memory lapse (errors in the memory process) by appointing (specifying) who is responsible for closing watertight doors (e.g. Boatswain (Bsn)) and having them report back explicitly when the work is completed.

Therefore, the risk level is assessed as 20 : HH because of the potential for serious injury if left unattended. However, the risk level can be reduced to 2 : LL by ensuring that the watertight doors are closed and reported, and that a supervisor, such as a Master or Chief Officer (C/O), visually inspects the site.

The closing work of watertight doors is one of the countermeasures for rough weather that we take for granted, but by practising a risk assessment and sharing the information with the crew, we can ensure that we don't carelessly forget to do it.

The vessel's pre-work risk assessment table is reported to the ship management company's responsible department, which reviews the ship's report and re-evaluates it each item. The results are then posted on the risk assessment table (Fig. 28) and fed back to the vessel with a decision on whether or not to proceed. In this example, the risk level has been reduced from HH to M, and although it is in the ALARP region, it has been determined a tolerable area.

Attachment 8

XXX | Safety management system | SMS-1301

Risk assessment form (Ref. No.)

Date and time of assessment:
Vessel name:
Master:

Scenario	Title:
	Study of countermeasures for rough weather
	Risk assessment regarding countermeasures for rough weather on the Deck

Participants
Capt., C/O, 2/O and 3/O
Bsn, AB x 3, OS x 2
10 personnel in total

① Assessment of initial frequency and severity of occurrence prior to implementation of countermeasures

Initial frequency of occurrence: Select A to E with reference to the frequency of risk in Table 1 of the risk management procedure. Selected frequency of occurrence: 3

Initial severity: Select 1 to 4 with reference to the level of severity in Table 2 of the risk management procedure.

① Impact on health and safety	4
② Environmental impact	–
③ Media impact	–
④ Financial impact	4
⑤ Impact on the Safety Management System	–
Assessment average of ①~⑤	1

② Study of countermeasures
Consideration of alternative methods, preventive/mitigation measures with reference to the procedure manual

Alternative means	Fixing of moving objects
	Strengthening of communication between the charterer and the ship management company
Prevention countermeasures	Fixing of moving objects
	Strengthening of communication between the charterer and the ship management company
Mitigation measures	

③ Assessment of frequency and severity of occurrence after implementation of measures and actions

Last recorded frequency of occurrence: Select A to E with reference to the frequency of risk in Table 1 of the risk management procedure. Selected frequency of occurrence: 3

Last recorded level of severity: Select 1 to 4 with reference to the level of severity in Table 2 of the risk management procedure.

① Impact on health and safety	2
② Environmental impact	–
③ Media impact	–
④ Financial impact	1
⑤ Impact on the Safety Management System	–
Assessment average of ①~⑤	2

Initial risk assessment: Based on the results of ②, input "X" for the initial risk.
Final risk assessment: Based on the results of ③, input "Y" for the final risk.

Frequency of occurrence / Severity

Severity \ Frequency	5	4	3	2	1
1					
2			Y		
3					
4		X			

Risk: High level
Risk: Medium level
Risk: Low level
Initial assessment: "X"
Final assessment: "Y"

④ Verification of final assessment
Are the countermeasures and actions taken appropriate and has the level of risk been reduced?

YES. Implementation of the proposed countermeasures will reduce the level of risk to a low level.

Revised date: YYYY/MM/DD | Rev. XX | No. of years to be filed for: XX years

Fig. 28 Risk assessment regarding countermeasures for rough weather on Deck

② Engine department (Figs. 29,30,31 and 32 Attachments 9, 10 and 11)

As with the Deck, a total of 8 risks were identified and the change in risk level between before and after measures are implemented is shown below. The severity of Personal injury has reduced from 12(H) to zero and Non-personal injury severity has reduced from 12(H) to 6(M).

	Before measures are implemented		After measures are implemented
・Mean value in Frequency of occurrence :	3	➡	3
・Mean value in Severity (Personal injury) :	4		–
・Mean value in Severity (Non-personal injury) :	4		2
・Risk level (Personal injury) :	12 (H)		–
・Risk level (Non-personal injury) :	12 (H)		6 (M)

Attachment 10

Pre-work risk assessment table (Reference No.)

Specific ： Rough weather navigation countermeasures (Deck・Engine・Catering)

Particulars ：

Date and time of assessment ： 1 April 2021 to MM DD

Place and name of work ：

Work category ： Routine work / Non-routine work

	① Possible hazards and risk assessment: Possible hazard (because of~, by doing~, (causing specific trouble))	Frequency of occurrence (a)	Severity (b): Accident involving people	Severity (b): Other	Risk (a×b)	Risk level	② Prevention/mitigation measures and post-measure risk assessment: Prevention/mitigation measures	Frequency of occurrence (a)	Severity (b): Accident involving people	Severity (b): Other	Risk (a×b)	Risk level	③ Company assessment: Frequency of occurrence (a)	Severity (b): Accident involving people	Severity (b): Other	Risk (a×b)	Risk level	Measures adopted
5	Fuel consumption increases due to increased navigation distance caused by giver-way manoeuvres, resulting in fuel shortages. (Hazard) Fuel Oil	3		4	12	H	(a. Essential measures) (b. Physical countermeasures) (c. Administrative countermeasures) ROB is to be constantly monitored. (d. Use of personal protective equipment)	3		1	3	L	3		1	3	L	○
6	Failure to inform crew not to use the lifts, following the triggering of safety devices caused by hull agitation led to crew being confined. (Hazard) Lifts	1		2	2	LL	(a. Essential measures) Switch off the power supply so that the lift cannot be used. (b. Physical countermeasures) (c. Administrative countermeasures) (d. Use of personal protective equipment)	1		1	1	LL	1		1	1	LL	○
7	Overload operation of the main engine, surging and facing of the supercharger (turbocharger) were not considered, so the main engine tripped. (Hazard) Supercharger (turbocharger)	3		3	9	M	(a. Essential measures) (b. Physical countermeasures) Exchange information with the Master, check the load on the main engine and slow down if necessary. (c. Administrative countermeasures) (d. Use of personal protective equipment)	3		2	6	M	3		2	6	M	○
8	Clogging of the fuel system strainers due to hull agitation caused by rough weather, resulting in tripping of the main engine or generator. (Hazard) Fuel system strainers	4		5	20	HH	(a. Essential measures) (b. Physical countermeasures) (c. Administrative countermeasures) Frequent strainer switching and cleaning before being being exposed to rough weather and manoeuvring in rough weather. (d. Use of personal protective equipment)	4		2	8	M	4		2	8	M	○
	Total (1~8)	23	7	23	82		Total (1~8)	25	4	10	34		25	4	10	34		
	Risk level prior to countermeasure (Avg.) No.	8	2	8	8		Risk level prior to countermeasure (Avg.) No.	9	3	7	9		9	3	7	9		
	Risk level prior to countermeasure (Avg.) Avg.	2.9	3.5	2.9	10.3		Risk level prior to countermeasure (Avg.) Avg.	2.8	1.3	1.4	3.8		2.8	1.3	1.4	3.8		
	Level (See the criteria)	3	4	3	12	H	Level (See the criteria)	3	2	2	6	M	3	2	2	6	M	

Final assessment: Risk level change H ⇒ M (Work possible? Yes / No)

The risk after implementing countermeasures must be less than or equal to "9".

The risk assessment was carried out as described above.

Signature of the person responsible for the operation:

As a result of the risk assessment, we herewith confirm that safe work is possible.

Master's signature :

As assessed as above, it is our hope that countermeasures be implemented.

Affiliation and full name :

Level assessed : LL 1~2 (Very low) / L 3 (Low) / M 4~9 (Medium) / H 10~15 (High) / HH 16~20 (Very high)

Date revised : DD/MM/20YY　Rev. No. XX　No. of years to be filed for: X years

Fig. 29　Risk assessment regarding countermeasures for rough weather effect on Engine (Attachment 10)

As with the Deck, two items are extracted from the eight risks and compared.

Extracted from Attachment 9

If there is no countermeasure:

	① Possible hazards and risk assessment: Possible hazard (because of~, by doing~, (causing specific trouble))	Frequency of occurrence (a)	Severity (b): Accident involving people	Severity (b): Other	Risk (a×b)	Risk Level
2	Inadequate lubrication of main engine, generator and other equipment, and hull agitation causing low level alarm and tripping (emergency stop). (Hazard) Lack of lubricant	4	–	4	16	HH

With just a simple effort:

	② Prevention/mitigation measures and post-measure risk assessment: Prevention/mitigation measures	Frequency of occurrence (a)	Severity (b): Accident involving people	Severity (b): Other	Risk (a×b)	Risk Level
2	(a. Essential measures)					
	(b. Physical countermeasures) Check lubricant level and top up if necessary. Cleaning of strainer (including that of fuel system)	4	–	1	4	M
	(c. Administrative countermeasures)					
	(d. Use of personal protective equipment)					

Fig. 30　Risk assessment regarding countermeasures for rough weather effect on Engine (Example 1)

Extracted from Attachment 10

If there is no countermeasure:

	① Possible hazards and risk assessment					
	Possible hazard (because of~, by doing~, (causing specific trouble))	Frequency of occurrence (a)	Severity (b) Accident involving people	Severity (b) Other	Risk (a × b)	Risk Level
8	Clogging of the fuel system strainers due to hull agitation caused by rough weather, resulting in tripping of the main engine or generator. (Hazard) Fuel system strainers	4	–	5	20	HH

Conduct watch more carefully;

	② Prevention/mitigation measures and post-measure risk assessment					
	Prevention/mitigation measures	Frequency of occurrence (a)	Severity (b) Accident involving people	Severity (b) Other	Risk (a × b)	Risk Level
8	(a. Essential measures)					
	(b. Physical countermeasures)					
	(c. Administrative countermeasures) Frequent strainer switching and cleaning before being exposed to rough weather and manoeuvring in rough weather.	4	–	2	8	M
	(d. Use of personal protective equipment)					

Fig. 31 Risk assessment regarding countermeasures for rough weather effect on Engine (Example 2)

According to accident investigations by the Transport Safety Board, for example, cases of low lubricant levels being detected due to insufficient lubricant caused by hull movement in rough weather, or main engine tripping due to a clogged strainer, leading to accidents, have been reported. (See Loss Prevention Bulletin Vol.49 “Tips for Effective Engine Management and Maintenance”)

In engineering departments on most vessels, these countermeasures are a normal part of an engineer’s work when rough weather is expected. However, when a change in risk level is assessed numerically by risk assessment, the importance of the operation becomes all the more apparent.

The company also receives the risk assessment reports from the Engineering Department. After re-evaluating them, they approve the implementation of all countermeasures and feed them back to the vessel (Figure 39).

Also in this example, the risk level has been reduced from HH to M, and although it is in the ALARP region, it has been determined a tolerable area.

Attachment 11

XXX	Safety management system	SMS-1301

Risk assessment form (Ref. No.)

Date and time of assessment:
Vessel name:
Master:

Scenario Title: Study of countermeasures for rough weather
Risk assessment regarding countermeasures for rough weather affect on the engine

Participants
C/E, 1/E, 2/E and 3/E
FTR, OLRs x 3 and a WPR
9 personnel in total

① Assessment of initial frequency and severity of occurrence prior to implementation of countermeasures

Initial frequency of occurrence: Select A to E with reference to the frequency of risk in Table 1 of the risk management procedure. Selected frequency of occurrence: 3

Initial severity: Select 1 to 4 with reference to the level of severity in Table 2 of the risk management procedure.

① Impact on health and safety	4
② Environmental impact	–
③ Media impact	–
④ Financial impact	4
⑤ Impact on the Safety Management System	
Assessment average of ①~⑤	4

② Study of countermeasures
Consideration of alternative methods, preventive/mitigation measures with reference to the procedure manual

Alternative means	Fixing of moving objects Reinforce lubricants management
Prevention countermeasures	Fixing of moving objects Strengthening of communication between the charterer and the ship management company
Mitigation measures	

③ Assessment of frequency and severity of occurrence after implementation of measures and actions

Last recorded frequency of occurrence: Select A to E with reference to the frequency of risk in Table 1 of the risk management procedure. Selected frequency of occurrence: 3

Last recorded level of severity: Select 1 to 4 with reference to the level of severity in Table 2 of the risk management procedure.

① Impact on health and safety	2
② Environmental impact	–
③ Media impact	–
④ Financial impact	1
⑤ Impact on the Safety Management System	–
Assessment average of ①~⑤	2

Initial risk assessment: Based on the results of ③, input “X” for the initial risk.
Final risk assessment: Based on the results of ③, input “Y” for the final risk.

Frequency of occurrence / Severity

Severity \ Frequency	5	4	3	2	1
1					
2			Y		
3					
4			X		

Risk: High level
Risk: Medium level
Risk: Low level
Initial assessment: “X”
Final assessment: “Y”

④ Verification of final assessment
Are the countermeasures and actions taken appropriate and has the level of risk been reduced?
YES. Implementation of the proposed countermeasures will reduce the level of risk to a low level.

Revised date: YYYY/MM/DD	Rev. XX	No. of years to be filed for: XX years

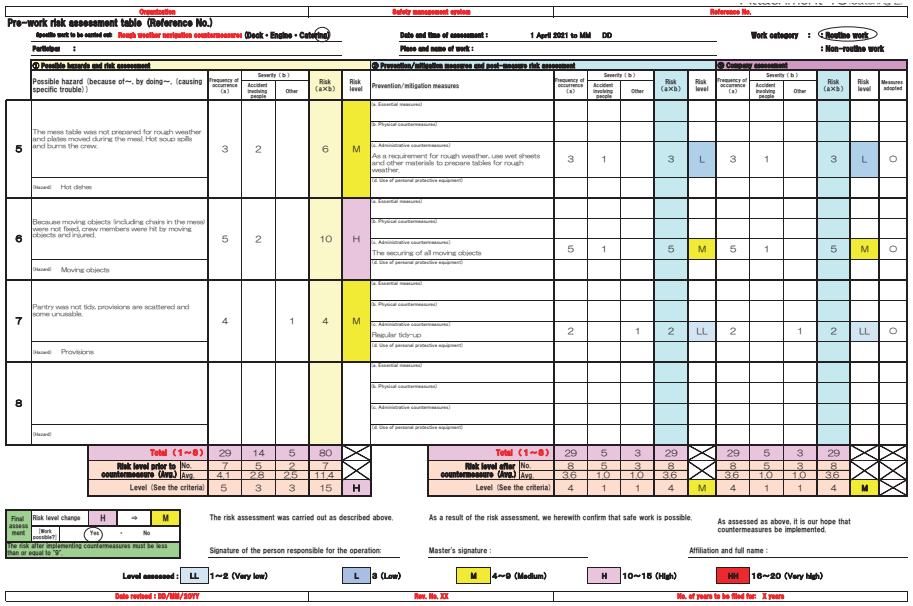
Fig. 32 Risk assessment regarding countermeasures for rough weather effect on Engine Risk assessment table (Attachment 11)

③ Catering department (Figs. 33,34,35 and 36 Attachments 12, 13 and 14)

A total of seven risks were identified. The change in risk level between before and after measures are implemented is shown below. The severity of Personal injury has reduced from 15(H) to 4(M) and Non-personal injury severity has reduced from 15(H) to 4(M).

	Before measures are implemented		After measures are implemented
・Mean value in Frequency of occurrence	5	➡	4
・Mean value in Severity (Personal injury)	3		1
・Mean value in Severity (Non-personal injury)	3		1
・Risk level (Personal injury)	15(H)		4 (M)
・Risk level (Non-personal injury)	15 (H)		4 (M)

Attachment 13



Pre-work risk assessment table (Reference No.)

	② Possible hazards and risk assessment: Possible hazard (because of~, by doing~, (causing specific trouble))	Frequency of occurrence (a)	Severity (b): Accident involving people	Severity (b): Other	Risk (a×b)	Risk level	② Prevention/mitigation measures and post-measure risk assessment: Prevention/mitigation measures	Frequency of occurrence (a)	Severity (b): Accident involving people	Severity (b): Other	Risk (a×b)	Risk level	③ Company assessment: Frequency of occurrence (a)	Severity (b): Accident involving people	Severity (b): Other	Risk (a×b)	Risk level	Measures adopted
5	The mess table was not prepared for rough weather and plates moved during the meal. Hot soup spills and burns the crew. (Hazard) Hot dishes	3	2		6	M	(c. Administrative countermeasures) As a requirement for rough weather, use wet sheets and other materials to prepare tables for rough weather.	3	1		3	L	3	1		3	L	○
6	Because moving objects (including chairs in the mess) were not fixed, crew members were hit by moving objects and injured. (Hazard) Moving objects	5	2		10	H	(c. Administrative countermeasures) The securing of all moving objects	5	1		5	M	5	1		5	M	○
7	Pantry was not tidy, provisions are scattered and some unusable. (Hazard) Provisions	4		1	4	M	(c. Administrative countermeasures) Regular tidy-up	2		1	2	LL	2		1	2	LL	○
8	(Hazard)																	
	Total (1~8)	29	14	5	80		Total (1~8)	29	5	3	29		29	5	3	29		
	Risk level prior to countermeasure (Avg.) No.	7	5	2	7		Risk level after countermeasure (Avg.) No.	8	5	3	8		8	5	3	8		
	Avg.	4.1	2.8	2.5	11.4		Avg.	3.6	1.0	1.0	3.6		3.6	1.0	1.0	3.6		
	Level (See the criteria)	5	3	3	15	H	Level (See the criteria)	4	1	1	4	M	4	1	1	4	M	

Final assessment: Risk level change H ⇒ M; [Work possible?] (Yes) · No

The risk after implementing countermeasures must be less than or equal to "5"

The risk assessment was carried out as described above.

Signature of the person responsible for the operation:

As a result of the risk assessment, we herewith confirm that safe work is possible.

Master's signature :

As assessed as above, it is our hope that countermeasures be implemented.

Affiliation and full name :

Level assessed : LL 1~2 (Very low) L 3 (Low) M 4~9 (Medium) H 10~15 (High) HH 16~20 (Very high)

Date revised : DD/MM/20YY Rev. No. XX No. of years to be filed for: X years

Fig. 33 Risk assessment regarding countermeasures for rough weather: Catering department (Attachment 13)

Now we compare the top two with a significant reduction in risk level out of the seven risks, as well as with Deck and Engine.

Extracted from Attachment 12

If not always behaving appropriately:

	① Possible hazards and risk assessment: Possible hazard (because of~, by doing~, (causing specific trouble))	Frequency of occurrence (a)	Severity (b): Accident involving people	Severity (b): Other	Risk (a×b)	Risk Level
1	By forgetting to turn off the cooking apparatus, a fire was caused by moving objects falling. (Hazard) Cooking utensil and moving objects	5	–	4	20	HH

By checking twice:

	② Prevention/mitigation measures and post-measure risk assessment: Prevention/mitigation measures	Frequency of occurrence (a)	Severity (b): Accident involving people	Severity (b): Other	Risk (a×b)	Risk Level
1	(a. Essential measures)					
	(b. Physical countermeasures) Fixing of moving objects	5	–	1	5	M
	(c. Administrative countermeasures) Always turn off cooking apparatus after use, not just in rough weather.	2	–	1	2	L
	(d. Use of personal protective equipment)					

Fig. 34 Risk assessment regarding countermeasures for rough weather: Catering department (Example 1)

Extracted from Attachment 12

If not always behaving appropriately:

	① Possible hazards and risk assessment					
	Possible hazard (because of~, by doing~, (causing specific trouble))	Frequency of occurrence (a)	Severity (b) Accident involving people	Severity (b) Other	Risk (a × b)	Risk Level
2	Doors of lockers installed in common areas (e.g. mess room) in the accommodation space are left ajar, causing the door to open by hull agitation, pinching fingers and causing injury. (Hazard) Doors	4	4	–	16	HH

By checking twice:

	② Prevention/mitigation measures and post-measure risk assessment					
	Prevention/mitigation measures	Frequency of occurrence (a)	Severity (b) Accident involving people	Severity (b) Other	Risk (a × b)	Risk Level
2	(a. Essential measures)					
	(b. Physical countermeasures)					
	(c. Administrative countermeasures) **Locker doors are to be closed, not just in rough weather. Doors that are left open, such as in the mess room, are to always have a door stop applied and are to be lashed.**	4	1	–	4	M
	(d. Use of personal protective equipment)					

Fig. 35 Risk assessment regarding countermeasures for rough weather: Catering department (Example 2)

In addition to rough weather, it is also important to make it a habit to switch off the stove in the galley at the end of each work session, and to check this with at least two other people in the Catering department without fail. Also, it is important to make sure that doors in mess rooms are always closed on a regular basis, as this can be a problem for fire safety if they are kept open. If there are a large number of crew passing through during the daytime, and there are always crew in the adjacent galley, and the door is left open because there is no risk of fire, it is recommended that a rope be used to lash it as well as a door stopper.

This is something that we usually do on board without thinking about it, but if we make it a point to carry out a risk assessment like this and recognise the seriousness of the risk, the safety level will be increased.

Upon receipt of the risk assessment report in the Catering department, the company will carry out its own assessment, as will the Deck and Engine departments, and provide feedback to the vessel, including a decision on whether or not work can be carried out.

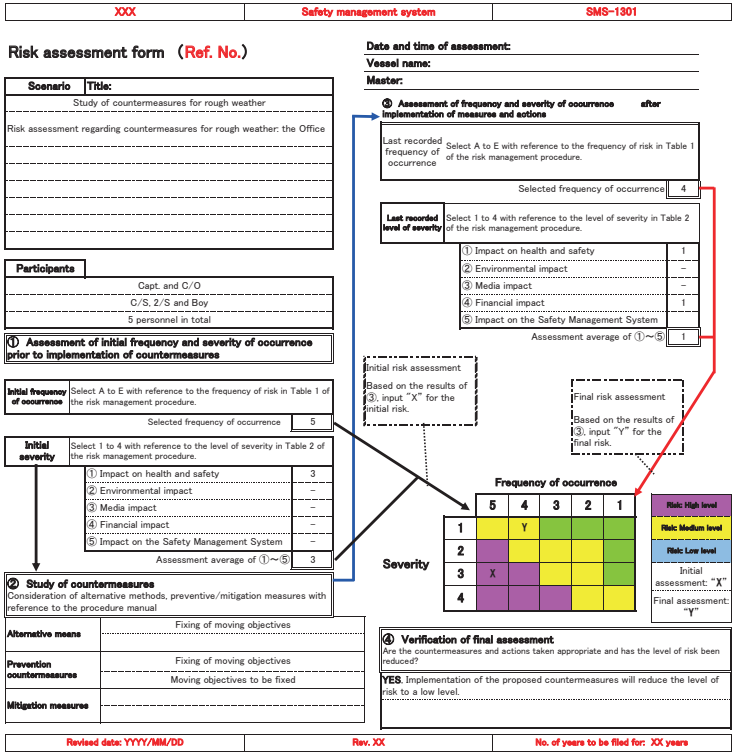


Fig. 36 Risk assessment regarding countermeasures for rough weather in the Catering department Risk assessment table (See Attachment 14)

4-4 How to handle risk assessment: summary

As we discussed countermeasures for rough weather as examples in the previous section, on the vessel, in particular, in the event of carrying out any unusual (unfamiliar) work, it is important that a risk assessment be carried out and that information is shared with all relevant crew members. Because even experienced crew may inadvertently forget or be unaware (error when inputting).

In addition, unlike the manufacturing industry on land, it is difficult for the management at the catering department or the safety department to visit the site to control the work, so most of the work itself must often be carried out under the supervision of a Master/Chief Engineer or Chief Officer/First Engineer.

This means that Essential measures and physical improvement measures are rarely taken. These countermeasures tend to be focused on administrative countermeasures which were established or developed on board and the use of protective wear which are designed to prevent trouble occurring. For the crew, who are a group of highly skilled and professional technicians, it is important to remember that this is where the pitfalls lie.

In addition, the risk assessment should not just be filed away in a document, but should also be used in conjunction with BRM/ERM to increase the effectiveness of the work.

As mentioned above, risk assessments have been introduced mainly from a business management perspective in the manufacturing industry on land, which means that crew members who are used to working on board may find them too time-consuming or too obvious. This is why it has become less effective.

However, as explained in the examples, if we visualise our everyday work in this way, we may find that we see things in a different light, so it is recommended to take this opportunity to feel free to use it. Figure 37 summarises this.

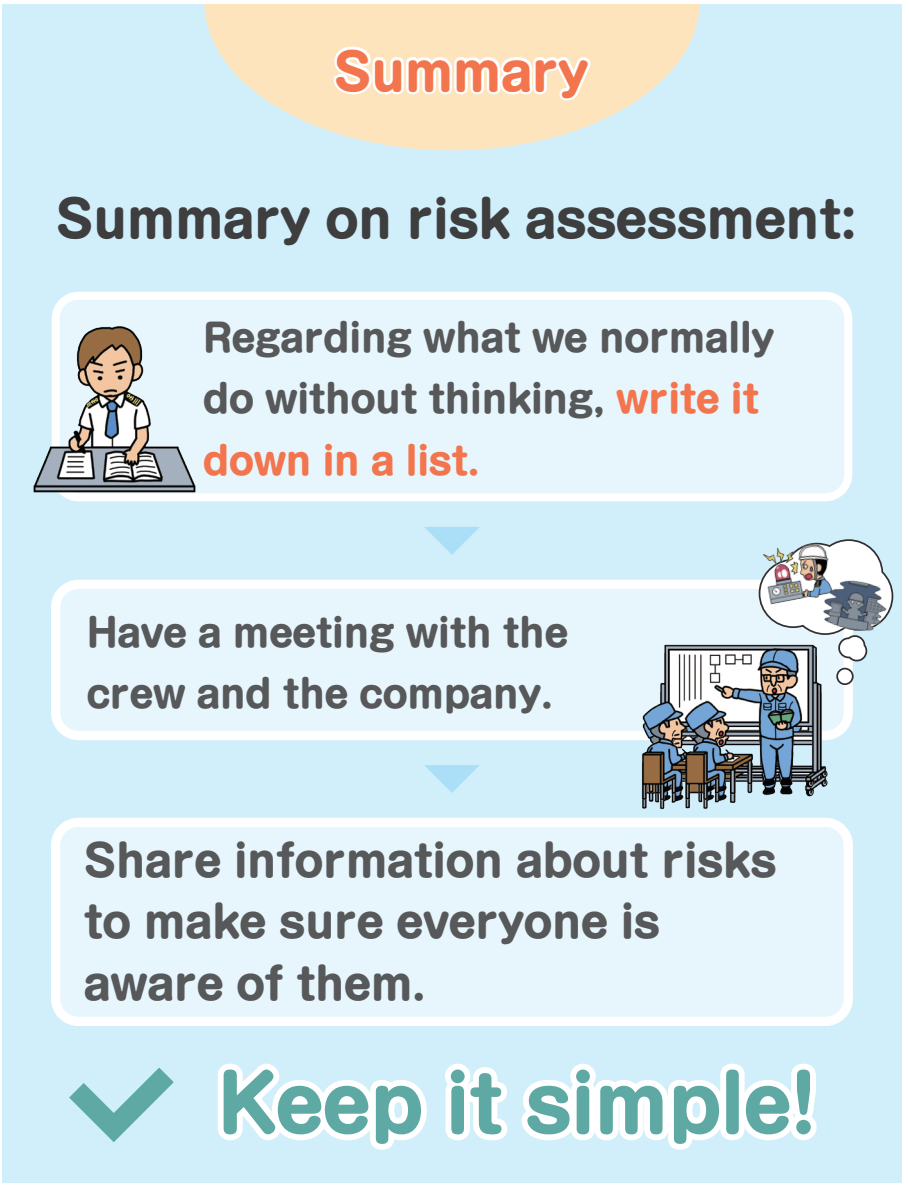


Fig. 37 Risk Assessment in practice: summary

§5 Case Study Analysis of an Accident

Let us take the Japan Transport Safety Board Report 〈less severe (keibi) 2019-5〉 and the decision of the Marine Accident Tribunal (Kobe issued No.11 in 2019), together with a 4M5E analysis and risk assessment to analyse the cause of the accident.

5-1 Date and time of occurrence and vessel particulars

Photograph 38 Vessel A

Date and time of occurrence
: On a certain day in November 2018, at approximately 12:09 (JST)
Vessel specifications
: Vessel A(748 GT) Single-engine, single-shaft stern hull bridge type coal ash and calcium carbonate carrier equipped with bow thrusters and a VecTwin system control unit (hereinafter referred to as "VecTwin system")
L × B × D : 79.26m x 14.00m x 8.15m
Draft : Bow 2.70m Stern 3.68m
Point accident occurred : Hanshin Port Kobe No. 2 port during entry work
Crew arrangement : Master, with third grade maritime officer (Navigation) and 7 other crew members in total
Manning system at time of accident
Bridge : Master (Single-handed navigation)
Chief Engineer : Engine control Fore : C/O + 2 crew members
Aft : 2/E + 1 crew member Eng/Room : First Engineer (1/E)
Weather and sea conditions when the accident occurred
: Fine, east-southeasterly wind Wind force of 2

Vessel movement

On a certain day in November, 2018, the vessel in question set sail at 14:10 from Kanda Port in Fukuoka Prefecture. At 10:40 the following day, she anchored in an offshore area South East of Kobe Airport in Hyogo Prefecture in order to await berthing time. Shortly after, the vessel then set sail for her scheduled 11:30 arrival at the KS1 berth in Kobe Port (now part of Hanshin Port) on her port side.

Rudder type: VecTwin Rudder (extracted from the homepage of Japan Hamworth & Co., Ltd.)

A New VecTwin Rudder System is a rudder system,in which a pair of Fish Tail Rudders respectively having special sectional profile is arranged symmetrically behind a single fixed pitch propeller, and enables a ship to be maneuvered in any mode of not only forwarding and turning port or starboard, but also going astern with steerability, hovering, extremely slow speed navigation, emergency stopping and head or stern gyrating by means of combining rudder angle positions of the respective rudders, with the propeller being kept rotating in the forward direction.
Such rudder angle combination control is conducted by a single Joystick lever, and a propeller slip stream is directed by the rudders so as to generate thrust in any direction. By virtue of such arrangement that VecTwin Rudders are arranged so as to enclose a propeller slip stream, which brings less propeller thrust fluctuation by wave and excellent course stability of a ship when going straight ahead, a New VecTwin System makes a horsepower loss and ship speed reduction, which are caused by seaway

condition, small. It is appraised that a ship equipped with a New VecTwin System shows less yawing especially when navigating in a condition of following wave, which means safe operation.

This is a system that brings excellent economical effect from the synthetic viewpoint, as a ship equipped with a New VecTwin System can be maneuvered easily and in short time in a harbor and for approaching to and departing from a pier, and mental and physical stress imposed on crew is lightened.

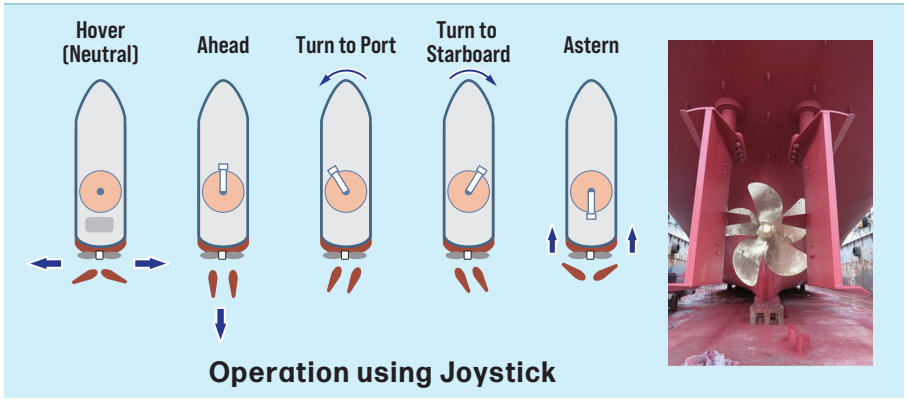
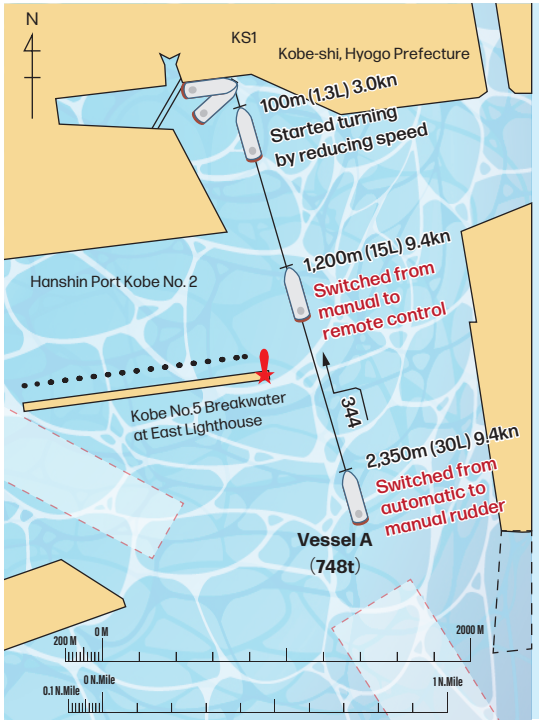


Fig. 39 VecTwin Rudder

Standard docking procedures



- After passing breakwater No.5 (approximately 1,200m from the quay), the VecTwin system manual control is switched to remote before making a final approach whilst also reducing speed.
- At a slow speed ahead and approximately 100m from the quay, the 2 rudders should be closed (put into neutral) by pulling back on the joystick.
- At approximately 80m from the quay, the joystick is pulled back further and with the propeller set in forward rotation, the vessel is brought to a halt. Docking then takes place with the use of the bow thrusters.

Fig. 40 Standard docking procedures

Fig. 41　Remote operation unit

Rudder control switch

Moving in a clockwise direction, the rudder control switch has 4 settings: Automatic, Manual, Non-follow up, and Remote Control. The joystick can be operated when this switch is in the remote-control mode.

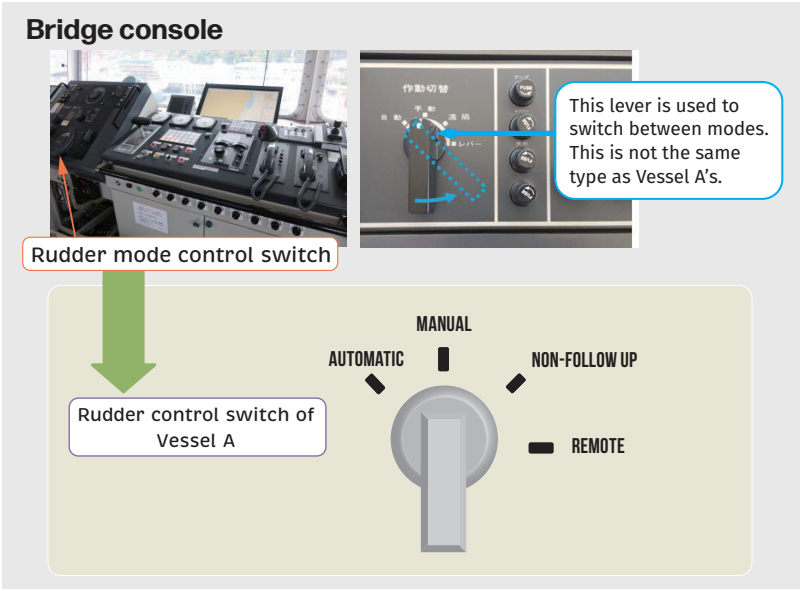


Fig. 42　Steering operation settings　Rudder control switch

In the event of turning the switch to remote mode, if the rudder switch on the control stand is not set to "Remote Control", the VecTwin Rudder will not move when trying to operate the joystick.

5-2　Timeline of events leading up to the accident

Let us take a closer look at the timeline of events leading up to the accident. For a full list, please see Attachment 15. All crew members were already engaged in the S/B (stand-by) operation for the entering of port to dock; the crew arrangement at the time was as follows.

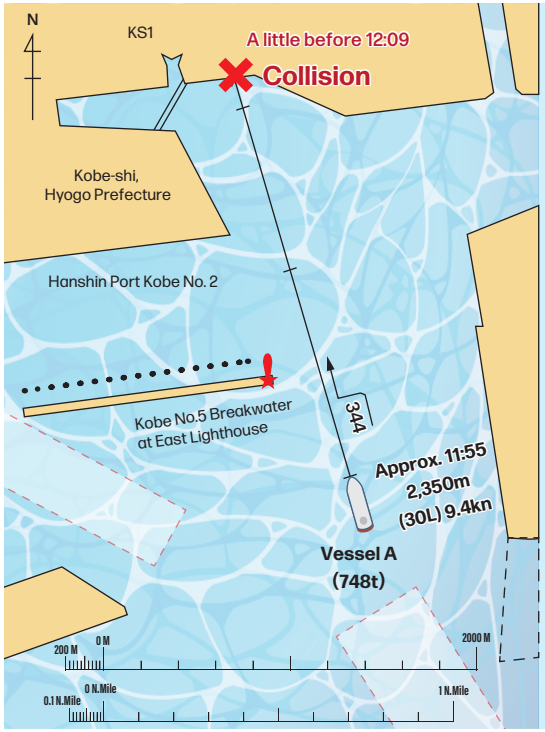
Bridge：	Master (Single-handed navigation)	
	Chief Engineer (Engine status monitoring and engine room control at engine console)	
		2 personnel in total
Fore：	C/O, Bsn and OS	3 personnel in total
Aft：	3/O and 2/E	2 personnel in total
Eng.Room：	1/E	1 personnel in total

Vessel A Quay collision accident Accident timeline

CREW ARRANGEMENT	STANDARD DOCKING PROCEDURES	TIME	SPEED	DISTANCE FROM THE QUAY (SHIP LENGTH RATIO)	ACTUAL ACTIONS TAKEN	WHO
Bridge Master・C/E Fore C/Off・Bsn・O/S Aft 2/AE・3/Off Eng. Room 1/AE	Engine in neutral position	11:55	9.4 kts	2,350 m (30 L)	At 2,350m before the quay (30L), engine half speed to neutral operation. Speed of 9.4 knots and switched from automatic to manual rudder	Master
	D.Slow Ahead Used VecTwin rudders for speed control both sternway and headway	12:00	9.0 kts	1,160 m (15 L)	The Master intended to use the joystick device to control the VecTwin Rudder system to manoeuvre the ship to the shore, and switch the rudder control to remote control. D.Slow Ahead	Master
					However, he did not realise that the rudder switch was stuck in the non-follow-up position and moved to the port side of the bridge in front of the remote control stand. He believed that it had switched to remote rudder control by only operating the one lever.	Master
		12:06	5.0 kts	317 m (4 L)	Distance to the quay was approximately four times the length of the vessel	Master
	D.Slow Ahead He made a sternway manoeuvre. Turned using bow thruster and joystick	12:08	3.1 kts	100 m (1 L)	At 100m before the quay, he thought he had tipped the joystick backwards and made a sternway manoeuvre, but in fact it was in neutral (hover).	Master
					He was too preoccupied with the distance to the quay that he did not look at the rudder angle indicator on the VecTwin rudders to notice that the rudders were heading sternway.	Master
					As the speed to fetch headway was not decreasing, he tried to make sternway by increasing engine speed (not effective as it was in neutral (hover) and anchored.	Master
		12:09	4.3 kts	0 m (0 L)	Collided with the quay at almost a right angle, maintaining a speed of 4.3 knots	Master

Table 43 Vessel A Timeline of events leading up to the accident

① 11 : 55 (approx.)



Ship speed :
9.4 knots
Distance from the quay :
2,350m (30L approx.)
L : Distance from the quay ÷ Ship length
(the same applies hereafter)
Engine operation :
engine between half speed and neutral position

At 2,350m before the quay (30L), engine between half speed (9.4 knots) and neutral position; switched from automatic to manual rudder.

Fig. 44 Vessel A at 11 : 55 (approx.)

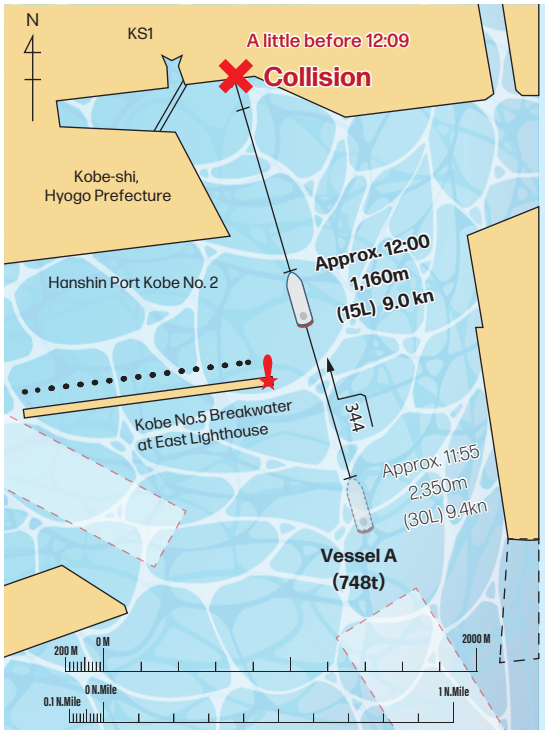
First human error

This operation itself was in accordance with standard docking procedures, but the rudder angle indicator was not checked during manual operation.

Furthermore, as there was no altered angle to the quay, and no wind tide effect, although the Master moved the steering wheel somewhat, each time he thought the rudder was moving as he operated it; he did not check the rudder angle indicator.

(Human characteristics of ③ Human beings sometimes forget, ⑤ Human beings have moments of inattention and ⑩ Human beings are sometimes lazy (See Figure 52) will be applicable.)

② 12 : 00 (approx.)



Ship speed :
9.0 knots
Distance from the quay :
1,160m (15L approx.)
Engine operation :
from neutral position to D.Slow Ahead

The Master intended to use the joystick device to control the VecTwin Rudder system to manoeuvre the ship to the shore, and switch the rudder control to remote control. He also set the speed for D.Slow Ahead.

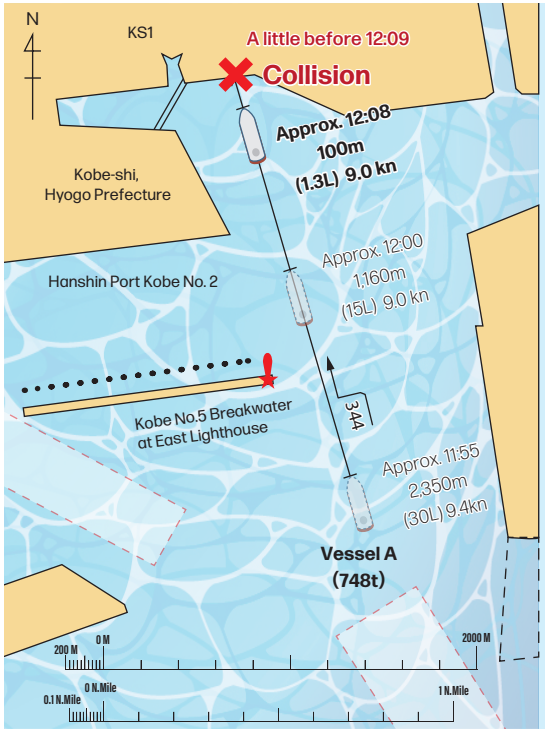
Fig. 45 Vessel A at 12:00 (approx.)

Second human error

However, he believed that it had switched to remote rudder control by moving it by only one notch. Actually, the rudder switch was stuck in the non-follow-up position (human characteristics: ⑨ Human beings sometimes make assumptions).

While he did not realise this, he moved to the port side of the bridge in front of the control stand. At this time, the VecTwin Rudder was in the neutral (hover) position (human characteristics: ④ Human beings sometimes do not notice).

③ At 12 : 08 (approx.)



Ship speed :
3.1 knots
Distance from the quay :
100m (1L approx.)
Engine operation :
D.Slow Ahead continuously

At 100m before the quay, he thought he had tipped the joystick backwards to manoeuvre the VecTwin Rudder sternway, but in fact the rudder switch was stuck in the non-follow-up position and the VecTwin Rudder was in the neutral (hover) position. (Human characteristics : ⑨ Human beings sometimes make assumptions)

The reason for the speed drop to 3.1 knots was that the VecTwin Rudder was in the neutral (hover) position.

Fig. 46 Vessel A at 12:08 (approx.)

Third human error

He thought he was steering the vessel with the joystick of the remote-control unit, but in fact the vessel was naturally slowed down while heading straight ahead with no wind tide effect, because the VecTwin Rudder was in the neutral (hover) position.

He was too preoccupied with the distance to the quay that he did not look at the rudder angle indicator on the VecTwin Rudder to make sure the rudders were heading sternway, but rather assumed that he could control the vessel's headway speed.

(Human characteristics : ⑨ Human beings sometimes make assumptions, ⑥ Human beings are sometimes only able to see or think about one thing at a time and ⑪ Human beings sometimes panic)

But at last, the quay was in sight, and as the speed to fetch headway was not decreasing, he tried to make sternway by increasing engine speed (not effective as it was in neutral (hover)). Then, he ordered the Bows'C/O to anchor, but the timing was too late. At this point, the Master was probably in a panic and unable to calmly judge the situation.

④ 12 : 09 (approx.)

Collided with the quay at a right angle with a speed of approx. 4 knots.

5-3 Determination of accident cause by the Japan Transport Safety Board and Japan Marine Accident Tribunal

● The Japan Marine Accident Tribunal

Negligence in the performance of his duties in failing to look at the rudder angle indicator and checking that the two rudders were closing. Accordingly, the Master's third grade maritime officer (Navigation) certificate was suspended for one month.

● Japan Transport Safety Board

It is considered that the Master of the vessel, during docking work, continued to manoeuvre without realising that the rudder switch on the control stand was not switching to remote rudder and that the joystick device could not control the speed to fetch headway which caused the collision with the quay.

5-4 Countermeasures to prevent recurrence by shipowners and the Japan Transport Safety Board

● Improvement measures taken by the shipowner following the accident

The shipowner has implemented the following countermeasures.

- **The operating instructions are to be clearly shown on the control stand and a switching procedure manual is to be created.**
  ▷ A method of instructing crew members to comply with compliance regulations by creating procedures, which is referred to as "c. Administrative countermeasures" in Attachment 4.

- **The rudder switch on the control stand has been improved so that it emits an electronic tone for a few seconds when it is in the remote position.**
  ▷ This is referred to as "b. Physical countermeasures" in Attachment 4.

● Japan Transport Safety Board Report: Preventive measures

- **When switching to joystick steering, (1) visual confirmation shall be made that the rudder mode control switch has been switched to the appropriate position, and (2) a joystick activation test shall be carried out prior to berthing manoeuvres to confirm that the switch has been successfully operated.**

⇒ Like the shipowner's countermeasure, the main focus is to be on the creation of the procedures and crew training compliance. This is referred to as "c. Administrative countermeasures" in Attachment 4.

5-5 4M5E Analysis

Let us apply the 4M5E Analysis introduced in Loss Prevention Bulletin Vol.50.

1 Summary of related facts (Fig. 47 Attachment 16)

From "5-2 Timeline of events leading up to the accident", extract the causes behind the accident and enter them in the "Summary of related facts" table in the 4M5E analysis

table, starting with the major causes first then completing the others in sequence. In this case study, the following five possible accident causes have been identified.

Attachment 16

Vessel A Quay collision accident
Maritime Accident Summary of Related Facts

Reference No.	Identified problems from survey findings				Direct cause		Accident cause evaluation	Re-examination necessity
	Date	Time	Caused by	Check facts and problem areas	Unsafe behaviour	Unsafe conditions		
1	XX November	12:00	Master	The Master intended to turn the rudder control switch to remote control but did not verify that this had indeed been done.	○	△	2	
2	XX November	12:00	Master	He did not realise that the rudder switch was stuck in the non-follow-up position (not switching to remote rudder) and moved to the port side of the bridge in front of the control stand.	○		3	
3	XX November	12:08	Master	He was too preoccupied with the distance to the quay that he did not look at the rudder angle indicator on the VecTwin rudders to notice that the rudders were heading sternway.	○		1	
4	XX November	12:08	Master	As the speed to fetch headway was not decreasing, he tried to make sternway by increasing engine speed (not effective as it was in neutral (hover) and anchored.	○		4	
5	XXXX	XXXX	Company	Operating procedures for important equipment had not been incorporated into Safety Management Code (SMS).		○	5	

Accident cause assessment: Prioritized according to the scale of the cause

Fig. 47 Vessel A Summary of related facts (Attachment 16)

● Master

① The Master intended to turn the rudder control switch to remote control but did not verify that this had indeed been done. (Unsafe behaviour) and (Unsafe conditions)

② He did not realise that the rudder switch was stuck in the non-follow-up position (not switching to remote control) and moved to the port side of the bridge in front of the control stand (Unsafe behaviour).

③ He was too preoccupied with the distance to the quay that he did not look at the rudder angle indicator on the VecTwin Rudders to notice that the rudders were heading sternway (Unsafe behaviour).

④ As the speed to fetch headway was not decreasing, he tried to make sternway by increasing engine speed (ineffective as it was in neutral (hover) and anchored (Unsafe behaviour).

● Company

⑤ Operating procedures for important equipment had not been incorporated into the Safety Management Code (SMS) (Unsafe conditions).

As described above, it is possible to observe that the accident occurred as a result of a chain of the Master's four human errors that could not be broken.

2 Accident Cause Analysis (Unsafe behaviour) (Fig. 55 and Attachment 17)

The four unsafe behaviours of the Master are marked with a circle on the corresponding items in the 4M5E analysis, the analysis chart of (Unsafe behaviour).

Attachment 17

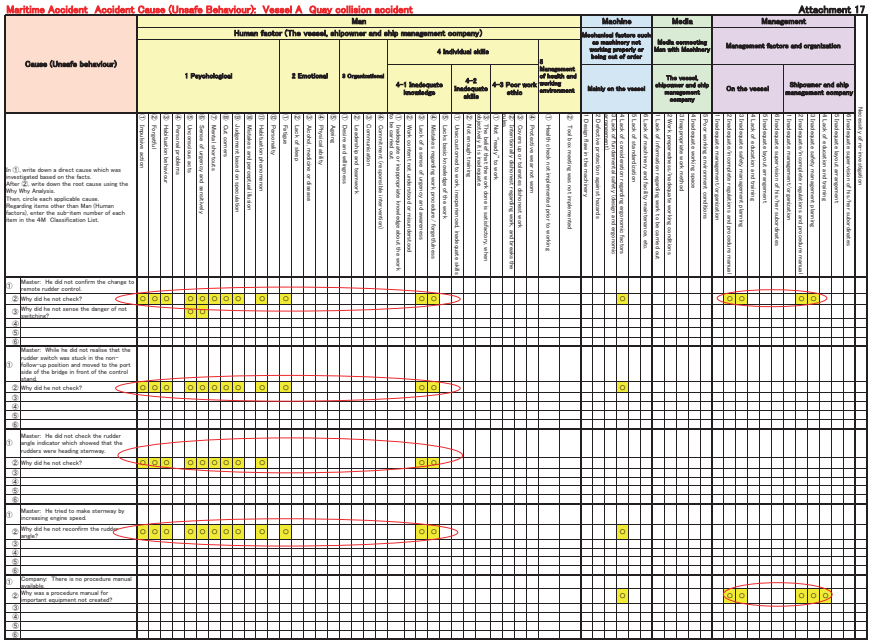


Fig. 48 Vessel A Master A's "Unsafe behaviour"Vessel A (Attachment 17)

As the Master's psychological factors of the four human errors identified in the Summary of related facts, the following common items have been identified: ① Impulsive action,

② Forgetful, ③ Habituation behaviour, ⑤ Unconscious acts, ⑥ Sense of urgency and sensitively, ⑦ Mental shortcuts, ⑧ Cutting corners, ⑨ Judgement based on speculation, and ⑪ Habituation phenomenon.

Also, as individual skills (insufficient knowledge), ③ Lack of a sense of urgency and awareness and ④ Mistakes regarding work procedure and forgetfulness are in commonly found in human error.

3 Accident Cause Analysis (Unsafe conditions) (Fig. 49 and Attachment 18)

Attachment 18

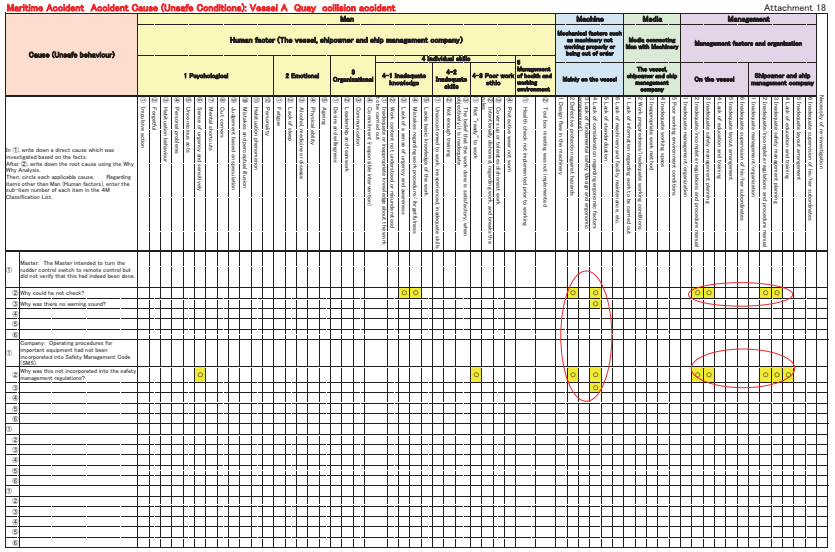


Fig. 49 Vessel A 's "Unsafe conditions" (Attachment 18)

The Unsafe conditions identified in the Summary of related facts are as follows:

The Master operates the rudder mode control switch by himself. However, considering that the safety measures for the equipment are inadequate in terms of human characteristics, ① Human beings sometimes make mistakes, ③ Human beings sometimes forget, and ⑨ Human beings sometimes make assumptions; it is considered to be unsafe (condition). Also, in terms of company management, unsafe conditions are highlighted by the lack of procedure manuals and safety management codes. If we circle the items in Attachment 18, the following points emerge as common for both Master and company management:

- **Machine (Mechanical factors such as machinery not working properly or being out of order)**

  2 Defective protection against hazards and 4 Lack of consideration regarding ergonomic factors

- **Management (Control factors and organization)**

  On the vessel : 2 Inadequate/incomplete regulations and procedure manual and 3 Inadequate safety management planning

  Company : 2 Inadequate/incomplete regulations and procedure manual and 3 Inadequate safety management planning

4 Preventive measures for Unsafe behaviour of Master (Fig. 50 and Attachment 19)

Attachment 19

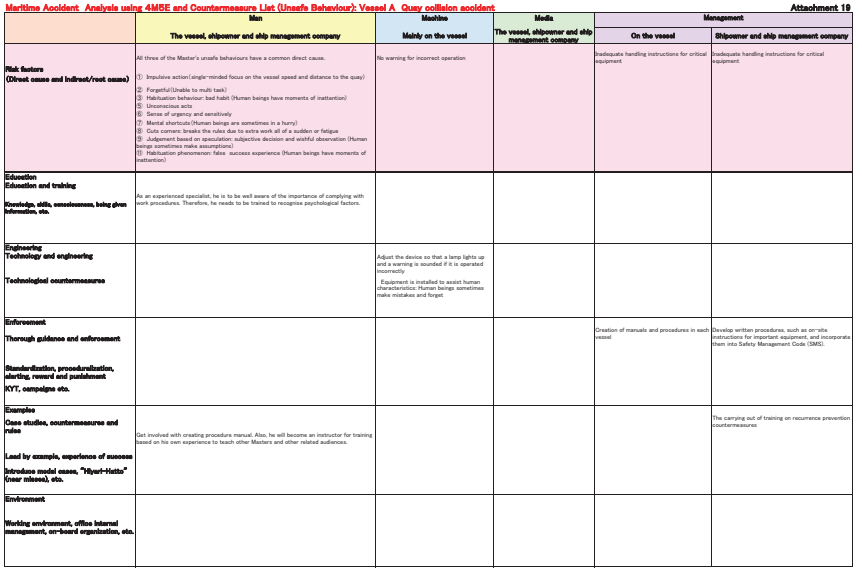


Fig. 50 Vessel A's Preventive measures for "Unsafe behaviour" (See Attachment 17)

In 2 Analysis of Accident Cause (Unsafe behaviour) (Attachment 17), we analysed the causes applicable with Man, Machine (machinery and equipment) and Management (management and organization). For each of these items, it will be a requirement that the following improvement measures be considered and carried out:

① Man

Education/training: knowledge, skills, consciousness, being given information, etc.

As an experienced Master, he is to be well aware of the importance of complying with work procedures. Therefore, an effective measure will be for him to receive training that helps him recognise psychological factors.

Example
(Case studies, countermeasures and rules : Lead by example, experience of success, introduce model cases, "Hiyari-Hatto" (near misses), etc.)

The Japan Marine Accident Tribunal judged that the Master's third grade maritime officer (Navigation) certificate be suspended for one month. However, he should be fully aware of what caused the accident and how the vessel was manoeuvred to this end. Therefore, instead of letting this experience go to waste, it would be useful for him to get involved with creating procedure manuals, and becoming an instructor for training to pass on such valuable experience to other Masters and related audiences.

② Machine (machinery and equipment)

Regarding Machine (machinery and equipment), the risk factors mentioned refer to the equipment not warning the operator (e.g. alarm sounds) when it is operated incorrectly, so the following countermeasures should be considered.

Engineering (Technology and engineering : Physical countermeasures)

As human beings sometimes make mistakes and forget, equipment is to be installed to assist such characteristics, whereby a lamp lights up and a warning is sounded in case of incorrect operation (error in the output process). After this accident, the shipowner requested the manufacturer to modify the rudder switch on the control stand so that it sounds an electronic tone for a few seconds when it is in the remote position.

③ Management (management and organization)

The vessel and the company (shipowner) are requested to create operation manuals and operating procedure manuals, in particular on-site instructions for important equipment such as rudder control and radar. In addition, such a procedure manual should be included into the safety management code and SMS manuals.

5 Preventive measures for "Unsafe conditions" for Master and Company

(Fig. 58 and Attachment 20)

Similar to " 4 Preventive measures for unsafe behaviour of Master" and preventive measures for unsafe conditions will be considered here as well.

Attachment 20

Maritime Accident Analysis using 4M5E and Countermeasure List (Unsafe conditions): Vessel A Quay collision accident — Attachment 20

	Man The vessel, shipowner and ship management company	Machine Mainly on the vessel	Media Work and environment-by Media connecting Man with Machinery The vessel, shipowner and ship management company	Management	
				On the vessel	Shipowner and ship management company
Risk factors (Direct cause and indirect/root cause)		No warning for incorrect operation		Inadequate handling instructions for critical equipment	Inadequate handling instructions for critical equipment
Education Education and training Knowledge, skills, consciousness, being given information, etc.					
Engineering Technology and engineering Technological countermeasures		Adjust the device so that a lamp lights up and a warning is sounded if it is operated incorrectly. Equipment is installed to assist human characteristics: Human beings sometimes make mistakes and forget.			
Enforcement Thorough guidance and enforcement Standardization, proceduralization, alerting, reward and punishment KYT, campaigns etc.				Creation of manuals and procedures in each vessel	The carrying out of training on recurrence prevention countermeasures Develop written procedures, such as on-site instructions for important equipment, and incorporate them into Safety Management Code (SMS).
Examples Case studies, countermeasures and rules Lead by example, experience of success, Introduce model cases, "Hiyari-Hatto" (near misses), etc.					
Environment Working environment, office internal management, on-board organization, etc.					

Fig. 51 Vessel A's Preventive measures for "Unsafe conditions" (See Attachment 20)

① Machine (machinery and equipment)

Similar to Unsafe behaviour, there was no warning sound or warning light to indicate that the equipment was being operated incorrectly, so it was in an Unsafe condition. The remedy is the same as for Unsafe behaviour.

② Management (management and organization)

There were deficiencies in handling procedures etc. for important equipment, which had not been incorporated into the Safety Management Code (SMS), thus, it was determined to be in an Unsafe condition. In order to prevent the recurrence of unsafe conditions, unlike unsafe behaviour, the creation of procedures and operation manuals and their incorporation into the Safety Management Code (SMS) have been incorporated into Enforcement (thorough guidance).

5-6 Accident cause from the perspective of human error

Let us analyse the Master's unsafe behaviour that caused the accident with 12 Human characteristics and 5 Psychological factors (Figure 52) which invite human error, introduced in Loss Prevention Bulletin Vol.50.

Twelve human characteristics

1. Human beings sometimes make mistakes
2. Human beings are sometimes careless
3. Human beings sometimes forget
4. Human beings sometimes do not notice
5. Human beings have moments of inattention
6. Human beings sometimes are able to see or think about only one thing at a time
7. Human beings are sometimes in a hurry
8. Human beings sometimes become emotional
9. Human beings sometimes make assumptions
10. Human beings are sometimes lazy
11. Human beings sometimes panic
12. Human beings sometimes transgress when no one is looking

Five psychological factors

1. **Psychological reactance (self-efficacy)**
   This is when people do not wish to do something that is not of their own volition. They may be inclined to say, "I won't do what you tell me."
2. **Entrainment phenomenon and peer pressure**
   This is when people follow the crowd, e.g., "What will the neighbours think?"
3. **Normalcy bias ➡ justification, cognitive dissonance**
   When people believe, "I'm special, nothing can hurt me!"
4. **Confirmation bias**
   People are unconsciously prone to believe only "what they want to believe" and "information that supports what they believe" rather than purposefully seeking information to the contrary. They may say something like, "Stop exaggerating!" or "Everything will be fine!"
5. **Social loafing**
   This is when someone does not choose to take the initiative. They may say, "Someone will do it for me."

Fig. 52 12 Human characteristics and 5 Psychological factors

The items corresponding to the "12 Human characteristics" and "5 Psychological factors" shown in Figure 52 are summarised in Table 53 (Attachment 21) corresponding to the human errors described in 5-2 Timeline of events leading up to the accident.

Attachment 21

Human characteristics, Human error and Psychology: Vessel A Quay collision accident

Date and time	Movement	Who?	Human error	Human characteristics	Psychological factors
12:00	Before passing breakwater No. 5	Master	The Master intended to use the joystick device to control the VecTwin Rudder system to manoeuvre the ship to the shore, and switch the rudder control to remote control. However, he did not realise that the rudder switch was stuck in the non-follow-up position (not switching to remote rudder) and moved to the port side of the bridge in front of the control stand.	① Human beings sometimes make mistakes: A mistake is apparent ④ Human beings sometimes do not notice: Switch position ⑥ Human beings are sometimes only able to see one thing at a time: Moved without checking ⑦ Human beings are sometimes in a hurry: He was distracted by the berthing manoeuvre	④ Confirmation bias: Human beings ignore information that is inconvenient for him or her.
12:08	At approximately 160m from the quay	Master	At 100m before the quay, he thought he had tipped the joystick backwards and made a sternway manoeuvre, but in fact it was in neutral (hover). He was too preoccupied with the distance to the quay that he did not look at the rudder angle indicator on the VecTwin rudders to notice that the rudders were heading sternway.	④ Human beings sometimes do not notice: Rudder indicator ⑥ Human beings are sometimes only able to see one thing at a time: Moved without checking? ⑦ Human beings are sometimes in a hurry: He was distracted by the berthing manoeuvre ⑨ Human beings sometimes make assumptions: Thought he had tipped the joystick backwards and made a sternway manoeuvre	③ Confirmation bias: "I' m special, nothing can hurt me!" ④ Confirmation bias: Human beings ignore information that is inconvenient for him or her.
			As the speed to fetch headway was not decreasing, he tried to make sternway by increasing engine speed (not effective as it was in neutral (hover) and anchored.	④ Human beings sometimes do not notice: Rudder indicator ⑥ Human beings are sometimes only able to see one thing at a time: Tried to make sternway by increasing engine speed ⑪ Human beings sometimes panic	④ Confirmation bias: Human beings ignore information that is inconvenient for him or her.
12:09	Accident occurs	Master	At a speed of 4.3 knots, the ship hit the quay at almost a right angle.		

Table 53 Accident cause from the perspective of human error

The numbers given in the table in "Human characteristics" and "Psychological factors" columns correspond with the numbers in Figure 52.

Human characteristics

The human characteristics regarding incorrect rudder switch control on the control stand, and the subsequent behaviour up to 12:08 (100m from the quay), can be summarised as follows:

① Human beings sometimes make mistakes :
The erroneously operated rudder control switch

④ Human beings sometimes do not notice :
Did not notice switch position and did not notice the indication on the rudder angle indicator

⑥ Human beings are sometimes only able to see one thing at a time :
Without checking the rudder control switch, moved to the port side of the bridge in front of the control stand. Focussed on the operation of the joystick only.

⑦ Human beings are sometimes in a hurry:
He was distracted by the berthing manoeuvre.

⑨ Human beings sometimes make assumptions :
VecTwin Rudder was in the neutral (hover) position, so the speed was only reduced naturally, yet he believed that the ship speed had decelerated due to his own manoeuvring.

⑪ Human beings sometimes panic :
When the quay was so close this caused a panic, and the situation could not be calmly judged.

Psychological factors

③ Normalcy bias : I always use the same ship-handling techniques and I never fail. This is when people believe, "I'm special, nothing can hurt me!"

④ Confirmation bias : People are psychologically prone to believe only "what they want to believe" and "information that supports what they believe" rather than purposefully seeking information to the contrary (Did not check the indication of each display panel).

These were the root causes behind the chain of human errors that led to the accident.

5-7 Risk assessment (Fig. 54, see Attachment 22)

Now let us carry out a risk assessment based on the report from the Japan Transport Safety Board in hindsight of the accident.

Attachment 22

Organization | Safety management system | Reference No.

Pre-work risk assessment table (Reference No.)

Specific work to be carried out: Voyage plan (Cook/Engine-Catering Department) Vessel A Quay collision accident | Date and time of assessment: | Work category : Routine work・Non-routine work

Participants : △△△、XXX、□□□ | Place and name of work: Vessel A

	① Possible hazards and risk assessment						② Prevention/mitigation measures and post-measure risk assessment						③ Company assessment					
	Possible hazard (because of~, by doing~, causing specific trouble)	Frequency of occurrence (a)	Severity(b) Accident involving people	Severity(b) Other	Risk (a×b)	Risk Level	Prevention/mitigation measures	Frequency of occurrence (c)	Severity(b) Accident involving people	Severity(b) Other	Risk (a×b)	Risk level	Frequency of occurrence (c)	Severity(b) Accident involving people	Severity(b) Other	Risk (a×d)	Risk Level	Measures adopted
1	The joystick of the remote control unit moves even when the remote operation unit is switched to non-remote position, causing human characteristic error such as Human beings sometimes make assumptions.	5		4	20	HH	a. Physical countermeasures) Warning sound when switching modes	5		2	10	M	5		1	5	M	Y
							b. Physical countermeasures) Making the switch to remote mode a 2-stage operation	5		1	5	M						
							b. Physical countermeasures) Failure to complete both stages will freeze the joystick rendering it immobile.	5		1	5	M						
	Hazard: Rudder control switch for remote control and joystick						c. Administrative countermeasures) Repeat training to be carried out	5		1	5	M						
2	Three human errors occurred: incorrect rudder control switch, moving in front of the remote control on the port side of the bridge without checking the steering mode, and not checking the indication on the rudder angle indicator.	5		4	20	HH	a. Essential measures)											
							b. Physical countermeasures)											
							c. Administrative countermeasures) Repeat training and re-education to be carried out, along with the creation of procedures and a manual	5		2	10	H						
	Hazard: Human characteristics and Psychological factors						d. Use of personal protective equipment)											
3							a. Essential measures)											
							b. Physical countermeasures)											
							c. Administrative countermeasures)											
	Hazard:						d. Use of personal protective equipment)											
4							a. Essential measures)											
							b. Physical countermeasures)											
							c. Administrative countermeasures)											
	Hazard:						d. Use of personal protective equipment)											
	Total	10	0	8	40		Total	25	0	7	35							
	Risk level prior to countermeasure (Avg.) No.	1	0	1	2		Risk level after countermeasure (Avg.) No.	5	0	5								
	Risk level prior to countermeasure (Avg.) Avg.	10.0	0.0	8.0	20.0		Risk level after countermeasure (Avg.) Avg.	5.0	0.0	1.4	7.0							
	Level (See the criteria)	5		4	20	HH	Level (See the criteria)	5	0	2	10	H						

Final check: Risk level change H ⇒ H; Work possible or not (Yes) ・ No

The risk after implementing countermeasures must be less than or equal to "H".

The risk assessment was carried out as described above.

Signature of the person responsible for the operation:

As a result of the risk assessment, we herewith confirm that safe work is possible.

Master's signature :

As assessed as above, it is our hope that countermeasures are implemented.

Affiliation and full name :

Level assessed : LL 1~2(Very low) L 3(Low) M 4~9 (Medium) H 10~15 (High) HH 16~20 (Very high)

Date revised:DD/MM/20YY | Rev. No. XX | No. of years to be filed for: X years

Fig. 54 Quay collision accident risk assessment

The following two items are identified as hazards:

① Rudder control switch for remote control and joystick

② Human characteristics and Psychological factors

Since people have 12 Human characteristics, such as making mistakes and assumptions, and 5 Psychological factors that induce Human error (Fig. 59), we have identified "Man: Master" as a hazard.

5-7-1 Physical countermeasures

As to ways to improve the system, from an engineering point of view, it is a question of how to make ***"the operator aware of their own human error"***.

① Warning sound when switching modes

The ship owners had employed this system on vessel A, but since crew would sometimes miss the sound, it was not deemed to be sufficient.

② Making the switch to remote mode a 2-stage operation

③ Failure to complete both stages freeze the joystick rendering it immobile

② and ③ are based on the concept of foolproofing.

Foolproofing

This is the idea of making machine operations "foolproof" by designing and incorporating mechanisms whereby operational errors do not lead to hazardous situations. Concepts relating to safety engineering and design.

In cases like this, either the Master or the AB would be standing in front of the control stand when switching modes.

When changing from manual mode to automatic, it is necessary to set a course manually and then set the course heading automatically. It is therefore thought to be not so necessary to build in a foolproof mechanism in this case.

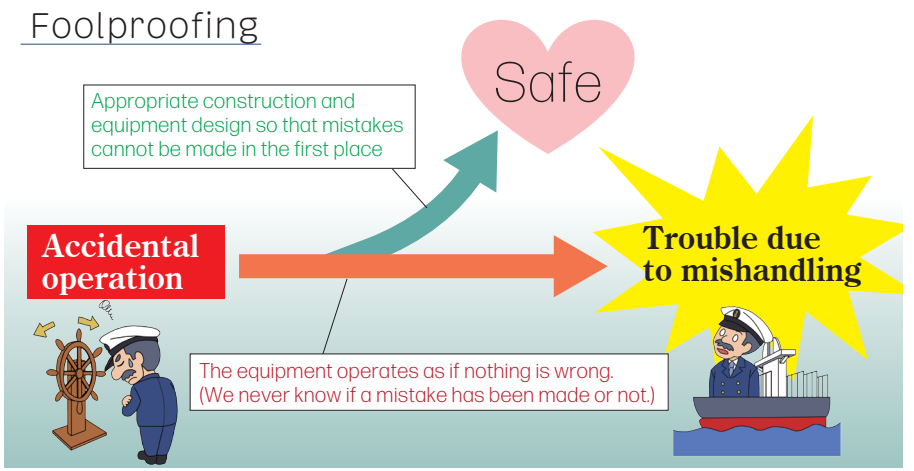


Fig. 55 Foolproofing

Similarly, it is also thought to be of minimum necessity when switching from automatic to manual or from manual to non-follow up mode since either the Master or the AB is

directly operating the rudder at that time.

However, in cases like this the Master is handling the vessel alone. When he switches to remote control mode he must move from the steering pedestal to the remote control stand on the port side of the bridge. There is plenty of scope for human error and as such it is necessary to build in some kind of foolproofing mechanism.

Rather than ② simply switching from one mode to the next, one option would be to make the switch to remote mode a 2-stage operation requiring the pulling (or pushing) of a lever to engage. Another alternative would be to build in some kind of required verification check at the remote control stand.

"③ By modifying the system so that the joystick stays fixed unless it is switched to remote control", or alternatively, the joystick could be locked when not switched to remote control.

For ocean going vessels which have both a Navigation Officer and an AB stationed inside the bridge to operate the rudder, even if the Master makes a mistake, his actions still need to be verified by the other officers on duty. Therefore, putting good BRM (Bridge Resource Management) into practice makes it possible to break the chain of sequential errors.

However, for most coaster vessels, the Master is generally working alone. Considering the limitations of BRM in these solo conditions, there is a need to incorporate some kind of engineering mechanism to make the system more foolproof.

5-7-2 Administrative countermeasures (How to break the chain of human error)

In section 5-2 Events that led to the accident, it has been explained that the accident occurred as a result of a chain of following three human errors that could not be broken.

1. The erroneously operated rudder control switch should have been changed from automatic to manual, but was mistakenly stuck in the non-follow-up position and was not checked afterwards.
2. Furthermore, the Master intended to switch from automatic to manual rudder, but in fact switched from non-follow up to manual, and without realising it, moved to the remote control stand on the port side.
3. The Master thought he could control the course and speed by remote control with the joystick lever. In fact, however, the vessel was heading straight ahead with no wind tide effect and the VecTwin Rudder was in the in neutral (hover) position, so the speed was only reduced naturally. Also, the Master was operating the joystick without checking the rudder angle indicator.

Summing up these three human errors, as explained in Figure 52 "12 Human characteristics and 5 Psychological factors" of 5-6 Causes of accidents in terms of human error, the rudder switch lever on the control stand was operated incorrectly and this triggered the Master to operate it without checking the rudder indicator (He was too preoccupied with the distance to the quay：Human beings are sometimes only able to see one thing at a time). By chance, the vessel was heading straight ahead unaffected by external forces and the VecTwin Rudder was in the neutral (hover) position, so the speed was only reduced naturally, but the Master thought he was controlling the course and speed by remote control with the joystick lever.

As administrative countermeasures, we have to implement countermeasures such as repeat training on how to operate the rudder control switch and a method of confirmation.

§ 6 Conclusion

As described in Chapter 2, risk management is advocated by the Ministry of Health, Labour and Welfare (MHLW) for the manufacturing industry on land, in line with the Industrial Safety and Health Act (Act No. 57, 1972), as a business management technique to effectively deal with unforeseen losses caused by various hazards at minimum cost. Also, the enforcement of the Companies Act 2006 requires joint-stock companies to have "systems related to management of the risk of loss" in place. In addition, the Japanese version of Sarbanes-Oxley (SOX) Act came into force in 2008 and a "financial risk management system" has been required since then.

As a result of this, the shipping industry has been required to incorporate risk management in safety management codes and SMS manuals since around 2010, but this has been difficult for ship management and the vessel to adopt in practice. One of the reasons why risk management has not permeated this industry is because the Master, Chief Engineer and experienced crew both on Deck and in the Engine departments have already been practising risk assessment implicitly as part of their work.

However, it is now customary that a crew of several nationalities with different cultures and customs be on board to achieve the safe operation of a ship. In this context, the approach (top down) mentioned above, on board a vessel, where risk assessments are practised individually and implicitly by following orders from experienced crew members, may actually reduce the level of safety.
It is important that the management at the shore catering department, such as the ship owner or ship management company, understand what has been explained in this guide. As explained in section 4-3 "Risk assessment procedures", for example, regarding countermeasures for rough weather, management is not to be left solely to the discretion of the Master/Chief Engineer or Chief Officer/First Engineer, but that all crew members take time to participate in the discussion and share their opinions and countermeasures. It is recommended that risk assessments are practised in a relaxed and systematic manner, where unexpected oversight or other problems can be identified by evaluating them numerically in writing. As a result, we believe that the safety level of the vessel will surely be improved.

References

- Japan Industrial Safety and Health Association (JISHA)
  - Risk assessment duties for person in charge
  - Workplace risk assessment case studies
  - Practical risk assessment training materials for health and safety staff

A range of training resources in risk assessment is available by the Japan Industrial Safety and Health Association (JISHA). For details, please refer to the association's homepage below.

- Introduction to System Safety (Provisional translation) :
  System Safety Engineering, Nagaoka University of Technology (Yokendo Ltd.)
- The Forefront of Safety Engineering - The Concept of System Safety -
  (Provisional translation) The Japan Society of Mechanical Engineers, ed.
  (Kyoritsu Shuppan Co., Ltd.)

Attachments

Attachment 1 Quantified risk assessment index guidelines (criteria)：Severity

【Frequency of occurrence evaluation criteria】 Attachment 1

Frequency of occurrence	Nominal frequency of occurrence	Probability of occurrence
5	Level of repeated encounters in a lifetime (occurring in less than 3 to 6 months)	3/10
4	A level that has more than one encounter in a lifetime (occurring about once every six months to a year)	3/100
3	A level that has several encounters in a lifetime (occurring in less than 3 to 5 years)	3/1,000
2	A level that has very few encounters in a lifetime (occurring about once every 5-20 years)	3/10,000
1	A level that is close to zero encounters in a lifetime (occurring once in more than 20 years)	3/100,000

Attachment 2 Quantified risk assessment index guidelines (criteria)：
Frequency of occurrence

【Severity evaluation criteria】 Attachment 2

Level	Health and safety	Public concern	Environment impact	Economic loss	Management system
4	Death/public impact	Worldwide media coverage	Large-scale and long-term pollution	100 mm yen above	Complete shutdown
3	Serious injury or illness, limited public impact	National press coverage	Serious pollution	10 - 100 mm yen	Possible shutdown
2	Minor injury, small impact on public	Reported in local press	Medium-sized pollution of medium duration in a limited area	5 mm - 10 mm yen	Affected
1	Minor injury/no public impact	Rarely broadcasted	Minor pollution or no pollution	Less than 5 mm yen	No impact

Attachment 3 Risk assessment index guidelines (criteria):
Risk severity assessment and classification

【Risk severity assessment classification】 Attachment 3

Risk severity assessment	Level	Region	Assessment as to whether or not work can be carried out
1	LL	Very low risk	[Region of safety]	[Work possible] Ensure that risk mitigation measures are implemented and that work is carried out in line with this
2				
3				
4	L	Low risk		
5	M	Medium risk	[Region of uncertainty] (Permissible and ALARP region)	
6				
7				
8				
9				
10	H	High risk	[Hazardous region] (Region whereby permission is not allowed)	[Work not possible] Where it is necessary to carry out work in order to respond to an emergency or for other reasons, the work must not be carried out without the permission of the manager, notwithstanding the safety management regulations.
11				
12				
13				
14				
15				
16	HH	Extremely high risk		
17				
18				
19				
20				

ALARP AREA ：As low as Reasonably Practicable

Organization | Safety management system | Reference No.

Pre-work risk assessment table (Reference No.)

Specific work to be carried out : (Deck・Engine・Catering)

Date and time of as DDMMYY~DDMMYY

Work category : Routine work : Non-routine work

Participants :

Place and name of work:

① Possible hazards and risk assessment						② Prevention/mitigation measures and post-measure risk assessment						③ Company assessment						
Possible hazard (because of~, by doing~, (causing specific trouble))	Frequency of occurrence (a)	Severity (b) Accident involving people	Severity (b) Other	Risk (a×b)	Risk level	Prevention/mitigation measures	Frequency of occurrence (a)	Severity (b) Accident involving people	Severity (b) Other	Risk (a×b)	Risk level	Frequency of occurrence (a)	Severity (b) Accident involving people	Severity (b) Other	Risk (a×b)	Risk level	Measures adopted
1 (Hazard)						(a. Essential measures) (b. Physical countermeasures) (c. Administrative countermeasures) (d. Use of personal protective equipment)											
2 (Hazard)						(a. Essential measures) (b. Physical countermeasures) (c. Administrative countermeasures) (d. Use											
3 (Hazard)						(a. Essential measures)											
4 (Hazard)						(d. Use of personal protective equipment)											
Total (1~4 only)	0	0	0	0			0	0	0	0		0	0	0	0		
Risk level prior to countermeasure (Avg.)	No.						No.										
	Avg.						Avg.										
Level (See the criteria)																	

Describe possible risks and hazards

Fill in the frequency and severity of occurrence with reference to the criteria and multiply

Decide on level

Assess the level of risk by describing the frequency and severity of the occurrence after having implemented the countermeasures

Fill in the appropriate boxes with measures to be taken

Companies are to assess the report from the vessel

Final assessment	Risk level change		⇒	
	[Work possible?]	Yes	・	No

The risk after implementing countermeasures must be less than or equal to "9".

The risk assessment was carried out as described above.

Signature of the person responsible for the operation:

As a result of the risk assessment, we herewith confirm that safe work is possible.

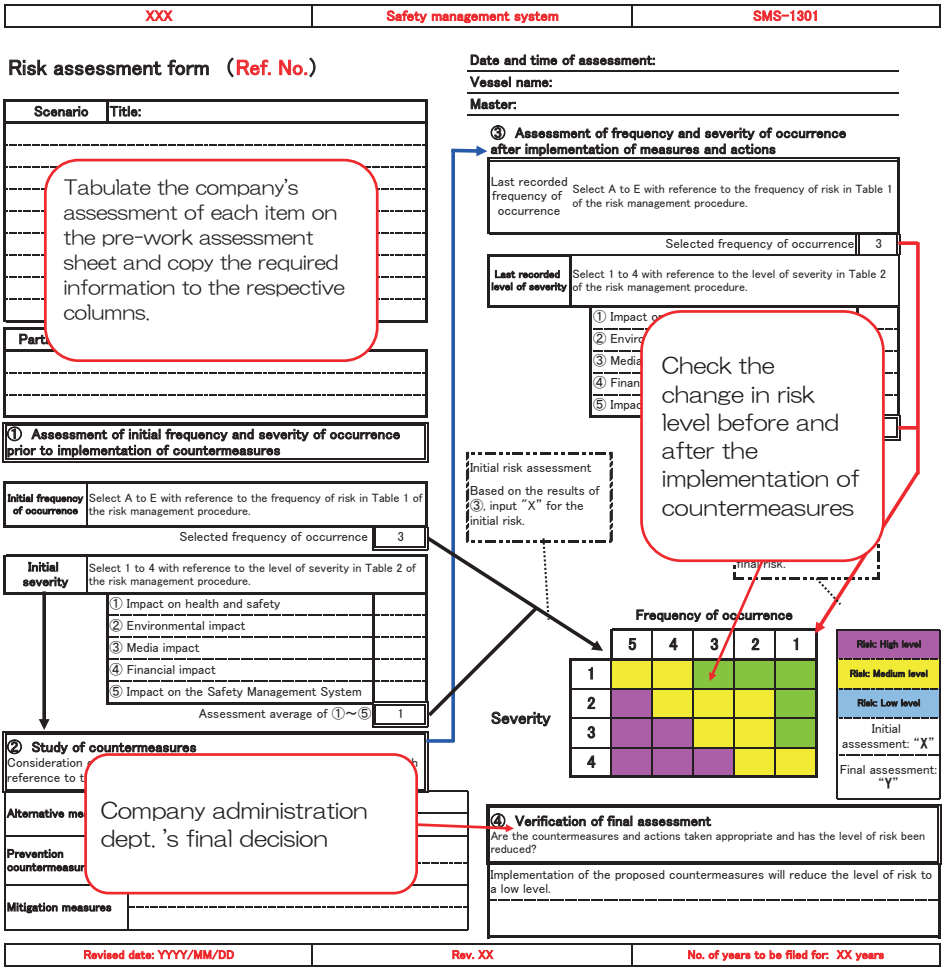
Master's signature :

As assessed as above, it is our hope that countermeasures be implemented.

Affiliation and full name :

Level assessed : LL 1~2 (Very low) L 3 (Low) M 4~9 (Meduim) H 10~15 (High) HH 16~20 (Very high)

Date revised : DD/MM/20YY | Rev. No. XX | No. of years to be filed for: X years


XXX
Safety management system
SMS-1301
Risk assessment form （Ref. No.）
Date and time of assessment:
Vessel name:
Master:
Scenario
Title:
Tabulate the company's assessment of each item on the pre-work assessment sheet and copy the required information to the respective columns.
① Assessment of initial frequency and severity of occurrence prior to implementation of countermeasures
Initial frequency of occurrence
Select A to E with reference to the frequency of risk in Table 1 of the risk management procedure.
Selected frequency of occurrence
3
Initial severity
Select 1 to 4 with reference to the level of severity in Table 2 of the risk management procedure.
① Impact on health and safety
② Environmental impact
③ Media impact
④ Financial impact
⑤ Impact on the Safety Management System
Assessment average of ①～⑤
1
② Study of countermeasures
Alternative me
Prevention countermeasur
Mitigation measures
Company administration dept. 's final decision
③ Assessment of frequency and severity of occurrence after implementation of measures and actions
Last recorded frequency of occurrence
Select A to E with reference to the frequency of risk in Table 1 of the risk management procedure.
Selected frequency of occurrence
3
Last recorded level of severity
Select 1 to 4 with reference to the level of severity in Table 2 of the risk management procedure.
Check the change in risk level before and after the implementation of countermeasures
Initial risk assessment
Based on the results of ③, input "X" for the initial risk.
Frequency of occurrence
5 4 3 2 1
Severity
1
2
3
4
Risk: High level
Risk: Medium level
Risk: Low level
Initial assessment: "X"
Final assessment: "Y"
④ Verification of final assessment
Are the countermeasures and actions taken appropriate and has the level of risk been reduced?
Implementation of the proposed countermeasures will reduce the level of risk to a low level.
Revised date: YYYY/MM/DD
Rev. XX
No. of years to be filed for: XX years

Organization	Safety management system	Reference No.

Pre-work risk assessment table (Reference No.)

Specific 1 : Rough weather navigation countermeasures (Deck • Engine • Catering)

Date and time of assessment : 1 April 2021 to MM DD

Work category : : Routine work / : Non-routine work

Participan : △△△、xxx、□□□

Place and name of work :

	① Possible hazards and risk assessment						② Prevention/mitigation measures and post-measure risk assessment							③ Company assessment						
	Possible hazard (because of~, by doing~, (causing specific trouble))	Frequency of occurrence (a)	Severity (b) Accident involving people	Severity (b) Other	Risk (a×b)	Risk level	Prevention/mitigation measures	Frequency of occurrence (a)	Severity (b) Accident involving people	Severity (b) Other	Risk (a×b)	Risk level		Frequency of occurrence (a)	Severity (b) Accident involving people	Severity (b) Other	Risk (a×b)	Risk level	Measures adopted
1	Failure to plan for evacuation in a rough sea area, and failure to inform relevant parties of estimated arrival delays, resulting in confusion in rescheduling (Hazard) No review of the voyage plan	2		4	8	M	(a. Essential measures) (b. Physical countermeasures) (c. Administrative countermeasures) If there is a significant change in estimated time of arrival, this is to be reported immediately (d. Use of personal protective equipment)	2		1	2	LL		2		1	2	LL	○
2	Failure to secure or stow moving objects in the bridge, resulting in bruising or fractures when the moving object hits a person. Further, this can damage nautical instruments. (Hazard) Moving objects in bridge	3	3		9	M	(a. Essential measures) (b. Physical countermeasures) Securing or storing of moving objects in lockers etc. (c. Administrative countermeasures) (d. Use of personal protective equipment)	1	1		1	LL		1	1		1	LL	○
3	Failure to secure moving objects on the deck or in the store will damage the hull or other parts of the ship, or lead to injury. (Hazard) Moving objects on deck or in the store	3		4	12	H	(a. Essential measures) Anchor lashing must be used throughout the voyage (b. Physical countermeasures) (c. Administrative countermeasures) (d. Use of personal protective equipment)	2		1	2	LL		2		2	4	M	○
4	Failure to close watertight doors, through which water can enter and cause wet damage, or, fractures caused from being caught in a watertight door. (Hazard) Watertight doors	4	5	4	20	HH	(a. Essential measures) (b. Physical countermeasures) Watertight doors are always to be securely closed and, if necessary, locked (c. Administrative countermeasures) (d. Use of personal protective equipment)	2	1	1	2	LL		2	1	1	2	LL	○
	Total (1~4 only)	12	8	12	49		Total (1~4 only)	7	2	3	7			7	2	4	9		
	Risk level prior to countermeasure (Avg.) No.	4	2	3	4		Risk level after countermeasure (Avg.) No.	4	2	3	4			4	2	3	4		
	Risk level prior to countermeasure (Avg.) Avg.	3.0	4.0	4.0	12.0		Risk level after countermeasure (Avg.) Avg.	1.8	1.0	1.0	1.8			1.8	1.0	1.3	2.3		
	Level (See the criteria)	3	4	4	12	H	Level (See the criteria)	2	1	1	2	LL		2	1	2	4	M	

Final assessment	Risk level change		⇒	
	[Work possible?]	Yes	•	No

The risk after implementing countermeasures must be less than or equal to "9".

The risk assessment was carried out as described above.

Signature of the person responsible for the operation:

As a result of the risk assessment, we herewith confirm that safe work is possible.

Master's signature :

As assessed as above, it is our hope that countermeasures be implemented.

Affiliation and full name :

Level assessed : LL 1~2 (Very low) L 3 (Low) M 4~9 (Medium) H 10~15 (High) HH 16~20 (Very high)

Date revised : DD/MM/20YY	Rev. No. XX	No. of years to be filed for: X years

Organization	Safety management system	Reference No.

Pre-work risk assessment table (Reference No.)

Specific 1 : Rough weather navigation countermeasures (Deck • Engine • Catering)

Participer : △△△、xxx、□□□

Date and time of assessment : 1 April 2021 to MM DD

Place and name of work :

Work category : : Routine work / : Non-routine work

	① Possible hazards and risk assessment						② Prevention/mitigation measures and post-measure risk assessment							③ Company assessment						
	Possible hazard (because of~, by doing~, (causing specific trouble))	Frequency of occurrence (a)	Severity (b) Accident involving people	Severity (b) Other	Risk (a×b)	Risk level	Prevention/mitigation measures	Frequency of occurrence (a)	Severity (b) Accident involving people	Severity (b) Other	Risk (a×b)	Risk level		Frequency of occurrence (a)	Severity (b) Accident involving people	Severity (b) Other	Risk (a×b)	Risk level	Measures adopted
5	When a navigation light bulb went out, and was replaced with a spare bulb, the spare bulb was also out of order. There were no lights on.	2		2	4	M	(a. Essential measures)												
							(b. Physical countermeasures)												
							(c. Administrative countermeasures) Always check the navigation lanterns.	2		1	2	LL		2		1	2	LL	O
	(Hazard) Navigation lanterns						(d. Use of personal protective equipment)												
6	The handrail was damaged. When trying to hold oneself up due to swaying, this caused a fall which led to bruising and broken bones.	3	3		9	M	(a. Essential measures)												
							(b. Physical countermeasures) Immediately repair any damage, not just the handrails.	3	1		3	L		3	1		3	L	O
							(c. Administrative countermeasures)												
	(Hazard) Handrails						(d. Use of personal protective equipment)												
7	The lifelines on deck were not in place. As there is no means of support in the event of a ship's motion, this may cause the crew to fall over or overboard.	4	5		20	HH	(a. Essential measures)												
							(b. Physical countermeasures) Lifelines are to be set in place in rough weather.	4	2		8	M		4	2		8	M	O
							(c. Administrative countermeasures) If not described it in the procedures for dealing with rough weather, this is to be added.	4	2		8	M		4	2		8	M	O
	(Hazard) No installation of lifelines						(d. Use of personal protective equipment) If work must be carried out, a life belt connected to a lifeline is to be worn.	4	2		8	M		4	2		8	M	O
8	(Shared information) Failure to prepare a cabin for rough weather may result in injury from falls or dropping objects.	3	2		6	M	(a. Essential measures)												
							(b. Physical countermeasures) Securing of moving objects in the accommodation areas and rooms.	3	1		3	L		3	1		3	L	O
							(c. Administrative countermeasures) The room is always tidy.	3	1		3	L		3	1		3	L	O
	(Hazard) Moving objects in each room						(d. Use of personal protective equipment)												
	Total (1~8)	24	18	14	88		Total (1~8)	30	11	4	42			30	11	5	44		
	Risk level prior to countermeasure (Avg.) No.	8	5	4	8		Risk level after countermeasure (Avg.) No.	11	8	4	11			11	8	4	11		
	Risk level prior to countermeasure (Avg.) Avg.	3.0	3.6	3.5	11.0		Risk level after countermeasure (Avg.) Avg.	2.7	1.4	1.0	3.8			11.0	1.4	1.3	4.0		
	Level (See the criteria)	3	4	4	12	H	Level (See the criteria)	3	2	1	6	M		3	2	2	6	M	

Final assessment	Risk level change	H	⇒	M
	[Work possible?]	Yes	•	No

The risk after implementing countermeasures must be less than or equal to "9".

The risk assessment was carried out as described above.

Signature of the person responsible for the operation:

As a result of the risk assessment, we herewith confirm that safe work is possible.

Master's signature :

As assessed as above, it is our hope that countermeasures be implemented.

Affiliation and full name :

Level assessed : LL 1~2 (Very low) L 3 (Low) M 4~9 (Medium) H 10~15 (High) HH 16~20 (Very high)

Date revised : DD/MM/20YY	Rev. No. XX	No. of years to be filed for: X years

Attachment 8　Risk assessment examples　Pre-work assessment table:
Preparation of Deck for rough weather

Attachment 8(Deck)

XXX	Safety management system	SMS-1301

Risk assessment form （Ref. No.）

Date and time of assessment:

Vessel name:

Master:

Scenario	Title:
Study of countermeasures for rough weather	
Risk assessment regarding countermeasures for rough weather on the Deck	

Participants
Capt., C/O, 2/O and 3/O
Bsn. AB x 3, OS x 2
10 personnel in total

① Assessment of initial frequency and severity of occurrence prior to implementation of countermeasures

Initial frequency of occurrence	Select A to E with reference to the frequency of risk in Table 1 of the risk management procedure.	
	Selected frequency of occurrence	3
Initial severity	Select 1 to 4 with reference to the level of severity in Table 2 of the risk management procedure.	
	① Impact on health and safety	4
	② Environmental impact	–
	③ Media impact	–
	④ Financial impact	4
	⑤ Impact on the Safety Management System	–
	Assessment average of ①～⑤	1

② Study of countermeasures

Consideration of alternative methods, preventive/mitigation measures with reference to the procedure manual

Alternative means	Fixing of moving objects	Strengthening of communication between the charterer and the ship management company
Prevention countermeasures	Fixing of moving objects	Strengthening of communication between the charterer and the ship management company
Mitigation measures		

③ Assessment of frequency and severity of occurrence after implementation of measures and actions

Last recorded frequency of occurrence	Select A to E with reference to the frequency of risk in Table 1 of the risk management procedure.	
	Selected frequency of occurrence	3
Last recorded level of severity	Select 1 to 4 with reference to the level of severity in Table 2 of the risk management procedure.	
	① Impact on health and safety	2
	② Environmental impact	–
	③ Media impact	–
	④ Financial impact	1
	⑤ Impact on the Safety Management System	–
	Assessment average of ①～⑤	2

Initial risk assessment
Based on the results of ③, input "X" for the initial risk.

Final risk assessment
Based on the results of ③, input "Y" for the final risk.

Frequency of occurrence

Severity	5	4	3	2	1
1					
2			Y		
3					
4			X		

Risk: High level
Risk: Medium level
Risk: Low level
Initial assessment: "X"
Final assessment: "Y"

④ Verification of final assessment

Are the countermeasures and actions taken appropriate and has the level of risk been reduced?

YES, Implementation of the proposed countermeasures will reduce the level of risk to a low level.

Revised date: YYYY/MM/DD	Rev. XX	No. of years to be filed for: XX years

Attachment 9(Eng . 1)

Organization	Safety management system	Reference No.

Pre-work risk assessment table (Reference No.)

Specific \ : Rough weather navigation countermeasures (Deck・Engine・Catering)

Date and time of assessment : 1 April 2021 to MM DD

Work category : ・Routine work

Participer : △△△, xxx, □□□

Place and name of work :

: Non-routine work

	① Possible hazards and risk assessment						② Prevention/mitigation measures and post-measure risk assessment							③ Company assessment						
	Possible hazard (because of~, by doing~, (causing specific trouble))	Frequency of occurrence (a)	Severity (b) Accident involving people	Severity (b) Other	Risk (a×b)	Risk level	Prevention/mitigation measures	Frequency of occurrence (a)	Severity (b) Accident involving people	Severity (b) Other	Risk (a×b)	Risk level	Measures adopted	Frequency of occurrence (a)	Severity (b) Accident involving people	Severity (b) Other	Risk (a×b)	Risk level	Measures adopted
1	The C/E and 1/O do not consult with the deck personnel (Master and 1/O) and the engine department's measures against rough weather are inadequate or implemented too late. (Hazard) None	2		1	2	LL	(a. Essential measures) (b. Physical countermeasures) (c. Administrative countermeasures) Not only should meetings be regular, but items (d. Use of personal protective equipment)	2		1	2	LL	○	2		1	2	LL	○
2	Inadequate lubrication of main engine, generator and other equipment, and hull agitation causing low level alarm and tripping (emergency stop). (Hazard) Lack of lubricant	4		4	16	HH	(a. Essential measures) (b. Physical countermeasures) Check lubricant level and top up if necessary. Cleaning of strainer (including that of fuel system) (c. Administrative countermeasures) (d. Use of personal protective equipment)	4		1	4	M	○	4		1	4	M	○
3	Failure to secure moving objects in the engine room and engine control room, causing damage to the console and other parts, and injury to crew members who are hit by those moving objects. (Hazard) Moving objects	3	4	4	12	H	(a. Essential measures) (b. Physical countermeasures) Fixing of moving objects (c. Administrative countermeasures) (d. Use of personal protective equipment)	2	2	2	4	M	○	2	2	2	4	M	○
4	Inadequate cleaning of the floor in the engine room, causing oil and water on the floor to accumulate leading to crew slipping and being injured. (Hazard) Oil and water on the floor	3	3	–	9	M	(a. Essential measures) Floor cleaning in advance. Dry each time afterwards. (b. Physical countermeasures) If necessary, apply slip resistant material. (c. Administrative countermeasures) (d. Use of personal protective equipment)	3 3	1 1		3 3	L L	O O	3 3	1 1		3 3	L L	O O
	Total (1~4 only)	12	7	9	39		Total (1~4 only)	14	4	4	16			14	4	4	16		
	Risk level prior to countermeasure (Avg.) No.	4	2	4	4		Risk level after countermeasure (Avg.) No.	5	3	3	5			5	3	3	5		
	Risk level prior to countermeasure (Avg.) Avg.	3.0	3.5	2.3	9.8		Risk level after countermeasure (Avg.) Avg.	2.8	1.3	1.3	3.2			2.8	1.3	1.3	3.2		
	Level (See the criteria)	3	4	3	12	H	Level (See the criteria)	3	2	2	6	M		3	2	2	6		

Final assessment	Risk level change		⇒	
	[Work possible?]	Yes	・	No

The risk after implementing countermeasures must be less than or equal to "9".

The risk assessment was carried out as described above.

As a result of the risk assessment, we herewith confirm that safe work is possible.

As assessed as above, it is our hope that countermeasures be implemented.

Signature of the person responsible for the operation:

Master's signature :

Affiliation and full name :

Level assessed : LL 1~2 (Very low) L 3 (Low) M 4~9 (Medium) H 10~15 (High) HH 16~20 (Very high)

Date revised : DD/MM/20YY	Rev. No. XX	No. of years to be filed for: X years

Organization	Safety management system	Reference No.

Pre-work risk assessment table (Reference No.)

Specific ↑ : Rough weather navigation countermeasure (Deck • Engine • Catering)

Participar :

Date and time of assessment : 1 April 2021 to MM DD

Place and name of work :

Work category : Routine work / Non-routine work

	① Possible hazards and risk assessment						② Prevention/mitigation measures and post-measure risk assessment						③ Company assessment						
	Possible hazard (because of~, by doing~, (causing specific trouble))	Frequency of occurrence (a)	Severity (b) Accident involving people	Severity (b) Other	Risk (a×b)	Risk level	Prevention/mitigation measures	Frequency of occurrence (a)	Severity (b) Accident involving people	Severity (b) Other	Risk (a×b)	Risk level	Frequency of occurrence (a)	Severity (b) Accident involving people	Severity (b) Other	Risk (a×b)	Risk level	Measures adopted
5	Fuel consumption increases due to increased navigation distance caused by give-way manoeuvres, resulting in fuel shortages. (Hazard) Fuel Oil	3		4	12	H	(a. Essential measures) (b. Physical countermeasures) (c. Administrative countermeasures) ROB is to be constantly monitored. (d. Use of personal protective equipment)	3		1	3	L	3		1	3	L	○
6	Failure to inform crew not to use the lifts, following the triggering of safety devices caused by hull agitation led to crew being confined. (Hazard) Lifts	1		2	2	LL	(a. Essential measures) Switch off the power supply so that the lift cannot be used. (b. Physical countermeasures) (c. Administrative countermeasures) (d. Use of personal protective equipment)	1		1	1	LL	1		1	1	LL	○
7	Overload operation of the main engine, surging and lacing of the supercharger (turbocharger) were not considered, so the main engine tripped. (Hazard) Supercharger (turbocharger)	3		3	9	M	(a. Essential measures) (b. Physical countermeasures) Exchange information with the Master, check the load on the main engine and slow down if necessary. (c. Administrative countermeasures) (d. Use of personal protective equipment)	3		2	6	M	3		2	6	M	○
8	Clogging of the fuel system strainers due to hull agitation caused by rough weather, resulting in tripping of the main engine or generator. (Hazard) Fuel system strainers	4		5	20	HH	(a. Essential measures) (b. Physical countermeasures) (c. Administrative countermeasures) Frequent strainer switching and cleaning before being being exposed to rough weather and manoeuvring in rough weather. (d. Use of personal protective equipment)	4		2	8	M	4		2	8	M	○
	Total (1~8)	23	7	23	82		Total (1~8)	25	4	10	34		25	4	10	34		
	Risk level prior to countermeasure (Avg.) No.	8	2	8	8		Risk level prior to countermeasure (Avg.) No.	9	3	7	9		9	3	7	9		
	Risk level prior to countermeasure (Avg.) Avg.	2.9	3.5	2.9	10.3		Risk level prior to countermeasure (Avg.) Avg.	2.8	1.3	1.4	3.8		2.8	1.3	1.4	3.8		
	Level (See the criteria)	3	4	3	12	H	Level (See the criteria)	3	2	2	6	M	3	2	2	6	M	

Final assessment: Risk level change H ⇒ M

[Work possible?] (Yes) • No

The risk after implementing countermeasures must be less than or equal to "9".

The risk assessment was carried out as described above.

Signature of the person responsible for the operation:

As a result of the risk assessment, we herewith confirm that safe work is possible.

Master's signature :

As assessed as above, it is our hope that countermeasures be implemented.

Affiliation and full name :

Level assessed : LL 1~2 (Very low) L 3 (Low) M 4~9 (Meduim) H 10~15 (High) HH 16~20 (Very high)

Date revised : DD/MM/20YY	Rev. No. XX	No. of years to be filed for: X years

Attachment 11　Risk assessment examples　Risk assessment form: Preparation of Engine for rough weather

XXX	Safety management system	SMS-1301

Risk assessment form （Ref. No.）

Date and time of assessment:

Vessel name:

Master:

Scenario	Title:
Study of countermeasures for rough weather	
Risk assessment regarding countermeasures for rough weather affect on the engine	

Participants
C/E, 1/E, 2/E and 3/E
FTR, OLRs x 3 and a WPR
9 personnel in total

① Assessment of initial frequency and severity of occurrence prior to implementation of countermeasures

Initial frequency of occurrence	Select A to E with reference to the frequency of risk in Table 1 of the risk management procedure.	
	Selected frequency of occurrence	3

Initial severity	Select 1 to 4 with reference to the level of severity in Table 2 of the risk management procedure.	
	① Impact on health and safety	4
	② Environmental impact	–
	③ Media impact	–
	④ Financial impact	4
	⑤ Impact on the Safety Management System	
	Assessment average of ①～⑤	4

② Study of countermeasures

Consideration of alternative methods, preventive/mitigation measures with reference to the procedure manual

Alternative means	Fixing of moving objects
	Reinforce lubricants management
Prevention countermeasures	Fixing of moving objects
	Strengthening of communication between the charterer and the ship management company
Mitigation measures	

③ Assessment of frequency and severity of occurrence after implementation of measures and actions

Last recorded frequency of occurrence	Select A to E with reference to the frequency of risk in Table 1 of the risk management procedure.	
	Selected frequency of occurrence	3

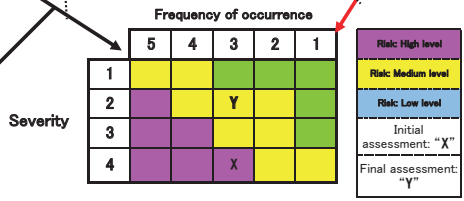
Last recorded level of severity	Select 1 to 4 with reference to the level of severity in Table 2 of the risk management procedure.	
	① Impact on health and safety	2
	② Environmental impact	–
	③ Media impact	–
	④ Financial impact	1
	⑤ Impact on the Safety Management System	–
	Assessment average of ①～⑤	2

Initial risk assessment

Based on the results of ③, input "X" for the initial risk.

Final risk assessment

Based on the results of ③, input "Y" for the final risk.



④ Verification of final assessment

Are the countermeasures and actions taken appropriate and has the level of risk been reduced?

YES Implementation of the proposed countermeasures will reduce the level of risk to a low level.

Revised date: YYYY/MM/DD	Rev. XX	No. of years to be filed for: XX years

Organization | Safety management system | Reference No.

Pre-work risk assessment table (Reference No.)

Specific 1 : Rough weather navigation countermeasures (Deck • Engine • Catering)

Participar :

Date and time of assessment : 1 April 2021 to MM DD

Place and name of work :

Work category : : Routine work / : Non-routine work

	① Possible hazards and risk assessment						② Prevention/mitigation measures and post-measure risk assessment							③ Company assessment						
	Possible hazard (because of~, by doing~, (causing specific trouble))	Frequency of occurrence (a)	Severity (b) Accident involving people	Severity (b) Other	Risk (a×b)	Risk level	Prevention/mitigation measures	Frequency of occurrence (a)	Severity (b) Accident involving people	Severity (b) Other	Risk (a×b)	Risk level		Frequency of occurrence (a)	Severity (b) Accident involving people	Severity (b) Other	Risk (a×b)	Risk level	Measures adopted	
1	By forgetting to turn off the cooking apparatus, a fire was caused by moving objects falling.	5		4	20	HH	(a. Essential measures)													
							(b. Physical countermeasures) Fixing of moving objects	5		1	5	M		5		1	5	M	O	
							(c. Administrative countermeasures) Always turn off cooking apparatus after use, not just in rough weather.	2		1	2	L		2		1	2	L	O	
	(Hazard) Cooking apparatus and moving objects						(d. Use of personal protective equipment)													
2	Doors of lockers installed in common areas (e.g. mess room) in the accommodation space are left ajar, causing the door to open by hull agitation, pinching fingers and causing injury.	4	4		16	HH	(a. Essential measures)													
							(b. Physical countermeasures)													
							(c. Administrative countermeasures) Locker doors are to be closed, not just in rough weather. Doors that are left open, such as in the mess room, are to always have a door stop applied and be lashed.	4	1		4	M		4	1		4	M	O	
	(Hazard) Doors						(d. Use of personal protective equipment)													
3	Carelessly holding plate in each hand while serving, and falling over due to hull agitation, resulting in burns or injury.	4	3		12	H	(a. Essential measures)													
							(b. Physical countermeasures)													
							(c. Administrative countermeasures) Make it a habit to keep one hand free at all times.	4	1		4	M		4	1		4	M	O	
	(Hazard) Hot plates						(d. Use of personal protective equipment)													
4	The floor in the mess room was wet and a crew member slipped and fell. Injured sustained	4	3		12	H	(a. Essential measures)													
							(b. Physical countermeasures)													
							(c. Administrative countermeasures) Keep floor surfaces dry, not just in rough weather.	4	1		4	M		4	1		4	M	O	
	(Hazard) Wet floors						(d. Use of personal protective equipment)													
	Total (1~4 only)	17	10	4	60		Total (1~4 only)	19	3	2	19			19	3	2	19			
	Risk level prior to countermeasure (Avg.) No.	4	3	1	4		Risk level after countermeasure (Avg.) No.	5	3	2	5			5	3	2	5			
	Avg.	4.3	3.3	4.0	15.0		Avg.	3.8	1.0	1.0	3.8			3.8	1.0	1.0	3.8			
	Level (See the criteria)	5	4	4	20	HH	Level (See the criteria)	4	1	1	4			4	1	1	4			

Final assessment: Risk level change [ ] ⇒ [ ] (Work possible?) Yes · No

The risk after implementing countermeasures must be less than or equal to "9".

The risk assessment was carried out as described above.

Signature of the person responsible for the operation:

As a result of the risk assessment, we herewith confirm that safe work is possible.

Master's signature :

As assessed as above, it is our hope that countermeasures be implemented.

Affiliation and full name :

Level assessed : LL 1~2 (Very low) L 3 (Low) M 4~9 (Meduim) H 10~15 (High) HH 16~20 (Very high)

Date revised : DD/MM/20YY | Rev. No. XX | No. of years to be filed for: X years

Organization	Safety management system	Reference No.

Pre-work risk assessment table (Reference No.)

Specific work to be carried out: Rough weather navigation countermeasures (Deck • Engine • Catering)

Date and time of assessment : 1 April 2021 to MM DD

Work category : (Routine work) / Non-routine work

Participan :

Place and name of work :

	① Possible hazards and risk assessment						② Prevention/mitigation measures and post-measure risk assessment							③ Company assessment						
	Possible hazard (because of~, by doing~, (causing specific trouble))	Frequency of occurrence (a)	Severity (b) Accident involving people	Severity (b) Other	Risk (a×b)	Risk level	Prevention/mitigation measures	Frequency of occurrence (a)	Severity (b) Accident involving people	Severity (b) Other	Risk (a×b)	Risk level		Frequency of occurrence (a)	Severity (b) Accident involving people	Severity (b) Other	Risk (a×b)	Risk level	Measures adopted	
5	The mess table was not prepared for rough weather and plates moved during the meal. Hot soup spills and burns the crew. (Hazard) Hot dishes	3	2		6	M	(a. Essential measures) (b. Physical countermeasures) (c. Administrative countermeasures) As a requirement for rough weather, use wet sheets and other materials to prepare tables for rough weather. (d. Use of personal protective equipment)	3	1		3	L		3	1		3	L	○	
6	Because moving objects (including chairs in the mess) were not fixed, crew members were hit by moving objects and injured. (Hazard) Moving objects	5	2		10	H	(a. Essential measures) (b. Physical countermeasures) (c. Administrative countermeasures) The securing of all moving objects (d. Use of personal protective equipment)	5	1		5	M		5	1		5	M	○	
7	Pantry was not tidy, provisions are scattered and some unusable. (Hazard) Provisions	4		1	4	M	(a. Essential measures) (b. Physical countermeasures) (c. Administrative countermeasures) Regular tidy-up (d. Use of personal protective equipment)	2		1	2	LL		2		1	2	LL	○	
8	(Hazard)						(a. Essential measures) (b. Physical countermeasures) (c. Administrative countermeasures) (d. Use of personal protective equipment)													
	Total (1~8)	29	14	5	80		Total (1~8)	29	5	3	29			29	5	3	29			
	Risk level prior to countermeasure (Avg.) No.	7	5	2	7		Risk level after countermeasure (Avg.) No.	8	5	3	8			8	5	3	8			
	Risk level prior to countermeasure (Avg.) Avg.	4.1	2.8	2.5	11.4		Risk level after countermeasure (Avg.) Avg.	3.6	1.0	1.0	3.6			3.6	1.0	1.0	3.6			
	Level (See the criteria)	5	3	3	15	H	Level (See the criteria)	4	1	1	4	M		4	1	1	4	M		

Final assessment: Risk level change H ⇒ M ; [Work possible?] (Yes) · No

The risk after implementing countermeasures must be less than or equal to "9".

The risk assessment was carried out as described above.

Signature of the person responsible for the operation:

As a result of the risk assessment, we herewith confirm that safe work is possible.

Master's signature :

As assessed as above, it is our hope that countermeasures be implemented.

Affiliation and full name :

Level assessed : LL 1~2 (Very low) / L 3 (Low) / M 4~9 (Medium) / H 10~15 (High) / HH 16~20 (Very high)

Date revised : DD/MM/20YY	Rev. No. XX	No. of years to be filed for: X years

Attachment 14　Risk assessment examples Risk assessment form:
Preparation of Catering department for rough weather

XXX	Safety management system	SMS-1301

Risk assessment form （Ref. No.）

Date and time of assessment

Vessel name

Master

Scenario	**Title:**
Study of countermeasures for rough weather	
Risk assessment regarding countermeasures for rough weather in the house	

Participants
Capt. and C/O
C/S, 2/S and Boy
5 personnel in total

① Assessment of initial frequency and severity of occurrence prior to implementation of countermeasures

Initial frequency of occurrence	Select A to E with reference to the frequency of risk in Table 1 of the risk management procedure.	
	Selected frequency of occurrence	5
Initial severity	Select 1 to 4 with reference to the level of severity in Table 2 of the risk management procedure.	
	① Impact on health and safety	3
	② Environmental impact	–
	③ Media impact	–
	④ Financial impact	–
	⑤ Impact on the Safety Management System	–
	Assessment average of ①～⑤	3

② Study of countermeasures

Consideration of alternative methods, preventive/mitigation measures with reference to the procedure manual

Alternative means	Fixing of moving objectives
Prevention countermeasures	Fixing of moving objectives Moving objectives to be fixed
Mitigation measures	

③ Assessment of frequency and severity of occurrence after implementation of measures and actions

Last recorded frequency of occurrence	Select A to E with reference to the frequency of risk in Table 1 of the risk management procedure.	
	ɔlected frequency of occurren	4
Last recorded level of severity	Select 1 to 4 with reference to the level of severity in Table 2 of the risk management procedure.	
	① Impact on health and safety	1
	② Environmental impact	–
	③ Media impact	–
	④ Financial impact	1
	⑤ Impact on the Safety Management System	
	Assessment average of ①～⑤	1

Initial risk assessment

Based on the results of ③, input "X" for the initial risk.

Final risk assessment

Based on the results of ③, input "Y" for the final risk.

Frequency of occurrence

Severity	5	4	3	2	1
1		Y			
2					
3	X				
4					

Risk: High level

Risk: Medium level

Risk: Low level

Initial assessment: "X"

Final assessment: "Y"

④ Verification of final assessment

Are the countermeasures and actions taken appropriate and has the level of risk been reduced?

YES, Implementation of the proposed countermeasures will reduce the level of risk to a low level.

Revised date: YYYY/MM/DD	Rev. XX	No. of years to be filed for: XX years

Attachment 15

Vessel A Quay collision accident　Accident timeline

Crew arrangement	Standard docking procedures	Time	Speed	Distance from the quay (Ship length ratio)	Actual actions taken	Who
Bridge Master • C/E	Engine in neutral position	11:55	9.4 kts	2,350 m (30 L)	At 2,350m before the quay (30L), engine half speed to neutral operation. Speed of 9.4 knots and switched from automatic to manual rudder	Master
Fore C/Off • Bsn • Sailer	D.Slow Ahead Used VecTwin rudders for speed control both sternway and headway	12:00	9.0 kts	1,160 m (15 L)	The Master intended to use the joystick device to control the VecTwin Rudder system to manoeuvre the ship to the shore, and switch the rudder control to remote control. D.Slow Ahead	Master
Aft 2/AE • 3/Off					However, he did not realise that the rudder switch was stuck in the non-follow-up position and moved to the port side of the bridge in front of the remote control stand. He believed that it had switched to remote rudder control by only operating the one lever.	Master
Eng. Room 1/AE		12:06	5.0 kts	317 m (4 L)	Distance to the quay was approximately four times the length of the vessel	Master
	D.Slow Ahead He made a sternway manoeuvre. Turned using bow thruster and joystick	12:08	3.1 kts	100 m (1 L)	At 100m before the quay, he thought he had tipped the joystick backwards and made a sternway manoeuvre, but in fact it was in neutral (hover).	Master
					He was too preoccupied with the distance to the quay that he did not look at the rudder angle indicator on the VecTwin rudders to notice that the rudders were heading sternway.	Master
					As the speed to fetch headway was not decreasing, he tried to make sternway by increasing engine speed (not effective as it was in neutral (hover)) and anchored.	Master
		12:09	4.3 kts	0 m (0 L)	Collided with the quay at almost a right angle, maintaining a speed of 4.3 knots	Master

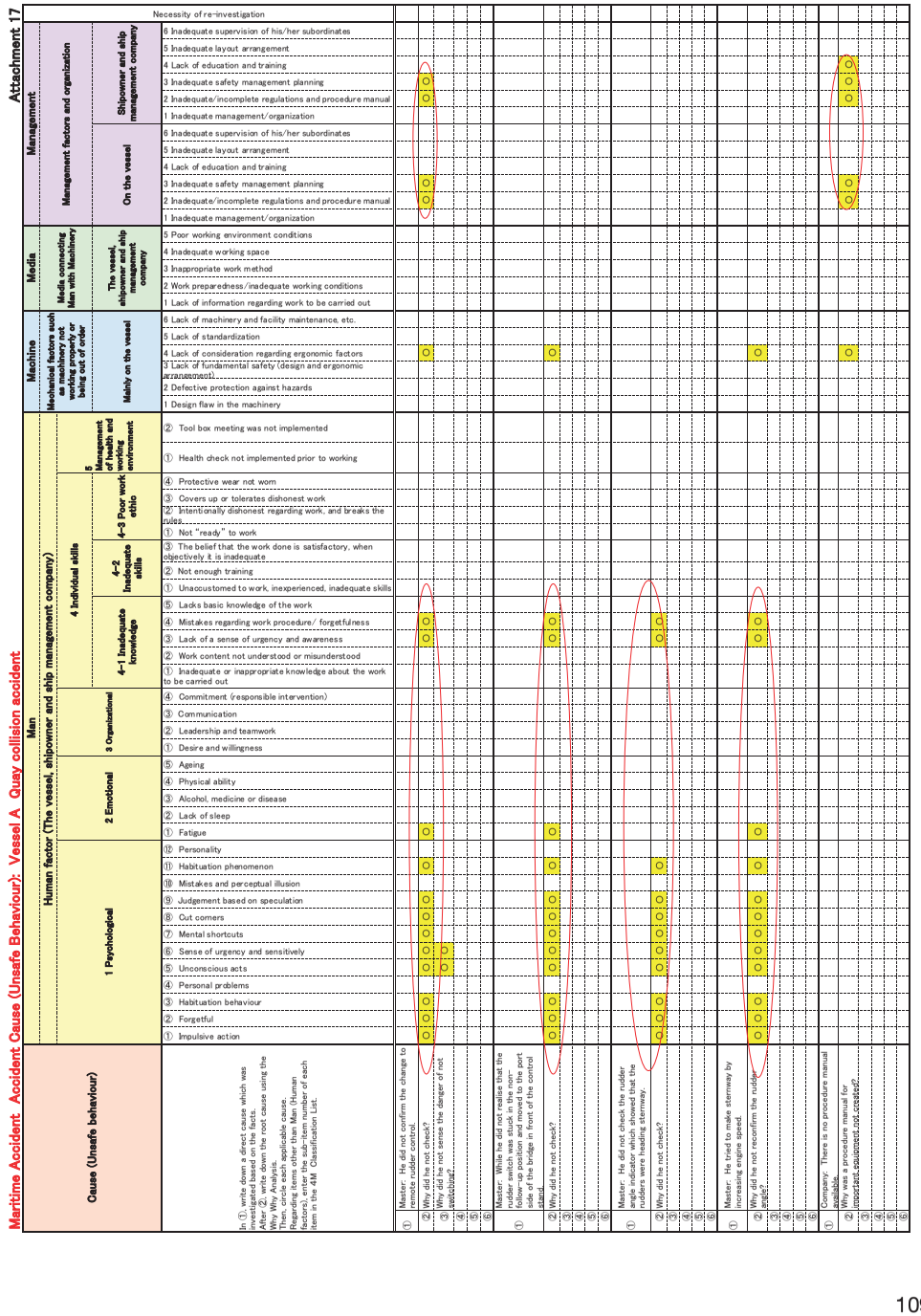
Attachment 16　Vessel A Quay collision accident Maritime Accident Summary of Related Facts

Vessel A　Quay collision accident
Maritime Accident　Summary of Related Facts

Reference No.	Identified problems from survey findings				Direct cause		Accident cause evaluation	Re-examination necessity
	Date	Time	Caused by	Check facts and problem areas	Unsafe behaviour	Unsafe conditions		
1	XX November	12:00	Master	The Master intended to turn the rudder control switch to remote control but did not verify that this had indeed been done.	○	△	2	
2	XX November	12:00	Master	He did not realise that the rudder switch was stuck in the non-follow-up position (not switching to remote rudder) and moved to the port side of the bridge in front of the control stand.	○		3	
3	XX November	12:08	Master	He was too preoccupied with the distance to the quay that he did not look at the rudder angle indicator on the VecTwin rudders to notice that the rudders were heading sternway.	○		1	
4	XX November	12:08	Master	As the speed to fetch headway was not decreasing, he tried to make sternway by increasing engine speed (not effective as it was in neutral (hover) and anchored.	○		4	
5	XXXX	XXXX	Company	Operating procedures for important equipment had not been incorporated into Safety Management Code (SMS).		○	5	

Accident cause assessment: Prioritized according to the scale of the cause

Attachment 17 Maritime Accident Accident Cause (Unsafe behaviour): Vessel A Quay collision accident



Maritime Accident Accident Cause (Unsafe Conditions): Vessel A Quay collision accident

Attachment 18

	Cause (Unsafe behaviour)	Man																																		
		Human factor (The vessel, shipowner and ship management company)																																		
		1 Psychological												2 Emotional					3 Organizational				4 Individual skills: 4-1 Inadequate knowledge					4-2 Inadequate skills			4-3 Poor work ethic				5 Management of health and working environment	
	In ①, write down a direct cause which was investigated based on the facts. After ②, write down the root cause using the Why Why Analysis. Then, circle each applicable cause. Regarding items other than Man (Human factors), enter the sub-item number of each item in the 4M Classification List.	① Impulsive action	② Forgetful	③ Habituation behaviour	④ Personal problems	⑤ Unconscious acts	⑥ Sense of urgency and sensitively	⑦ Mental shortcuts	⑧ Cut corners	⑨ Judgement based on speculation	⑩ Mistakes and perceptual illusion	⑪ Habituation phenomenon	⑫ Personality	① Fatigue	② Lack of sleep	③ Alcohol, medicine or disease	④ Physical ability	⑤ Ageing	① Desire and willingness	② Leadership and teamwork	③ Communication	④ Commitment (responsible intervention)	① Inadequate or inappropriate knowledge about the work to be carried out	② Work content not understood or misunderstood	③ Lack of a sense of urgency and awareness	④ Mistakes regarding work procedure/ forgetfulness	⑤ Lacks basic knowledge of the work	① Unaccustomed to work, inexperienced, inadequate skills	② Not enough training	③ The belief that the work done is satisfactory, when objectively it is inadequate	① Not "ready" to work	② Intentionally dishonest regarding work, and breaks the rules.	③ Covers up or tolerates dishonest work	④ Protective wear not worn	① Health check not implemented prior to working	② Tool box meeting was not implemented
①	Master: The Master intended to turn the rudder control switch to remote control but did not verify that this had indeed been done.																																			
②	Why could he not check?																							○	○											
③	Why was there no warning sound?																																			
④																																				
⑤																																				
⑥																																				
①	Company: Operating procedures for important equipment had not been incorporated into Safety Management Code (SMS).																																			
②	Why was this not incorporated into the safety management regulations?						○																								○					
③																																				
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	Cause (Unsafe behaviour)	Machine						Media					Management												
		Mechanical factors such as machinery not working properly or being out of order						Media connecting Man with Machinery					Management factors and organization												
		Mainly on the vessel						The vessel, shipowner and ship management company					On the vessel						Shipowner and ship management company						
		1 Design flaw in the machinery	2 Defective protection against hazards	3 Lack of fundamental safety (design and ergonomic arrangement)	4 Lack of consideration regarding ergonomic factors	5 Lack of standardization	6 Lack of machinery and facility maintenance, etc.	1 Lack of information regarding work to be carried out	2 Work preparedness/inadequate working conditions	3 Inappropriate work method	4 Inadequate working space	5 Poor working environment conditions	1 Inadequate management/ organization	2 Inadequate/incomplete regulations and procedure manual	3 Inadequate safety management planning	4 Lack of education and training	5 Inadequate layout arrangement	6 Inadequate supervision of his/her subordinates	1 Inadequate management/ organization	2 Inadequate/incomplete regulations and procedure manual	3 Inadequate safety management planning	4 Lack of education and training	5 Inadequate layout arrangement	6 Inadequate supervision of his/her subordinates	Necessity of re-investigation
①	Master: The Master intended to turn the rudder control switch to remote control but did not verify that this had indeed been done.																								
②	Why could he not check?		○		○									○	○					○	○				
③	Why was there no warning sound?				○																				
④																									
⑤																									
⑥																									
①	Company: Operating procedures for important equipment had not been incorporated into Safety Management Code (SMS).																								
②	Why was this not incorporated into the safety management regulations?		○		○									○	○					○	○	○			
③					○																				
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Maritime Accident Analysis using 4M5E and Countermeasure List (Unsafe Behaviour): Vessel A Quay collision accident

Attachment 19

	Man The vessel, shipowner and ship management company	Machine Mainly on the vessel	Media The vessel, shipowner and ship management company	Management On the vessel	Management Shipowner and ship management company
Risk factors **(Direct cause and indirect/root cause)**	All three of the Master's unsafe behaviours have a common direct cause. ① Impulsive action(single-minded focus on the vessel speed and distance to the quay) ② Forgetful(Unable to multi task) ③ Habituation behaviour: bad habit (Human beings have moments of inattention) ⑤ Unconscious acts ⑥ Sense of urgency and sensitively ⑦ Mental shortcuts(Human beings are sometimes in a hurry) ⑧ Cuts corners: breaks the rules due to extra work all of a sudden or fatigue ⑨ Judgement based on speculation: subjective decision and wishful observation (Human beings sometimes make assumptions) ⑪ Habituation phenomenon: false success experience (Human beings have moments of inattention)	No warning for incorrect operation		Inadequate handling instructions for critical equipment	Inadequate handling instructions for critical equipment
Education **Education and training** **Knowledge, skills, consciousness, being given information, etc.**	As an experienced specialist, he is to be well aware of the importance of complying with work procedures. Therefore, he needs to be trained to recognise psychological factors.				
Engineering **Technology and engineering** **Technological countermeasures**		Adjust the device so that a lamp lights up and a warning is sounded if it is operated incorrectly Equipment is installed to assist human characteristics: Human beings sometimes make mistakes and forget			
Enforcement **Thorough guidance and enforcement** **Standardization, proceduralization, alerting, reward and punishment** **KYT, campaigns etc.**				Creation of manuals and procedures in each vessel	Develop written procedures, such as on-site instructions for important equipment, and incorporate them into Safety Management Code (SMS).
Examples **Case studies, countermeasures and rules** **Lead by example, experience of success** **Introduce model cases, "Hiyari-Hatto" (near misses), etc.**	Get involved with creating procedure manual. Also, he will become an instructor for training based on his own experience to teach other Masters and other related audiences.				The carrying out of training on recurrence prevention countermeasures
Environment **Working environment, office internal management, on-board organization, etc.**					

Maritime Accident Analysis using 4M5E and Countermeasure List (Unsafe conditions): Vessel A Quay collision accident

Attachment 20

	Man The vessel, shipowner and ship management company	Machine Mainly on the vessel	Media Work and environment≒ Media connecting Man with Machinery The vessel, shipowner and ship management company	Management	
				On the vessel	Shipowner and ship management company
Risk factors **(Direct cause and indirect/root cause)**		No warning for incorrect operation		Inadequate handling instructions for critical equipment	Inadequate handling instructions for critical equipment
Education **Education and training** **Knowledge, skills, consciousness, being given information, etc.**					
Engineering **Technology and engineering** **Technological countermeasures**		Adjust the device so that a lamp lights up and a warning is sounded if it is operated incorrectly. Equipment is installed to assist human characteristics: Human beings sometimes make mistakes and forget.			
Enforcement **Thorough guidance and enforcement** **Standardization, proceduralization, alerting, reward and punishment** **KYT, campaigns etc.**				Creation of manuals and procedures in each vessel	The carrying out of training on recurrence prevention countermeasures Develop written procedures, such as on-site instructions for important equipment, and incorporate them into Safety Management Code (SMS).
Examples **Case studies, countermeasures and rules** **Lead by example, experience of success,** **Introduce model cases, "Hiyari-Hatto" (near misses), etc.**					
Environment **Working environment, office internal management, on-board organization, etc.**					

Attachment 20 Maritime Accident Analysis using 4M5E and Countermeasure List (Unsafe conditions): Vessel A Quay collision accident

Human characteristics, Human error and Psychology：Vessel A Quay collision accident

Date and time	Movement	Who?	Human error	Human characteristics	Psychological factors
12:00	Before passing breakwater No. 5	Master	The Master intended to use the joystick device to control the VecTwin Rudder system to manoeuvre the ship to the shore, and switch the rudder control to remote control. However, he did not realise that the rudder switch was stuck in the non-follow-up position (not switching to remote rudder) and moved to the port side of the bridge in front of the control stand.	① Human beings sometimes make mistakes: A mistake is apparent ④ Human beings sometimes do not notice: Switch position ⑥ Human beings are sometimes only able to see one thing at a time: Moved without checking ⑦ Human beings are sometimes in a hurry: He was distracted by the berthing manoeuvre	④ Confirmation bias: Human beings ignore information that is inconvenient for him or her.
12:08	At approximately 160m from the quay	Master	At 100m before the quay, he thought he had tipped the joystick backwards and made a sternway manoeuvre, but in fact it was in neutral (hover). He was too preoccupied with the distance to the quay that he did not look at the rudder angle indicator on the VecTwin rudders to notice that the rudders were heading sternway.	④ Human beings sometimes do not notice: Rudder indicator ⑥ Human beings are sometimes only able to see one thing at a time: Moved without checking? ⑦ Human beings are sometimes in a hurry: He was distracted by the berthing manoeuvre	③ Confirmation bias: "I' m special, nothing can hurt me!"
				⑤ Human beings sometimes make assumptions: Thought he had tipped the joystick backwards and made a sternway manoeuvre	④ Confirmation bias: Human beings ignore information that is inconvenient for him or her.
			As the speed to fetch headway was not decreasing, he tried to make sternway by increasing engine speed (not effective as it was in neutral (hover) and anchored.	④ Human beings sometimes do not notice: Rudder indicator ⑥ Human beings are sometimes only able to see one thing at a time: Tried to make sternway by increasing engine speed ⑪ Human beings sometimes panic	④ Confirmation bias: Human beings ignore information that is inconvenient for him or her.
12:09	Accident occurs	Master	At a speed of 4.3 knots, the ship hit the quay at almost a right angle.		

Organization	Safety management system	Reference No.

Pre-work risk assessment table (Reference No.)

Specific work to be carried out: Voyage plan (Deck・Engine・Catering Department) — Vessel A Quay collision accident

Date and time of assessment:

Work category : Routine work ・ Non-routine work

Participants : △△△、XXX、□□□

Place and name of work: Vessel A

① Possible hazards and risk assessment							② Prevention/mitigation measures and post-measure risk assessment							③ Company assessment						
	Possible hazard (because of~, by doing~, (causing specific trouble))	Frequency of occurrence (a)	Severity (b) Accident involving people	Severity (b) Other	Risk (a×b)	Risk Level	Prevention/mitigation measures	Frequency of occurrence (a)	Severity (b) Accident involving people	Severity (b) Other	Risk (a×b)	Risk level		Frequency of occurrence (a)	Severity (b) Accident involving people	Severity (b) Other	Risk (a×d)	Risk Level	Measures adopted
1	The joystick of the remote control unit moves even when the remote operation unit is switched to non-remote position, causing human characteristic/error such as Human beings sometimes make assumptions.	5		4	20	HH	(b. Physical countermeasures) Warning sound when switching modes	5		2	10	M		5		1	5	M	Y
							(b. Physical countermeasures) Making the switch to remote mode a 2-stage operation	5		1	5	M							
							(b. Physical countermeasures) Failure to complete both stages will freeze the joystick rendering it immobile.	5		1	5	M							
	(Hazard) Rudder control switch for remote control and joystick						(c. Administrative countermeasures) Repeat training to be carried out	5		1	5	M							
2	Three human errors occurred: incorrect rudder control switch, moving in front of the remote control on the port side of the bridge without checking the steering mode, and not checking the indication on the rudder angle indicator.	5		4	20	HH	(a. Essential measures)												
							(b. Physical countermeasures)												
							(c. Administrative countermeasures) Repeat training and re-education to be carried out, along with the creation of procedures and a manual	5		2	10	H							
	(Hazard) Human characteristics and Psychological factors						(d. Use of personal protective equipment)												
3							(a. Essential measures)												
							(b. Physical countermeasures)												
							(c. Administrative countermeasures)												
	(Hazard)						(d. Use of personal protective equipment)												
4							(a. Essential measures)												
							(b. Physical countermeasures)												
							(c. Administrative countermeasures)												
	(Hazard)						(d. Use of personal protective equipment)												
	Total	10	0	8	40		Total	25	0	7	35								
	Risk level prior to countermeasure (Avg.) No.	1	0	1	2		Risk level after countermeasure (Avg.) No.	5	0	5									
	Risk level prior to countermeasure (Avg.) Avg.	10.0	0.0	8.0	20.0		Risk level after countermeasure (Avg.) Avg.	5.0	0.0	1.4	7.0								
	Level (See the criteria)	5		4	20	HH	Level (See the criteria)	5	0	2	10	H							

Final assessment	Risk level change	H	⇒	H
	[Work possible or not]	Yes ・ No		

The risk after implementing countermeasures must be less than or equal to "9".

The risk assessment was carried out as described above.

Signature of the person responsible for the operation:

As a result of the risk assessment, we herewith confirm that safe work is possible.

Master's signature :

As assessed as above, it is our hope that countermeasures are implemented.

Affiliation and full name :

Level assessed : LL 1~2 (Very low) L 3 (Low) M 4~9 (Medium) H 10~15 (High) HH 16~20 (Very high)

Date revised: DD/MM/20YY	Rev. No. XX	No. of years to be filed for: X years

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