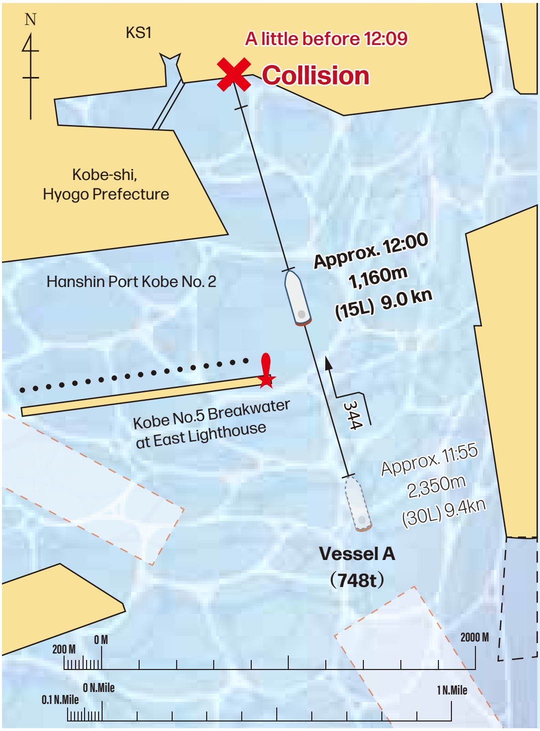
② 12 : 00 (approx.)



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.

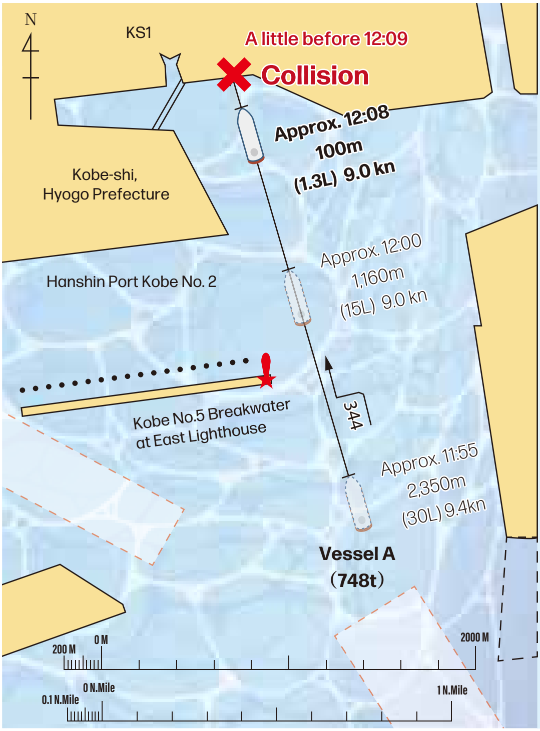
Fig. 52 Vessel A at 12:00 (approx.)

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. 53 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

● Marine Accidents Inquiry Agency (MAIA)

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.

● 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 4M4(5)E Analysis

Let us apply the 4M4(5)E Analysis introduced in Loss Prevention Bulletin Vol.50.

1 Summary of related facts (Fig. 54 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 4M4(5)E 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

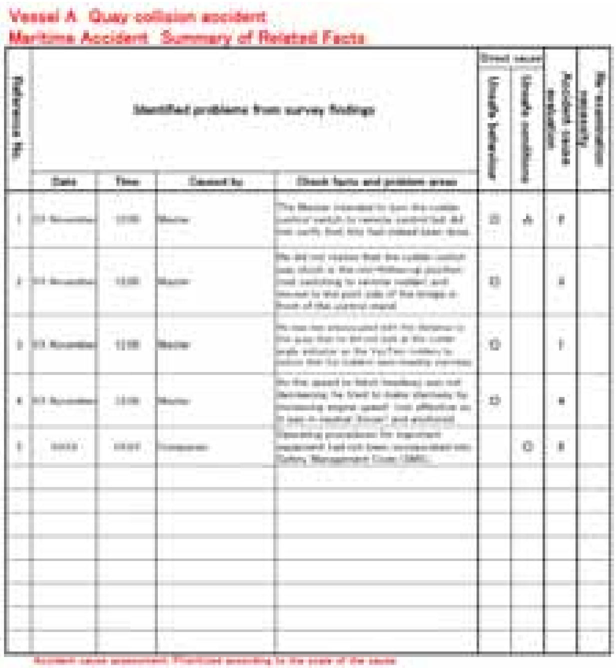


Fig. 54 Vessel A Summary of related facts (Attachment 16)

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 rudder) 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).

● Companies

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 4M4(5)E analysis, the analysis chart of (Unsafe behaviour).

Attachment 17

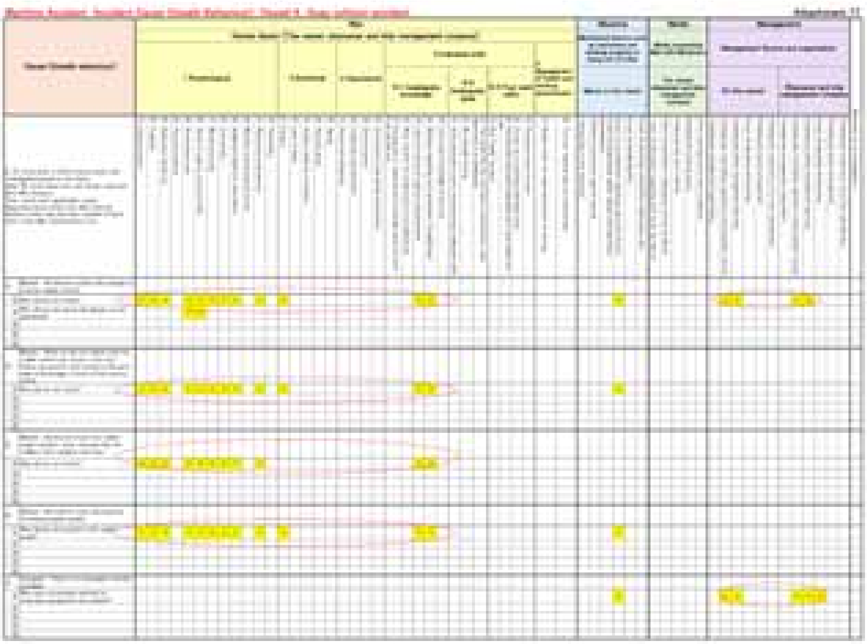


Fig. 55　Vessel A Master A's“ Unsafe behaviour ” Vessel A (Attachment 17)

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. 56 and Attachment 18)

Attachment 18

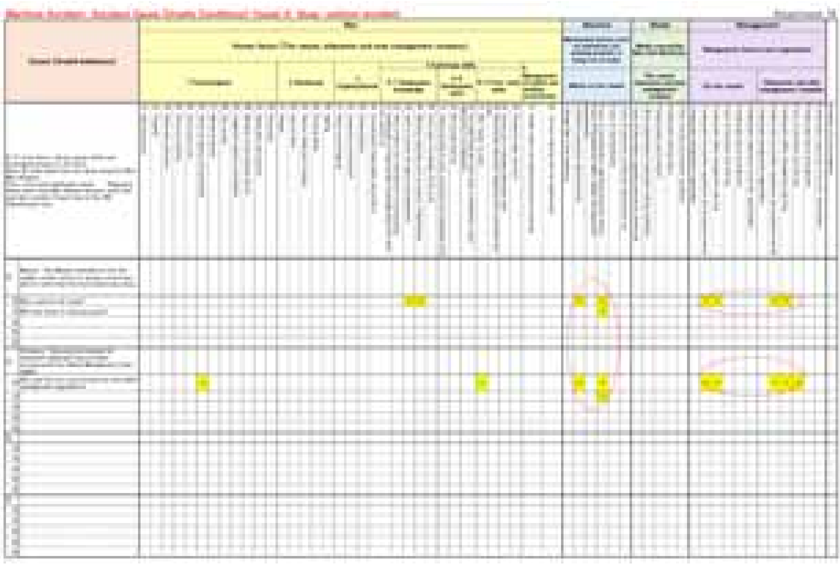


Fig. 56 Vessel A 's“ Unsafe conditions ”(Attachment 18)

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. 57 and Attachment 19)

Attachment 19

Fig. 57 Vessel A's Preventive measures for“ Unsafe behaviour ”(See Attachment17)

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.)

MAIA 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” and preventive measures for unsafe conditions will be considered here as well.

Attachment 20

Fig. 58　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 59) 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

❶ 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.”

❷ Entrainment phenomenon and peer pressure

This is when people follow the crowd, e.g., “What will the neighbours think?”

❸ Normalcy bias ➡ justification, cognitive dissonance

When people believe, “I’m special, nothing can hurt me!”

❹ 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!”

❺ Social loafing

This is when someone does not choose to take the initiative. They may say, “Someone will do it for me.”

Fig.59　12 Human characteristics and 5 Psychological factors

The items corresponding to the “12 Human characteristics” and “5 Psychological factors” shown in Figure 59 are summarised in Table 60 (Appendix 21) corresponding to the human errors described in 5-2 Timeline of events leading up to the accident.

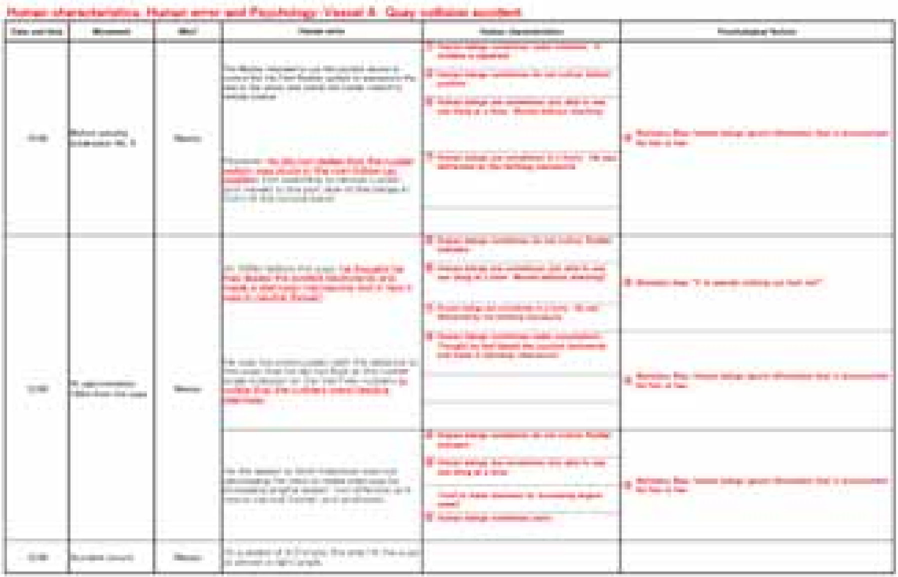


Table 60　Accident cause from the perspective of human error

The numbers given in the table in "Human characteristics" and "Psychological factors" columns correspond with the numbers in Figure 58.

Human characteristics

The human characteristics regarding incorrect rudder switch control on the control stand, and the subsequent behaviour up to 12:08 (160m 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. 61, 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

Fig. 61　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.

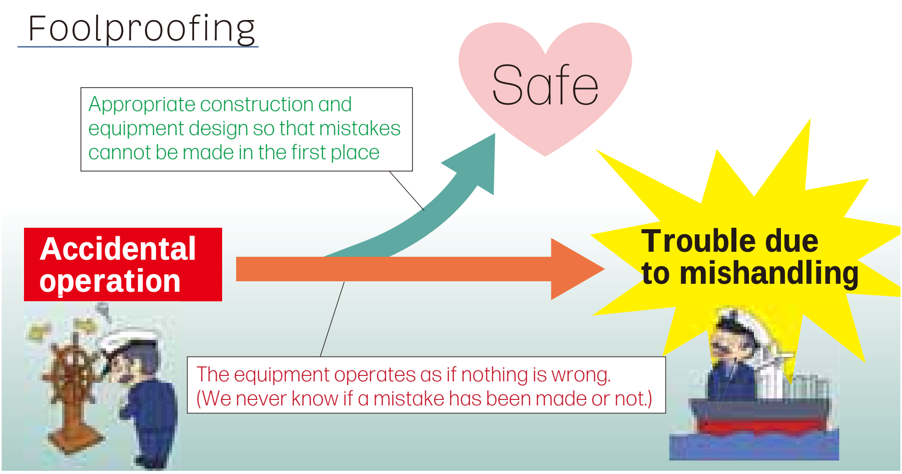


Fig. 62　Foolproofing

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.

In the author's own experience, whenever entering or leaving port, it would be advisable to move from the bridge console to the wing console in order to co-ordinate the operation of the bow thrusters, hence standing in front of the wing console pointing at and audibly calling out instructions to the on-duty officer (3/O).

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 BTM (Bridge Team 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 BTM in these solo conditions, there is a need to incorporate some kind of engineering mechanism to make the system more foolproof.

Other mechanisms which might be considered are "fail-safe" or "interlock" devices.

Fail-safe (adapted from Wikipedia)

A fail-safe is some kind of trusted device or practice that prevents or mitigates the unsafe consequences of any operational errors or malfunctions. This presupposes that there has been a system or equipment breakdown.

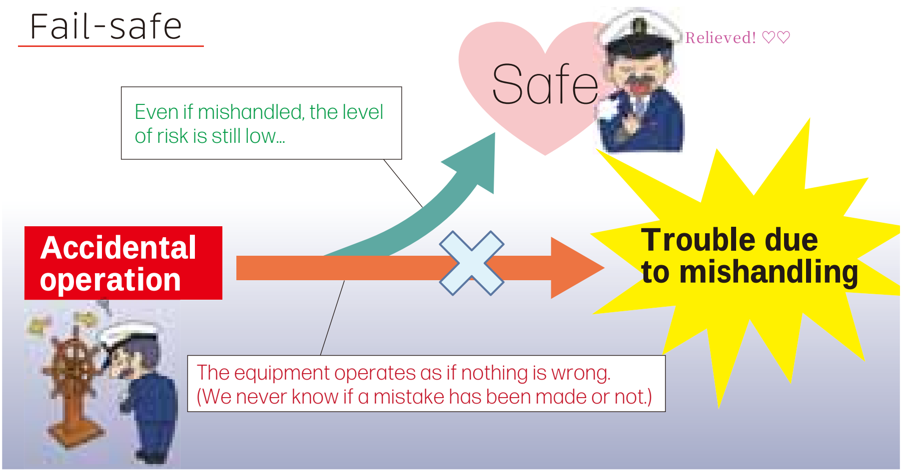


Fig.63 Fail-safe

Interlock (adapted from Wikipedia)

An interlock is a feature which prevents equipment or systems from straying from proper procedures due to handling errors or insufficient verification. In the event of any deviation from the standard manufacturing/operation state, the interlock system will automatically cut off the supply of fuel or regulate the operation of the equipment in question. In short, it is a mechanism incorporated into the instrument's circuit which regulates the operation of all safety related parts.

It is the same system which prevents plant and equipment from being started up until certain conditions have been met, and which also automatically shuts down machines under certain circumstances. It is also used to regulate M0.
The purpose of the interlock mechanism is to allow all safety related parts to function properly, and therefore a high degree of reliability is required.

Fig. 64　Engine control

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 59 "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.

We have to accept the fact that people make these human errors, and establish applicable countermeasures for these, but there is a limit to Human Brain Capacity (for more information, see Loss Prevention Bulletin Vol.50, Optical illusions (P.8)).
However, we cannot just give up without making effort. Therefore, 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.

The author is certain that the Master who caused the accident is fully aware of the error of his actions. Thus, the author believes that the Master concerned will never cause a similar accident again. In the meantime, the company has explained the accident to other Masters and navigation officers and has developed simulator training, but it is not crystal clear to what extent this has been effective; because there are variations in the personalities and skill levels of each individual.

Therefore, the author believes that it would be more effective if the Master who caused the accident could talk about his experience, and also draw up a procedure including recurrence prevention countermeasures to instruct other Masters and Navigation Officers during simulation training. In addition, the Master, a highly skilled technician, can share some common traits with the rest of the crew, such as feeling isolated from the outside world and a strong sense of camaraderie. Through understanding these tendencies, the author envisions that training could be more effective if personal experiences are shared with peers, rather than them simply being punished and the case being closed.

§ 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.
When I was on board as a young navigation officer, I used to see how the experienced crew were able to prepare for unexpected trouble with deck machinery and nautical instruments, and how they were able to prepare for hazards in nonchalant way.
Moreover, in the top-down society of an on-board organization, it was common practice for the Master, Chief Engineer and Chief Officer/First Engineer to not only prepare for work on board (e.g. docking), by referring to the operating instructions and drawings, but also to appropriately supervise their junior crew members actually working on site.

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 office, 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.

中労労働災害防止協会

- 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】

<table>
<tr><th colspan="2">Risk severity assessment</th><th>Level</th><th>Region</th><th>Assessment as to whether or not work can be carried out</th></tr>
<tr><td>1</td><td rowspan="3">LL</td><td rowspan="3">Very low risk</td><td rowspan="4">[Region of safety]</td><td rowspan="9">[Work possible]
Ensure that risk mitigation measures are implemented and that work is carried out in line with this</td></tr>
<tr><td>2</td></tr>
<tr><td>3</td></tr>
<tr><td>4</td><td>L</td><td>Low risk</td></tr>
<tr><td>5</td><td rowspan="5">M</td><td rowspan="5">Medium risk</td><td rowspan="5">[Region of uncertainty]
(Permissible and ALARP region)</td></tr>
<tr><td>6</td></tr>
<tr><td>7</td></tr>
<tr><td>8</td></tr>
<tr><td>9</td></tr>
<tr><td>10</td><td rowspan="6">H</td><td rowspan="6">High risk</td><td rowspan="11">[Hazardous region]
(Region whereby permission is not allowed)</td><td rowspan="11">[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.</td></tr>
<tr><td>11</td></tr>
<tr><td>12</td></tr>
<tr><td>13</td></tr>
<tr><td>14</td></tr>
<tr><td>15</td></tr>
<tr><td>16</td><td rowspan="5">HH</td><td rowspan="5">Extremely high risk</td></tr>
<tr><td>17</td></tr>
<tr><td>18</td></tr>
<tr><td>19</td></tr>
<tr><td>20</td></tr>
</table>

ALARP AREA : As low as Reasonably Practicable

Attachment 4 How to fill in the Pre-work risk assessment table

Attachment 4

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:

No.	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
							(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 of personal protective equipment)											
							(a. Essential measures) (b. …) (c. …)											
4	(Hazard)						(d. Use of personal protective equipment)											
	Total (1~4 only)	0	0	0	0		Total (1~4 only)	0	0	0	0		0	0	0	0		
	Risk level prior to countermeasure (Avg.) No. / Avg.						Risk level prior to countermeasure (Avg.) No. / Avg.											
	Level (See the criteria)						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

Fill in the appropriate boxes with measures to be taken

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

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 :

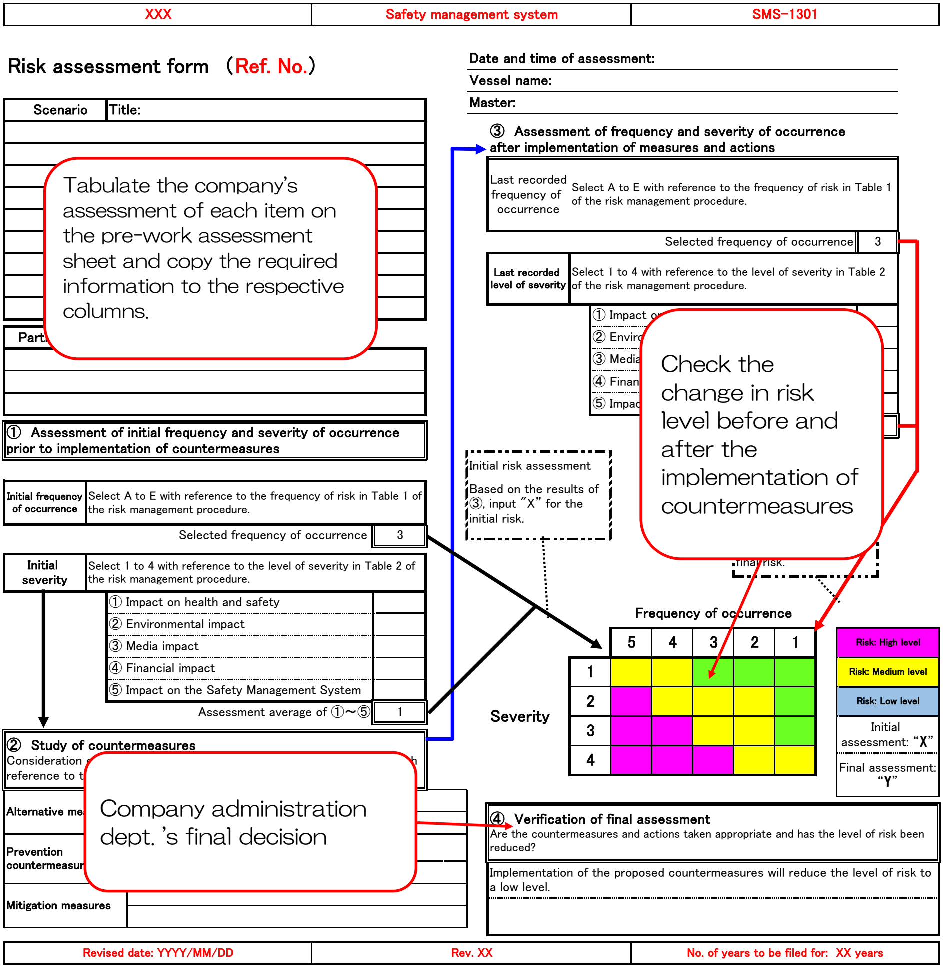
As assessed as above, it is our hope that countermeasures be implemented.

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

Attachment 5　How to fill in the Risk assessment table



Attachment 6 Risk assessment examples Pre-work assessment table: Preparation of Deck 1 for rough weather

Attachment 6 (Deck 1)

Organization	Safety management system	Reference No.

Pre-work risk assessment table (Reference No.)

Specific : Rough weather navigation countermeasures (Deck · Engine · Catering) — Deck circled

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

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

Participar : △△△、 xxx、□□□

Place and name of work :

No.	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
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 (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 7 Risk assessment examples Pre-work assessment table: Preparation of Deck 2 for rough weather

Attachment 7 (Deck 2)

Organization	Safety management system	Reference No.

Pre-work risk assessment table (Reference No.)

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

Particip : △△△, xxx, □□□

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

Place and name of work :

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

No.	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	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 measures)											
							(b. Physical countermeasures)											
							(c. Administrative countermeasures) Always check the navigation lanterns.	2		1	2	LL	2		1	2	LL	○
							(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. (Hazard) Handrails	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	○
							(c. Administrative countermeasures)											
							(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. (Hazard) No installation of lifelines	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	○
							(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	○
							(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	○
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 measures)											
							(b. Physical countermeasures) Securing of moving objects in the accommodation areas and rooms.	3	1		3	L	3	1		3	L	○
							(c. Administrative countermeasures) The room is always tidy.	3	1		3	L	3	1		3	L	○
							(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(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 Risk assessment examples Pre-work Risk assessment table: Preparation of Engine 1 for rough weather

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) [Engine circled]

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

Work category : Routine work [circled] / : Non-routine work

Particpar : △△△、XXX、□□□

Place and name of work :

No.	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
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 [illegible] (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.	3	1		3	L	3	1		3	L	○
							(b. Physical countermeasures) If necessary, apply slip resistant material. (c. Administrative countermeasures) (d. Use of personal protective equipment)	3	1		3	L	3	1		3	L	○
	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		
	Avg.	3.0	3.5	2.3	9.8		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.

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