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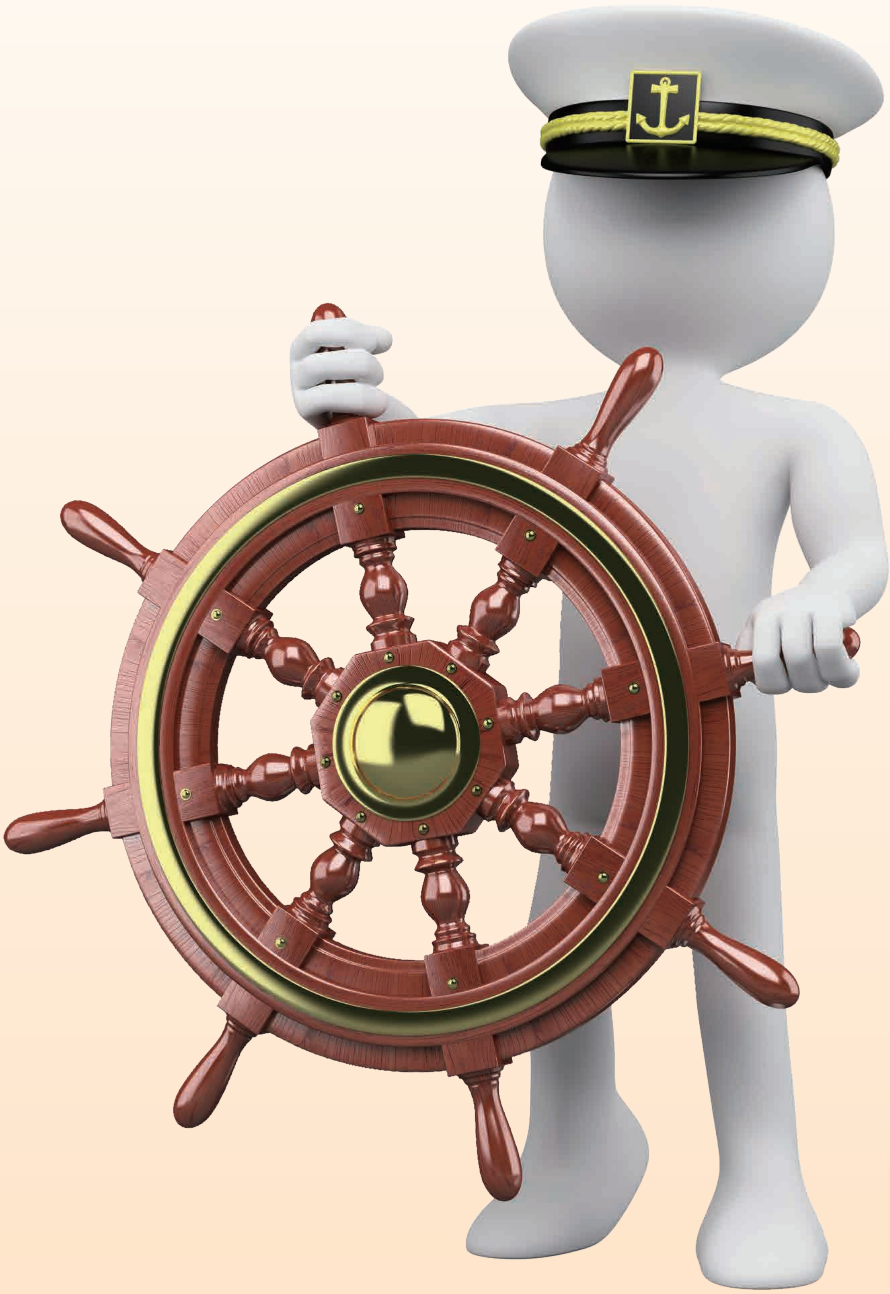
The Japan Ship Owners' Mutual Protection & Indemnity Association Loss Prevention and Ship Inspection Department

Thinking Safety

Bridge Resource Management and Engine Room Resource Management



Thinking Safety

Bridge Resource Management and Engine Room Resource Management

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Chapter 1 Introduction

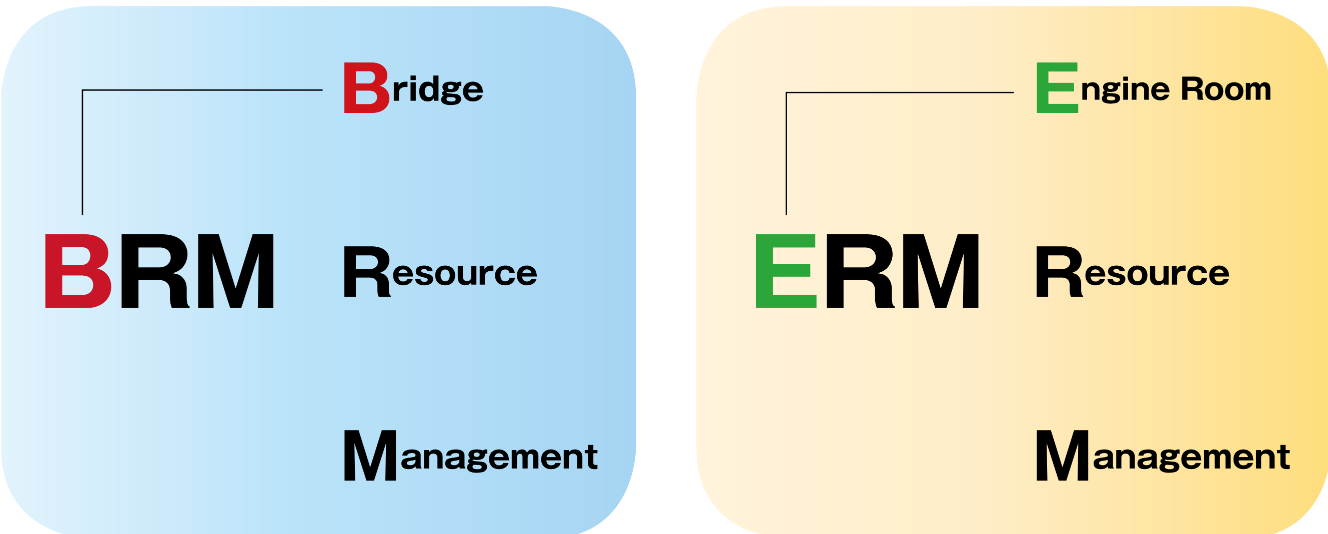
Approximately 20 years have passed since the introduction of Bridge Resource Management (BRM) for ocean-going vessels in the mid 1990s.
Proposals for revision of the STCW Convention as related to Engine Room Resource Management (ERM) were adopted at the IMO Conference in Manila in June 2010. One of these proposals related to the addition of 'Requirements for ERM' added to the engineers' abilities requirements list.

While BRM and ERM are understood as an effective means of achieving safe operation of vessels, when actual implementation is attempted, the word from those on-site is "we can't get it to work properly''.

To ensure effective operation of BRM and ERM, it is important to raise awareness of crews on-site through improved understanding of the overall concept, and in understanding component elements.
In other words, it is necessary that all members of the team engaged in operation of the bridge and engine room have a shared awareness, and that this awareness is not limited to specific crew such as captains and chief engineers.

The following explains the methodology for effective use of BRM and ERM from the point of view of those on-site.

Vessel passing through Golden Gate Bridge, San Francisco



Chapter 2 Thinking Safety

The following refers to series of publications for the '80th Captains Educational Lecture (Safety in a Proud Occupation, by the late Professor Isao Kuroda of the Japan Institute of Human Factors Institute) held by the Japan Captains Association on July 31st, 2000.

Expressions such as 'Safe Operation' and 'we pray for your safe voyage' are heard frequently, however before explaining BRM and ERM, it is important to consider 'what exactly is safety?'

* 2-1 What is Safety?

If we consider safety from the point of view that, not only the captain and chief engineer, but also the entire crew, comprise a collection of technicians, there are many who view safety as being at the leading edge of technology, and an extension of technology itself.

In other words, many are of the opinion that 'as vessel technology is improved, it automatically maintains safety'.

It must be simply stated that this thinking is incorrect and dangerous.

In the words of Professor Kuroda, 'Safety must be thought of as being a social value beyond technology, a dimension beyond technology'.

Engine Control Room Console

Technologies are specific to various fields, for example, and technology employed in operating vessels, in operating railways, each being simply a methodology with which our lives are made more plentiful.

Thus, it is necessary to consider that, unless the crew at the frontline of safety in operating the vessel separate safety and technology, unless they have a different dimension to safety, safety cannot be maintained.

However, when an accident occurs, the focus is on preventing reoccurrence, and there is a strong tendency to analyze from a technical perspective, and to develop measures against reoccurrence in technical terms.

For example, a Maritime Accident Inquiry is held following a collision accident, and the vessel is found to be in contravention of Clause XX of the Maritime Collisions Prevention Act.

Launching Ceremony in Japanese Traditional Style

In consequence, the accident is the responsibility of the person in contravention of the legislation, and that person is then subject to suspension of his/her license for a specified number of days. In other words, the focus is commonly on 'who was responsible', and **the person in question is punished, and everyone moves on**.

However, this approach does not investigate and analyze in practical detail **'why the accident occurred'.** As a result, the measures developed to prevent reoccurrence become simply a patch on the problem, and a similar

kind of accident is likely to reoccur.
Professor Kuroda referred to this as the 'grave-post type' of safety measure, i.e. a safety measure which commemorates the accident, calls an end to it, and moves on, without any connection to preventing reoccurrence.
In fact, what we should really consider are social considerations, for example, ensuring that no lives are lost, or that no pollution occurs. It is necessary to consider safety from the point of view of preventative measures to ensure that the accident does not reoccur. Professor Kuroda referred to this as the 'preventative type' of safety measure.

Safety Management System

An accident-free site, that is, a safe site, is always sought, but is there such a thing as 'safety'? The English psychologist Reason defines safety as 'having resistance to danger to which an organization is constantly exposed'.
When we consider operation of a vessel, we focus on existing dangers for example, the dangers of a collision, the dangers of a cargo accident, the dangers of damage to harbor facilities, and the dangers of an engine failure. We therefore see 'how to avoid these dangers' as being associated with safety. As human beings, we face these dangers, and engage in activities to avoid them.

When proposed measures to prevent reoccurrence are not of the preventative type, many are in the form of guidelines in the SMS manuals and in Safety Management Regulations for the purpose of preventing reoccurrence of accidents. Checklists are probably one form of the guidelines. However, implementation of safety management in these guidelines requires human actions, and thus considerable energy is required. People who lack sufficient energy will therefore necessarily take the easier path. In operation, there is a tendency to 'check without confirmation', even though a checklist has been prepared, and this may be a background factor in reoccurrence of the same type of accidents.
Furthermore, the common personality traits of personnel with high levels of skill such as the captain, chief engineer, navigator, and engineer conflict with these guidelines, and as a result, it is undeniable that the proposed safety management becomes a mere shell of the original in a very short space of time.
A considerable amount of study is required of seamen, in particular, in order to obtain a seamen's license. The true meaning of this study becomes effective when qualifications are obtained and they commence working on a vessel. However, in practical terms, the majority of seamen, once acquiring qualifications, exhibit a tendency to simply perform daily duties without expending effort in further study. Furthermore, while participation in training on days off is common, if we think of the true meaning of 'study', it is unsatisfactory to refer to simply showing up 'education and training'.

Safety in the true sense requires raising one's awareness, and improving the safety management culture in the organization.
BRM and ERM, and SMS manuals and Safety Management Regulations, are tools for the purpose of improving safety.

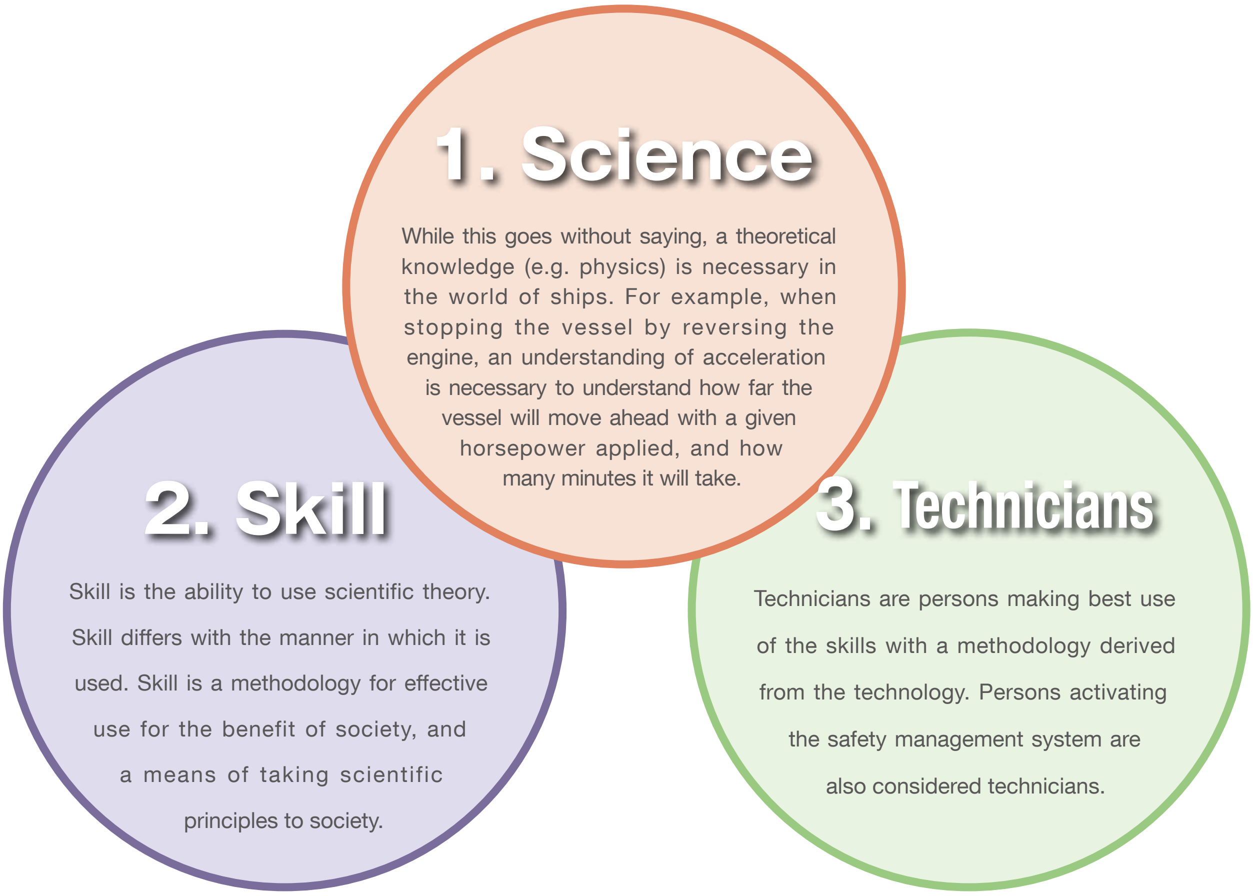
Important

Improving one's awareness, and improving safety management culture

BRM is one way of achieving these goals

* 2-2 Safety and Culture

As described above, considerable energy is required to activate the system developed within safety management. This energy must be seen and derived from the safety culture. When we consider this culture, we must see it in terms of the following three components.



* 2-3 Technicians

Electronic charts, GPS, and AIS have been introduced at a rate hitherto unimaginable, and provide a much greater volume of information than previously in visual format.
These technologies are integrated on the radar screen to provide digital displays of information such as movement of vessels, vessel names, and closest point of approach. Technology is available to issue alarms for vessels which are at a collision risk via ARPA (Automatic Radar Plotting Aid).

At the same time, technicians are responsible for setting the point at which alarms are issued, and for the decision as to whether or not to use the various information displayed. These devices do not automatically control the vessel to avoid dangers in navigation. Until the development or the robotic vessel of the future, the captain and chief engineer as technicians, will conduct an overall evaluation of the provided information and control the vessel accordingly. In addition, vessels employing M0


Inside the Bridge
- passenger vessel

operation are increasing in the engine room, and a considerable proportion of operation is now automated. However, even if operation of individual engines can be automated, the captain and chief engineer as technicians view the entire engine room as plant operated using the five senses to prevent problems, are still necessary.

Technicians are therefore required to acquire knowledge and skills for safe operation of the vessel and devices to ensure safety, and obtain a seamen's license as evidence of having such knowledge and skills. In other words, safe operation of the vessel and devices is extremely complex and difficult. There are therefore considerable differences in decision-making and discretion involved in this work, and the seamen's license can be considered as providing the necessary authority.

'Safe operation of the vessel and devices' is the subject of much expectation from the wider society, and from this point of view, the following are required.

Important

Required : Ability to predict accurately

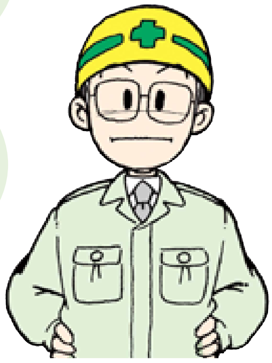
Evaluation of information provided, and prediction to avoid associated dangers.

Means to achieve these requirements: Experience

Experience is important in improving the ability to predict

However, the question arises as to why technicians holding a seamen's license cause the same type of accidents. To answer this question, it is relevant to point out that highly skilled captains and navigators, and chief engineers and engineers, share common characteristics as noted below.

1. Pride and confidence in one's work and skills.
2. When hearing of an accident, they have a strong conviction that 'I would never cause an accident like that'.
3. Behind this there is the assumption that safety comes naturally if one has a high level of skill.
4. Feel offended by imposition of Safety Management Regulations and SMS manuals etc. from the management division.
5. Occlusive. Protect each other, particularly in the case of an accident.
6. Mistakes are matters of acute embarrassment, and concealed.



Many readers of this document will undoubtedly be in agreement with the above. It has occurred to me that all six points apply to me personally! As an aside, a few years ago, I was aboard a 330m container vessel of approximately 80,000 G/T. After avoiding anchored vessels and fishing boats while navigating to the specified anchorage prior to passage through the Suez Canal, the anchor was lowered precisely at the specified location. Furthermore, large changes in course were made in the Singapore Straits etc. without deviating from the planned course on the electronic chart, and the resultant track of the vessel was able to be displayed.

Container vessel anchored off-Singapore

However, I regularly told my navigators to 'steal skills to learn', but none appreciated my guidance. Only the Chief officer's wife, the family member on board, graciously commented that my skill in comfortably navigating such a large vessel was admirable. This appreciation brought a tear, and left me without words.


Plotting Chart - Departing Jeddah, Saudi Arabia

Within the context of the modern world in which technology changes from day to day, the mission of a technician is one of lifetime study. It is also necessary to improve awareness through a calm appreciation of one's own personality. Awareness in prevention and prediction to guard against accidents, creation of one's own technical framework (or use of an existing technical framework), its implementation, and constant consideration of what is the most important in its use, is constantly required.

Important

- **Lifetime study**
- **Calm evaluation of one's own personality**
- **Constant awareness in prevention and prediction to guard against accidents**

▶ **Increased awareness in everything!**

* 2-4 Human Factors and Human Error

Maritime accidents have many causes. In the case of collisions, 80% - 90% are said to be due to insufficient watch-keeping, that is, human error. Furthermore, most accidents are due to a chain of errors, rather than a single error.

If we assume that 'humans are error-prone', preventing the chain of human error is a matter of BRM and ERM **designed to achieve safe vessel operation** by raising awareness of bridge and engine room teams.

Let's consider 'human factors' and 'human error' in this context.

Human factors

The study of human factors is **the study of the skills and the limitations, and characteristics** of persons necessary to ensure that systems comprised of machinery and technology function safely and effectively.

Human error

Human error is defined as **'behavior against expectations'** which is an unintentional departure from the target to be achieved.

When an accident occurs solely due to human error, the person directly responsible and those in the vicinity are able to ask 'What was the mistake?' and consider the cause on that basis. In most cases, the immediate matter is considered and a caution given, or in some cases punishment is applied. However, this is the grave-post type of safety measure, and can be considered as of no use at all in preventing reoccurrence.

Rather, the preventative type of safety measures are necessary in which we ask why the accident occurred, and what was the background to the accident, and consider the best means to prevent reoccurrence.
Nobody operates a vessel or an engine with the expectation of causing an accident. We must be aware that the human brain does not possess a 'voluntary error generation mode', and that investigating 'causes which inhibit human abilities' is associated with preventing reoccurrence.

* 2-5 Causes Which Inhibit Human Abilities

This section considers the mechanism which gives rise to errors inhibiting human abilities.

1. Human Characteristics

Human characteristics as viewed in terms of the information processing process are as shown in Fig. 1. A large amount of information exists in the surroundings. We evaluate which information to use and the criteria for this evaluation are our past experience and the results of our training.
Humans make an overall evaluation of the various information available and take action. New information appears as a result of this action. This process is then repeated.

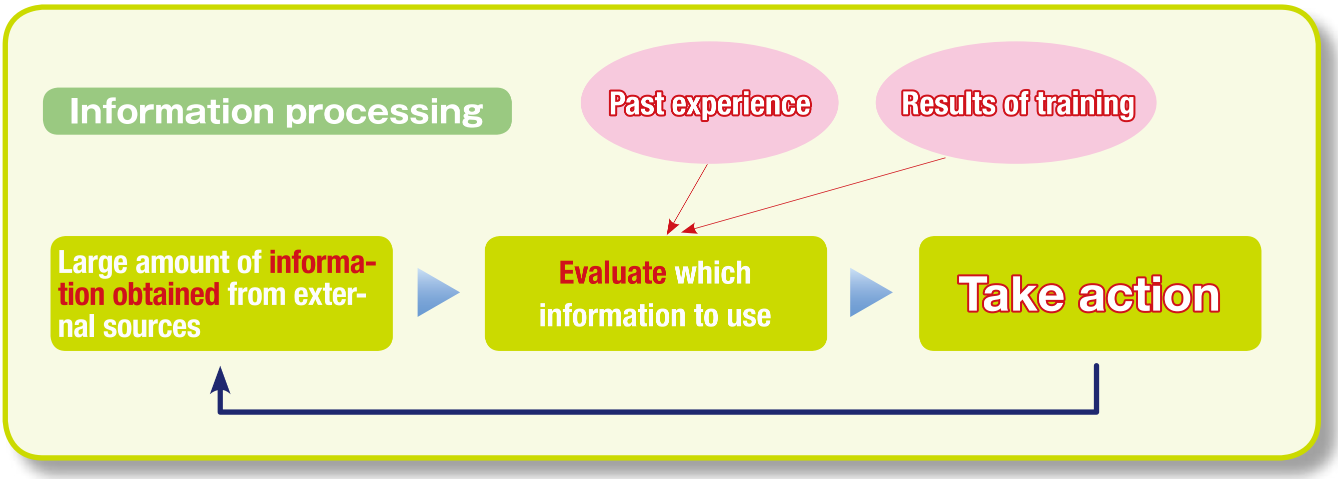


Fig. 1

The process of deciding which information to use is shown in Fig. 2. Approximately 80% is not through individual evaluations but through our daily activities. As a result, unconscious errors occur, leading to honest mistakes. With BRM and ERM, an accident occurs if this error chain continues.

Fig. 2

Causes which inhibit human motion characteristics are as follows. (from Nihon VM centte "Anzen no Komado" No.18 30/6/2002)

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 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

If we consider the above, it appears that human beings are nothing but a collection of defects and shortcomings. However, from another point of view, 'human beings have wonderful abilities'.

1	Attention dispersal model	⇔	Simultaneously perform multiple tasks effectively
2	Evaluate and act on assumptions	⇔	Able to make overall decisions
3	Make decisions on limited information	⇔	Able to make decisions efficiently
4	Haphazard behavior	⇔	Able to make flexible responses to suit the conditions

Human beings have a wide range of information input systems, with a single processing system. This system is easily interrupted, and the focus easily switched.
Furthermore, human beings tend to seek the comfortable option, to have real intentions and stated reasons, to be sleepy in time zones, and to find work harder as they become older. These problems are controlled with 'attentiveness' and 'awareness' as information processing sources, however they are limited and become causes of an inability to avoid errors.
For example, investigation of the time zones in which vessel collisions occur show that it is most common between 2am and 6am, and 2pm and 4pm, which is likely due to these factors.

2. Human behavior patterns: Rasmussen's SRK behavior pattern

When human beings initiate any kind of behavior, this behavior is processed in a number of steps depending on the details of the behavior.
Rasmussen, a Danish cognitive scholar, described this simply with his SRK model in which human behavior can be considered in terms of three patterns (S, R, K).

1	**Intuitive behavior bypassing the information process, behavior at the reflex level**	**(S : Skill-base)**
	For example, when climbing stairs, we climb without verifying the height in centimeters of each step. Behavior repeated daily in which we intuitively know the height of each step. Such behavior is mostly unconscious and automatic, and not determined by verification against memory and knowledge acquired through past experience and the results of training. Errors such as tripping occur on stairs of unfamiliar height.	
2	**Behavior at the rule level**	**(R : Rule-base)**
	Not to the same extent as the reflex level above, but behavior in accordance with habits and rules learnt in work in which one is comparatively experienced. A short period of time is required in comparison to reflex level behavior. Errors due to mistakes of fact, mistakes in selection of rules, and mistakes in application of procedures.	
3	**Behavior at the knowledge level**	**(K : Knowledge-base)**
	Behavior when responding to situations not normally experienced. Behavior with which problems must be resolved with one's own knowledge when responding to difficult matters and malfunctions which occur rarely etc. An evaluation is made that something has occurred, the objective defined, measures developed based on one's own knowledge of what to do, a procedure planned, and behavior initiated. In some cases, a new investigation must be conducted to obtain the appropriate information, and a response initiated. Requires more time than behavior at the rules level. Errors are induced through misunderstanding of fact, lapses of memory, and misapplication of knowledge.	

These three behavior patterns are affected by stress, fatigue, the content and volume of information, and the personality of the individual, and these factors affect the frequency of the induced errors.
For example, even an experienced veteran sometimes acts unconsciously when distracted, due to a desire for something, or under external pressure.

* 2-6 Accident Examples

The following are two examples in a consideration of measures to prevent an accident reoccurring.

Accident example (1)

The first example relates to a collision between a container vessel (9,977 G/T) and a fishing vessel (8 G/T) at Genkainada in off-Hakata port. Movement of both vessels prior to the collision is shown in Fig. 3 and Table 3 (source: Judgments on the Maritime Accident Inquiry Tribunal website).

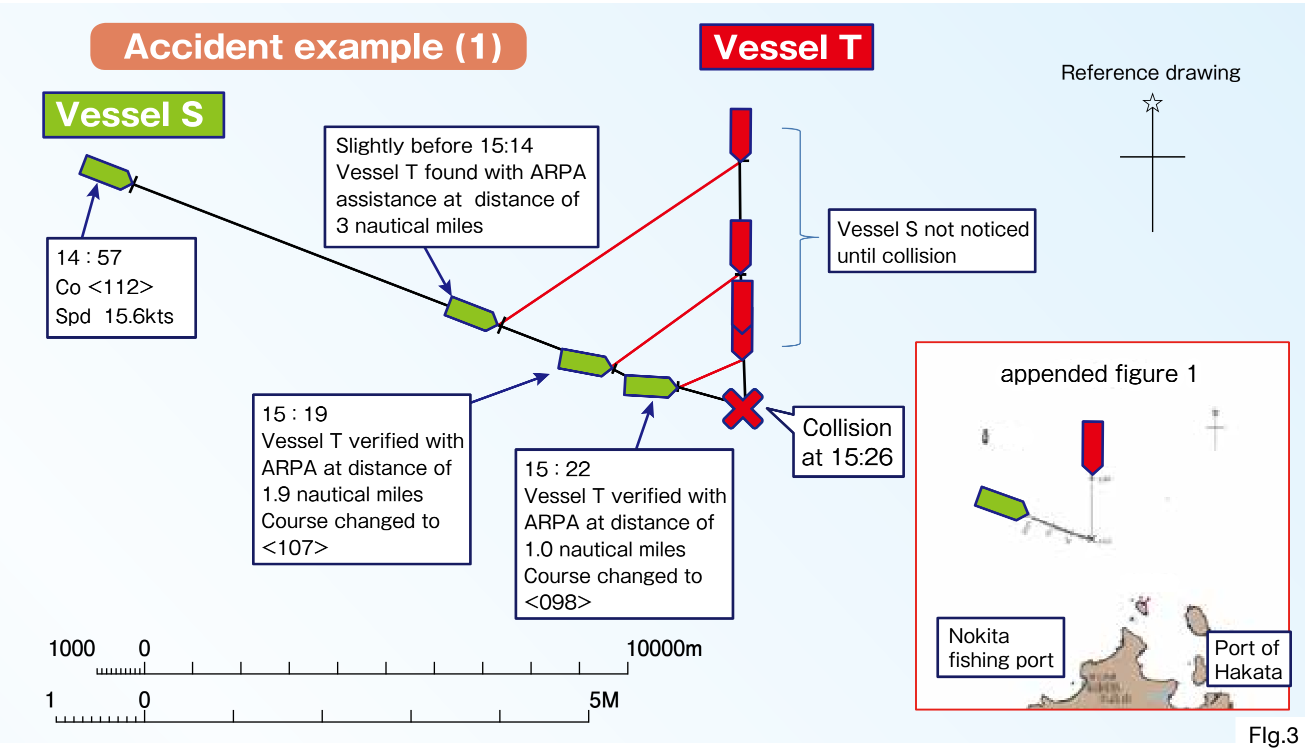


Fig.3

Collision example (1) location: Genkainada weather: cloudy SE wind, wind strength 2, good visibility

Time	Distance to other vessel (nautical miles)	Vessel S Vessel S, 9,977 G/T, container vessel, with 18 Chinese crew. From Port of Qingdao, China bound for Port of Hakata. Original course <112> Speed 15.6 Kts Second mate and able seaman on duty.	Vessel T Vessel T, 8 G/T, fishing vessel, with 2 Japanese crew. Returning from Genkainada to Nokita fishing port. Original course <180> Speed 15.0 Kts Captain on duty.
Slightly before 15:14	3.3	Vessel T verified at range of 3 nautical miles (off center) on radar, supplemented with ARPA.	Determined that no other vessels were in vicinity, and switched to automatic steering. Commenced processing catch with deck crew.
15:19	2.0	Based on ARPA information, thought vessel T was cutting across bow, changed course 5° to port to course of <107>.	Continued above work. Did not notice vessel S.
15:22	1.0	Based on ARPA information, thought CPA was 0.1 nautical miles crossing ahead, changed course 9° to port to course of <098>. No warning signal and no joint action	In situation in which vessel S was visible, however, continued with above work.
15:26	Collision	Turned full to starboard immediately before collision. Insufficient. Collided with bow when turned to <114>. Grazing marks amidships on port side.	Did not notice until collision, continuing on same course and speed. Crushing of bow plating, no injuries. Returned to Nokita fishing port under TOW by consort.

Table 3

+ Maritime Accident Inquiry Judgment - main points +

The judgment of the Maritime Accident Inquiry is summarized as follows.

1 Principal text **License of captain of vessel T suspended for 1 month.**

2 Applicable legislation **Clause 15(Crossing Situation) of COLREGS - International Regulation for Preventing Collision at Sea**

Note: Clause 15.1(Crossing Situation) of COLREG

When two power-driven vessels are crossing so as to involve risk of collision, the vessel which has the other on her own starboard side shall keep out of the way and shall, if the circumstances of the case admit, avoid crossing ahead of the other vessel.

3 Outline of accident

After completing fishing, the fishing vessel T (8.0 G/T) headed for the fishing port of Nokita in Fukuoka Prefecture. After determining that no other vessels were in the vicinity, the vessel was switched to automatic pilot. The bridge was left unattended and the captain commenced processing the catch with the deck crew. Vessel S was unnoticed until the collision.

Vessel S verified the image of vessel T on radar, assisted by ARPA, at a distance of 3.3 nautical miles approximately 15 minutes before the collision, however movement was not verified. The vessel was further verified again visually 7 minutes before the collision, however it was thought that it would continue to cross the bow of vessel S, and course was altered 5º to port to ensure sufficient distance for avoidance. Change in heading was subsequently not verified, and course again altered 9º to port 4 minutes prior to the collision. Turned full to starboard immediately prior to the collision, however this action was insufficient, resulting in the collision.

4 Cause of accident

Primary cause Insufficient watch-keeping by vessel T

Secondary cause Vessel S did not issue warning, and no joint action (action as will best aid to avoid collision) was taken.

5 Discussion of causes

Vessel T Vessel should have been under control of one crew on watch. Avoiding action could have been taken if a crew member was on watch.

Vessel S The possibility of collision would have been apparent if watch-keeping or look-out were sufficient and crew had not relied solely on the ARPA signal.

+ Transport Safety Board Report - main points +

The Transport Safety Board report is summarized as follows based on causes and measures to prevent reoccurrence.

1 Causes

The 2 crew of vessel T were busy processing the catch and ignored watch-keeping or proper look-out. The second officer of vessel S assumed that vessel T would take avoiding action.

2 Reference (measures to prevent reoccurrence)

- Sound horn as necessary, and signal to attract attention.
- The most appropriate joint action is necessary when it is apparent that the burdened vessel is unable to avoid collision solely by adjustments to course of the give-way vessel.
- Do not leave the wheelhouse unmanned while under way, and maintain a sharp look-out on the surroundings as appropriate.

Accident example (2)

The second example relates to a collision between a container vessel (44,234 G/T) and fishing vessel (18 G/T) in Katsuura Light House off Chiba Prefecture. Movement of both vessels prior to the collision is shown in Fig. 4 and Table 4 (source: Judgments on the Maritime Accident Inquiry Tribunal website).

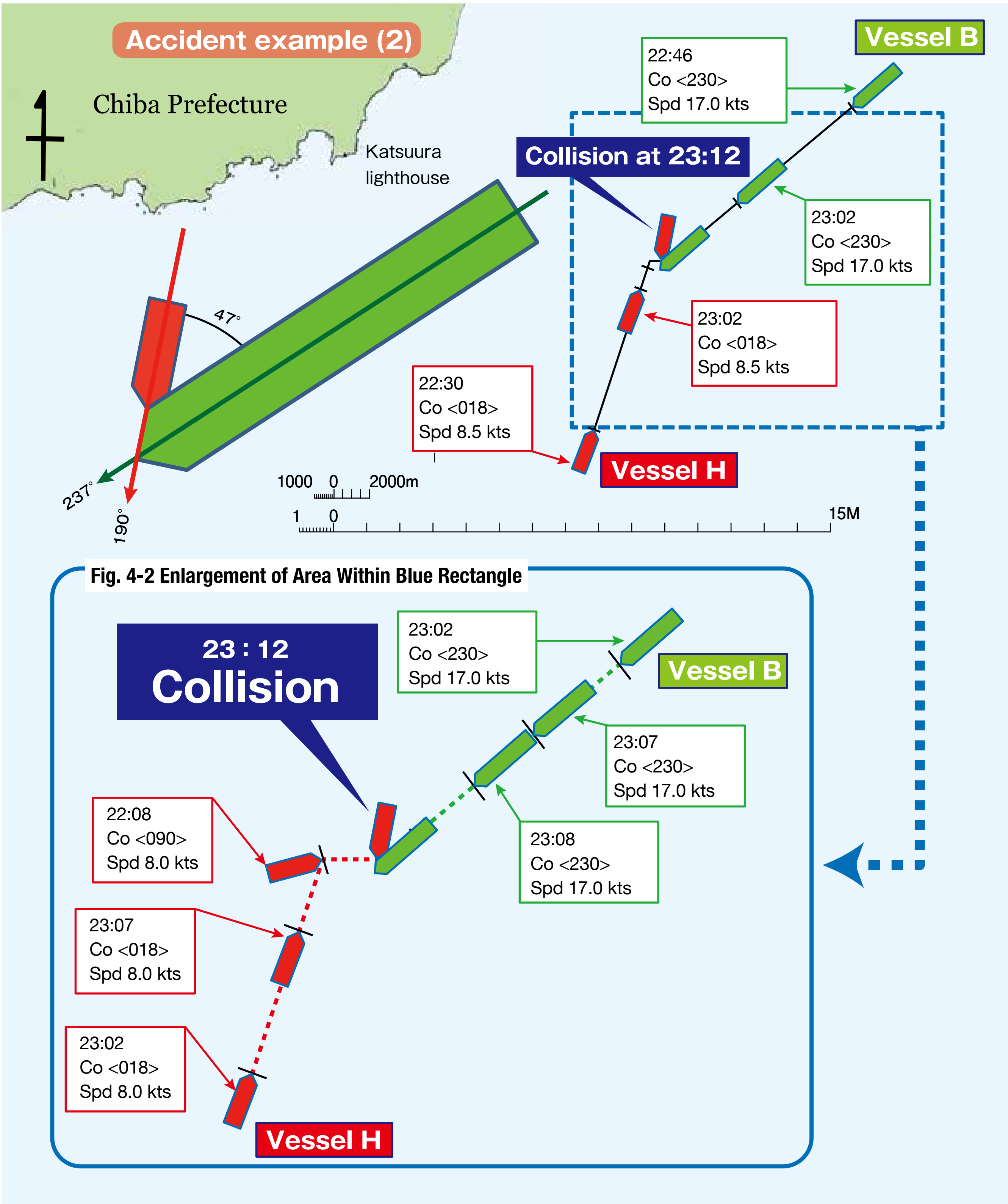


Fig 4-1

Accident example (2) location: Katsuura Bay off Chiba Prefecture weather: rain wind NNW, visibility 7-8 nautical miles

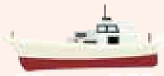
Time	Distance to other vessel (nautical miles)	 **Vessel B** Vessel B 44,234 G/T container vessel with 21 Filipino crew Bound for Tokyo from Oakland USA Original course <230> Speed 17.0 Kts Third mate and able seaman on duty	 **Vessel H** Vessel H 18 G/T fishing vessel with 3 Japanese and 3 Indonesian crew Returning to the port of Choshi from fishing grounds 410 nautical miles south of the port of Chosi off Chiba Prefecture. Original course <018> Speed 8.5 Kts Captain on duty alone
22:30	14.7 (approx)	—	Course <018>, 8.5 Kts full speed ahead. **Sitting in chair watching radar.**
22:46	10.5 (approx)	Course <230>, speed 17.0 kts. **General conversation with able seaman continued until 23:08.** Radar range set to 12 nautical miles.	—
23:07	**2.0**	Situation allowed vessel H to be recognized approaching Northwards at distance of 2.0 nautical miles 7.5° <237.5> off starboard bow, **however it was not noticed. Communications of other vessel monitored on VHF.**	Radar set to 3 nautical miles range. Recognized vessel B on radar at a distance of 2.0 nautical miles 37.5° <055.5> off starboard bow. **Not supplemented with ARPA**. Situation allowed mast lights and green light of vessel B to be verified visually, and passage on vessel B's heading was able to be verified, however **it was not verified visually.**
23:08	**1.4**	Vessel H proceeded further on the same heading. The situation allowed recognition of the other vessel at 15.5° <245.5> on the starboard bow at a distance of 1.4 nautical miles, however it was not noticed.	Able to pass starboard-to-starboard at 6.3 cables on a heading of 47.5° <065.5> off starboard bow at a distance of 1.4 nautical miles, however **attempted to pass port-to-port without ARPA assistance.** Furthermore, **gave rise to the danger of another collision** with a course of <090>.
23:11	**0.6**	The able seaman discovered vessel H to starboard at 0.6 nautical miles and reported it to the third mate, however after changing the radar range to 6 nautical miles and checking the image, was unable to find the vessel.	—
23:12	**Collision**	The mast lights and red light of vessel H were recognized as a danger 27° <257> on the starboard bow at a distance of 0.3 nautical miles. A long blast was sounded on the horn and the wheel turned hard to starboard, however it was too late and the collision occurred as the bow was turned to <237>.	Vessel B recognized on radar at a distance of 0.3 nautical miles 13° <077> off port bow and turned hard to starboard, however it was too late and the vessel collided with the bow of vessel B as the bow was turned to <190>. The vessel sank, however all crew were rescued by vessel B.

Table4

+ Maritime Accident Inquiry Judgment - main points +

The judgment of the Maritime Accident Inquiry is summarized as follows.

1 Principal text **License of captain of vessel H suspended for 1 month.**

2 Applicable legislation **Since vessel H turned to starboard after passing in the bow direction of vessel B, giving rise to the danger of a collision, no regulation exists in legislation. This case is therefore judged in accordance with Clause 38 and 39 (normal duties of seamanship) of the Japan Maritime Collisions Prevention Act.**

Note: Clause 38 of the Japan Maritime Collisions Prevention Act (special situations associated with dangers in approach)

In construing and complying with these Rules due regard shall be had to all dangers of navigation and collision and to any special circumstances, including the limitations of the vessels involved, which may make a departure from these Rules necessary to avoid immediate danger.

Note: Clause 39 of the Japan Maritime Collisions Prevention Act (responsibility for negligence)

Nothing in these Rules shall exonerate any vessel, or the owner, master, or crew thereof, from the consequences of any neglect to comply with these Rules or of the neglect of any precaution which may be required by the ordinary practice of seamen, or by the special circumstances of the case.

Note: Statutory interpretation of normal duties of crew: From description of the Japan Maritime Collisions Prevention Act.

'Normal duties of crew' is commonsense to all those associated with maritime matters, and covers 'the knowledge, experience, and practices of seamen'. Scope is wider since it is not limited to 'operation' as in 'Appropriate practices for operation of vessels' (Clause 8.1). A typical example is the avoidance of anchored vessels by vessels underway.

Note: Clause 8(a) of the Maritime Collisions Prevention Act

(a). Any action to avoid collision shall be taken in accordance with the Rules of this Part and shall, if the circumstances of the case admit, be positive, made in ample time and with due regard to the observance of good seamanship.

3 Outline of accident

Vessel H was proceeding north with vessel B underway on a south-easterly heading to starboard as required when there is a danger of collision. The captain of vessel H was sitting in the chair watching the radar (set to 3 nautical mile range), and recognized vessel B on the radar at a distance of 2 nautical miles (not assisted by ARPA). At this point, the vessel passed in the bow direction of vessel B, however no visual check was conducted. The image on vessel H's radar shows 47.5˚ to starboard at a distance of 1.4 nautical miles. Attempted to pass port-to-port on a course of <090>, however vessel B had already passed in the bow direction of vessel H, and the heading for a collision was set.

The navigator on duty on vessel B was busily engaged in conversation with the able seaman, and neglected to watch the radar and conduct visual checks. Although he was monitoring VHF communications of the other vessel, he neglected watch-keeping. The able seaman first noticed vessel H at a distance of 0.6 nautical miles and reported it to the navigator on duty, however the navigator continued trying to find vessel H on the radar without conducting visual checks. The only measure taken was to switch the radar from 12 to 6 nautical mile range, and since the STC (Sensitivity Time Control circuit), used to eliminate sea clutter) was applied to a high degree, vessel H was not found.

4 Cause of accident

Primary cause Vessel H placed vessel B (ready to pass without problems) in a new danger of collision.

Secondary cause Vessel B neglected to watch the surroundings sufficiently, did not issue a warning, and did not take action to avoid collision.

5 Discussion of causes

Vessel H

- Had the duty to sufficiently monitor and issue caution of movement of vessel B to ensure that a new danger of collision did not occur.
- Should have used ARPA assistance, radar plots, and visual verification.

Vessel B

- Should have kept watch and sharp look-out by radar and visual observation.

+ Transport Safety Board Report - main points +

The Transport Safety Board report is summarized as follows based on causes and measures to prevent reoccurrence.

1 Causes

Vessel H

- Turned to starboard without monitoring the movement of vessel B sufficiently.
- Assumed that when turning to starboard, the other vessel must be avoided by passing port-to-port.
- Did not appropriately monitor movement of the other vessel using the electronic cursor on the radar, and ARPA.

Vessel B

- The third officer did not pay appropriate look-out to radar and visual checks.
- Attention was directed to conversation and communications of the other vessel, and not to appropriate watch-keeping.

2 Reference (measures to prevent reoccurrence)

- Do not allow conversation to interfere with watch-keeping and look-out.

- Ensure that radar is watched appropriately.
- Ensure that changes in heading of the other vessel are carefully measured with the radar cursor and ARPA, make accurate decisions on the possibility of collision, and maintain a safe distance while passing.

Major revisions were made to the Japan Maritime Accident Inquiry Act in May 2008, and causes of accidents are now clarified as follows by the Transport Safety Board.

Before and after comparison of Maritime Accident Inquiry Act

Previous Japan Maritime Accident Inquiry Act

Before

Clause 1

This legislation is designed to clarify the causes of maritime accidents through inquiry by the Marine Accidents Inquiry Agency, and to contribute towards preventing their reoccurrence.

Revised Maritime Accident Inquiry Act (revised May 2nd, 2008)

after

Clause 1

This legislation determines procedures for inquiry at the Maritime Accident Inquiry Tribunal established in the Ministry of Land, Infrastructure and Transport for the purpose of providing disciplinary punishments for maritime accidents caused by intentional or unintentional neglect of duty by maritime technicians, small vessel operators, or pilots, and to contribute towards preventing their reoccurrence.

Clarification of causes of maritime accidents

Transport Safety Board Establishment Act (revised May 2nd, 2008)

(Purpose)

Clause 1

This legislation establishes a Transport Safety Board to accurately conduct investigations to clarify the causes of air accidents, railway accidents, and maritime accidents, the causes of damage arising from such accidents, and to seek implementation of the necessary policies and measures by the Minister of Land, Infrastructure and Transport and persons associated with causes based on the results of these investigations, and to contribute to preventing such accidents, and to alleviating damage arising from such accidents.

The Maritime Accident Inquiry touches on the causes of accident when determining disciplinary punishments for maritime technicians etc., however the primary task of clarifying causes is the work of the Transport Safety Board. In the case of collisions, lawyers for both parties negotiate the division of responsibility based on the judgment of the Maritime Accident Inquiry and the Transport Safety Board, however in some cases it appears that causes as noted by the Maritime Accident Inquiry and as investigated by the Transport Safety Board differ.

* 2-7 Basic Considerations for Preventing Reoccurrence of Accidents

Consideration of the causes of the two accident examples introduced above, and points common to parts related to preventing reoccurrence, are as follows.

+ Maritime Accident Inquiry +

In accordance with the New Maritime Accident Inquiry Act, Japanese holders of a seamen's license are subject to punishment by suspension of license for a period of one month, and responsibility for the cause of the accident, the reason for punishment, is sought in terms of crew negligence.

+ Transport Safety Board +

It refers to enforcement of watch-keeping and look-out, cooperative action by burdened vessels, and failure to issue warning signals, however the point of 'why was that action taken?' appears not to have been touched.

Grave-post and preventative types of measures have been explained above. In the following, human characteristics, factors which inhibit these characteristics, and the occurrence of human error will be considered in relation to **reoccurrence of the same accidents if preventative measures are not developed.**

In other words, most accidents are caused by human error. From the Accountability type of measure in which the person is investigated to determine what mistakes were made, responsibility apportioned, and the curtain drawn, it is necessary to change our awareness to the pursuit of background factors of human error, investigating 'why it happened', and the development of valid measures of the Countermeasures-oriented type.

Important

A change in awareness from the Accountability type to the Countermeasures-oriented type

If we return to the point of view of preventing reoccurrence of the same type of accident, we need to change our consideration of accidents and phenomena.
As noted above, no one undertakes a task, or pilots a vessel, with the intention of causing an accident. Furthermore, if we consider the matter in terms of human factors, punishment of the person involved has no suppressive effect, and makes no major contribution to preventing reoccurrence.
In other words, when developing preventative measures, an analysis in terms of the following points is necessary.

1. Analyze the accident from the point of view of the person involved.

Analyze the phenomena occurring up to the accident in terms of 'what would I have done if it had happened to me?'.

2. Consider human characteristics

Consider why human error occurred, and the background factors, in terms of 'Human Characteristics' in 2-5.

3. Based on a consideration of causes

Analysis results in terms of 'should' and 'should have' simply conclude with seeking responsibility of the person involved, and are meaningless from the point of view of preventing reoccurrence. It is necessary to return to the origin and consider that matters collapsed, giving rise to the accident.

Use of the M-SHELL model, an element in **Bridge Resource Management** explained in Chapter 3 results in the following.

As shown in Fig. 5, the person at the center (L :Person responsible for the accident) is surrounded by those resources such as: ' H :Hardware: ', ' S :Software', ' E :Environment', and ' L :Persons other than the person responsible for the accident.' Each resource is always in a state of change. This situation can be shown in terms of quivering rectangles. Here, if communication and cooperation between the person ' L ' and those resources are insufficient, ' L ' is unable to have sufficient contacts with others and human error occurs; in consequence, safety is no longer assured.

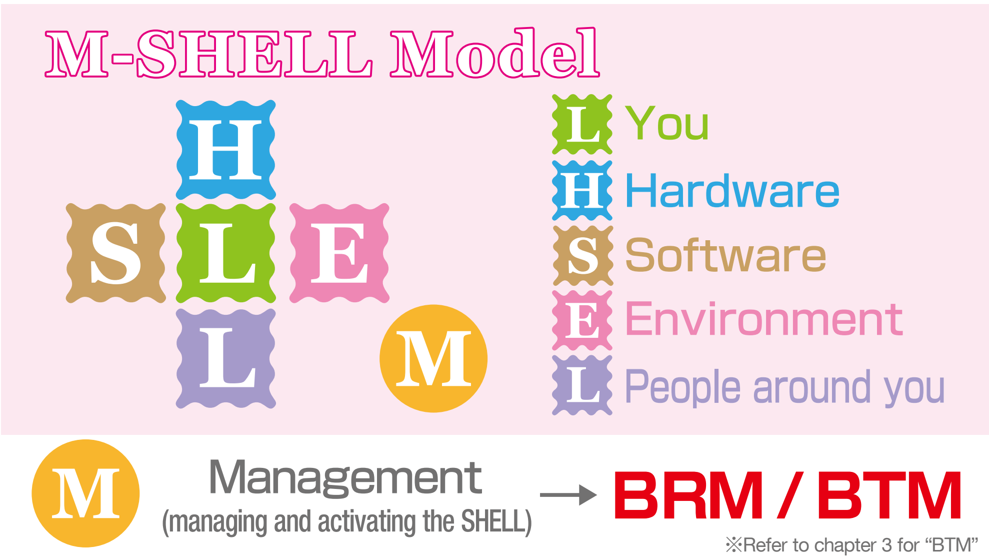


Fig. 5

The accident example has been summarized in Fig. 6 and Table 6 by evaluation against human characteristics and analysis using the M-SHELL model.

+ Accident example (1) +

Human Characteristics and Comparison of Behavior of Persons Involved

	Human characteristics	Vessel S 2/O	Behavior	Vessel T captain	Behavior
①	Human beings sometimes make mistakes	○	Turned to port despite being stand-on vessel.	×	—
②	Human beings are sometimes careless	×	—	○	Aware of need for watch-keeping, however intervals were too long.
③	Human beings sometimes forget	○	Ignored Maritime Collisions Prevention Act.	○	Ignored Maritime Collisions Prevention Act.
④	Human beings sometimes do not notice	×	—	○	Did not notice other vessel.
⑤	Human beings have moments of inattention	○	Verified only with ARPA.	○	Aware of need for watch-keeping, however did not execute.
⑥	Human beings sometimes are able to see or think only one thing	×	—	○	Busy processing catch.
⑦	Human beings are sometimes in a hurry	×	—	○	In a hurry to return to port.
⑧	Human beings sometimes emotional	×	—	×	—
⑨	Human beings sometimes make assumptions	○	Assumed other vessel would take avoiding action.	○	Thought all was normal, and no problems.
⑩	Human beings sometimes lazy	○	Did not issue warning signal or take appropriate action.	○	Aware of need for watch-keeping, however did not execute.
⑪	Human beings sometimes panic	×	—	×	—
⑫	Human beings sometimes transgress when no one is looking	×	—	○	Nobody on-site to call attention to insufficient watch-keeping.

Table 6

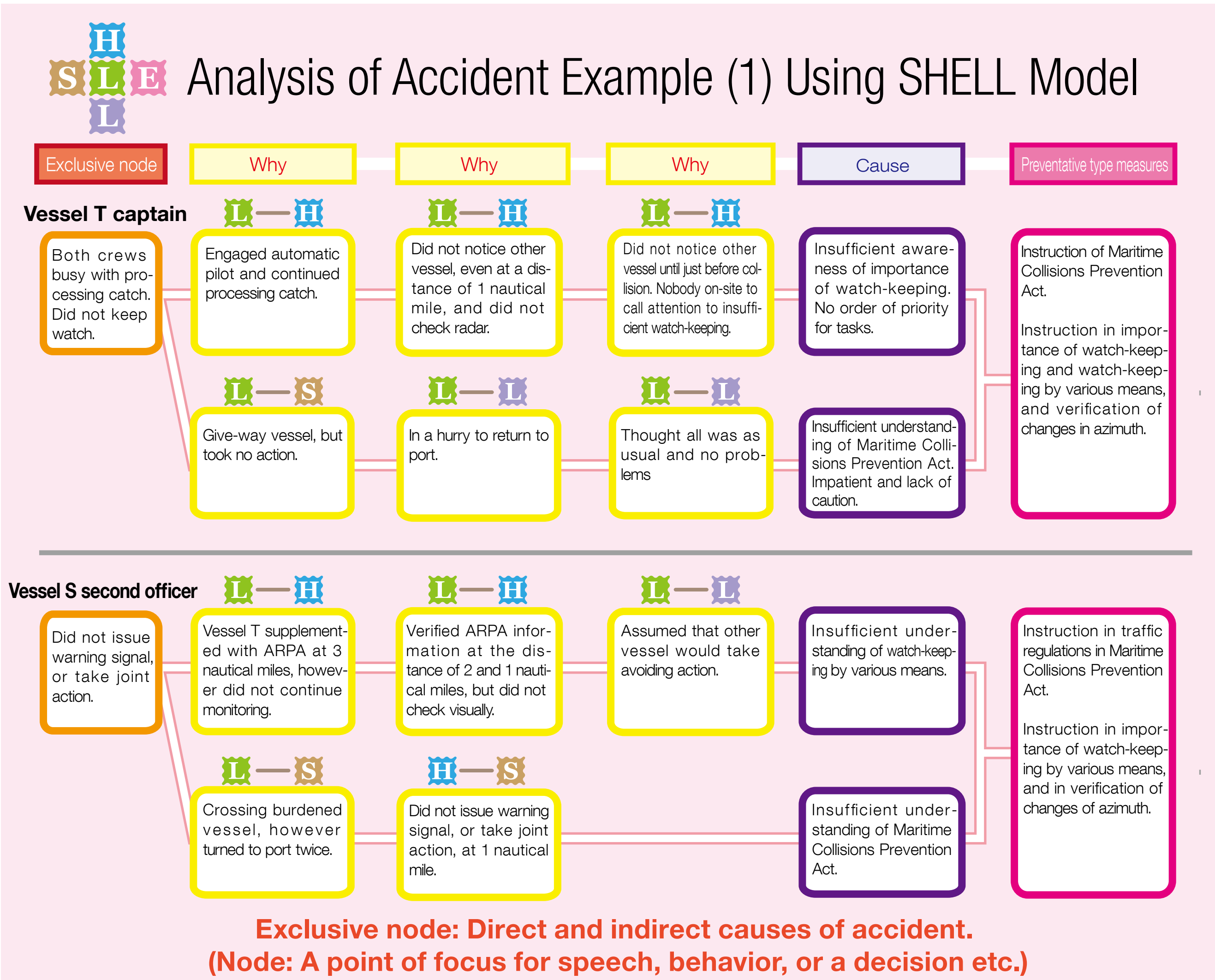


Fig. 6

5 of the 12 human characteristics apply to the second officer of vessel S, and 9 of the 12 apply to the captain of vessel T. An analysis using the M-SHELL model of why the behavior was taken in relation to these characteristics using is shown in Fig. 6.

In the examination of causes by the Maritime Accident Inquiry, and in reference to the Transport Safety Board (measures to prevent reoccurrence), associating primary causes and measures to prevent reoccurrence are associated as the exclusive node, and items verified against human characteristics as 'why?' in considering corresponding resources. Thus, the cause becomes apparent as a background factor, and preventative type improvement measures can be established for that cause.
In this accident example, 'Reeducation of Maritime Collisions Prevention Act' and instruction on the 'importance of watch-keeping, watch-keeping by various means, and verification by change in bearing' were established as measures for both vessels. These factors are considered as a commonsense result by the vessel operator.
Note: Exclusive node: Direct and indirect causes.
(Node: A point of focus for speech, behavior, or a decision etc.)

+ Accident example (2) +

Accident example (2) similarly summarized in Table 7 and Fig. 7.

	Human characteristics	Vessel B 3/O	Behavior	Vessel H captain	Behavior
①	Human beings sometimes make mistakes	×	—	○	Gave rise to another danger of collision.
②	Human beings are sometimes careless	×	—	×	—
③	Human beings sometimes forget	×	—	×	—
④	Human beings sometimes do not notice	○	Did not conduct watch-keeping.	○	Verified other vessel solely by radar.
⑤	Human beings have moments of inattention	○	Negligent in watch-keeping.	○	Verified other vessel solely by radar. No visual verification.
⑥	Human beings sometimes are able to see or think only one thing	○	Distracted by VHF and conversation.	○	Verified other vessel solely by radar.
⑦	Human beings are sometimes in a hurry	×	—	×	—
⑧	Human beings sometimes emotional	×	—	×	—
⑨	Human beings sometimes make assumptions	○	Thought that radar displayed images of all vessels.	○	Assumed that all crossing must be port-to-port.
⑩	Human beings sometimes lazy	○	Did not verify visually.	○	Sitting in chair concentrating on radar. Did not conduct watch-keeping by various means.
⑪	Human beings sometimes panic	×	—	×	—
⑫	Human beings sometimes transgress when no one is looking	○	Did not carry out captain's instructions (careful watch-keeping).	○	Did not conduct watch-keeping by various means.

Table 7

Verification against human characteristics shows six characteristics applicable to the third officer of vessel B, and 7 applicable to the captain of vessel H. Exclusive nodes can be taken as 'did not notice other vessel until immediately prior to collision' for vessel B, and 'operation giving rise to a new danger of collision' for the captain of vessel H.

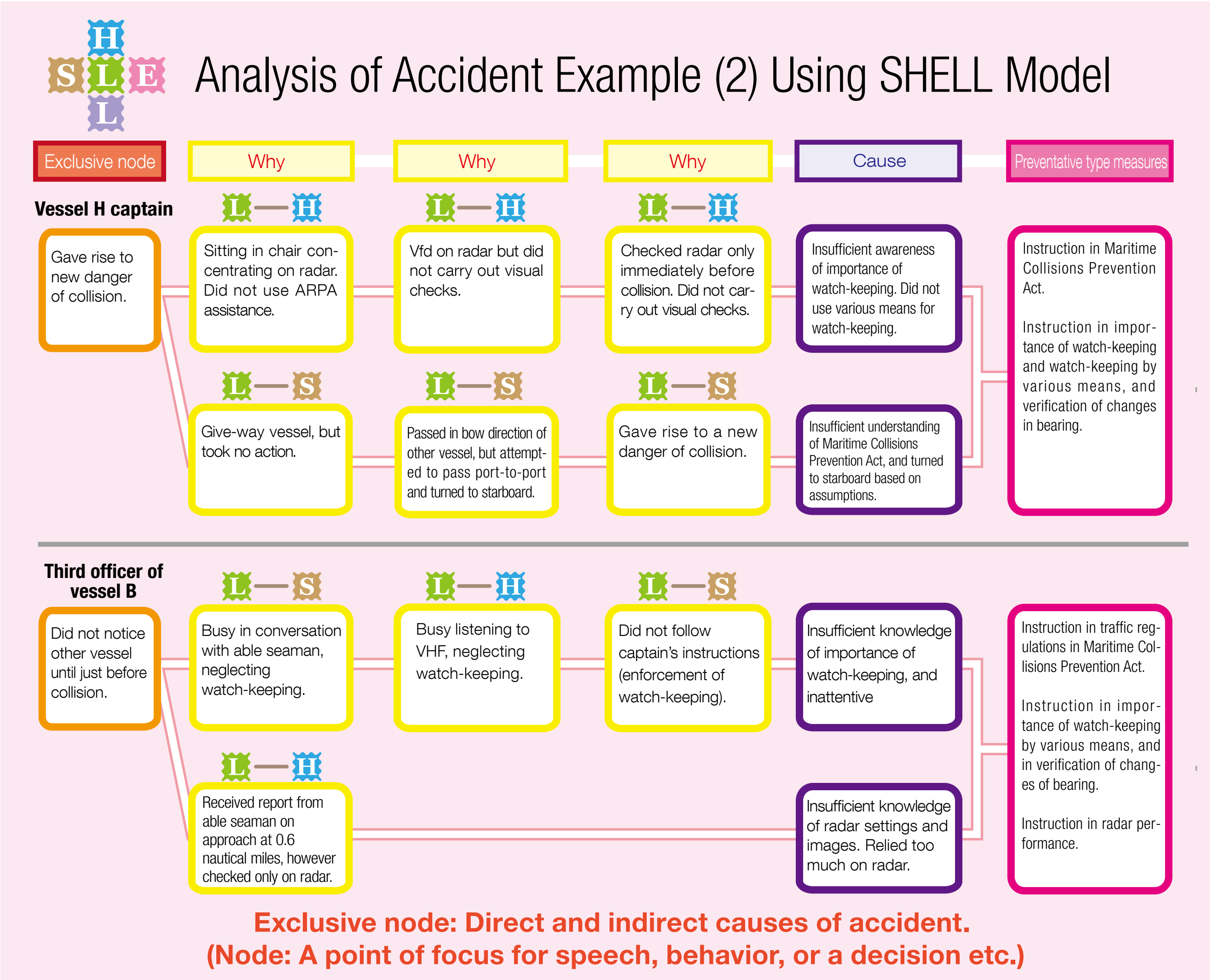


Fig. 7

In accident example (2), as with accident example (1), it can be seen that 'Reeducation of Maritime Collisions Prevention Act' and education on the 'importance of watch-keeping, watch-keeping by various means, and verification by change in bearing' were necessary. Additionally, for the third officer of vessel B, 'instruction in radar performance' was also necessary. The method of instruction for crew is described in Chapter 6.

Chapter 3 Bridge Resource Management (BRM)

This chapter describes the outline and history of BRM.

* 3-1 What is Bridge Resource Management (BRM)?

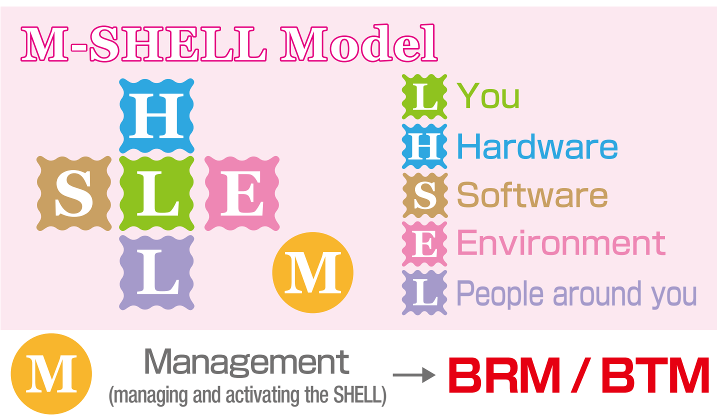
Bridge Resource Management is the effective use (M as in management) of the range of resources (R: personnel, objects, information) available on the bridge (B) for safe and efficient operation of the vessel. The term Bridge Team Management (BTM) has also come into use in recent years.
The following describes the difference between BRM and BTM.

As described above, the objective of BRM is the effective use of resources (including personnel) on the bridge, in particular the effective use of human resources for management functions which must be implemented by a leader of an organized team.
However, the achievement of safe operation is not simply due to the efforts of the leader, but it requires all members of the team to raise the level of their abilities. Improved functioning of all members of the team, including the leader, is essential. The function to achieve this, including management, is the BTM.
From the relationship between the two, the functions which must be achieved by the leader of the team are positioned as BRM, and since the leader is a member of the team, he/she must achieve BTM as a function to be executed as a member.

Important

BTM is a function to be achieved by all members of the team.
BRM is a part of BTM, and a function to be achieved by the leader.

The following explains the situation before the introduction of the concept of BRM and BTM, and the difference between the two.
In terms of the work performed on the bridge, there is no difference in the work of watch-keeping, vessel positioning, external communications, and handling navigation equipment etc. However, if we combine resources and consider matters from an outline of human factors, BRM and BTM are intended behavior. Here it becomes the concept of the M-SHELL model.



As described above, L (You) at the center, and the surrounding resources, are never static. BRM and BTM act to ensure good communication with each resource, eliminate causes inhibiting the 12 motion characteristics of human beings, and suppress the occurrence of errors.

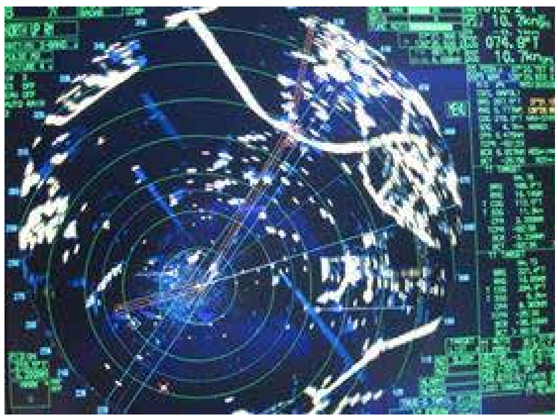
* 3-2 Physical Resources on the Bridge

How communication between physical resources on the bridge and human resources take place?

1. Hardware H

Hardware provides information available from various navigational equipments (radar, ARPA: Automatic Radar Plotting Aid, electronic charts). Binoculars are also an important item of hardware.

If visual information such as radar images and electronic charts is available, audio information emitted by ARPA etc. is also available. In particular, information for the prevention of collisions requires the operator's communication with the equipment to set ARPA alarms. Furthermore, work to obtain information by aligning the ARPA cursor on information on other vessels on radar images requires communication with the hardware.



Thus, the pilot is required to be skilled in the use of the hardware, and information set manually must be shared with the team. For example, even if the captain sets the CPA: Closest Point of Approach, and TCPA: Time to CPA, alarms in the ARPA settings, the officer on duty may sometimes change the alarm settings without the permission of the captain if the alarm is excessively loud. However, from the BRM point of view, this behavior gives rise to misunderstandings by team members in relation to alarm tones and further errors.

2. Software S

Software cover navigation regulations such as the Maritime Collisions Prevention Act and the Maritime Traffic Safety Act, and procedures determined in SMS manuals and safety management rules. Movement of stand-on vessels when crossing is regulated under Clause 17 of the Maritime Collisions Prevention Act (stand-on vessels) as 'unless such action is impossible, the stand-on vessel is required to turn to port'.
However, the second officer of vessel S in accident example (1) turned to port after evaluating only the ARPA information CPA and the vector, and did not visually check the change in bearing of the other vessel. Furthermore, for navigation in conditions of restricted visibility, Clause 19.5.1 of the Maritime Collisions Prevention Act regulates that

'when other shipping is in a position abeam or forward of abeam (excluding the case in which one's own vessel passes the other vessel), one's own vessel changes course to port' shall be followed unless such action is impossible. However, in conditions of restricted visibility, most collisions are due to one of the vessels not monitoring vessel movement sufficiently with radar etc. while turning to port. In such cases, the navigator on duty and the captain have ignored the requirements of the Maritime Collisions Prevention Act.

Many accidents can be prevented by simply following the procedures laboriously established in SMS and safety management regulations. In such cases, as well, it is necessary not only to determine the responsibility of the person on duty, but also to investigate causes in terms of why the regulations were not followed.

3. Environment E

Handled as environment in the SHELL model. The following information from external sources is relevant.

Information from External Sources

- **Navigation information: For example, MARTIS information from the Marine Traffic Center.**
- **Weather maps and navigation alarms**
- **Communications with other vessels via VHF etc.**
- **Navigation alarms from the Maritime Safety Agency**
- **Various information from the company**

In particular, with navigation under conditions of restricted visibility in congested sea areas and narrow channels, a careful examination of information obtained via VHF to identify valid and invalid information is necessary, however the priority of work must be clarified simultaneously before taking action. The third officer in example (2) was busy listening to the VHF communications from the other vessel, and engaged in conversation with the able seaman, neglecting watch-keeping, resulting in the collision.

Very few maritime collision accidents resemble motor vehicle collisions in which the two vehicles are head-on. Most reports indicate that the collision occurred despite the other vessel having been already recognized. In most cases, the Maritime Accident Inquiry and the Transport Safety Board Report indicate insufficient watch-keeping. However, most collision accidents can be prevented not only through awareness of the insufficient watch-keeping 'exclusive node', but also by breaking the error chain.

Fig. 8 shows the error chain up to a collision accident.

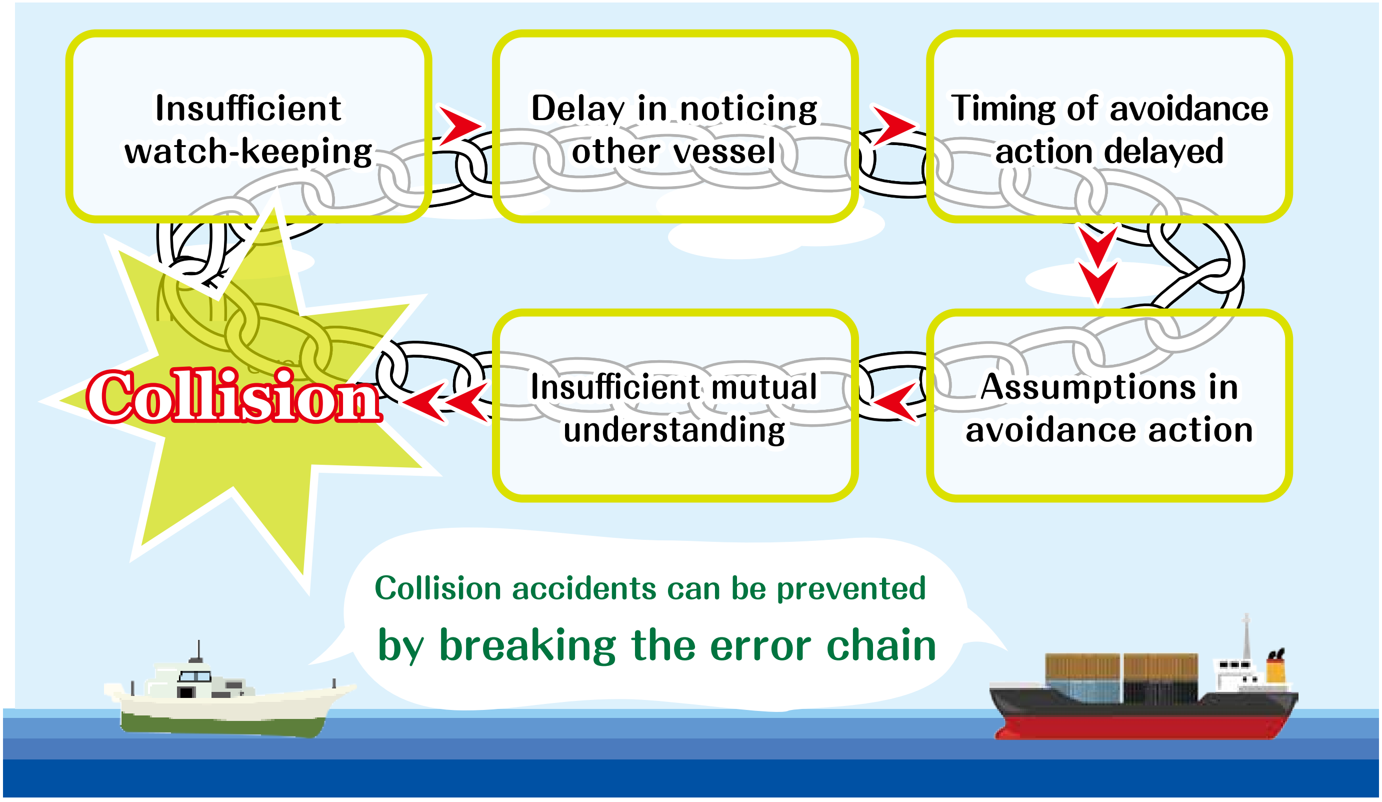


Fig. 8

The initial error chain was insufficient watch-keeping. This gave rise to a delay in noticing the other vessel, and as a result, the start of avoidance action was delayed. Then the assumption that the other vessel would take avoidance action was made without confirming the name of the other vessel in the AIS information in order to call it on VHF to verify each other's intentions; and a collision resulted. A collision could have been prevented by executing one or more of these five error chains.

* 3-3 History of BRM

The concept of human factors was first introduced at the Hawthorne plant of the US electrical manufacturer Western Electric between 1924 and 1930 in an effort to improve efficiency of work.
Subsequently, the idea that machines must be suited to human characteristics in order to obtain optimum results was taken up in the US in 1940 for the manufacture of military equipment during WWII.

A large number of aircraft accidents occurred in the 1960s, and while no major change occurred in the accident rate, the greater size and number of aircraft resulted in an increase in the number of casualties. It became apparent that if the accident rate continued, by the year 2000, an aircraft accident would occur every week somewhere in the world. A sense of impending crisis grew in the aircraft industry that the public would come to view an aircraft as an unsafe mode of travel.
In 1971, the training in 'Human Factors in Transport Aircraft Operation' commenced at Loughborough University

in the UK. Voice recorders and flight recorders were then fitted to aircrafts, and the majority of aircraft accidents subsequently were considered to have resulted from human error.

The trigger for the training by the airline industry incorporating human factors was the accident at Tenerife described below.

Jumbo Jet Collision at Tenerife

This accident occurred in the island of Tenerife in the Spanish territory of the Canary Islands at 17:06 local time on March 27th, 1977 on the runway at Los Rodeos airport.
The accident involved two 747 Jumbo aircraft, one KLM, and one Pan American, the aircraft colliding on the runway after failing to visually identify each other. A total of 583 passengers and crews were killed, with 54 passengers and 7 crews surviving. The accident was the worst in the history of the airline industry.

Circumstances of the accident

The captain of the KLM aircraft released the brakes and began moving down the runway. The co-pilot noted that clearance had not been received, and a few seconds later checked and obtained clearance from the controller.
This clearance was only for ‘standby to takeoff’, and not for ‘takeoff when ready’. When the controller issued clearance he used the term ‘takeoff’, and it is thought that crew on the KLM aircraft understood this as permission for ‘takeoff when ready’. At 17:06:23 the KLM co-pilot, speaking with a Dutch accent, responded with either “We are at take off” or “We are taking off”. The controller was confused by this response, and in turn responded with “OK”, followed after a 2-second silence by “Stand by for take off. I will call you”. This ‘OK’ and the following 2-second silence subsequently became a point of contention.

The crew on the Pan Am aircraft were listening to this conversation, and immediately felt uneasy and warned that “No, we are still taxiing down the runway”. This silence from the Pan Am aircraft occurred immediately after the 2-second silence noted above, and on the KLM aircraft, the crew heard only “OK”, and transmission then became inaudible due to interference, and nothing was recorded.
On the Pan Am aircraft, the 2-second silence was interpreted as completion of the controller’s transmission, and the Pan Am crew then began transmission, however controller was still holding down the send button, resulting in the interference. Neither the controller nor the Pan Am crew noticed this interference.
Thus, the Pan Am crew thought that the warning had reached both the KLM aircraft and the controller, the controller thought that the KLM aircraft was waiting at the takeoff position, and the KLM crew thought that ‘OK’ meant that permission to take off had been issued, and opened the throttle for takeoff.

Due to the thick fog, the KLM crew thought that the Pan Am 747 was still on the runway, and were unaware that it was moving in their direction. Furthermore, personnel in the control tower were unable to see either aircraft, and even worse, no ground control radar was installed on the runway.

There was, however, one last chance to avoid the collision - only 3 seconds after the conversation noted above, the controller asked the Pan Am crew to “report when runway is clear”. The Pan Am crew responded with “OK, we’ll report when we’re clear”. The KLM crew heard this conversation clearly, and the KLM fight engineer feared that the Pan Am aircraft was on the runway. The conversation at this point was recovered after the accident from the cockpit voice recorder of the KLM aircraft.

KLM flight engineer : "Looks like it's still on the runway" .

KLM captain : "What!"

KLM flight engineer : "Looks like Pan Am is still on the runway" .

KLM captain/co-pilot : "We're OK" (in a strong voice)

The situation was that the KLM captain was not only the superior of the flight engineer, but also one of the most experienced pilots. It appears that in this context, the flight engineer clearly hesitated to push the point.

Since 1980, CRM (Cockpit Resource Management) has become a fixture, and the training is now conducted in the airline industry.
Currently, Crew Resource Management includes cabin staff, and thus includes all crew. In Japan, the training was introduced in 1985 triggered by the Osutakayama crash.

In the maritime world, BRM training was introduced in Europe and the US in the 1990s. In Japan, it was introduced by large shipping companies in 1998.

Chapter 4 BRM in Practice

* 4-1 BRM on the Bridge

BRM was introduced to ocean-going vessels almost 20 years ago. As described in Chapter 2-4 Human Factors and Human Error, BRM was introduced with the understanding that ‘everyone makes a mistake’ and ‘there are limits to abilities’, and to cover the weakness of human beings on the bridge with team work and information to ensure that errors do not lead directly to a threat to the safe operation of the vessel.

However, while the efficacy of BRM is understood, complaints to the effect that it cannot be put into practice on-site are heard. The following explains how to use BRM to ensure that it functions effectively.

* 4-2 Clarifying Division of Labor and Ship Handling

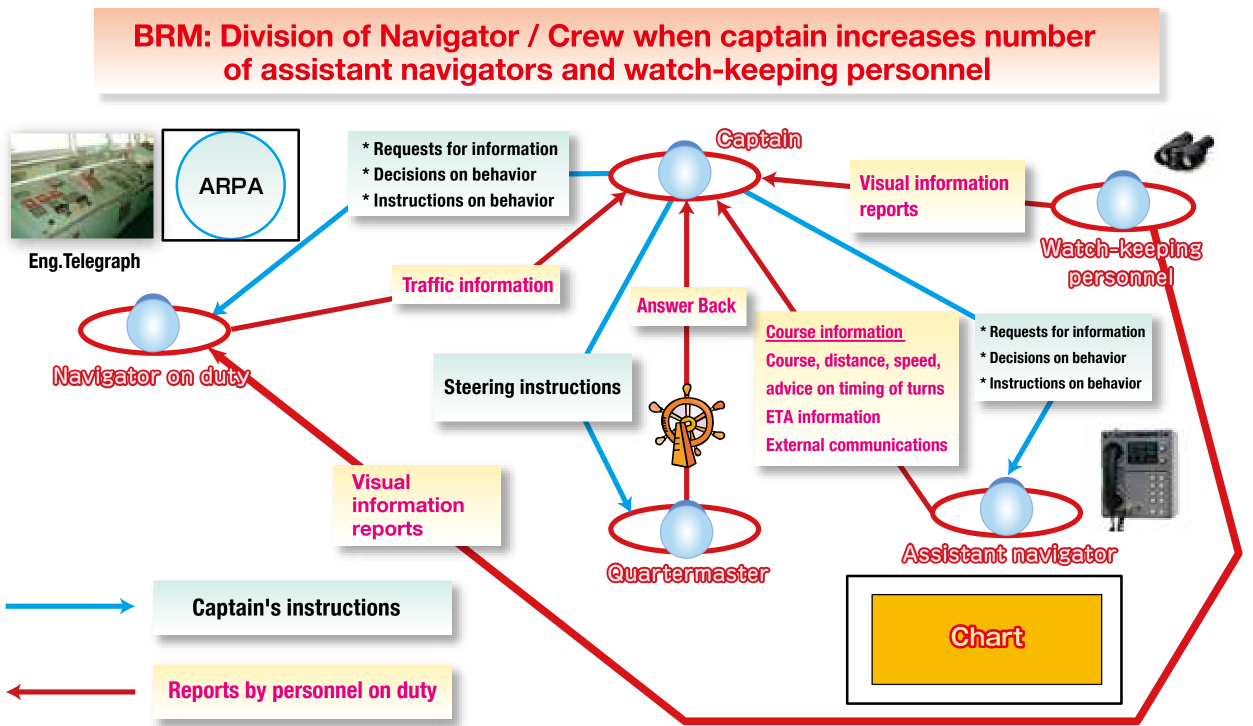


Fig. 9

Fig. 9 shows the command structure for steering of the vessel when entering and leaving port, in congested areas, and in narrow channels with increased numbers of assistant navigators and watch-keeping crew.

1 Captain

Takes command at the center of the bridge.
In particular, when giving instructions to change course and for engine control, it is important to explain the intentions to team members if sufficient time is available. For example, to change course and reduce speed to avoid another vessel, or course change towards the next turning point and increase or decrease speed to avoid another vessel. It is also necessary to clarify switching between manual and automatic pilot to the able seaman.

2 Navigator on duty

The primary task is watch-keeping work using ARPA, while using the engine telegraph and communicating with other sections of the vessel such as the engine room and deck. Follow the instructions of the captain in communicating with engine control and other sectors of the vessel, and advise captain on steering.

3 Able seaman on duty

Focus on steering of vessel, as well as watch-keeping.

4 Assistant navigator

Verify vessel position and associated reports on course, giving successive reports on course and distance to next turning point, assistance in steering timing, and external communications via VHF.

5 Increasing number of watch-keeping crews

Focus on watch-keeping tasks, and also quick and clear reporting to all bridge crews on current situation in a clear voice.

Instructions of the leader (captain), instructions of team members, and reports must be heard by all crew members on the bridge. To which crew each instruction is addressed must clearly be understood, and repetition of the message is required for all instructions and reports from the leader.

It is important that the leader in command of the vessel repeat the message and visually confirm all reports from team members. For example, identification of other vessels moving in the vicinity, verification of reports from the able seaman with the rudder indicator, and verification of engine speed during engine operation.

Caution is required on the following points by the leader (captain) and team members when considering this bridge team communication.

Leader (captain)

Verify vessel position and associated reports on course, giving successive reports on course and distance to next turning point, assistance in steering timing, and external communications via VHF.
Repeat content of report. Answering with a simple 'Understood' or 'OK' does not constitute verification when large amounts of information are current. In other words, in these situations, it becomes unclear what the answer referred to, and which task or report is 'OK'.

Team members

Report simply and clearly.
Care is required with instructions by the leader to other crew on duty, and with reports to the leader. Ensure that all questions on each instruction and report are resolved.

When taking over from the navigator on duty, even the captain is formally required to take command of the vessel. It is important the captain declares to all crew on the bridge that 'I am taking control' to clarify that he now has responsibility. In one case, an ocean-going shipping company notes the taking of command of the vessel in its bell book and daily navigation log.

Conversely, if this is not the norm and the captain repeatedly issues sudden instructions to the able seaman to change course, and communicates personally with the engine room without communicating these details to the crew on duty, the bridge crew will automatically assume that the captain takes command of the vessel when he comes up to the bridge, resulting in errors. .

* 4-3 Increase the Number of Crew on Duty When Passing Through Congested Waters and Narrow Channels with Limited Visibility

While a captain's view that, if possible, the navigator and able seaman should rest after cargo handling after entering port, and when leaving port immediately after cargo handling, is admirable, if we consider the priority requirement for safe operation of the vessel, it is important not to hesitate to increase the number of crew on duty at these times.

When the schedule for passing through navigation areas such as congested waters and narrow channels can be predicted, a plan to increase the number of crew on duty can be scheduled in advance, allowing for crew working hours etc. to be planned.

The passage plan in Table 10 shows the watch level, and who is to be added for watch-keeping.

Watch level	Personnel	Control of vessel
Watch level 1	Navigator on duty / Able seaman on duty — Total 2 persons	Navigator on duty
Watch level 2	Captain / Navigator on duty / Able seaman on duty — Total 3 persons	Captain
Watch level 3	Captain / Navigator on duty / Able seaman on duty / Increasing number of watch-keeping crews — Total 4 persons	Captain
Watch level 4	Captain / Navigator on duty / Assistant navigator / Able seaman on duty / Increasing number of watch-keeping crews — Total 5 persons	Captain

Table 10

* 4-4 Captain's Understanding of Crew Abilities and Issuing Thorough Instructions

+ Understanding Crew Individuality and Abilities +

Abilities of individual navigators and able seamen differ considerably. The captain should understand the following points.

(1) Knowledge and skill

It is important to understand the knowledge of traffic regulations and handling of navigational equipment, and the level of skill of each crew member on duty.

A wide variety of training, notably simulator training, of navigators is undertaken, however nothing is more effective than experience gained on-site. Understanding the efficacy of OJT (On the Job Training) as described in Chapter 6, and training crew, is an important part of the work of a captain.

As far as time allows, briefing and debriefing of all on duty when entering and leaving port, and passage through narrow channels is important not only in terms of actual operations, but also as an effective method of OJT (see Appendix (1) Singapore Straits Passage Plan BRM Briefing Materials (sample)).

(2) Individual differences (individuality)

Human beings exist in many different personality types, for example, those who are overconfident, those who are negligent, and those who are quiet and modest.
In bridge work, it is necessary to provide consistent BRM training that minimizes these individual differences including the provision of methodology for instructions and reports stated above.

(3) The limits of ability

The captain cannot handle an infinite amount of work. For example, it is impossible to check the position of the vessel on the chart, issue steering commands, and communicate on VHF while watch-keeping, all simultaneously, for even the most experienced captains. It is therefore important to have a plan for crew deployment that allows for sufficient time to carry out tasks.

+ Thorough instructions +

Standing orders and the night order log are very important in providing practical instructions on such matters as the CPA to be followed, the minimum visibility (in nautical miles) at which a report to the captain is required
The watch level is often handled only by the navigator and able seaman on duty. If the details of the captain's instructions are not fully understood, matters are at the discretion of the navigator on duty, giving rise to errors in communication between the captain and navigator on duty (see Appendix (2) Standing Orders and the Night Order Log (sample)).
Appendix (2) provides a sample of Standing Orders and a Night Order Log issued by the author while aboard the vessel.
The author has obliged the navigator to read aloud the Standing Orders each time before coming on duty.
The Night Order Log was not only read thoroughly and signed before coming on duty, but the navigator previously on duty explained verbally the main points to the current navigator.

As described previously, it is necessary to clearly accept authority to control the vessel. Even the captain must formally be handed over the control after accepting it from the navigator on duty.

In terms of BRM/BTM, the most important point is ensuring the atmosphere on the bridge. It is an important duty of the captain to ensure that the atmosphere is always one in which anyone with doubts is able to verify as necessary.

As explained in * 4-1, by clarifying the division of labor of crew on duty, wasteful duplication is avoided and efficient BRM/BTM can be practiced.

Chapter 5 Engine Room Resource Management (ERM)

+ From 'Maritime Human Resource Institute: Engine Room Resource Management' +

* 5-1 What is Engine Room Resource Management (ERM)?

Proposals for revision of the STCW Convention were adopted at the IMO Conference in Manila in June 2010. One of these proposals related to the revision of Requirements for ERM added to the engineers' abilities requirements list. This requires knowledge of abilities in the list and 'Maintaining Safe Engine Watches', knowledge of ERM in terms of understanding and skills, and their practical implementation.
To ensure the functions of ERM, it is important that all crew grasp the overall picture, understand the constituent elements, and increase their knowledge in practice. Furthermore, both ERM and BRM are shared knowledge, not something which can be implemented if understood by specific crew, and it is vital that all members of the team have a common awareness of this requirement.

ERM is a method of ensuring safe operation of the vessel through appropriate management of resources in the machinery space (resources: equipment and plant, crew, information) while using these resources effectively. The revised abilities requirements list regulates the following as important items when practicing ERM.

Abilities requirements list

- **Disposition of resources**
- **Duties and order of priority**
- **Effective communication**
- **Clear indication of intention and leadership**
- **Situational awareness**
- **Apply the experience of team members, and understand the principles of ERM**

Resource management is summarized in Fig. 11.

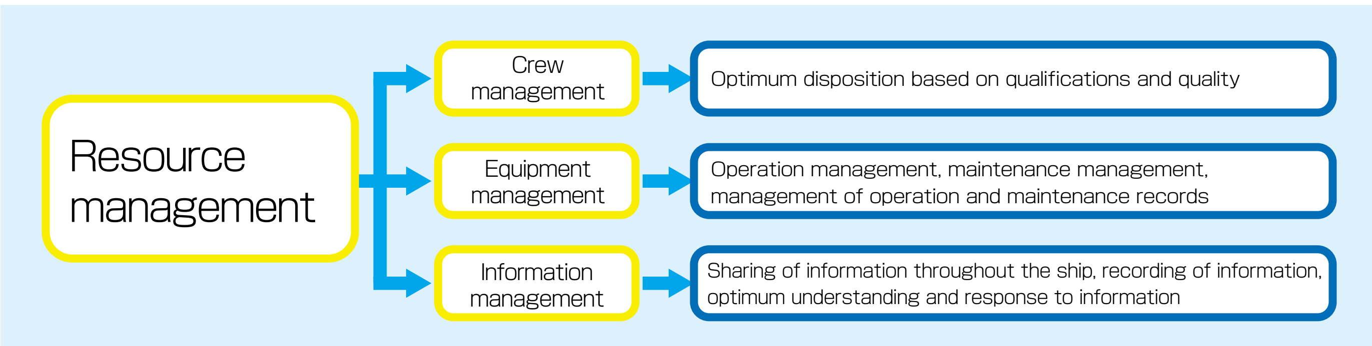


Fig. 11

The correlation diagram for ERM requirements based on the ability requirement list is shown in Fig. 12.

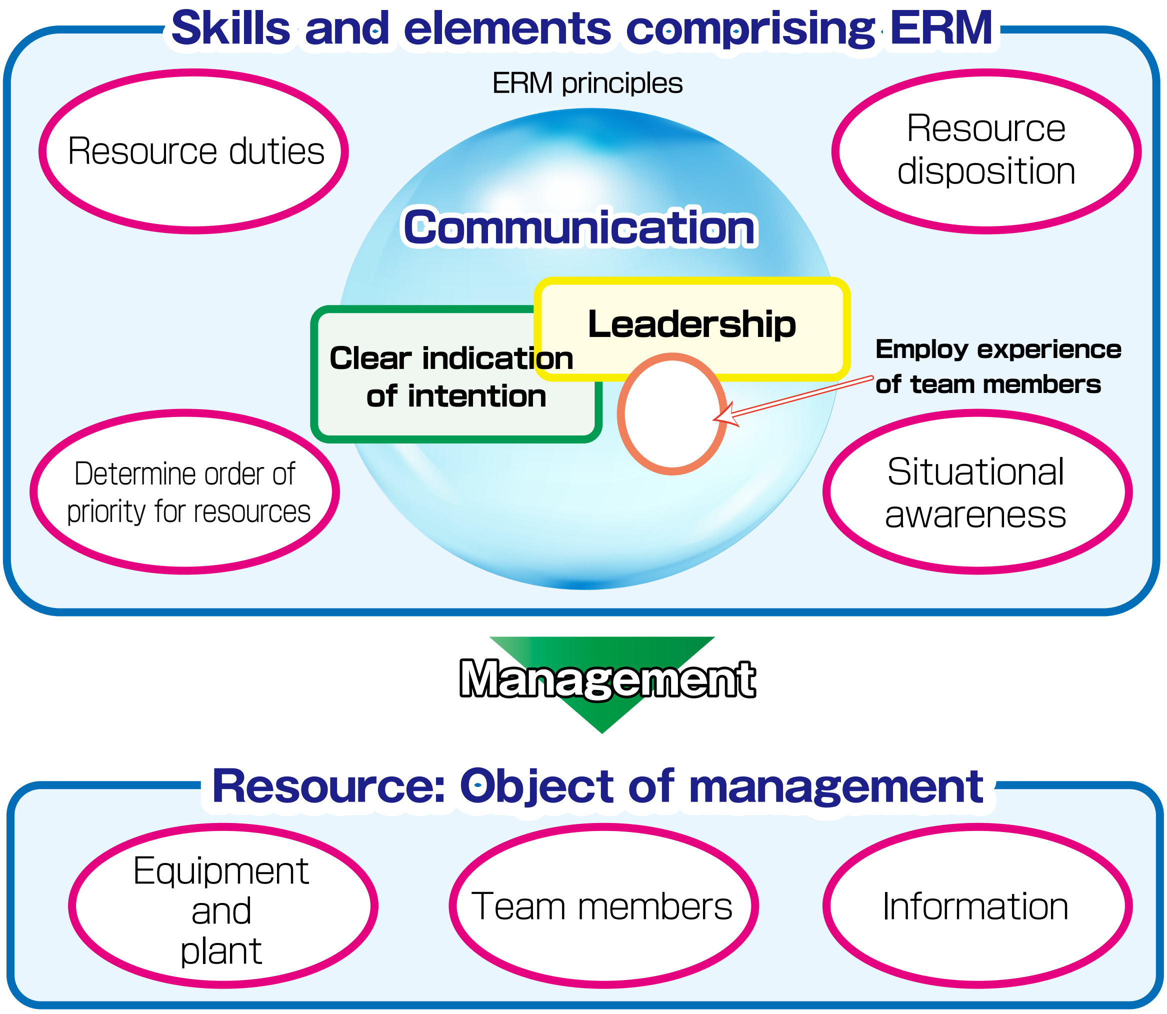


Fig. 12

This diagram shows that communication is the most important element in ERM, that leadership and clear indication of intention are abilities based on the foundation of communication. Applying the experience of team members is also an ability based on the foundation of communication, and shares points with leadership.

The three requirements (duty, disposition, determine order of priority) related to resources and situational awareness have no commonality with communications, and can be seen as independent requirements. The principles of ERM are these four as shown within the rectangle, and are elements shared within ERM. They are the disposition of crew necessary for maintenance of safe operation, and the principles related to abilities necessary for crew and scope of activities.

In particular, ERM principles for implementation are, as per the ‘ERM Principles in the 2010 Revised STCW Convention’, regulated in Part 3 (General Principles of Duty Maintenance) of the revised STCW code A-VIII/Section 2 (Duty System and Principles to be Observed).

* 5-2 Three Requirements for ERM

(1) Resource disposition

(2) Duty

Resource disposition and duty are requirements related to human resources. It indicates that crew assigned duties in accordance with their occupations should be disposed appropriately and is the part corresponding to ‘ L ’ in the BRM SHELL model. In particular, within the context of preparing for entry and exit from port, it is necessary to develop an appropriate command structure and a system for effective operation of equipment. An optimum disposition of crew is required over and above the normal work on the voyage. While keeping in mind the need for the right man in the right place, positioning of experienced crew in the necessary locations according to the situation, and training of younger crew in these situations should be considered.

(3) Determining order of priority

Crew assigned to management of specific equipment are required to thoroughly read and understand the manual for the equipment, and obtain sufficient information on its operation and maintenance in order to develop operation and maintenance plans. They must also record detailed information on operation, maintenance, and consumption of spare parts to ensure that successors have the appropriate information.

* 5-3 Resources to Be Managed

The three resources to be managed (plant and equipment, crew, information) are shown in Fig. 12.

(1) Plant and equipment management

Plant and equipment is required to have the functions necessary for operation of the vessel and equipment must be disposed in a manner optimum for maintenance of safe operation of the vessel, and functions of the plant and equipment must be sufficiently manifested.

Management of plant and equipment involves management of operation of each item of equipment, maintenance management, and management of records of operation and maintenance. Temperature, pressure, and operational status are transmitted by each item of equipment, and such information must be received and viewed.
Crew on duty in the engine room are in charge of operation and maintenance of the equipment, and are therefore naturally required to circulate periodically around the engine room, however they must also be aware of slight changes in noise and vibration etc. emitted by the equipment as a sign of problems.

(2) Crew management

Crews are dispersed around the vessel to ensure safe its operation. In addition to having the appropriate abilities to carry out their duties, including relevant maintenance, they must also have the ability to manage and make good use of other crew. Each member of the crew is required to have a good understanding of the functions of the plant and equipment, verify that these functions are available, and understand the information from the plant and equipment and be able to use it.

(3) Information management

Information from spaces other than the machinery space, e.g. from the bridge, information from each item of plant and equipment in the machinery space (e.g. noise, vibration, temperature, pressure, alarms), and information from team members ensures good teamwork and therefore effective equipment operation and continuing high levels of team motivation.

In particular, although information from external sources tends to be insufficient, for the engine room team, understanding the external situation can be difficult: therefore information on the movement of the vessel permits prospective responses, and is useful in improving the reliability and speed of equipment operation. Exchange of information with the bridge is therefore a matter of the utmost importance.

Each member of the team must be aware of the fact that he/she is associated with operation of the vessel, and that it is important to share information held by the team and by the individual on any point that is a source of concern. The chief engineer, as the leader, and the first engineer, are responsible for creating this atmosphere in which information is shared.

* 5-4 ERM Examples

The ERM videos at the Maritime Human Resource Institute website introduces the main points of ERM. Videos are available on the homepage stated below:

Maritime Forum
http://www.maritime-forum.jp/en/index.php)

→ Maritime Education and Training

→ Maritime Forum

Movie

http://www.maritime-forum.jp/en/index.php

1. Situation

Problems with No.2 generator in the engine room while on standby to enter port.

2. Description

- Started the No.2 generator. Commenced operation of two generators in parallel, and third engineer immediately commenced checks.
- The third engineer monitoring the No.2 generator on-site noticed that the increase in temperature was a little too rapid, but thought that it would settle down.
- After a period of operation, the No.2 generator's No.1 cylinder exhaust temperature alarm indicated 'High'. The No.3 generator was started in the engine control room and the No.2 generator was shut down.
- Reduction in speed of the main engine continued while switching over to the No.3 generator, and S/B Eng. preparations were completed, however the second engineer was busy with the generator problem and forgot to notify the bridge and chief engineer in the engine room. Upon receiving a request for confirmation from the bridge, he noticed his mistake and reported the trouble to the chief engineer. Simultaneously, the main engine exhaust temperature dropped, requiring closure of the exhaust gas economizer damper, however the second engineer forgot.
- The chief engineer shouted at the second engineer to reprimand him for the two mistakes.
- The first engineer in the engine control room, at his own decision, instructed the third engineer to replace the No.1 cylinder fuel valve which was the cause of the alarm from the No.2 generator.
- The third engineer at the generator anticipated that (1) S/B Eng. was approaching, and that the labor required in replacing the fuel valve would make a response to another emergency difficult, and (2) if the No.2 generator was unusable there would be no backup generator: therefore, if, for some reason, a problem occurred with the generator during operation, the vessel would have insufficient power. The third engineer made these two points to the first engineer.

- The chief engineer accepted the third engineer's suggestions and halted the replacement of fuel valve of the No.2 generator, and decided to undo the operation and hold it as the standby generator, issuing appropriate instructions to all members of the engine section.

3. The ERM point of view

A consideration of the above case from the ERM point of view reveals a number of interesting points.

- **The third engineer was at the generator when it commenced operation. This is the standard position and enables immediate communication with the engine control room.**

  ▶ Consider the division of labor and dispersal of crew to appropriate positions.

- **The third engineer thought that the exhaust temperature was increasing too rapidly on the No.2 generator, though did not report this fact.**

  ▶ On the basis of his intuition, he did not share the information sent from the equipment with other team members and his superiors. If he had, it would have resulted in cautious monitoring from the control room, and the situation being resolved before an alarm sounded. Doubts and thoughts must be conveyed to the leader.

- **The second engineer noted the condition of the No.2 generator, and did not report completion of S/B Eng. preparations to the engine control room crew and to the bridge. And also, he forgot to close the damper.**

  ▶ There may be a subsequent problem with operation of the vessel if there is no confirmation from the bridge. The order of priority was not determined for the tasks (duties) in hand.

- **The chief engineer shouted at the second engineer.**

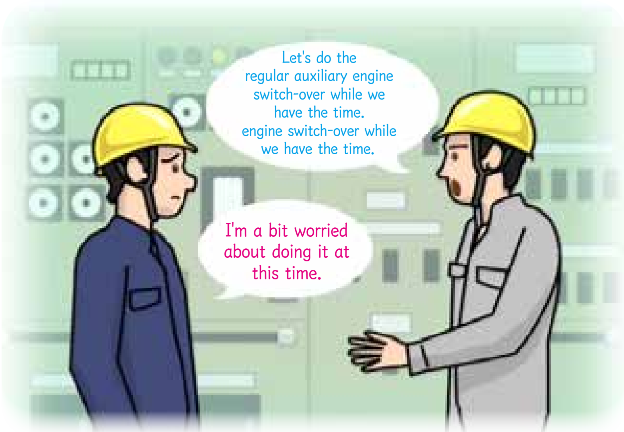
  ▶ This had the effect of inhibiting communication with the second engineer and other members of the team. All needed was to instruct him to close the damper calmly.

  ▶ In terms of maintaining a system of good communication, shouting in an emotional tone should be avoided at all costs.

- **The third engineer judged and suggested from the point of view of the person in charge on-site the first engineer's instruction to replace the fuel valve should not be carried out because of the small possibility of another problem.**

  ▶ This corresponds to the ERM rule that doubts must be voiced out, and was good decision-making that he clearly expressed his intention.

  ▶ It was also the correct decision in terms of both verifying the situation, and determining the order of priority.



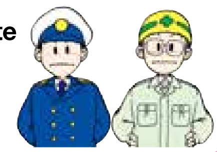
Chapter 6 Thorough BRM and ERM

* 6-1 Why have BRM and ERM Not Become Popular?

Despite 20 years having elapsed since the introduction of BRM, neither BRM nor ERM have become popular. Possible causes are given below.

Possible causes

1) **If technical skills are at a high level, it is assumed that 'safety is guaranteed'.**
2) **Management is not seen as a skill, and the traditional idea of separate deck and engineering sections remains strongly entrenched.**
3) **Crew training is primarily on OJT, leaving responsibility to the site.**



A revolution in awareness is required in light of this way of thinking, the way of thinking of safety, the question of what is management, and reconsideration of OJT, as described in Chapter 2.

The captain, chief engineer, and the company are required to develop 'an atmosphere in which subordinates (i.e. team members) are able to speak up on matters of safety in operation'. This is the foundation of effective use of BRM and ERM.

In comparison with the shipping industry, CRM (Crew Resource Management) appears to be running smoothly in the airline industry. When we compare the two, it appears the difference lies in the level of technology. In an aircraft, the difference in level of skill between the captain and the co-pilot is appears to be greater than between a ship's captain and chief officer, or between a chief engineer and engineer.

For example, if the captain of an aircraft were incapacitated in flight, the co-pilot should be capable of landing.

On the other hand, can a third officer operate his vessel safely to its destination? There is a major difference between ships and aircrafts in terms of the methodology of crew training, including up-skilling.

* 6-2 Improving Skill Levels

(source: Japan Captains' Association DVD - Individual Competence That Support BRM - How to Improve the Skill Level of Inexperienced Navigators)

The nine technical elements necessary for navigation with watch-keeping crew are listed below.

1. Skills associated with watch-keeping
2. Skills associated with measuring vessel position
3. Skills associated with handling navigation instruments (e.g. radar)
4. Skills associated with exchanging information by communication
5. Legislative compliance skills
6. Vessel piloting skills
7. Management skills to identify the work necessary in response to a situation, and assign and execute an order of priority
8. Skills associated with verifying charts etc. before going on duty
9. Skills for emergency response to equipment problems

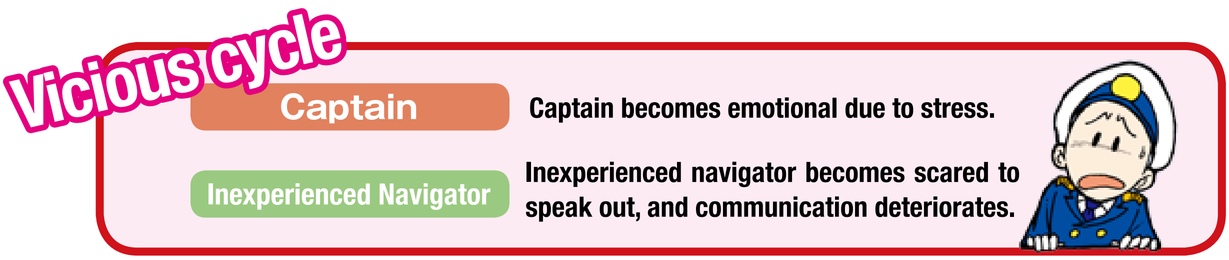
When the captain takes control of the vessel and is assisted by the navigator, able seamen, and watch-keeping crew in navigating in congested waters and narrow channels, or when entering and leaving port S/B, ❶ Skills associated with watch-keeping, ❹ skills associated with exchanging information by communication, and ❼ Management skills to identify the work necessary in response to a situation, and assign and execute an order of priority become apparent when evaluated in terms of whether or not they are used effectively for BRM.

Execution of BRM will be inhibited unless skill levels for other than ❶ , ❹ , and ❼ are able to satisfy the levels of the bridge team members (including the team leader). As a result the ability of the entire bridge team will deteriorate, leading to errors.

In particular, **'threats'** are sources of errors. With BRM and ERM, if threats are considered as elements which increase the possibility of errors, the following can be noted.

- A large volume of work (i.e. not enough personnel available to do the work)
- Time pressure (when the leader is in a rush and this is picked up by team members, it will leave everybody unsettled)
- Pressure from superior (in particular, regularly shouting at subordinates, scaring them into silence, and inhibiting operation of BRM and ERM)
- Fatigue and stress (attention is distracted when fatigued, and external stress is a cause of deterioration in abilities)

In other words, unless BRM and ERM can operate properly, not only will errors occur, but stress will develop between the leader and team members, giving rise to a vicious cycle.



* 6-3 Training of Inexperienced Navigators and Engineers with Low Skill Levels

To prevent errors, inexperienced navigators and engineers with low skill levels must individually and objectively evaluate and understand the skills with which they are deficient, and endeavor to reach the level of an experienced captain/navigator or chief engineer/engineer as soon as possible.

OJT and training on shore are methods used in training inexperienced navigators and engineers with low skill levels. However, the awareness and motivation of the trainee is important.

If we consider the level to which skills can be raised with OJT and shore training, Student Oriented in Fig. 13 below provides guidelines.

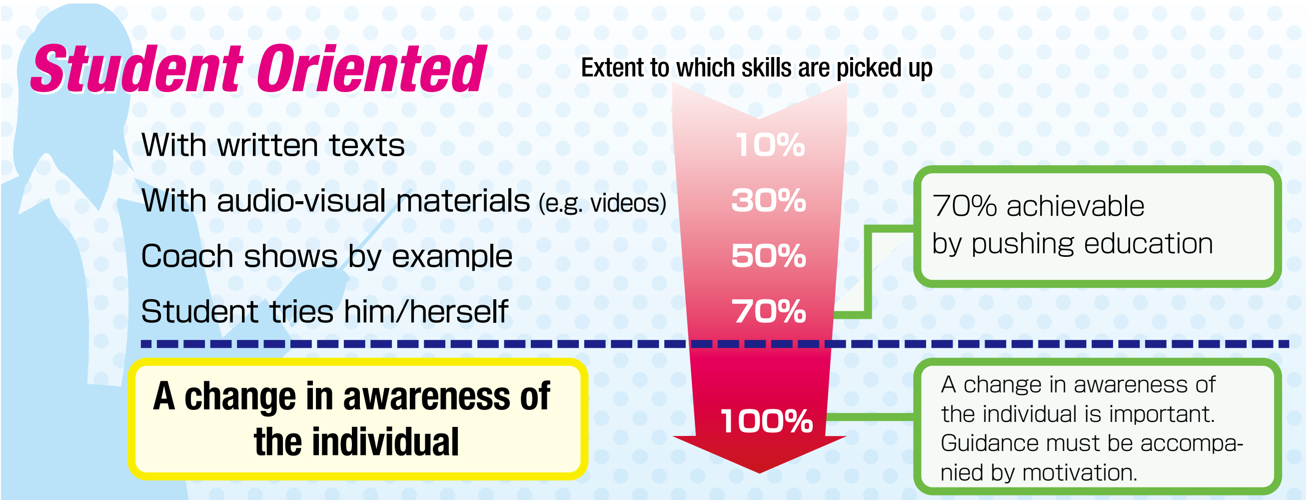


Fig. 13

Approximately 10% of skills are considered to be learned in classroom lessons using written texts. These skills consist primarily of fundamental theory and knowledge.

Use of videos, PCs, and the Internet as audio-visual materials is considered to raise the skill level to approximately 30%.

Subsequent practice and OJT in which the coach demonstrates is considered to increase the skill level to 50%. Further use of simulators and OJT to provide the student with experience is considered to increase the skill level to 70%. In summary, pushing the student is effective to a certain degree, however the 100% skill level is only achieved on-site.

Increasing the remaining 30% skill level is fundamentally a matter of changing the awareness of the individual. Education at this stage is primarily focused on OJT, and coaching is required to raise the motivation of the student.

* 6-4 Meaning and Objectives of OJT - What Is 'Cultivation' in the Context of Training

+ from the P&P network website +

http://www.h2.dion.ne.jp/~ppnet/

The following introduces an interesting item on OJT found on the Internet.

Basic concepts

OJT is about building the team for tomorrow. Lack of OJT will come back to bite you and your team.

(1) OJT (On-the-Job Training) is training during and via work.

OJT is not simply a matter of being thrown into the workplace, and being left to understand and learn alone. It is designed to consciously incorporate the following training and guidance activity through the assistance of managers and those more experienced.

1. Preparation for growth to become a member of the organization.
2. An attitude incorporating the necessary knowledge and skills in one's work.
3. How to best convey to one's subordinates and those less experienced the value and sense of achievement of work.

To a manager, training and guiding subordinates is about building tomorrow's organization. To forget this is sunset management.

- It is to 'strengthen today's fighting abilities for tomorrow'
- It is to 'cultivate one's successors'
- It is to 'build the personnel of tomorrow'
- It is to 'work with one's eyes on the next step'

The strength of the organization must be more than the sum of the strengths of each individual. The backbone of management binding and focusing this strength in a single direction is the fruit of having cultivated one's subordinates. There is no leadership without cultivating and binding one's subordinates as the organization for tomorrow.

For managers to achieve the objectives of the team and section they are entrusted with, the effective distribution of the resources of people, things, money, information, knowhow, and time, is work of major importance.

OJT and guidance of subordinates is simply the improvement of human resources day-by-day. Improvement of the most important of the available resources, i.e. the human resource, is not work that can be hastened, or from which immediate results can be expected. On the other hand, it is a core task affecting the very future of the organization, and therefore requires reappraisal of its value.

(2) OJT itself is not the purpose

OJT itself is not an objective. The objective of OJT differs from the point of view of the manager, the person engaged in OJT, the company, and the team.

1. The awareness of problems by the manager must naturally increase the strength of the team members. The power of the team can be increased through efficient integration and use of the total of resources of all members. The maintenance and improvement of such a team depends on the manager and individual team members developing the abilities (knowledge, experience, skills) to fulfill their roles within the division of labor, to improve themselves further, and to develop this as the total of members (i.e. teamwork). The total strength of the team is the source and the pivot of its ability to achieve objectives. The objective of OJT is here for the organization, the system, and the managers.

2. The motivation of personnel receiving OJT is to be recognized as member of the team which naturally entails them adopting the problem awareness of the team, however this does not always match the growth objectives of the individual.

As shown in Fig. 14, adjustment of what the organization should do with what the individual wants to do, and individual growth, cannot be forced on the individual. These matters are not to be forced on the individual, but must be at the will of the individual, and continued voluntarily.

The individual thus comes to understand that that growth is necessary for oneself, or must not forget that it is left to the manager. From the point of view of the organization, 'we want you to do it' does not result in a long-term desire in the individual.

Fig. 14

3. To the company, if the 'mind' of the enterprise and the employment culture 'identity' is acquired, a continuing effect should be expected. In other words, the DNA of the organization is inherited for cultivation of the next generation.

(3) Meaning of 'cultivation' of the next-generation – What, who, is OJT for?

+ The departure point in consideration of OJT – Component elements +

● Component elements

When considering 'cultivation' through work, the component elements are shown in Fig. 15.

For what?	▶	Purpose	What is on-the-job training for? What does it mean, and who is it for?
Who?	▶	Subject	Superiors, one's seniors. While not directly so, cultivation engages the entire workplace.
When, where?	▶	Opportunity	Providing work themes in the process of carrying out the work.
For whom?	▶	Object	Consider new entrants, juniors, successors separately.
What?	▶	Target and details	Acquire the knowledge, skills, and mind to carry out the task.
How?	▶	Method	Through daily work, set individual guidance/new themes and opportunities for tasks.
How far?	▶	Level	Expectation level: What kind of situation? Cultivation level.

Fig. 15

● OJT component elements (purpose, target, method) – OJT itself is not the purpose

Simply considering the component elements of OJT, and drawing up a plan, achieves nothing. It must be considered in terms of the starting point of who OJT is for. The final target is the development of the independence of the person receiving the OJT (see Fig. 16).

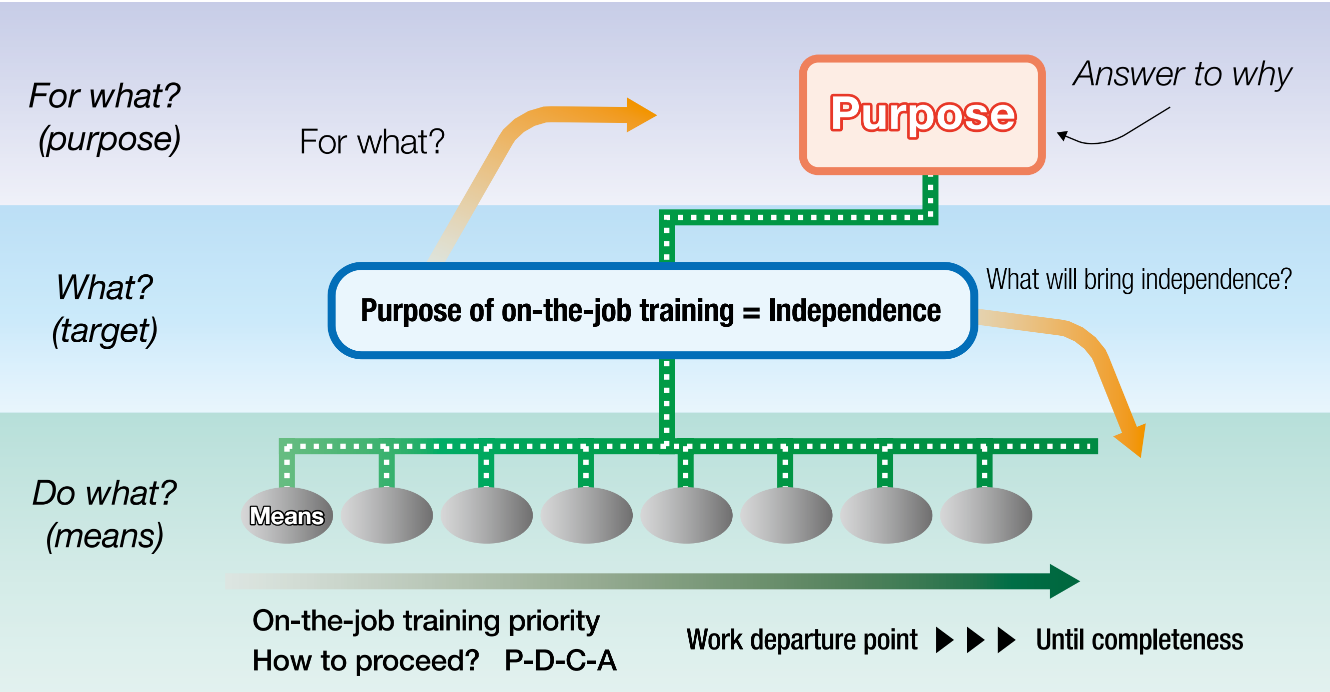


Fig. 16

(4) The meaning of 'cultivation' through work - Raising the strength as a team.

Different meanings for the OJT leader, the OJT partner, the company, the organization, and the team, however the problem awareness of the team leader raises the strength of the whole team.

- The power of the team can be increased through efficient integration and use of the total of resources of all members. The maintenance and improvement of such a team depends on each individual team member developing the abilities (knowledge, experience, skills) to fulfill their roles, to improve themselves further, and to develop this as the total of members (i.e. teamwork). This team (synthesis) strength is the needed source of the strength to achieve targets. The purpose of OJT must be considered in these terms.
- The motivation of personnel receiving OJT is to be recognized as a member of the team which naturally entails them adopting the problem awareness of the team, however this does not always match the growth objectives of the individual.
- To the company, if the 'mind' of the enterprise and the employment culture 'identity' is acquired, a continuing effect should be able to be expected.

(5) Cultivation expectation value (standard) - Cultivating subordinates (juniors)

What is the level of expectation when we consider 'independence ', the target of OJT?

❶ Competent Subordinates at work

We are aiming at 'competent subordinates (juniors) at work'. The word 'competent' implies 'having confidence and perspective to effect changes through one's own efforts'.

This ability and confidence are manifested in a 'sense of capability' and a 'sense of effectiveness'. In responding to a 'sense of capability' and a 'sense of effectiveness', it is essential that the object of these efforts is one's own autonomy (ability to make one's own decisions). In other words, it is possible to see matters in terms of the confidence that 'one should be more effective if one's thoughts are realized'.

❷ Abilities required

In any given situation, abilities are 'competence' in response to understanding of the expected role and its execution, and individual 'abilities' such as the ability to speak English. Irrespective of the subjective 'sense of capability' to be acquired, lacking an understanding of one's situation, and the corresponding competence, will serve only to inhibit other members (membership deficiency).

❸ Awareness of role expectations

In carrying out tasks within the organization, one must be aware of the expected role in carrying out tasks under the prevailing conditions. The importance placed on the competence in carrying out these tasks is the need to have an awareness of what one 'should do'. The sole requirement is to accept subjectively the requirements under the circumstances, and the intentions to achieve the objective, consider how to execute one's own tasks, and to have the required overall competency associated with results as output.

④ 'Sense of effectiveness' and 'sense of capability'

The following processes are considered important in cultivating a 'sense of effectiveness' and a 'sense of capability' (Argyris).

- Determine the target yourself.
- Find out what to do to achieve the target, and take up the challenge.
- Based on what you consider of value, determine yourself what should be done.
- Have a sense that your abilities are insufficient to achieve the task, and the need to extend yourself.
- Have the results achieved acknowledged by persons you take seriously.

(6) Cultivation processes as cooperative work - Effects of self-monitoring of 'cultivation' behavior

OJT must be considered for each thought of both teams, that is, the team that teaches and the other team that is taught; and the following points must be considered for cultivation processes as cooperative work.

① Relationship between teaching and taught, the cultivators and the cultivated

In a wider sense, this raises the level of one's own team strength, while in a narrower sense, 'teaching' and 'cultivating' should be seen as 'taught' and 'cultivated' from one's own position.
In other words, OJT is cooperative work between the teaching and the taught. This is not always in one direction, and even though the OJT leader may unilaterally set the cultivation target, subordinates (juniors) must have self-awareness and independently conceive it.

'How to cultivate' is what the cultivating party's consideration of the team, the organization, the company, and the work is being incorporated into actual work, and alignment in the processes accomplished.
As a result, it becomes processes aligning values and ways of thinking such as 'to the team', 'eventually the state of the organization and achieving work for teamwork', and 'growth of each member'.

② Cooperative work

As shown in Fig. 17, in the OJT process implementing the division of labor (cooperative work) to confirm the purpose of 'cultivation', and clarify the target of 'being cultivated', team targets are shared, and the division of labor implemented: This can be considered as teamwork for mutual understanding of intentions.

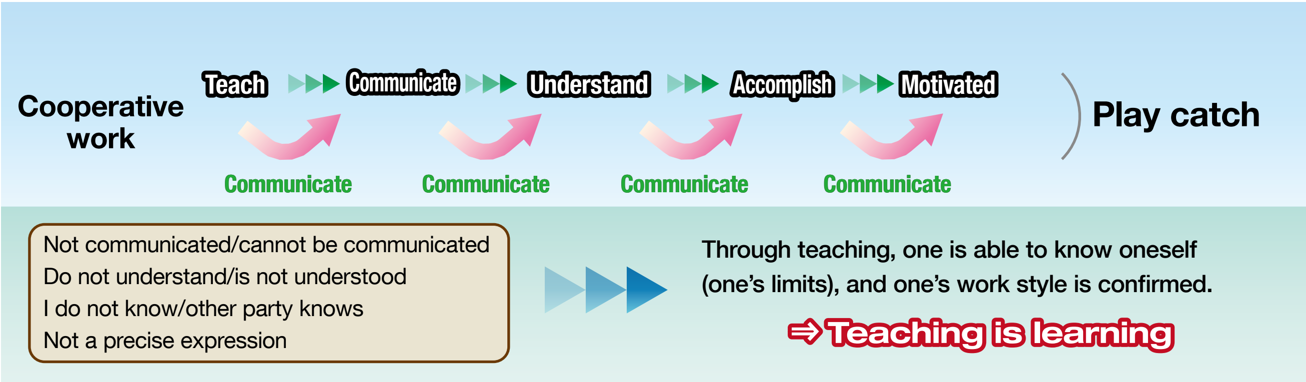


Fig. 17

③ Effects of self-monitoring

'Teaching' is an act of monitoring of one's own view of work and work style.

Effects of 'cultivating' target achievement process – OJT must be considered as tasks.

(7) Effects of 'cultivating' target achievement process

+ Think of OJT as tasks +

Effects of 'cultivating' target achievement process must also be considered.

① Cultivation of subordinates (juniors) = Set as task

For example, think of yourself as one who has been given the task of 'cultivating subordinates (juniors)'.

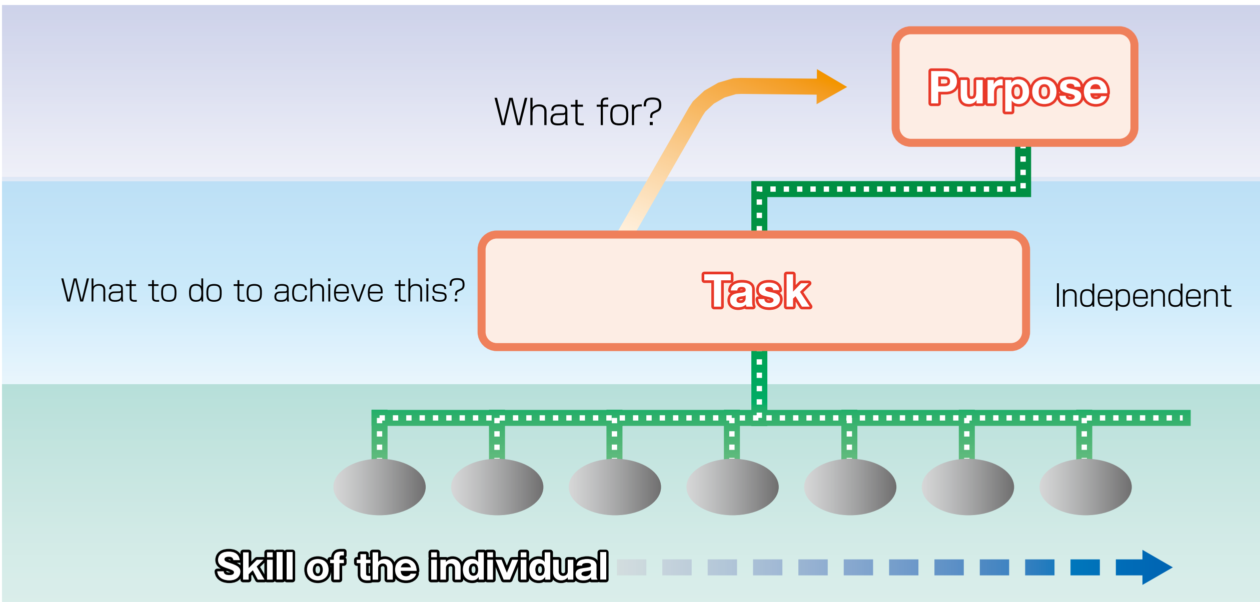


Fig. 18

② Firstly, clarify what must be achieved to clear the task

What can be done? What is the sign? What to do to achieve the task as it becomes an increasingly practical target? - These questions specifies practical methods. In order to clarify this meaning, it is important to determine what is to be communicated and how.

③ This is training for a team leader

What are you aiming at? What do you want to achieve? These must be shared with members in order to ensure that methods for achievement are unified.

④ One is cultivated through achievement of such tasks

What is the task? One is taught through considering what must be done to achieve it, and is cultivated.

⑤ Cultivation of subordinates (juniors) = See it as a project

For example, think it is as a ‘subordinate (junior)’ cultivation project and you are leader of it; so as to share the same target and proceed one by one (see Fig. 19).

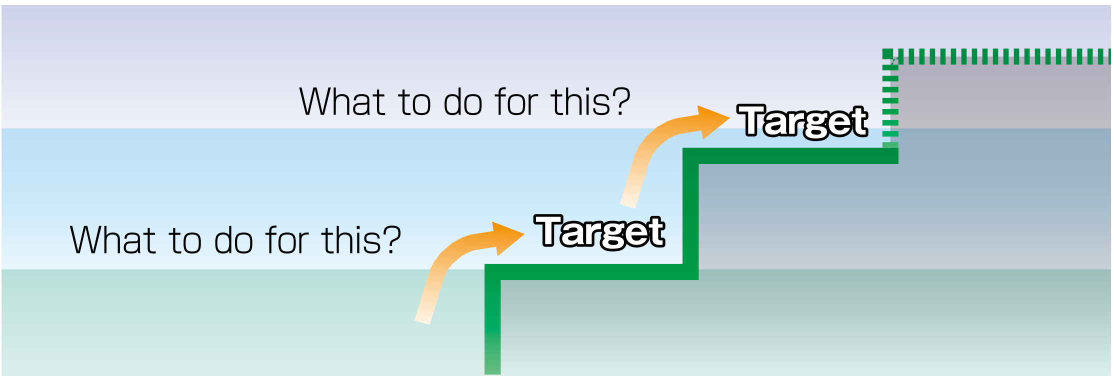


Fig. 19

⑥ The target must be shared by the leader and subordinates (juniors)

This requires targets, meanings, and directions that are worth for sharing. Persuasiveness, self-confidence, and belief (OJT leader’s belief supports the belief of subordinates (juniors)) are also required.

⑦ This is clarification of the ‘control’ in ‘control function’ and ‘maintenance function’ - the two roles of the leader

⑧ In this case, unless the leader ensures that the subordinates understand the abilities required, and their expected roles, they cannot be shared

Once sharing is achieved, and the ring for the first mutual catch game is prepared.

⑨ Team requirements are sharing of targets, division of labor, and communication

Subordinates (juniors) and OJT leaders can be seen as forming a team for the shared task of ‘cultivation’. Subordinates (juniors) must also be considered as important members for achievement of shared targets.

⑩ Subordinates (juniors) cultivation = Plan as an implementation plan

- The OJT process as PDCA -

Planning for achieving the target of cultivation of subordinates (juniors) and the execution flow is shown below in Fig. 20.

This is not simply a project, but daily task management and guidance of subordinates (juniors). PDCA (Plan → Do → Check → Act) is also self-monitoring of work.

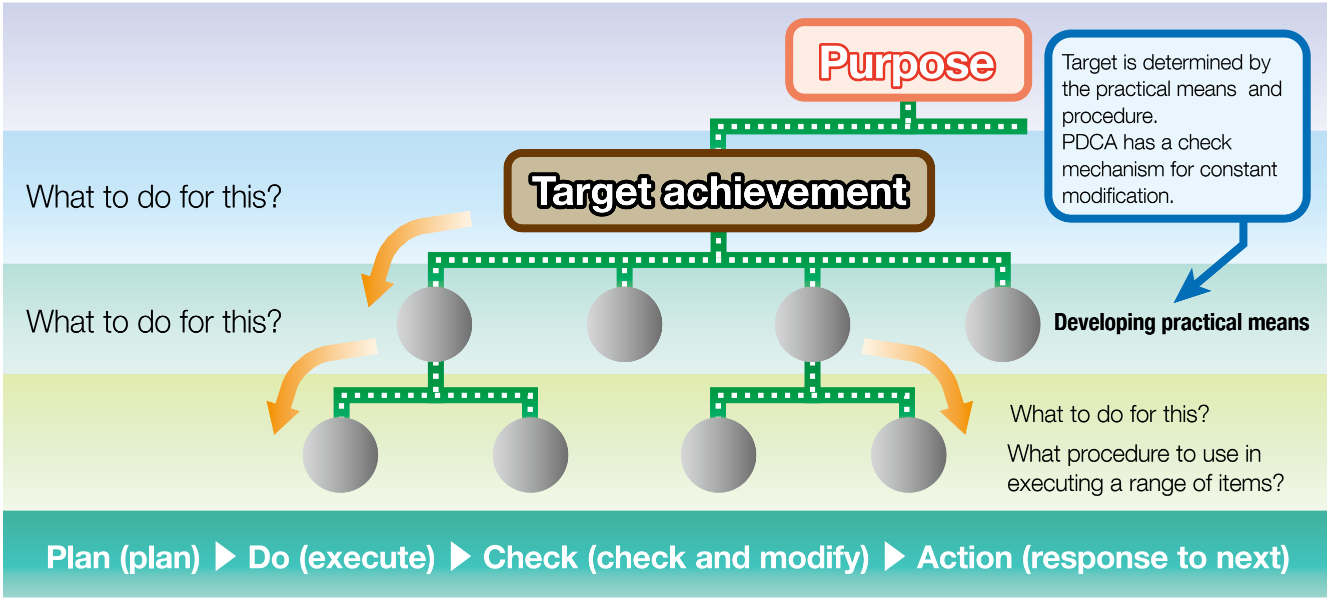


Fig. 20

⑪ Cultivation of subordinates (juniors) = skill

+ Cultivation of subordinates has the following two aspects:

two aspects

- **Leadership and process management skills in order to achieve the target**
- **Business skills for cultivation required in the process of cultivation of subordinates (juniors)**

The former can be seen as team building and accomplishment planning for realizing themes, the latter as communication skills (inter-personal skills).

+ Skills in guidance of subordinates (juniors) can be summarized as follows.

+ Basic guidance skills (guidance of subordinates, cultivation points)

1. Methods of offering praise and caution
2. Methods of practical guidance
3. Methods of cultivating motivation
4. Methods of cultivating role awareness
5. Methods of cultivating target achievement

+ Guidance communication skills

Demanded functions/sympathetic functions/transmitted functions

+ Guidance methods

Individual guidance/situational guidance

* 6-5 Requirements for Leaders

When considering OJT, requirements and points of caution for captains, experienced navigators, chief engineers, experienced engineers, and company 'leaders' are as follows.

1. Remember your days as an inexperienced navigator or engineer.
2. Conduct briefings before entering and leaving port, and passage through narrow channels.
3. Conduct debriefings after entering and leaving port, and passage through narrow channels.
4. Eliminate variation in teaching content between individual instructors to ensure commonality between teaching materials and texts.
5. Understand that OJT is the most effective method of instruction, and ensure that the company prepares teaching materials and texts for trainees and instructors.
6. Ensure that tests and reports are presented to verify degree of achievement.

When the number of coastal vessels and port visits is large and schedules become tight, there may not be sufficient time available to conduct briefings and debriefings before entering and leaving port, and passage through narrow channels.
However, inexperienced navigators and engineers recently boarding the vessel must receive briefings at least once immediately after coming aboard.

With the same content and in the same scenario, variations in the methods of teaching of instructors result in differing interpretations by those receiving instruction. For example, a problem arises if one captain avoids to starboard, and another to port, inexperienced navigators and engineers will always tend to take the easy route.

It is important that the company prepares materials and texts mindful of Safety First and compliance with rules and regulations to ensure common guidance for all.

Appendix (3) 'Navigator Education – Navigation Questions and Answers' provides an example of tests the author has always given young navigators during voyages. When looking at reports and the circumstances of normal independent navigation duties etc., the author was able to understand the technical level of young navigators.

LNG Vessel navigating Bisan-Seto

Chapter 7 Near Miss and Potential Accident Reports

In terms of prevention, near miss and potential accident reports are an effective means of understanding the root causes of accidents before they occur.

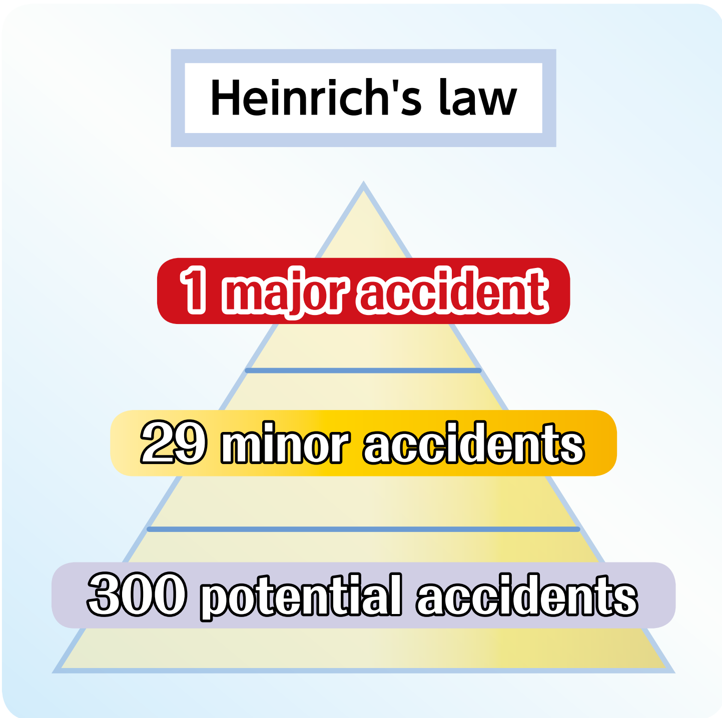
7-1 Near Miss and Potential Accident Reports

Behind one major accident or disaster is said to lie 29 minor accidents or disasters, and a further 300 potential accidents.

In order to prevent a major accident or disaster it is necessary to deal with problems in the potential accident stage at which they can be predicted.

Heinrich's law
Simulation such as risk prediction training, and providing simulated risk experience in training facilities etc. is considered as an effective method of accident prevention.

Summarized as follows.



Important

Disasters are eliminated if accidents are prevented

Elimination of unsafe behavior and unsafe situations eliminates accidents and disasters.

(safety checks and maintenance in the workplace environment, in particular in reference to appropriate employment, training, and monitoring of personnel, and the related responsibility of managers)

* 7-2 Potential Accident Reports in Practice

A large number of companies have introduced the potential accident report system, however the frequent complaint from managers in the shore-based management division is that ‘we can’t get the reports’. The following must be considered in order to use potential accident reports effectively.

1. The basic data for the potential accident report is a report from the site (the vessel and the navigation management division). The report is therefore prepared by personnel on-site, and it is those personnel in which improved awareness is required. The captain and chief engineer, and the company, must take the lead in the awareness program.
It is also important that not only ‘potential accident items’, but also improvement measures etc., are reported.

2. Making a tabulation and analysis of the potential accident report have to be done periodically. The presented potential accident reports must be classified every 3 - 6 months, and the time zones for occurrence and preventative measures to be summarized.

3. If measures to prevent reoccurrence, and improvement measures, are proposed for each report and summarized monthly in table format, they can be used as attachments to the analysis results described above. It is important to use the preliminary figures as feedback for the vessel.

4. It is important that tabulation and analysis results are taken up as topics by the safety conference etc.

The name of the vessel and the name of the person preparing the report must not be disclosed, and care is required to maintain anonymity.

Feedback to the person reporting, and to the vessel in question, must be provided with thanks for the submission of the report, and measures to prevent reoccurrence, and handled confidentially. These measures increase the motivation of the person reporting, and are linked to submission of the next report.
Furthermore, one proposal is to award each person reporting and each site (the vessel and the navigation management division) in accordance with details and number of reports at safety conferences etc.
Conversely, unless these measures are taken, the person reporting is unsure as to how his/her potential accident report has been taken up by the company, and the number of reports will diminish.

In addition to potential accident reports, introduction of an improvement submissions system etc. is linked to raising motivation on-site.

Chapter 8 Conclusion

The author is confident that readers have understood that management with BRM and ERM are effective in achieving safety in operation.

However, in comparison with the difference in technical level between aircraft pilots and co-pilots, that of between captains and navigators, or between chief engineers and engineers, is considerable. The question of how to cultivate inexperienced navigators and engineers to the levels expected of captains and chief engineers is a topic for future discussion.

PCC navigating Seto Inland sea

Furthermore, modern vessels are manned by a combination of different nationalities, and BRM and ERM management must also apply to non-Japanese navigators, engineers, and crews. In other words, BRM and ERM management must also be considered with diversity in characteristics, culture, and customs.

In the case of aircraft, landing and takeoff are associated with the most tension being concentrated into a period of approximately 11 minutes, referred to as the 'critical eleven'. For shipping, coastal voyages and passage through narrow channels, arriving and departing the pier, loading and unloading, various vessel inspections, looking after customers, and repairs, makes for continued tension within the context of the increasingly diverse crews employed. This work may justifiably be termed **critical week (month)**.

Under these conditions, using OJT as the means for education of inexperienced navigators and engineers may place too greater burden on the captain and chief engineer.

In this context, the large number of frameworks in the SMS manual and safety management regulations have led to an increase in the volume of reports and document management work which is, without exaggeration, by a factor of anything from a few to a few tens over the former level. Furthermore, such regulations as ballast water management and the use of low sulfur fuel, and vessel inspections such as PSC, have increased.

Approximately 20 years have passed since introduction of the SMS manual. Almost ten years has passed since introduction of safety management regulations for coastal vessels. These may be essential tools for safe operation, however if the same accident occurs again, and we consider that they have not served to eliminate the accident, it may be time to consider revising SMS and safety management regulations documentation control and preparation of reports and reduce the load on site personnel.

Reference materials

Provided by Maritime Human Resource Institute:

* Engine Room Resource Management
* Above on DVD
  (http://www.maritime-forum.jp/en/index.php)

Japan Captains Association:

* Educational lectures
  No.75 Human Error from the Point of View of Psychology
  No.77 BRM
  No.80 Safety in a Proud Occupation – Why is BRM necessary?
  No.81 Eliminating Accidents Caused by Human Factors
  Skills of Individuals Supporting BRM – Improving the Skills of Inexperienced Navigators (DVD)

Nihon VM Centre : Anzen no Komado
(http://www.maroon.dti.ne.jp/nvmc/komadobkNo.html)

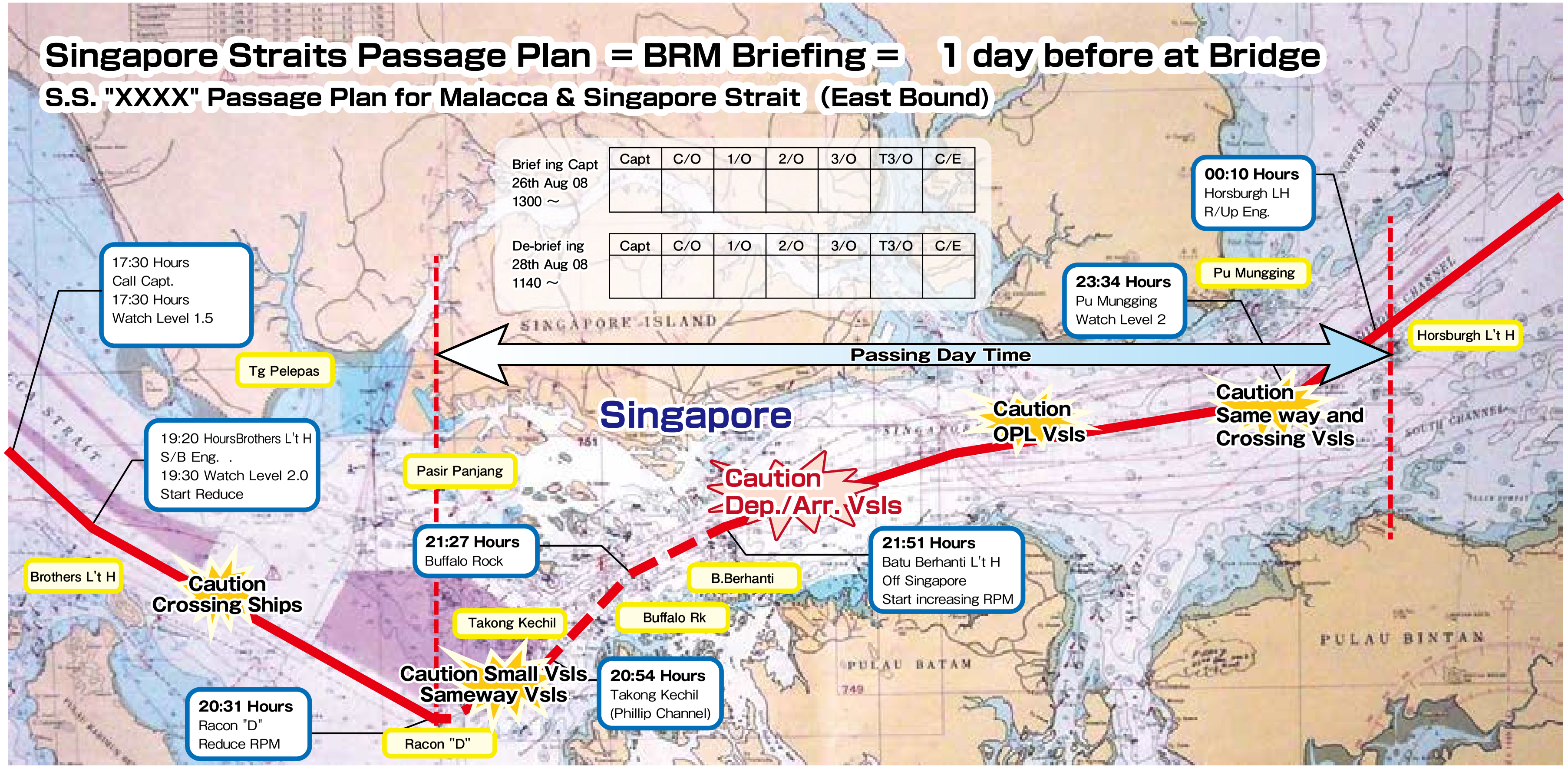
P&P Network: Meaning and Objectives of OJT
(http://www.d1.dion.ne.jp/~ppnet/prod06150.htm)

Seizando Shoten: Bridge Resource Management

Maritime Accident Inquiry Tribunal:
(http://www.mlit.go.jp/jmat/saiketsu/saiketsu_kako/04saiketsu.htm)

Transport Safety Board Report
(http://jtsb.mlit.go.jp/jtsb/ship/)

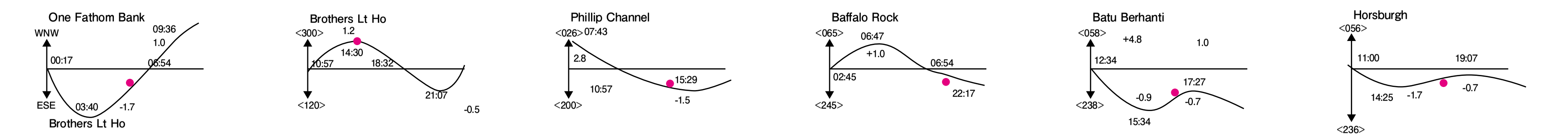
Appendix ① Singapore Straits Passage Plan - BRM Briefing Materials (Sample)



Voy. No. 98 Laden　　dF 10.95　　Sun Rise 0712　age
27th Aug 08　　dA 11.95　　Sun Set 1938
@sp'd 16.5 (72 RPM)　　@sp'd 16.5 (70 RPM)　　@sp'd 12.0 (48 RPM)　　@sp'd 16.5 (72 RPM)　　@sp'd 16.5 72 RPM Plan

Point	① Call Capt.	② Brothers L't H	③ Racon "D"	④ Racon "D"	⑤ Takong Kecil	⑥ Buffalo Rk	⑦ B.Berhanti	⑧ Pu Mungging	⑨ Horsburgh L't H	⑩ Clear Out SPR St
Co./Dist.	<131>30	<121>18.8	<090>0.6	<060>4.6	<040>6.6 <056>	<066>4.9	<066>28.1 <082>	<049>4.9	<049>5	
Time Req.	1:49	1:08	0:03	0:23	0:33	0:24	1:42	0:17	0:18	
ETPass	17:30	19:20	19:30 20:28	20:31	20:54	21:27	21:51	23:34	23:51	0:10
Actual Time										
Eng. Motion		Start Reduce	S/B Eng.	Reduce RPM depend on situation			R/up eng. and Start increasing rpm			
Watch Level	19:05 ～ W/L 1.5		W/L 2.0	W/L 3.0(Tr.3/O, 2/O)			Level-1.5		0050hrs ～ Level - 1	
Remarks	☐ Report to VTIS ☐ Check Navigational equipment ★ Lock Entrance / light up on poopdeck / water injection ★ A.B. Double Watch ★ Call Capt. 30' to TSS Ent.	☐ VTIS Report	☐ VTIS Report Watch leaving/entering vessels for anchorage P.M. 25th Aug ～ AM. 28th Aug 1930 h rs ～ 2300hrs 27th Aug. Depending on Traffic		＊ Check ship's position Caution other vessels ＊ Passing Deep Draft Channel ★ Pirates Counter 1800hrs/26th Aug. - 0700 hrs/27th Aug. Measure Disch. Sea Water.		☐ Passing Singapore Report to ECR, CCR ＊ Watch departing/arriving vessels, check VTis information		☐ VTIS Report Watch same way, crossing vessels and fishing boats.	☐ Steering Single

Tidal Current Information



Master of S.S. XXXX
Capt. Takuzo OKADA

Appendix ②－1　Standing Order and Night Order Log（Sample）

xxth XXXXXX, 20XX

MASTER'S STANDING ORDER

This is master's standing order during the time I command the vessel M.V. "ABC" and I do expect all OOW to maintain safe navigation.

1. Be proud of Your Duty

There are many lives on board M.V. "ABC" and the vessel carries an enormous sum of cargoes from many customers.
Value of cargoes are too high and the influences of damage to cargoes or late arrival of cargoes caused by accident are too much to estimate.
This means you have so much important responsibilities with safe lives and cargoes on board the vessel on behalf of Master during you are on navigational watch and you can be proud of your important duty.

2. Avoid Any Navigational Accident

Study International COLREG well and other rules of navigation and consult SMS Manual and so on continuously to make use of avoiding any navigational accident.

1 When in Ocean, give all other vessels ample room;
   More than 2.0 miles of CPA and 5 miles clearance in front.

2 When in Coastal cruising, give all other vessels ample room;
   At least 1 mile of CPA and 2 miles clearance in front.

3 It is highly recommended to alter her course before the distance between the ship becomes less than 6- 8 miles.

3. Do Call Me at Anytime and Well Ahead of Time

Call me at anytime and well ahead of time when you encounter situations Mentioned below and instructed by SMS Manual or Master's night order.

＊ Visibility less than 3 miles.
＊ Heavy traffic or group of fishing boats.
＊ Ship's position in doubt.
＊ Remarkable change of weather and sea condition.
＊ Difficulties in maneuvering the vessel.

In addition to the above, Call me when you find anything unusual or any sign of Trouble.

4. Pay Keen attention to All Aspects to catch any sign of trouble all the time.

5. Keep a Sharp Lookout All the Time when on Watch.

Keep good, Sharp and Continuous look out using all available means regardless of weather and other situation.
Secure at least one person always who gives exclusive attention to look-out.

6. Read this Master's Standing Order before your duty in every time.

C/Off.　　　2/Off.　　　3/Off.

M/V "ABC"　Capt. Takuzo OKADA

Appendix ②－２　Standing Order and Night Order Log（Sample）

Date： xxth XXXXX, 20XX

From Yokohama　to Singapore

G.Co <220>　　Mg. Co<225>

1. Keep a Sharp Lookout continuously with all available means

2. Give a wide room to all passing vessels and other boats

3. Keep a following CPA and Distance to all passing vessels

CPA	Mor than 2.0 miles
Distance in front	More than 5.0 miles

4. Call me at any time Visibility　less than 3 miles

Observe fishing group in front

Remarkable change of weather and sea condition

5. Do not hesitate;

Use a whistle

Use a Main Engine

Call Captain

6. Follow the Master's Standing Order and SMS manual strictly (Signiture)

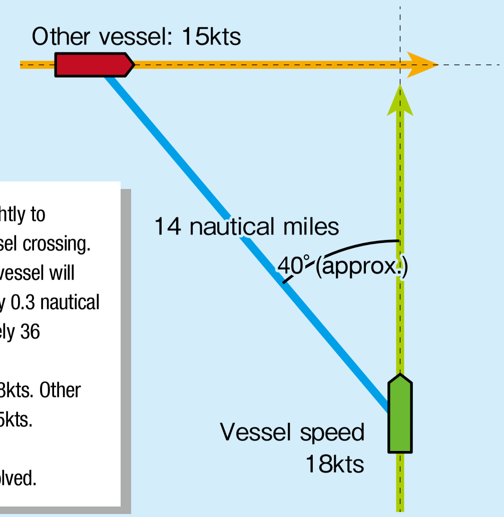
Have a good watch

C/Off	2/Off	3/Off
AB-A	AB-B	AB-C

Master of M/V"ABC" Capt. Takuzo OKADA

Navigation for vessels crossing (test question)

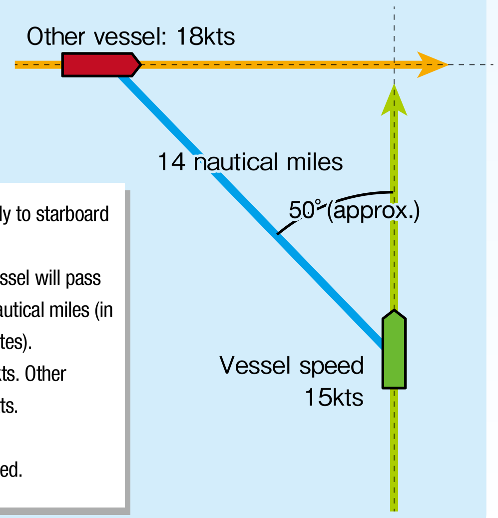
Case 1



Bearing changed slightly to starboard due to vessel crossing.
On this heading, the vessel will pass in approximately 0.3 nautical miles (in approximately 36 minutes).
Vessel travelling at 18kts. Other vessel travelling at 15kts.

No other vessels involved.

Case 2



Bearing changed slightly to starboard due to vessel crossing.
On this heading, the vessel will pass in approximately 0.3 nautical miles (in approximately 36 minutes).
Vessel travelling at 18kts. Other vessel travelling at 15kts.

No other vessels involved.

Actions to be taken by vessel itemized.

Burdened vessel

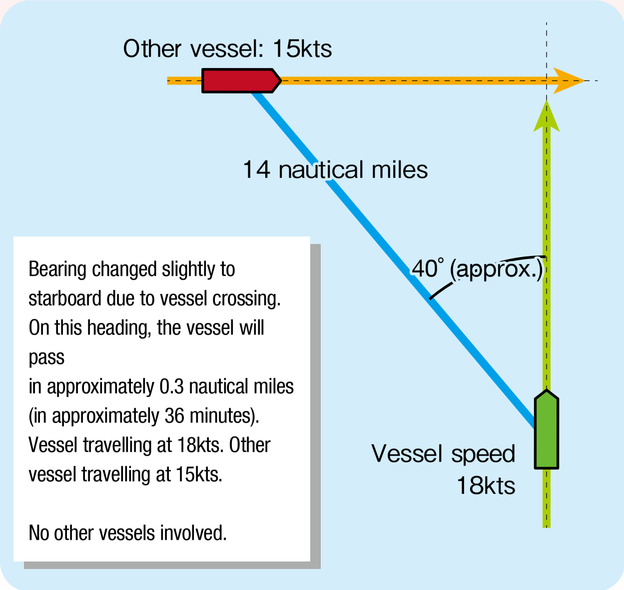
Rule 17 Where one of two vessels is to keep out of the way the other shall keep her course and speed.

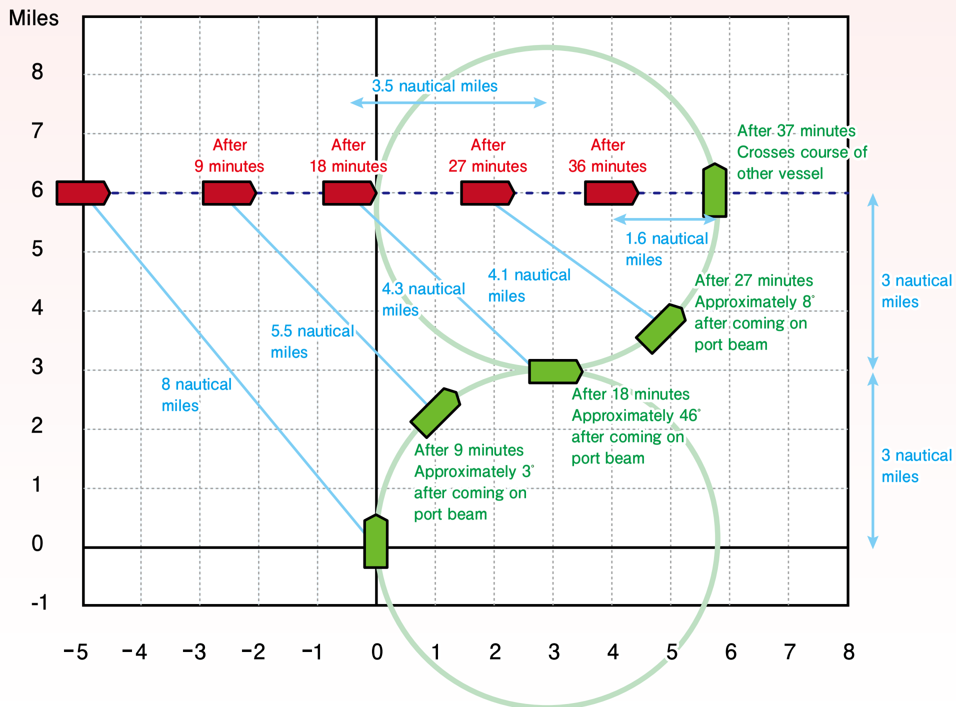
2 The latter vessel may however take action to avoid collision by her manoeuvre alone, as soon as it becomes apparent to her that the vessel required to keep out of the way is not taking appropriate action in compliance with these Rules. In this case, if the requirements of Rule 15.1 apply to these vessels, the burdened vessel shall turn to port unless impossible.

3 When, from any cause, the vessel required to keep her course and speed finds herself so close that collision cannot be avoided by the action of the give-way vessel alone, she shall take such action as will best aid to avoid collision.

Navigation for vessels crossing (answer)

Case 1





Give-way vessel

* When another vessel is crossing safely ahead after turning 90° to starboard, turn to port to cross ahead of the other vessel. Continue with a full turn if anxious.
* The other vessel sometimes turns to starboard to avoid. Use VHF for communication up to 8 nautical miles (approx.), and request passing astern of your vessel.
* When 8 nautical miles (next approach in approximately 20 minutes) is reached, begin turn to port while holding turn rate to approximately 5°/minute to ensure that speed does not drop.
* While watching movement of the other vessel, steer the vessel with the intention of turning until on a parallel course with the other vessel. If the other vessel takes avoiding action, return to the original course while ensuring that it is not ahead of abeam.

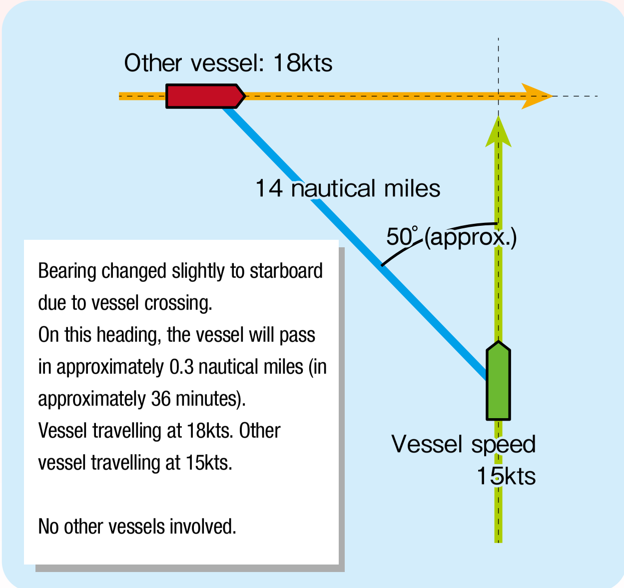
* If the other vessel does not take avoiding action, measure distances ahead and astern, and to port, immediately the parallel course is reached (3.5 nautical miles ahead and astern, 3 nautical miles to port).
* While maintaining a safe distance, return to the original course to cross ahead (cross 1.6 nautical miles ahead of other vessel)　→ within reason.

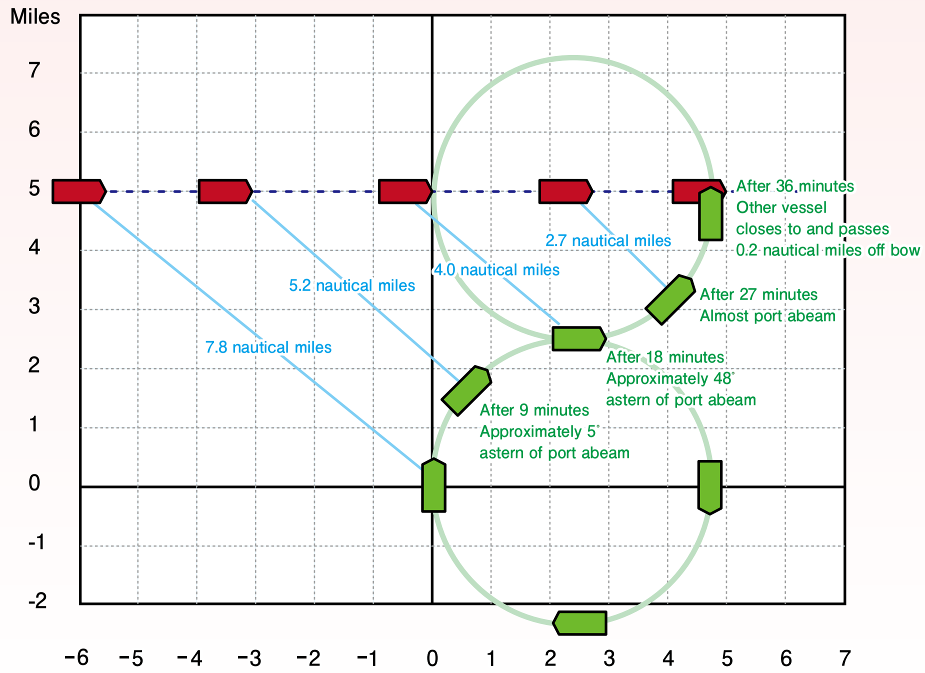
Evaluate whether or not to make the turn at this point. Continue verifying compass direction.

* Steer the vessel while ensuring that the other vessel is not ahead of port abeam.
* 90° turn = 18 minutes (turn rate 5°/minute) = speed 18kts, distance of travel 5.4 nautical miles, turn radius 2.9 nautical miles. Remember these values while on board.

Navigation for vessels crossing (answer)

Case 2





Give-way vessel:

Turning to port to pass astern of the other vessel to port should be done only when intentions have been mutually verified by VHF while at least 10 nautical miles is available.

Crossing ahead of the other vessel is not possible when turning to starboard. Turn provided if the other vessel does not take avoiding action.

Do not begin a turn to port after turning to starboard to a course parallel to the other vessel (a collision course will result if the other vessel turns to starboard).

Repeatedly request via horn, signal lamp, and VHF to encourage avoiding action by the other vessel.

When the speed of the other vessel is greater that your vessel, the first assumption should be that turning to starboard and passing ahead is not possible.

Since the other vessel sometimes turns to starboard suddenly, do not turn to port.

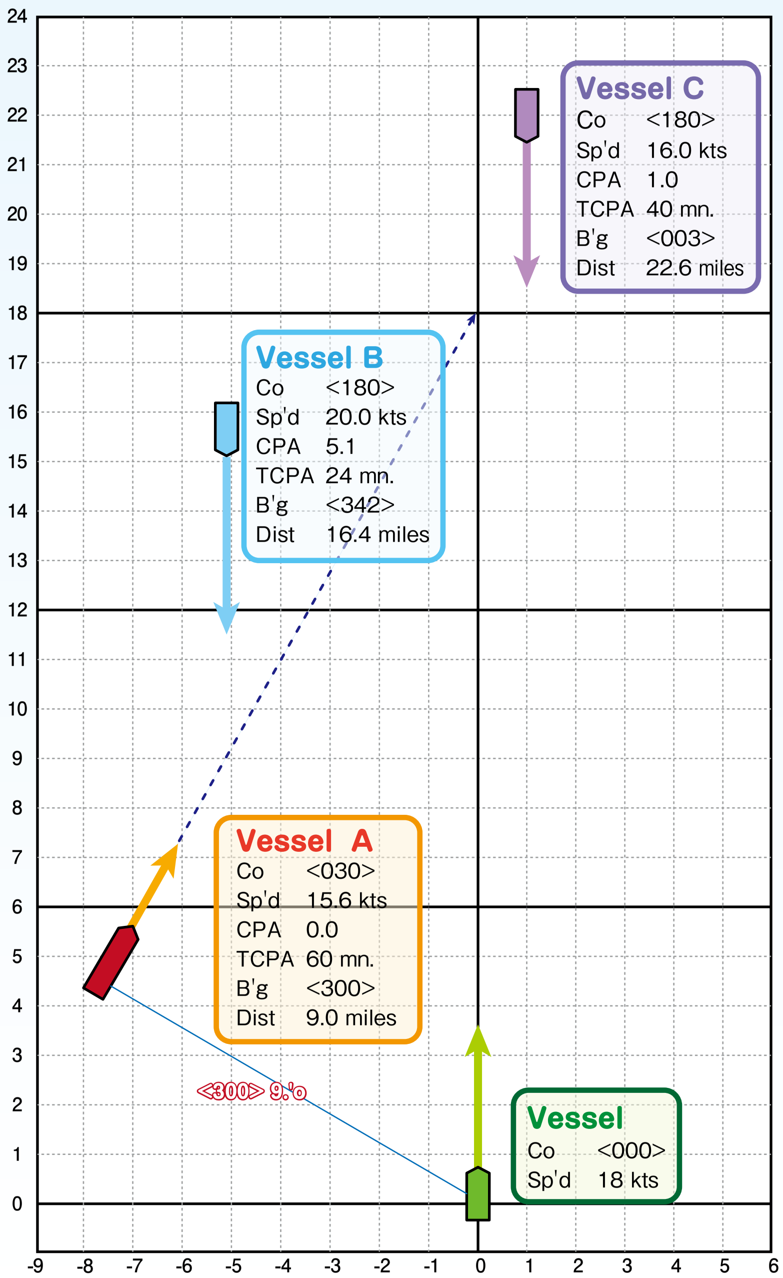
Vessel avoidance (question)

Information as shown in drawing at left obtained with ARPA.
Other vessels **A** and **C** evaluated as problematic.
(captain' s standing orders instructed as CPA 1.5 nautical miles or more)

This relationship with other vessels occurs comparatively frequently in the approaches to Osaka Bay, approaches to Tokyo Bay, approaches to Ise Bay, and the Malacca Straits.
Often in Watch Level 1 sea areas.

Question

What navigation measures are applicable to the vessel?
To the other vessel?
What action should the vessel take?



Vessel avoidance (answer)

Answer

Navigation measures of vessel crossing course of Vessel A. Vessel is burdened vessel.
After 20 minutes, while turning to starboard, other vessel is requested to turn behind vessel.
Although wish to turn to port as passing vessel, do not turn to port without communication on VHF etc. to determine mutual intentions.

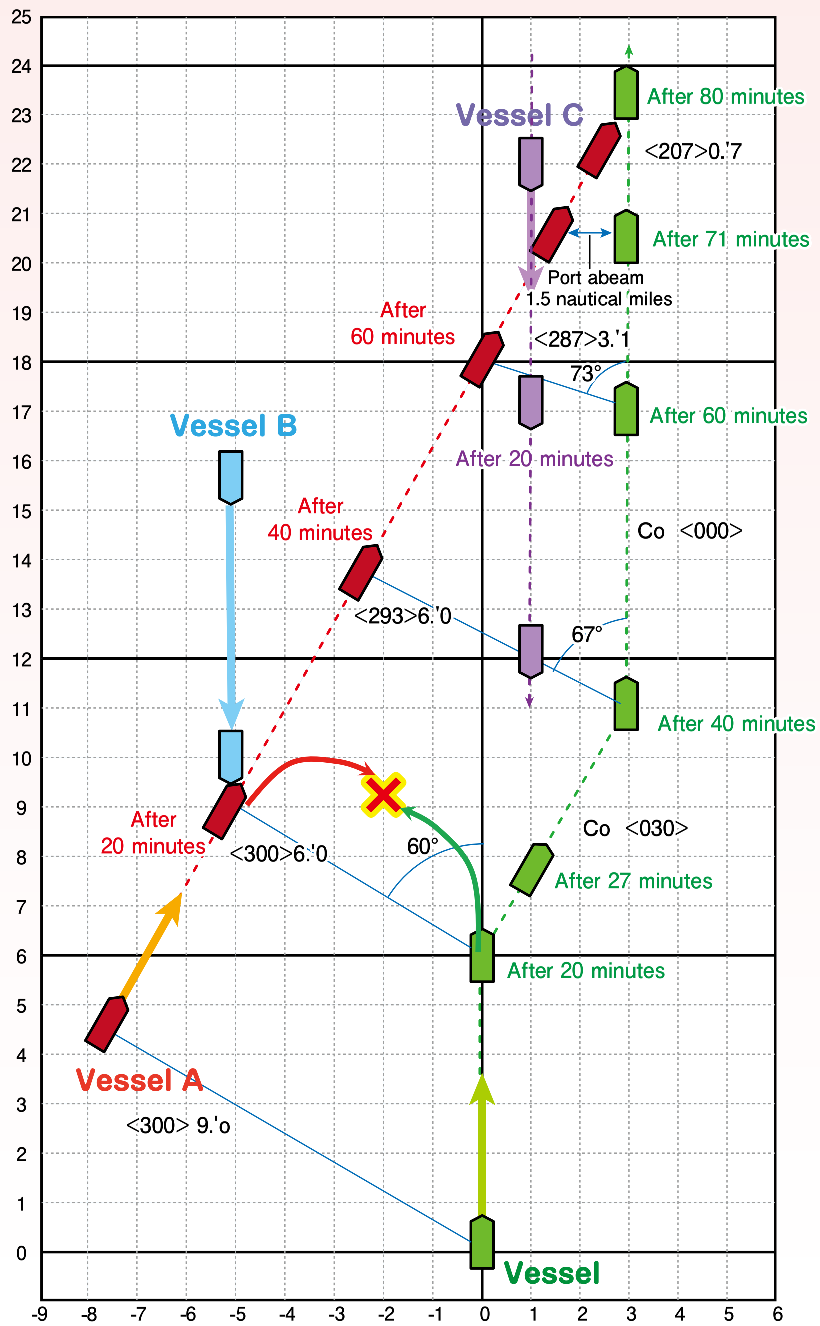
As shown on the left, the vessel is on a parallel course to the other vessel when Vessel A is at a distance of 6 nautical miles.
When approximately 1 nautical mile further ahead, it returns to its original course, and while monitoring the change in direction, crosses ahead of the other vessel.
Even after the vessel travels 3 nautical miles to starboard, the other vessel is eventually seen at 1.5 nautical miles on the port beam after 71 minutes.
The vessel then crosses the course of the other vessel 0.7 nautical miles ahead of it.
The other vessel is still too close at this distance, and the situation is therefore checked after 60 minutes,
and if necessary, another turn to starboard initiated, and the CPA must be expanded (CPA set as 1 nautical mile or more).

Contact Vessel A and Vessel B on VHF to mutually determine intentions before turning to port to go behind Vessel A.

Vessel C crosses ahead, and passes port-to-port. When commencing a starboard turn after 20 minutes,
the distance to Vessel C is still 11 nautical miles. The course of Vessel C is therefore crossed after 27 minutes.

On the other hand, Vessel A is required to maintain position relative to Vessel B.
Since Vessel B is travelling at 20kts,
it may be advisable to delay a starboard turn to cross ahead of Vessel B.

When a number of vessels are passing, predict the relative positions after 30 minutes, 60 minutes, and 90 minutes,
and prepare a plan to determine which side each vessel will pass on.

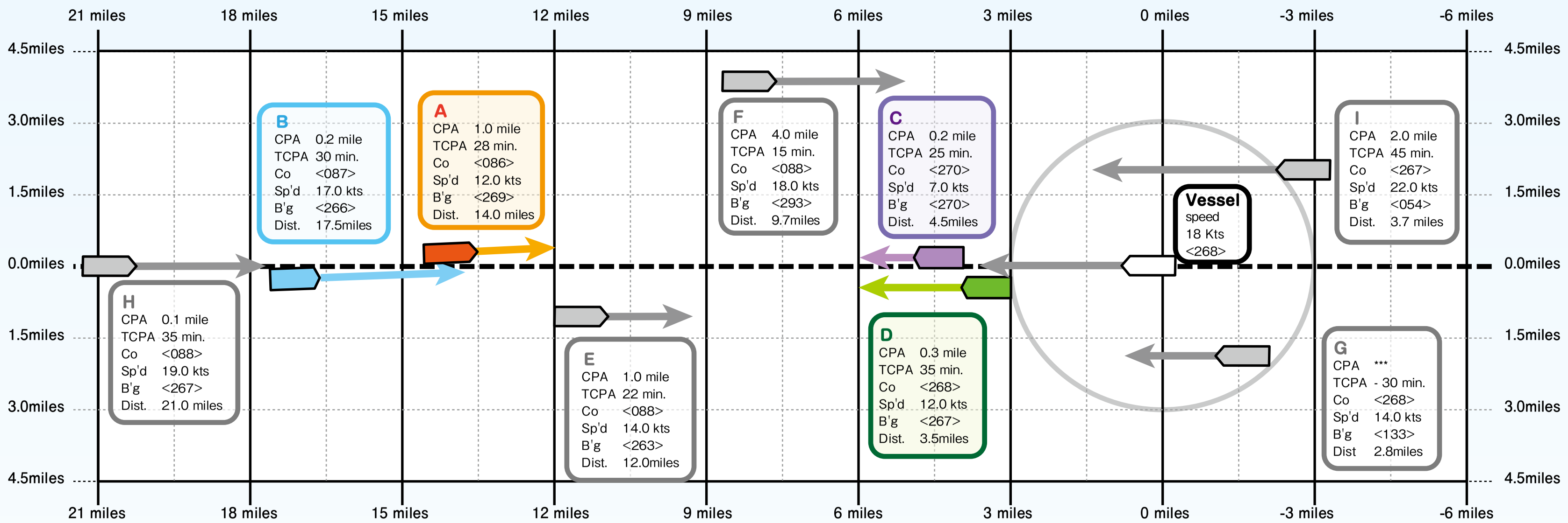


Radar and ARPA Information (Question)

Vessels on opposing and same courses may approach each other in 25 - 30 minutes at a distance of 1 nautical mile under these conditions. Avoiding action is therefore necessary. What avoiding action should be taken?

Order of priority, and reasons, for paying attention to other vessels when taking avoiding action.

Vector : 12 min.



Underway at night in Bay of Bengal, Indian Ocean (between Pu RONDO and Dondra Head) Co<268> Speed 18kts

TCPA for other vessels noted is less than 25 – 30 minutes, with CPA a maximum of 1 nautical mile (vessels noted above by colors).

Vessel A Almost dead ahead (slightly to starboard). CPA at 14.0 nautical miles is 1.0 nautical miles. TCPA in 28 minutes. Displaying green navigation light.

Vessel B Port 2°, CPA at 17.5 nautical miles is 0.2 nautical miles. If following ARPA information, pass on port side in 0.2 nautical miles after 30 minutes. Port and starboard navigation lights can be distinguished, however the red light appears slightly stronger.

Vessel C Vessel on same course. Speed 7kts. Gradually opening to starboard. Distance 4.5 nautical miles.

Vessel D Vessel on same course. 1 – 2° to port, 12kts. Course parallel to your vessel.

Other vessels involved shown in black.

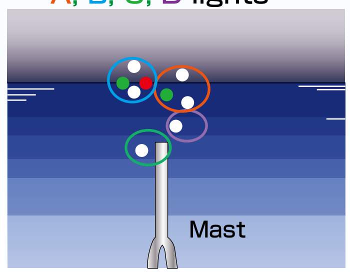
Vessel E Vessel on opposing course. Parallel at 5° to port. CPA 1.0 nautical mile. TCPA 22 minutes. Co<088> Speed 14kts.

Vessel G Vessel on opposing course. Parallel at 25° to starboard. CPA 4.0 nautical miles. TCPA 15 minutes. Co<088> Speed 18kts.

Vessel F Vessel on same course. 2.8 nautical miles astern. Passed to port 30 minutes ago at 1.7 nautical miles.

Vessel H Vessel on same course. Starboard astern <054> Distance 4.0 nautical miles. Passing at Co <267> Speed 22kts. CPA 2.0 nautical miles, TCPA 50minutes.

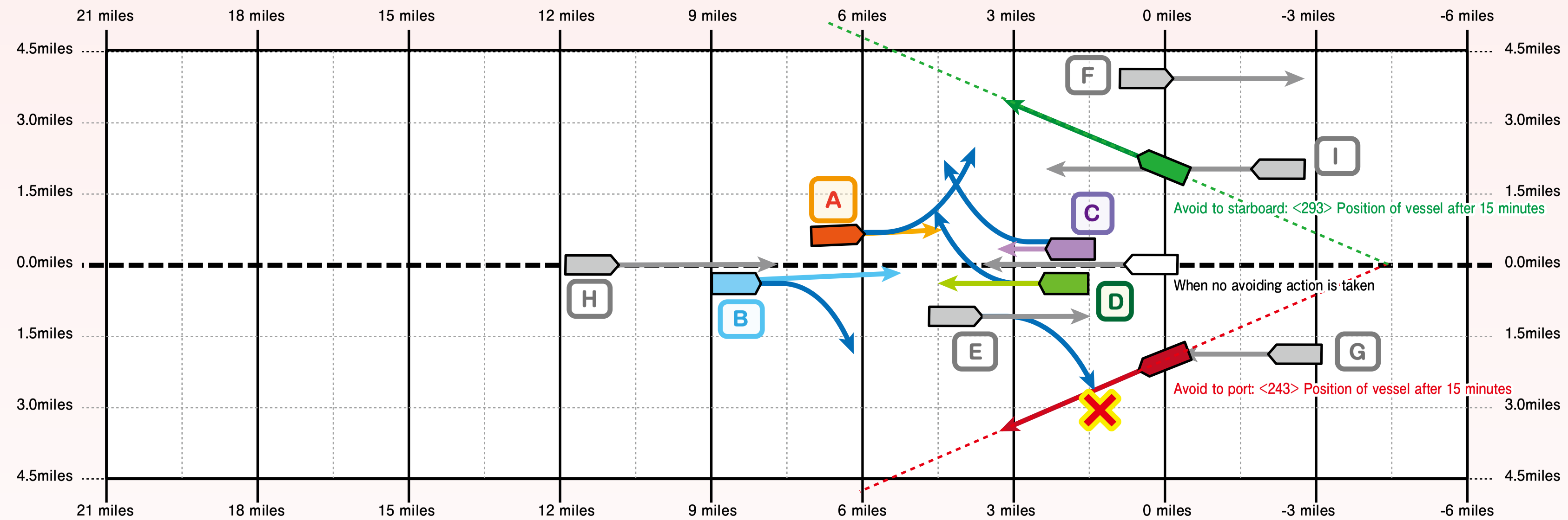
A, B, C, D lights



Radar and ARPA Information (answer)

After 15 minutes

Vector : 12 min.



Underway in Bay of Bengal, Indian Ocean (between Pu RONDO and Dondra Head)

Answer

Turn to starboard towards Vessel F. Ensure that course is not ahead of Vessel F. Always ensure that heading does not cross stern of Vessel F.
Diagram above shows relative positions of the vessels after 15 minutes. Changed from original course of <268> to <293>.
4.5 nautical miles travelled in 15 minutes. Vessel is therefore 1.9 nautical miles to starboard from original course, and all vessels except Vessel F are visible to port.
Sin 24° x 4.5 nautical miles = 1.90 nautical miles
Commencing avoiding action after 15 minutes is too late (cannot pass Vessels I and A) => Only solution is to turn hard to starboard.
A 25° turn to port moves vessel 1.90 nautical miles from original course, permitting crossing 4.5 nautical miles ahead of **Vessel E**, however Vessels E and **D** are in opposing directions,
and if an attempt is made to pass Vessel G following astern port-to-port there is a considerable possibility of a turn to starboard.
In this case, unless there is a further turn to port to approximately <190>, **Vessel E** may not be able to pass safely.
This will also result in dangerous positioning of the two vessels. It is also possible to avoid vessels **B** and **D** by turning to starboard.

Other vessels to be aware of.

1	Vessel I	After crossing at a point 2 nautical miles ahead.
2	Vessel A	Possibility of turn to port to avoid Vessel C.
3	Vessel C	Possibility of turn to starboard to avoid Vessel A.
4	Vessel D	Possibility of turn to starboard to avoid Vessel B.

An example of taking cautios avoiding action in advance

Points

Predict the relative to positions of the vessels after 15 minutes (use the ARPA simulation function if available).
In this case, Vessels A and C follow the rules for vessels in opposing directions, and Vessel C will therefore possibly turn to starboard. Because of its position relative to Vessels D and B it is apparent that there is a possibly of turning to starboard.
In this case, one possibility is to follow up on Vessel F, and turn further to starboard.
Crossing will occur 2 nautical miles ahead of Vessel I. Communicate by VHF beforehand the intended avoiding action (turn to starboard), and the intention to cross 2 nautical miles ahead of Vessel I.
Avoid causing any unease on the part of Vessel F. The best option is to cross the course of Vessel I if possible and return to the original course after Vessel I passes on your port side.
Without Vessel E present, an early turn to port is possible, however since Vessel G is crossed in all aspects, a wide turn to port while maintaining a safe distance is desirable (to avoid the possibility of collision even in the case of the next vessel in the opposing direction).

JAPAN P&I CLUB

P&I Loss Prevention Bulletin

The author

Capt. Takuzo Okada
Master Mariner
General Manager
Loss Prevention and Ship Inspection Dept.
The Japan Ship Owners' Mutual Protection & Indemnity Association

JAPAN P&I CLUB
日本船主責任相互保険組合

Website http://www.piclub.or.jp

●東京本部 〒103-0013 東京都中央区日本橋人形町2丁目15番14号 ………… Tel：03-3662-7229 Fax：03-3662-7107
Principal Office（Tokyo） 2-15-14, Nihonbashi-Ningyocho Chuoh-ku, Tokyo 103-0013, Japan

●神戸支部 〒650-0024 兵庫県神戸市中央区海岸通5番地 商船三井ビル6階…… Tel：078-321-6886 Fax：078-332-6519
Kobe Branch 6th Floor Shosen-Mitsui Bldg. 5, Kaigandori Chuoh-ku, Kobe, Hyogo 650-0024, Japan

●福岡支部 〒812-0027 福岡県福岡市博多区下川端町1番1号 明治通りビジネスセンター6階 … Tel：092-272-1215 Fax：092-281-3317
Fukuoka Branch 6th Floor Meiji-Dori Business Center 1-1, Shimokawabata-machi, Hakata-ku, Fukuoka 812-0027, Japan

●今治支部 〒794-0028 愛媛県今治市北宝来町2丁目2番地1 …………………… Tel：0898-33-1117 Fax：0898-33-1251
Imabari Branch 2-2-1, Kitahorai-cho, Imabari, Ehime 794-0028, Japan

●シンガポール支部 80 Robinson Road #14-01B SINGAPORE 068898…… Tel：65-6224-6451 Fax：65-6224-1476
Singapore Branch

● JPI英国サービス株式会社 38 Lombard Street, London EC3V 9BS U.K. ……… Tel：44-20-7929-3633 Fax：44-20-7929-7557
Japan P&I Club (UK) Services Ltd