Chapter 3 Trouble Related to Bunker Oil

In this chapter, we will introduce the cases related bunker oil, handled by our Club.

Firstly, we will confirm the situation of the case that oil spill to the ocean due to causes other than collision or stranding. Secondly, we will analyse the case of oil pollution accident, and finally we will explain about the special short bunker (cappuccino bunker).

3.1 Oil Pollution Accidents Trend

About the oil pollution cases caused by the other than collision or grounding, we made the graph for ocean-going vessels and one for coastal vessels, which show the number of accidents that, has happened in the past 7 years.

(1) Trend of Ocean-Going Vessels

Firstly, about ocean-going vessels, from Figure 66, the bar graph shows the change of the number of accident and insurance money by year with vertical axis. The number of accidents is around 40 in a year (281 in total over 7 years), and the annual average of the insurance money is approx. US$1.7 million (approx. US$11,833 million in total for 7 years).

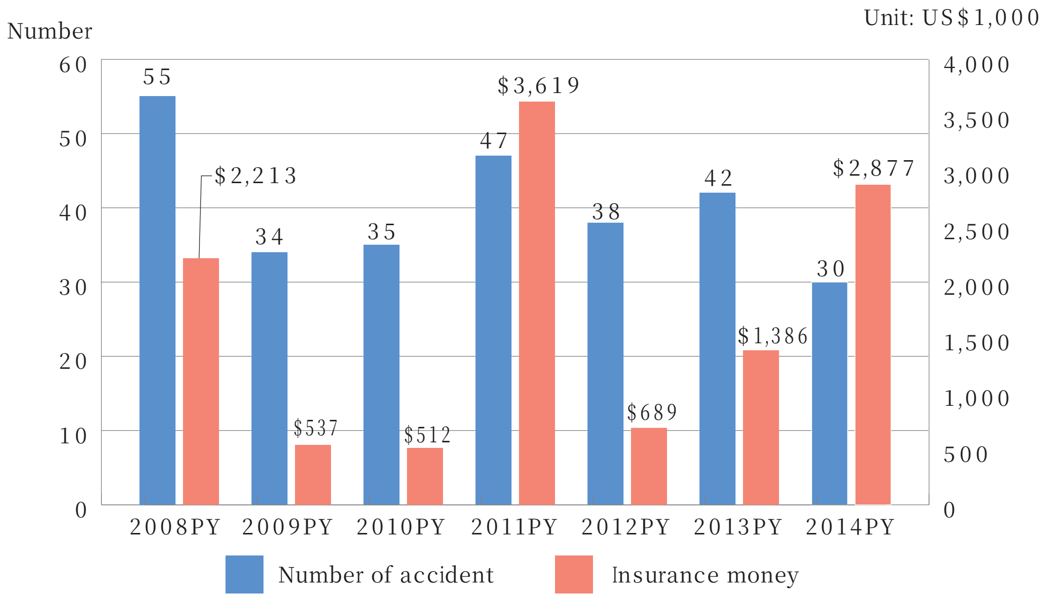

Figure 66 Trend of Oil Pollution Claims by Ocean-going vessels (2008-2014PY)

(2) Trend of Coastal Vessels

Next is about coastal vessels. From Figure 67, the bar graph shows the change of the number of accident and insurance money by year with vertical axis., The annual average of number of accidents is about 13 in a year (90 in total for 7 years), and the annual average of the insurance money is approx. JPY 68.793 million (approx. JPY 481,550 million in total for 7 years).

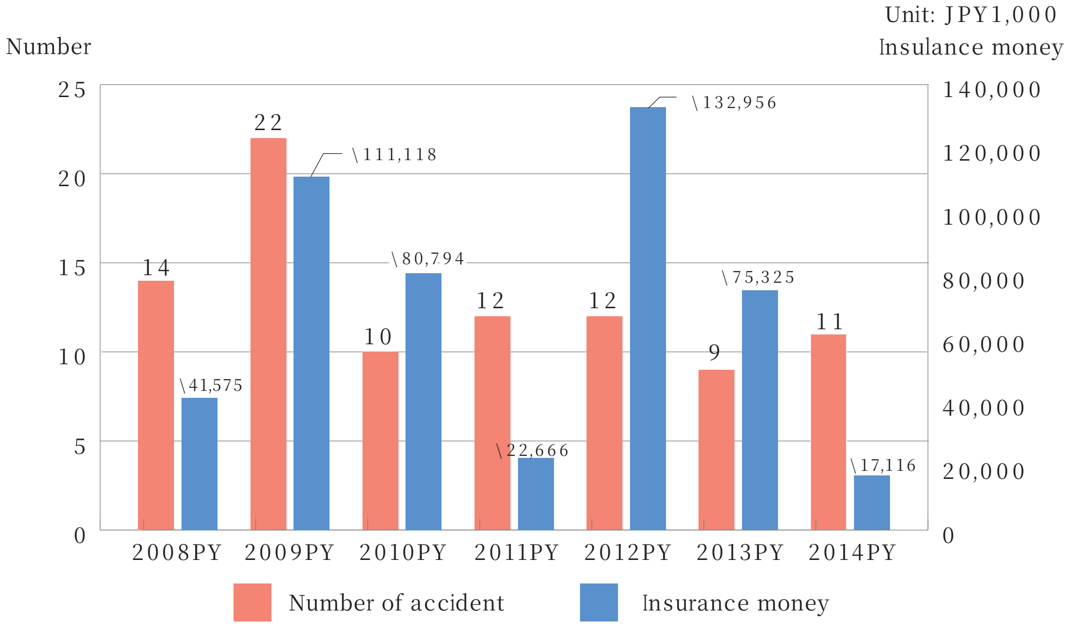

Figure 67　Trend of Oil Pollution Claims by Coastal vessels (2008-2014PY)

(3) The Summary of Oil Pollution Accident's Trend

For 7 years, from 2008PY to 2014PY, the number of oil pollution accidents is as follows; ocean-going vessels had about 40 accidents average in a year, and coastal vessels had about 13 accidents average in a year. In terms of environmental pollution, it is hard to say that both coastal and ocean-going vessel have low level, about the number of accidents. In addition, the common thing about these accidents is the fact that these accidents are not the leakage of cargo oil but the accidents that occur when bunkering.

3.2　Case Study : Oil Pollution at Bunkering

We will analyse the oil pollution claims when bunkering.

(1)　Outline

From Figure 68, it is shown that HFO was overflowed from the air vent pipe of the vessel's starboard fuel tank to the deck, and some of HFO (approx. 0.6 KL) was spilled to the sea. From Figure 69, it is shown that some of the spilled oil was getting over the oil fence extended around the vessel and diffused. Moreover, the sticky spilled oil spread both to harbour facilities and to the pleasure craft moored in the port. As a result, it took about one month to complete the cleaning work for the spilled oil.

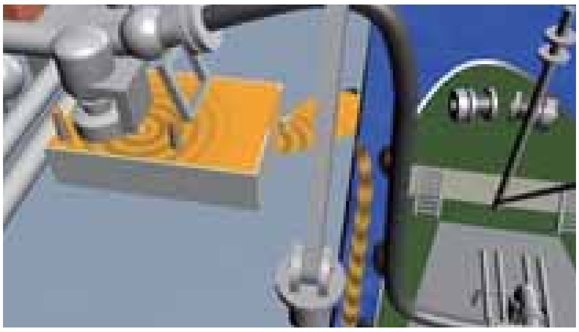

Figure 68　Leakage Image from air vent pipe / reference*17

Figure 69　Vessel surround

(2) Insurance Money

Cleaning Expense of Clean-up work for Spilled Oil	: US$ 818,000
Damage to Harbour Facilities, Pleasure Craft, and etc.	: US$ 91,000
Fine	: US$ 4,500
Lawyers fees/Surveyors fees	: US$ 182,000
The Total Amount	**: approx. US$ 1,095,500**

(3) What Happened in the Engine Room ?

(3)-1 [Bunkering Plan]

According to the bunkering plan, each 50 kl (kilo litre(s)) of HFO was planned to load into the starboard fuel tank and port fuel tank.

(3)-2 [The Accident Situation]

Accident situations are as follows.

1	Bunkering started after fully opened the filling valve of the starboard HFO tank, Oiler A who was assigned by the bunkering plan, based on C/E's instruction, was engaged in the bunkering works.
2	According to the bunkering plan, when 50 kl of the filling oil was reached in the starboard HFO tank, the filling valve of the port HFO tank, as shown in Figure 70, needed to be opened and the filling valve of the starboard HFO tank needed to be closed.
3	However, oiler A wrongly closed the valve of the port HFO tank, and at the same time, he kept the filling valve of the starboard HFO tank fully opened.
4	As a result, HFO was overflowed from air vent pipe to deck, and was spilled to the sea due to exceeding the capacity of the starboard tank.

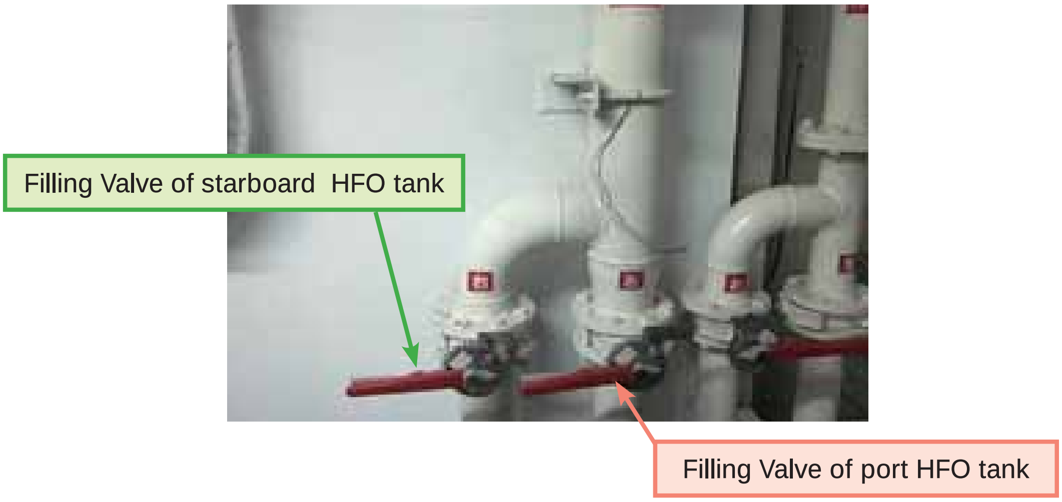

Figure 70 Arrangement of filling valve of HFO tanks for Bunkering
(Attention, Filling valve of starboard tank is located on the left side!)

(4) Cause Analysis - - - Check Point

As the accident was caused by incorrect valve operation, the following are the important points to be checked from the view of Hardware operation and safety.

Plan (Plan)

(4)-1 [Bunkering Plan]

1. Did the senior engineers such as C/E or 1/E have the enough awareness of both safety and environment?
2. Did the senior engineers such as C/E or 1/E consider the bunkering plan and bunkering instructions carefully and appropriately beforehand? (e.g., "bunker line", "personnel allocation", "no tank is filled to more than 90% of tank capacity", etc.)
3. Did 1/E prepare and summarize the important information beforehand? Its purpose is that crew could easily understand bunkering plan at meeting?
4. Why did they start bunkering with only one side valve open even if the tank was to receive from both sides? Did they not find any factors causing mistakes for " open and close" procedures of the valves?

【Caution】

When starting the bunkering operation, the procedure with multiple tanks in an "open" state is safe. It includes the meaning of confirming the valves status (position). The fundamentals and of switching valves are as follows.

1) Firstly, to confirm that all valves of the bunker line are closed.
2) Afterwards, to open valves on both on the pipe lines and filling valves of the receiving tanks.
3) After you start bunkering, during watching the increasing each tank level, to adjust and throttling the valve opening degree and oil supplied flow rate from the bunker barge,
4) Finally, to close filling valves on the tank sequentially depending on the reaching tank target level (liquid level). To complete bunkering at the end. However, the arrangement of valves and pipeline affect valve operations seriously. So, it is important to establish the valve operation procedure where are suitable for each ship design with the safety firs policy.

Meeting (Do)

(4)-2 [Pre- meeting (Tool Box Meeting)]

Did all crew that were part of the operations understand the instructions of bunkering and situation of the bunker line?

1. Did all engine crew related to bunkering work understand which valve they should close when volume in the starboard HFO tank reached 50 kl?
2. Were the following things considered, planned, and decided carefully by the senior engineers and specifically confirmed by engine crew beforehand?
   1) Who should switch valve?
   2) When should they switch valve?
   3) Which valve should be switched?
3. Did the oiler A, who was assigned, get the explanation about the bunkering plan & procedure and understand it well beforehand?
4. Was personnel allocation for bunkering appropriate? Because even if the engine department has bunker work, it is important to for C/E and 1/E coordinate and control the other works such as loading ship stores and attending ship visitors during berthing in port

Switching operation (Do & Check)

(4)-3 [Switching Operation]

1 Did the other crew carry out double-check during oiler A ' s valve switching operation?

We have never doubt fault by one crew. The other crew / senior engineers, as third person, should carefully confirm, check, and support, with the cooperation as a team, whether he surely completed his assignment after his work done report.

2 Did they indicate a nameplate on the each valve?

About valve operation to be carefully handled, we suggest to arrange the visualisation of valve open or close for current and next stage by a name plate, so that the other crew, who did not operate, are able to also compare, evaluate, and confirm whether the current situation is in normal or not.
If there are differences between the situation shown by nameplate and the valve's actual situation, we must doubt that the valves are not operated as planned or in a wrong state.

3 Did they check which filling valve is located on left and right beforehand?

It also applies to this case, as location (left & right) of the filling valve of HFO tank's valve often become opposite from the one towards us. We recommend you to take actions such as pointing and calling in order to avoid any misunderstandings.In that case, as mentioned before, it is more important for third person to reconfirm Others' Valve operation.

Condition monitoring (Do & Check)

(4)-4 [Condition Monitoring]

1 Did the crew continue to check the level (liquid level) in the starboard HFO tank after he should have switched its filling valves and to monitor its level changes?

If they had continued to check , watch, and monitor the tank level (liquid level),

1) they could have found the incorrect valve operation by the rising of the starboard HFO tank.
2) Off course they may also have been able to stop the oil overflow and to abate the amount of oil spill to the sea, by conducting emergency response such as rectifying of incorrect operation of valve or pump emergency stop operation on bunker barge.

2 Did they check the tank level (liquid level) regularly by the sounding tape in addition to the remote level gauge?

There are several ways to check the liquid level in the HFO tank. It is simply check with the remote level gauge. However, in order to check the situation precisely, the measurement by the sounding tape is the best way to do so. Therefore, you should check, monitor, and grasp the measurement discrepancy between by the sounding tape and by the remote level gauge.
For your reference, from Figure 71, it is shown that you can efficiently measure and confirm the liquid level rise by checking ullage, which is the distance from the top of the sounding pipe to the liquid surface.

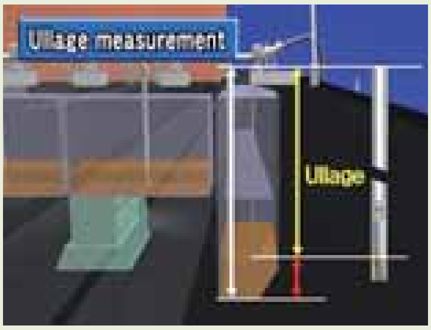

Figure 71 Measuring real tank level by Tape Sounding / reference*17

3 Was the bunkering flow rate (m^3/h) appropriate?

During the valve switching operation, the pressure inside of the pipeline temporarily becomes unstable.
Therefore, in order to focus on the safety in the most priority, you should also request the barge to reduce the bunkering flow rate temporarily, or to suspend pumping if a majority of the crew are inexperienced.
When the open & close operation of the valve during bunkering, as there are some risks inside of the pipeline, you should give your full attention to ensure safety.
For example, you would carefully check the pressure changes in the pipeline with the manifold pressure gauge or by watching the shaking of the bunker hose, which will help you to ensure safety.

This accident is also the case that it was not a single cause that brought about the accident, but the error chain coming from several causes.

Negative chain

(5) Preventive Measures

Supposing that there is some risks in these check points, you should prepare for bunkering so that you can avoid the risks.
In this case, **the most important thing is to eradicate the mistakes of valve operation**. About this, we have also found measures for operations and for safety from the above mentioned check points. Therefore, again, we would like to suggest the following as preventive measures.

(5)-1 Motivation at normal time **(awareness for environmental protection)**

1 At the daily study sessions, the engine department crew must be educated with the working instructions thoroughly.

2 Therefore, they should realise that even if they make any tiny mistakes during bunkering, and if it may occur oil spill, then it will have a significant negative impact on the ocean environment.
They also should have the essential awareness that they should carefully follow each procedure in accordance with the working instructions and play each crew's role based on a great deal of caution.

The most important:

Eradicate valve operation mistakes!

(5)-2 Establish Appropriate Bunkering Plan

These points are the same as mentioned before.

1 To secure enough extra space for the receiving tank plan and to secure an appropriate flow rate (m^3/h)

2 To clarify the work assignments ("line switching", "working description", "allocation" and etc.)

(5)-3 Pre-meeting

Pre-meeting (Figure 72) is also the same as the above-mentioned check points.

1. To confirm target liquid level of receiving tank
2. To confirm the procedure and operation of related switching pipeline and valves, etc.
3. To confirm work description (not only crew but also senior engineers)

(5)-4 Regular Checks of the Tank Level by SoundingTape

From Figure 73 it is shows that you must not entirely trust the remote level gauge too much, it is important to measure the tank level by sounding tape in order to grasp the actual level.

Figure 72 Pre-meeting / reference*18

Figure 73 Measuring real tank level byTape Sounding / reference*17

(5)-5 Appropriate Responses in Irregular Cases

1. If the junior engineers or oilers, who are assigned the bunker operation, was changed suddenly, the senior engineers should precisely give instructions of work description again both to the succeeded junior engineer or oiler and also to all crew.
2. As we mentioned above, you will have to do other work such as loading ships stores or attending to visitors even during bunkering in port. For example, in case that you have to change the oiler who assigned the valve operation, from oiler A to oiler B, because oiler A has to do the other work, we have to predict the operation influence. So, senior engineers should carefully give caution and instruction due to the change of oiler assigned the valve operation both to the person who succeeded the task and to all crew.

When oil pollution occurs, **please report it to proper authorities and our Club precisely**, as soon as possible.

(6) [Reference] Bunkering Plan

For reference, we will introduce concrete items of the bunkering plan stipulated in SMS manual.

For example, by using the bunkering plan as shown in Figure 74, when you make the bunkering plan, after deciding the tank to be bunkered and calculating amount to be bunkered, the estimated final liquid level in each tank, it is important to be calculated to secure 10% or more extra space precisely (no tank is filled to more than 90% of its capacity). (Please see

Reference ④)
About the emergency contact method between the vessel and barge, both sides, (two methods), need to prepare an individual system of communication. It means ship and barge establish and secure the duplicate communication route.
Of course, it should be checked the functions or performance of both the vessel's communication equipment and barge's carefully and precisely beforehand.

- Assignment of roles (Station and duties)
- Ship internal communication system (Transceiver)
- **Sets of Transceivers (the system of emergency contact with barge)**
- Piping diagram for bunkering and oil transferring
- Table of bunkering plan (Example: Figure 74)
- Work Instructions for Bunkering (Which tank should you start and which valve should you operate?)
- Safety check list before and after bunkering
- The measurement record sheet for the actual filling tank
- Emergency procedure (Oil spill, a fire, etc.)
- Fire extinguisher
- Materials of clean-up/prevent the spilled oil (Spilled oil disperses, spilled oil clean up agent, etc. sawdust, rags, oil adsorbent, and prescribed spill can)
- Tools, Thermometer, Pressure gauge, Reducer, Bunker sampler ,Bunker oil sample kit (Container and flange for sampling) , etc
- The followings are for your reference books and guidance,
  1) Ship Finished Plan
  2) Singapore Standard Code of Practice for Bunkering SS 600
  3) 25.4 The Bunkering Safety Check-List (ISGOTT)

Figure 74 Sample of bunker plan

3.3 Cappuccino Bunker (Special Trouble Related Short-Delivered Bunkers)

Despite the fact that the cappuccino bunker is reported as maritime-related information many times, bunker barge well knows that it is difficult for the vessel to find it out. In fact, such unfair practice is still being done.

In Japan, we may not see the above wrongdoing and trouble when bunkering. It has been decreasing in countries such as Singapore, however we realise that these cases have still been occurring. So, we would like to introduce the important points of each step. Its purpose is that the crew can realise the risks of this trouble and deal with it when they find it.

Related information

Our Club’s P&I Loss Prevention Bulletin

Vol.30 “Bunkers – Quantity and Quality Disputes”

(1) What is “Cappuccino Bunker”?

“Cappuccino bunker” is the unfair practice that the barge (fuel oil supplier) increases the apparent volume with mixing bubbles of air in fuel oil, by some chemicals and/or physics method when bunkering fuel oil to the vessel.

The matter of cappuccino bunker is shown time-sequence in Figure 75, 76, and 77.
The ochre coloured part indicates normal fuel oil, and the cream coloured part shows the fuel oil mixed with air.
From Figure 75, it is shown that fuel oil mixed with air is slightly supplied to the fuel oil tank in the middle of bunkering. At the final step of bunkering, from Figure 76, it is shown that you will see a lot of the fuel oil mixed with air in the upper part cream coloured as faked fuel level. A few days later, from Figure 77, it is shown that the bubbles will be gone, and as the actual fuel level appears, you will find the loss of volume, which will be the bubbles that have vanished.

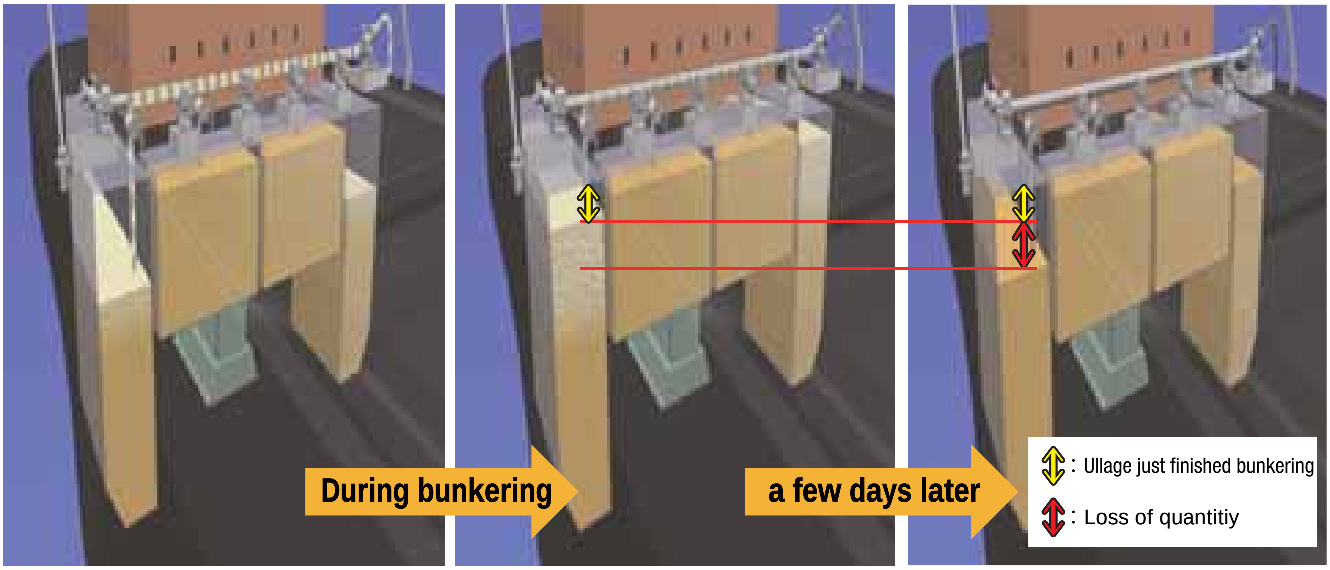

Figure 75 reference *17

Slight amount of bubble contamination from later half of bunkering

Figure 76 reference *17

By the time of the completion of bunkering,the upper part will mostly be filled with bubbles

Figure 77 reference *17

WithIn a few days, the bubbles will have dissappeared, and a substantial loss(short bunker) is discovered

This will bring about operating economic loss. About ship safety operation and management, if it may develop into the worst case, the operational failure will be caused by lack of fuel oil. Therefore, crew should pay a careful attention to bunkering.

However, even if crew should be careful, if they do not have the knowledge of what cappuccino is, they cannot evaluate and judge the state of bunker quality. From Figure 78 to 83, the pictures of cappuccino state and normal state are introduced.

Firstly, when compare the surface condition in the tank. From Figure 78, it is shown that a rough surface is in a cappuccino state which includes air (bubbles). From Figure 79, it is shown that smooth surface is in normal state which does not include air (glossy).

Figure 78 [Cappucino condition]
2 hours after bunkering: a lot of strong bubbles / reference*19

Figure 79 [Normal condition]
6 hours after bunkering: without bubbles / reference*19

Next, when compare the surface condition on the sounding tape. From Figure 80 it is shown that the tape without gloss is in a cappuccino state which includes bubbles. From Figure 81 it is shown that the tape with clear glossy reflection is in normal state which does not include bubbles.

Figure 80 [Cappuccino status]
a lot of bubbles on the tape (without lustre) / reference*19

Figure 81 [Normal status]
No bubbles on the tape (beautiful glossy reflection)/ reference *19

Finally, when compare the surface condition of the sounding tape's bob section (Dip weight). From Figure 82 it is shown that the state of the bob section without gloss is in the cappuccino state including the bubbles. From Figure 83 it is shown that the state of the bob section with clear glossy reflection is in normal state which does not include bubbles.

Figure 82 [Cappuccino status]
a lot of bubbles on the tape's dip weight (without lustre) / reference*19

Figure 83 [Normal status]
No bubbles on the tape's dip weight (clean glossy reflection) / reference*19

(2) Preventive Measures

Taking the cappuccino's features into consideration, we will explain the important points of each stage as preventive measures.

(2)-1 The Important Points of Bunker Barge Alongside

The important points of bunker barge alongside (when checking the total quantity in the barges) are as follows.

1	Before bunkering check and measure the total bunker oil quantity and its temperature in the barges.
2	Opening of ullage hatches or tank hatches should provide an opportunity to observe any foam on the surface of the bunkers. Bubble may also be detected on the ullage tape as shown in Figure 80.If there is no bubble then the oil level on the tape should appear distinct with no entrained bubbles as shown in Figure 81.
3	If entrained air is suspected then obtain a sample of the fuel by lowering a weighted bottle into the tank. Pour the sample into a clean glass jar and observe carefully for signs of foam or bubbles.

4	If these observations show entrained air, the C/E should not allow the bunkering to start and contact his head office immediately. At the same time, he should also arrange as follows: ● If the fuel is being provided by a charterer then they need to be made aware of the problem. Owners and/or Charterers should then request for an investigation by an independent Bunker Surveyor. ● The barge Master should be issued with a letter of protest (please see Reference ⑤) and a copy sent to the ship's agent. ● If the barge Master decides to disconnect from the ship and go to another location then the agent should immediately inform the port authority and try to establish where the barge has gone. ● All relevant times and facts should be recorded in the deck log book.

(2)-2 Important Points Before Bunkering

1	The C/E should check and confirm that the quantity held in these tanks is consistent with the quantity to be delivered and that on the bunker delivery note (hereinafter "BDN").
2	If the C/E has not observed any entrained air during the initial barge survey, it is still possible that air can be introduced to the barge tanks or the delivery line during the pumping period. The "Singapore Bunkering Procedure SS 600" prohibits the use of compressed air from bottles or compressors during the pumping period or during stripping and line clearing. It should be confirmed with the barge master that he will follow this procedure. (Reference SS600 2014: Paragraph 5.2.2.9.) Stripping of barge tanks can also introduce air and stripping should only be performed at the end of the delivery for a short period of time. The Barge Master must agree to inform the C/E when he intends to start stripping and when it has been completed. In case of conduct the striping every switching operation of barge tank and/or blow off air in order to push out the remained oil in the hose, a small amount of air will get mixed in to the tank, but it will see little influence.
3	It is important that the C/E measures and records the contents of all his bunker tanks before the delivery starts and if an independent surveyor is attending he should be asked to verify this record.

(2)-3 Important Points During Bunkering

1	Ship's crew need to be alert during bunkering and check for the following signs: ● Unusual movement of the delivery hose. ● Unusual sounds when standing in vicinity of bunker manifold with contacting the ear or the auscultation rod, ● Fluctuations of pressure indication on manifold pressure gauge. ● Unusual noises from the bunker barge ● Excessive bubbles observed on the sounding tape while taking sounding of bunkers in the ship's tanks.
2	If these observations suggest that air is being introduced into the bunkers then the C/E should request the barge Master to stop the pumping operation. In this case, open the manhole of the vessel's receiving fuel oil tank, and request to also confirm and understand the situation with barge master.
3	In addition to the above, take the sample of fuel oil and observe the condition such as air bubble and foaming. The C/E should aboard to the barge, measure all the tanks, note records, and obtain a signature from the barge master. Reporting to the shipowners or charterers, letter of protest, and noting in the log book are the same as the above (2)-1- ④ .
4	The bunker receipt should not be signed and no agreement reached with the barge Master on the quantity discharged or received. This should be checked and verified by an independent surveyor. Again, if the barge departs then the time of departure needs to be recorded and the ship's agent advised.

(2)-4 Important Points After Leaving Port

1	As a further check it would be prudent to remeasure ALL the ship's fuel oil tank contents about 12 hours after the delivery to check for any apparent loss but remember it would be very difficult to resolve any differences after the C/E has signed the BDN.
2	The crews should keep all check lists, sounding records, records of all matters and contents of meetings, receipts, and all other related records for later reference.

(3) [Summary]

Basically, it is very important to carry out appropriate measurements in the vessel's tank when bunkering at any port in order to avoid short delivery, regardless of cappuccino bunker.

In order to prevent cappuccino bunker, it is important to have acute power of observation "**before and during**" bunkering, especially about the above (2)-1- ② & ③ and (2)-3- ① . The most important thing is to detect as earliest.

Chapter 4 Engine-room Resource Management (ERM)

We would like to think about Engine-room Resource Management (hereinafter "ERM"), which is similar concept with Bridge Resource Management (hereinafter "BRM"), which people have not yet reached systematic and comprehensive understandings, in terms of accident prevention.

4.1 Reviewing " Thinking Safety "

We would like to reconfirm about the contents of our Loss Prevention Bulletin No. 35 "Thinking Safety" issued on July 2015. (Reference *20)

(1) What is Safety?

Several types of research establishing safety have been conducted. However, in fact, what we should essentially consider are social considerations. So, it is necessary to consider safety from the point of view of preventative measures to ensure that the accident and trouble does not reoccur.

The English psychologist **Professor James Reason** defines safety as "having resistance to danger to which an organization is constantly exposed".
For example, when we consider operation of a vessel, we could recognise many dangers such as 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.

Therefore, since safety is only just sense of values or concept, we should focus on and consider "how to avoid these dangers" as being most significantly associated with safety.

Since the result of guarding against accident is equivalent to the safe condition eventually, to think about the safety mechanism is first to "sense and anticipate any risks" and then to "prevent and avoid them".
Therefore, we can simply draw the conceptual map "Logic of " Safety = Avoiding risks " " as shown in Figure 84.

It is necessary to consider safety from the point of view of preventative measures to ensure that the accident does not reoccur.
We need to reffer to this as the 'preventative type' of safety measure.

▼

Therefore we should focus on and consider "how to avoid these dangers" as being most significantly associated with safety.

▼

In order to guard against accidents,

"firstly to sense and anticipate any risks,

and

then to think about its prevention and avoidance"

are constantly required!

It means after establishing one's own technical framework, we must always think what is the most important and efficient way to use and implementation it for the safety.

Figure 84 Safety = The logic of avoiding risks

In other words, there is a puzzle of risks, and then if you succeed in filling the pieces of puzzle, we can avoid the risks. On the other hand, if you cannot fill them or some blanks are remained, you will fall into the pitfalls as risk. It is a high possibility to come into the trouble or accidents. Therefore It is indispensable to sense & anticipate the risks precisely, and to make efforts to prevent & avoid them step by step.

(2) The Relationship Among Science, Technology, and Engineers

We have introduced the features of fuel, the characteristics of mixed fuel, and the fact that overheating will bring about vapour lock in the above case study of engine troubles.

About the machinery and systems in the engine room, the crew as technical professionals should understand and deal with the following; the purpose of using technology developed by science, which is the basic rule and principle of nature, the method of operating it rationally, and that of daily management.

It is important to fully establish the pyramid of science, technology (engineering), and technical professionals (engineers, marine officers) as shown in Figure 85.
For example, in the scientific field which is the base, we should know the fuel oil how state change after pressurisation or heating under the rule and principle of nature. Next, in the technology field, we develop how to control viscosity automatically, considering good use of the features of fuel oil. Moreover, marine officers as engineers and professionals consider and decide how to set viscosity or temperature based on the purpose of the pipe line system and appropriate viscosity,

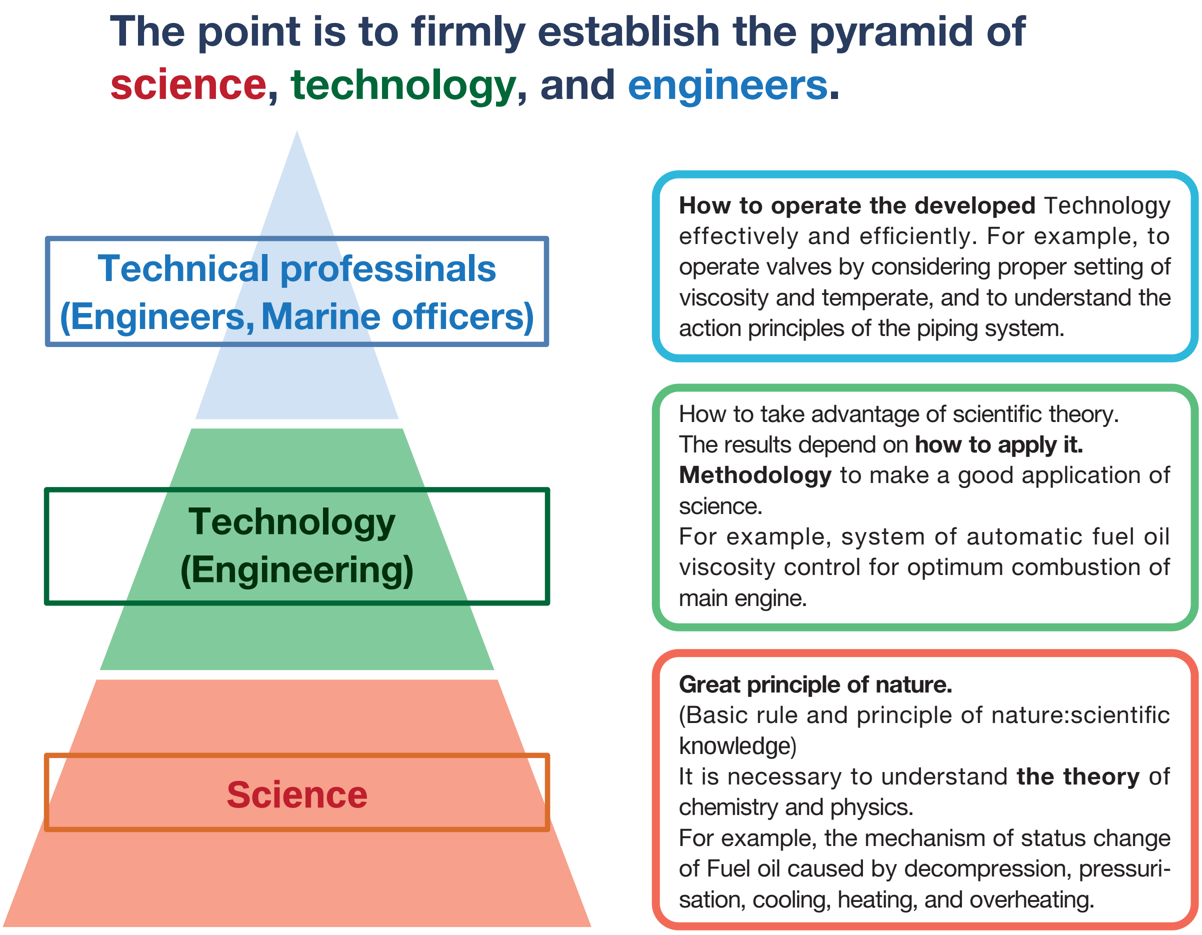

Figure 85 Pyramid of science, technology, and engineers

Therefore, in dealing with equipment, do not forget that the crew are to breathe life into machinery and make the best performance of machinery.

We have the phrase used at work site, “A word to the wise is enough!”(to understand everything from only one part). This means that a one instruction or decision always has the principles of science or technology as grounds, which is the elements for making a decision, which is 10 times or 100 times the amount of instructions or decisions.
For example, about the instruction from a senior engineer to a junior engineer, the junior engineer should understand the background precisely of the instruction. If the junior makes a decision by himself, the process should be logical. Otherwise, his each action does not bring out the power (meaning) of grounds (intention and conscious). Moreover, the junior engineer cannot improve himself.

If the junior engineers study the principle of science and technology only for the exam, and they do not try to obtain any knowledge after the graduation, they would not be able to have a mutual understanding related to the operation management with the senior engineers including C/E. As the result, we are afraid that it may cause the risk that the engine room’s work cannot be operated systematically.

Similarly, this can applies to the implementation of work instructions. The instructions are made in order to keep a certain safety level and complete work efficiently. The order of each work arranged in order in the work instructions has a meaning based on the principle of science and technology.
In the case study of a blackout accident, we have introduced the breach of work instructions. In order to follow the instructions, crew should understand the principle which supports them. Even if the trouble occur during the operation, if the crews understand the principle which supports the instructions, he can go back, remove the cause of the trouble, and finally restart its procedure.

From the above, the important point is to understand the basic rule and principle of scientific knowledge firmly so that the engineers can breathe life into machinery and operate the machinery precisely and efficiently.

4.2 Difference Between ERM and BRM

ERM’s concept is basically similar to BRM. However, the point of ERM which is absolutely different from BRM is the fact that "the engineers should cope with invisible situation as obstacles" in ERM..

For example, in BRM, at the bridge, navigator can watch all events happening in front them. Additionally, the ship navigators, such as the Master and pilot, have the solid common understanding which is called seamanship, which has been taken over from the age of discovery for a long time.
Under these circumstances, the key point of BRM is required how to take the prompt action to avoid risks with an appropriate decision.

On the other hand, in ERM, at engine control room or at the site of engine room, the engineers cannot directly see the phenomenon happening inside of machinery or pipeline, except for the inundation or a fire, if anything happen.
Therefore, the engineers have to correspond the difficult situation by taking into consideration with the technical objective

information, their analysis & estimation of the grounds which are based on the rule and the principle of science and technology.

Besides, though the basic concept of the engine system is the same, however arrangement of all machinery, pipelines, valves, and so on, are different depending on each ship. Under this circumstances, the engineers should judge the situation and decide the measures, based on the report from the site of engine room.
Of course, needless to say, the engineers as commander in the engine control room must also understand the arrangement of the machinery, pipelines, valves and so on in the engine room, and they should have and improve their enough skills and knowledge so as to operate machinery by themselves.

Therefore, in order to establish the ideal management system, we must think about something extra **[+α]**, as follows

1. It is important for the engineers to find the presage and indication of abnormality precisely before trouble or accidents occur by continuous machinery monitoring with acute power of observation .
2. In order to achieve the normal operation of system and machinery based on the principle, it is necessary for crew to conduct the scheduled inspection & maintenance regularly and grasp the operation status appropriately.
3. If the education and training system appropriately are established, it may be able to deal effectively with an emergency trouble and avoid accidents.

Finally, we expect that **ERM ＋ α** will bring better management.

4.3 What is ERM? (Attachment Document*18)

In this section, we will explain what the essential ERM is, quoted from “Engine-room Resource Management” introduced in web site of the General Incorporated Foundation, The Maritime Human Resource Institute

4.3.1 Ability Requirements Table and Resources

This is also the reviewing of P&I Loss Prevention Bulletin Vol.35 “Thinking Safety”.
According to International Maritime Organisation (hereinafter "IMO"), ERM is a method of ensuring safe operation of the vessel through appropriate management of resources (resources: equipment and plant, personnel(crew), information) effectively.
The revised abilities requirements table regulates the important items as shown in Figure86, when practicing ERM.

ERM’s ability requirements table in IMO

- resource arrangement
- effective communication
- the decision of duty and priority
- definite indication of intention and leadership
- the ability to recognise situation
- utilisation of team members experience and understanding of ERM principle

Figure 86　ERM’s ability requirements table in IMO

If we summarise the resource management, it will be as shown in Figure 87.

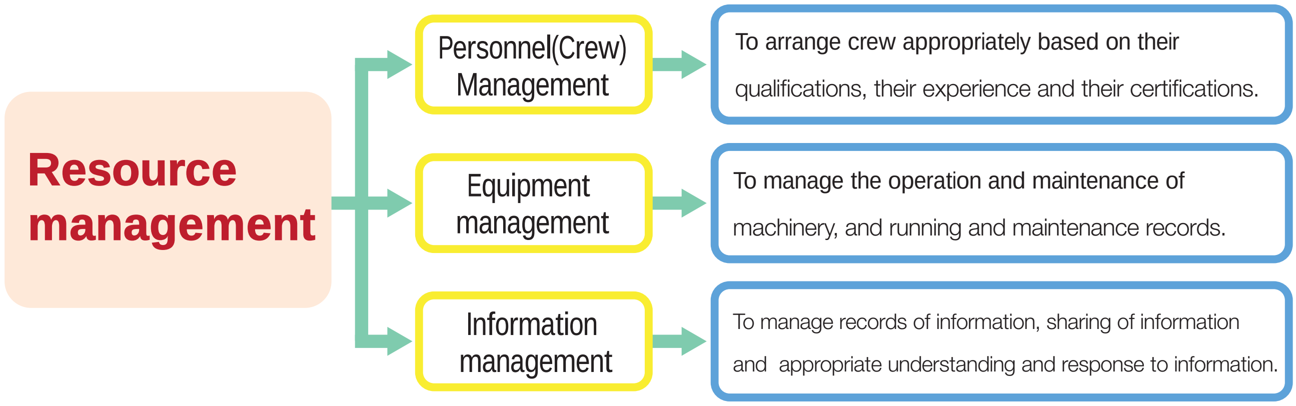

Figure 87 Resource management

From Figure 88, it shows about the correlation diagram for ERM requirements based on the ability requirement table in IMO

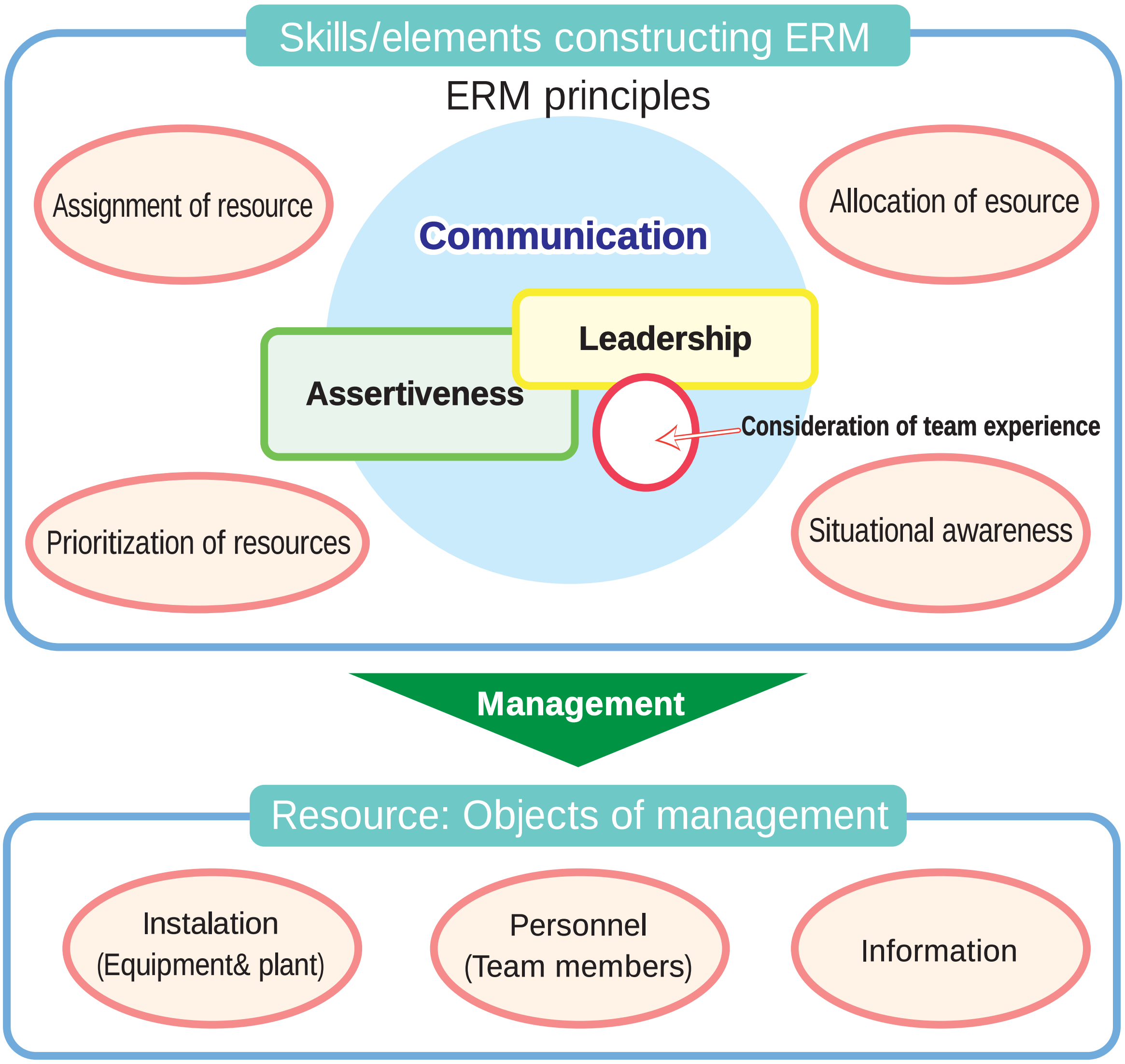

Figure 88 The interrelation among the ERM's requirements

From Figure 88 it is shown that **“the communication is the most important factor in ERM”**.
That is, assertiveness and leadership 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 (Allocation, Assignment and Prioritization) 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.

4.3.2 The Effects of ERM

It should understand that ERM’s extent is applied to all cases related to work in engine room. It means that it applies to both “entering and departing at a port or emergency responses” and “maintenance works”. In this subsection, we will introduce the case of the “tool box meeting”, described in teaching materials (video and textbooks) of The Maritime Human Resource Institute

(1) [Tool Box Meeting]

Recently, a tool box meeting have a routine work on the ship.
The background of introduction of this meeting is because the engine department’s personnel organisation has become multinational and multicultural. As a result, lack of communication has surfaced. As one of the preventive measures, the tool box meeting gives a opportunity of a mutual understanding and communication among each other crew in engine department in order to carry out safe and careful precise operations.
The custom to hold tool box meetings with the all of the engine department members joining haven’t had before. However, since regulations on safety have been strengthened and safety consciousness has been raised, the tool box meetings have come to be important.
As we mentioned before, the tool box meeting become important because the change of work environment on ship affected the characteristics of work process, including the influence of internationalisation and multi-culturalisation..

However, at the meetings, crew tend to focus on the topics such as working description, time schedule, and crew allocation. Is this really enough?

Figure 89 Tool box meeting (1)

Figure 90 Individual meeting for pre-work confirmation

Figure 91　Contact with relevant departments

Figure 92　Maintenance work in engine room

Figure 89, 90, and 91 are taken from the video published on the following HP.

The Maritime Human Resource Institute Website

Video ：http://www.maritime-forum.jp/et/movie/Engine_room_japanese/index.html

Textbook ：http://www.maritime-forum.jp/et/pdf/h23_EngineRoomResourceManagement_japanese.pdf

(2)　[Information Sharing]

Engineers should pay a careful attention to the coordination among each other works as well as consider influence to engine operation by individual work. Otherwise, it may cause and develop into accidents.

We will explain an example from the video above website;
No.1 oiler quoted the following example and gave advices 3/E to be paid attention as measures. (Figure 93 and 94)"
“Engineers and crew depended only upon following work instructions, but their **humanly five senses** didn't work at all and they couldn't fully prevent the accident where the cover was blown off during the cleaning of the seawater strainer as a simple work.

The direct cause was that residual pressure left in the strainer cover could not pull out , since the air vent pipe was clogged. As the result, the cover was blown off vigorously when engineers loosened the cover nut. Despite the person in charge followed as instructions doubtlessly, he neglected to confirm the essential state when releasing out residual pressure.

Therefore, the air vent pipe was clogged up, however engineer and crew could not let their humanly five senses work towards the following phenomenon, and then could not feel anything abnormal, which caused the trouble.

1. To listen to the sibilant air-borne sound which can be heard before sea water comes out from air vent pipe vigorously
2. To feel the temperature change coming from the change from air to sea water inside the pipe, which they could have felt if they had touched air vent pipe.

It is primitive, but it is important for crew to feel the change of state by applying humanly five senses and making a judgement, not only following instructions.

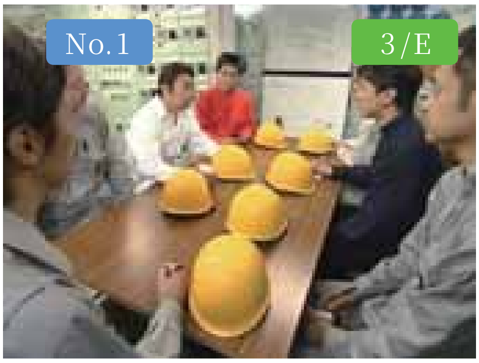

Figure 93　Advice from No.1 Oiler to 3/E

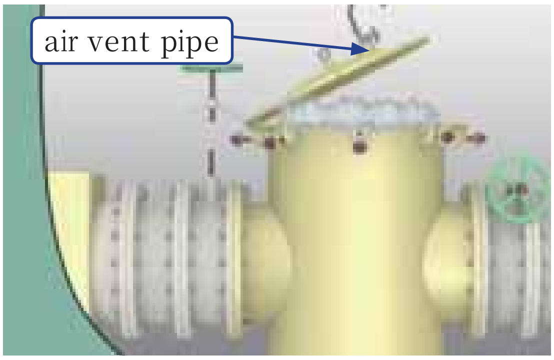

Figure 94　Sea water strainer

Next, the C/E introduced a situation, which had happened in another ship before, explaining the accident occurred after the conditions which was different from the normal at dry dock , and also the accident occurred due to a lack of information sharing after adjustment “ ① Leakage from Fuel Safety Valve, ② Damage of Diaphragm.”

He encouraged the other engineers to realise the importance of information sharing . (Figure 95, 96, 97 and 98)

He also told all engineers that information sharing in ERM’s principles are important both for “operation” and for “maintenance”.


Figure 95　Safety instructions from Chief engineer to all Engine member


Figure 96　Leaking safety valve of fuel oil heater


Figure 97　Damage of diaphragm on control valve


Figure 98　Information sharing at Tool box meeting

These are the effects of a tool box meeting, however, it is necessary for crew to realise that the information sharing is the essential and constitutional factor of the effective communication.

4.4 Did ERM Work in the Case studies?

We have introduced five cases in chapter 2 and 3. We have seen surprising cases that we would never imagine to see in such a series of pitfalls (negative chains).

We have analised several check points .However, from Figure 99 it shows about the review of accident check point in view of ERM's ability requirements about these five cases. What kind of things can we think? What kind of approach should we apply?

	ERM ability requirement	Check point
Boiler water leak	Allocation of resources	Did the person in charge (hereinafter "PIC") of boiler have enough management knowlege & ability to maintain the boiler as designed?
	Effective communication	Did the chief engineer or the superior give precise advice?
	Assignment and prioritization of resources	Did the PIC of the boiler understand the importance of boiler water control?
	Assertiveness and leadership	Did the C/E or the other experienced senior engineers give the PIC the explanation about the importance of maintenance?
	Situational awareness	Did the engine member have enough knowledge?
	Consideration of team experience and knowledge of ERM principles	"Didn't the other engineers with experience of the boiler have doubts? Didn't they give PIC any advice?"

	ERM ability requirement	Check point
Main engine start failure	Allocation of resources	Were the C/E unable to assign the crew around the main engine in order to manage fuel temperature and viscosity change frequently, depending on the situation, so that they can avoid the abnormal situation?
	Effective communication	Was the communication among engine room, engine control room (ECR), and bridge enough?
	Assignment and prioritization of resources	Was the timing for the change of fuel temperature setting from the C/E appropriate?
	Assertiveness and leadership	Was the C/E's instruction appropriate?
	Situational awareness	Did the C/E understand the status change of fuel oil in pipe line in the case of no Main Engine fuel consumption?
	Consideration of team experience and knowledge of ERM principles	Didn't the other engineers have doubts about the C/E's order or the situation in the pipe line?

	ERM ability requirement	Check point
Blackout	Allocation of resources	"Was the assignment role for engine member appropriate ? So they can restart Generator engine after its emergency stop?"
	Effective communication	Did the senior engineers recognise the situation of starting air valve ?(Why closed?) (Didn't he check?)
	Assignment and prioritization of resources	Were the operating instructions for the inspection items of recovery work clear?
	Assertiveness and leadership	Did the C/E and the 1/E give all Engine member appropriate instruction?
	Situational awareness	Did engine member have the appropriate situational awareness for Blackout recovery?
	Consideration of team experience and knowledge of ERM principles	Why didn't engine member understand the importance of blackout recovery drill? Did any engine member experience the blackout recovery work?How many experienced menber were there?

	ERM ability requirement	Check point
Boiler black smoke	Allocation of resources	Did the PIC of boiler have enough management knowledge & ability to have boiler function as design?
	Effective communication	Regarding black smoke condition, why wasn't the information of exhaust gas condition shared between the engineer officer on watch and the deck officer on watch?
	Assignment and prioritization of resources	How was the priority schedule of burner maintenance?
	Assertiveness and leadership	Did the C/E explan and motivate PIC of boiler how importance the maintenance is?
	Situational awareness	When the black smoke was found, why did engine member fail to take effective measures such as suppressing or preventing it? Didn't the engineer officer on watch monitor the black smoke outside?
	Consideration of team experience and knowledge of ERM principles	"Didn't the other engineers with experience of the boiler have doubts? Didn't they give PIC any advice?"

	ERM ability requirement	Check point
Oil leakage in bunkering	Allocation of resources	Of course the each role of engine members must be assigned in advance,however didn't anyone double-check their colleague?
	Effective communication	Did any senior engineers instruct and explain their engine member the operation procedure how to change-over the valve beforehand?
	Assignment and prioritization of resources	Did the senior engineer infrom their engine member the bunkering plan precisely in advance?
	Assertiveness and leadership	Did the senior engineer conevey their engine member the bunkering plan, and remind them concern oil pollution in advance? Did the experienced engine member educate the poor skilled member?
	Situational awareness	Did engine member check the liquid level of the tank regularly (e.g., every 15 minutes)?
	Consideration of team experience and knowledge of ERM principles	"Did the experienced engineers give their engine member the appropriate advice each other? How many experienced engine menber were there?"

Figure 99 The reviews of the accident examplerelated to ERM ability requirements

4.5 What is Engine Management? (ERM＋α)

Engine-room Resource Management (ERM) is the management of resources and means the system where crew in the engine department can directly cooperate with each other and organically function.

On the other hand, where we think about the appropriate engine management that can avoid accidents in terms of practical aspects, it is important to establish the situation monitoring, the maintenance, and the educational system which will be a base for engine management. It is something extra [+α] which supports essential ERM operation, causing indirect effect.

(1) What is Direct? (ERM)

The work site of direct effect for ERM generally means the following operating situation including the maintenance operation said in 4.3.2.

1. To handle the immediate response system to the standby maneuvering (engine operation) during the entering and departing at port.
2. To handle the immediate response system to emergencies such as a blackout, main engine's stop, oil leakage, a fire, and flooding.
3. To handle operation such as the bunkering of fuel or lubricating oil and discharge with sludge which may have the possibility of an oil pollution accident.
4. To handle watch-keeping at sea (cooperate with bridge maneuvering, engine operation)
5. To handle watch-keeping in port (cooperating with loading/discharge operation, maintenance operation)
6. To handle Maintenance operation (important information sharing , establish operational mutual cooperation, communication, support, and understanding the situation, normal operations, share the special status of the valves and equipment not to be operated, cooperation with other departments and so on.)

Speaking of cooperation, the cooperation in engine department is of course important. However, as we have introduced the case that the main engine start failure brought about submarine cable damages in chapter 2-2.2.2, we have pointed out that it is important for the deck department and engine department to communicate with each other in advance, about the timing of switching fuel oil when departing the port.

Another similar case is in case of that the fuel oil tank is located in the lower part of cargo hold; if a cargo weak to heating is to be loaded, the cargo department should issue a caution to request about the heating temperature of the fuel oil tank to the engine department. The engine department would have to flexibly adjust the temperature. Thus, it should pay an attention to the resource management focus on the optimality of the vessel.

The communication is important, however the engine room has big noise and it is difficult for the crew to communicate with each other. Therefore, it is necessary to think about the way to communicate. For example, the crew should try to use clear and simple phrases in order to convey their intentions clearly and can avoid misunderstandings.
When closing something, for instance, crew should decide on the word to use: "close" or "shut". It is necessary to have a firm policy to convey information.

(2) What is Indirect [＋α] ?

In order to prevent accidents, it is important to establish situation monitoring, maintenance, and educational system which is something extra [+α] as shown below, which supports direct operation:

1 Situation monitoring and judgement for continuous operating information of main engine and auxiliary machinery.(early detection of abnormal symptoms, understanding the characteristics under the environment of vessel operation, trial, comparing the same type of ships and so on)

As each ship has different sea service areas and loads, about status management, it is necessary for engineers to compare the current operational state with sea trial data or a normal operation state regularly.
To understand the characteristics of each machinery or system enables to find out something unusual, and to take appropriate measures on a timely.

2 Appropriately Planned Maintenance System: to maintain the situation so that machinery design performance can function.
(The instruction manual of the finished plan, manufacturer service information, maintenance instructions based on lessons learned (knowledge of experience), etc.)

Based on the case study, we learned and reconfirmed the importance of maintenance.
The vessel, ship management company, and operation department should do maintenance as a whole team under a common understanding. Moreover, the operation department should also understand the importance of ensuring the time of maintenance.
About maintenance, recommended maintenance interval has been given by the manufacturer, however the load on machinery will be different, depending on the operation environment such as operation load, operation pattern, sea service area, fuel oil and lubricating oil to be used and, etc.
Therefore, it is important for crew to carry out maintenance work with appropriate timing set by each company or each ship, considering the lessons learned (knowledge of experience) based on operational evaluation or the trouble experience of the company comprehensively. For example, each company should observe the state of deterioration by measuring at the overhauling maintenance.
That is, it is the know-how of maintenance. once again, this is one of the best management methods to avoid trouble, however it must not be the know-how with lowest safety.

3 Education on the ship: Establish the common understanding related to the engine system

Not taking too much time to complete the check list, and not taking the science part of the principle only as an armchair theory, let's think about the education on the ship to develop feasible engine management in terms of practical engineering.
We have considered the methods and introduce below.

- Hold study sessions regularly, about the meaning of the engine operations & the work instructions or the management of system operation.

This is a repetition of 4.1 (2), the relationship among science, technology, and engineers. On the ship, the work instructions are made and managed in order to keep a certain safety level, and complete work efficiently. The work instructions are based on principles. Even if the trouble occur during the operation, if the crews understand the principle which supports the instructions, he can go back, remove the cause of the trouble, and finally restart its procedure.

・ Information sharing on examples and experiences of trouble.

About information sharing, we have introduced the case of tool box meeting before. However, the crew do not have many opportunities to experience notable trouble that we would not be able to forget, at the work site. It is important for crew to share the experienced crew's experience on another ship, or past instances accumulated at a ship management company.

・ Study sessions focusing on maintenance work instructions or risk assessment.

Making good use of the lessons learned (knowledge of experience) based on trouble experience, anticipating risks and making efforts to upgrade the safety level are very important. For example, since the junior crew have little experience, they will be able to develop the ability to avoid risks by sharing the experienced senior crew's experience at another ship, and by discussing the past instance accumulated at a ship management company.

・ Conduct emergency drills such as a blackout recovery drill

Needless to say, it should carry out the drill regularly. It's purpose is that the crew can respond promptly when trouble of critical machinery occurs, which does not occur frequently.
In the case of a blackout, there are two procedures: one is procedure of automatic recovery and the other is procedure of manual recovery. It is important for engineers to recognise both of them. At the same time, it is helpful to understand the machinery and equipment supplied by emergency generators, which are not operated regularly. Furthermore, it will be a great opportunity to think about what kind of attention the engineers should be paid even during normal operation, about the machinery and equipment which cannot be fed by the emergency generators.

・ Review of reasonableness of check lists, instructions, and SMS by the study sessions.

We advised before that the work instructions have a reason/background.
When theories match practices at work site rationally, the established procedures will be followed for a long time.
However, if the first version of work instructions were established based on the crew's experience, that is, if the first version of work instructions were established based on custom which done at the work site from a long time ago, it is focused on the priority to the rationality of work, or on the contrary, excess the safety factor. In the case, it is necessary to revise and optimise instructions due to generational change or technical innovation.
While the ship has instructions, once accidents occur, it is necessary to take preventive measures.
For example, the contents of descriptions and the details will be different, depending on level of the safety knowledge and safety performance for marine officers (engineers). For those who have a lot of knowledge and experience, the framework of instructions will be enough, as each of them can take actions flexibly and individually.

On the other hand, for those who don't have enough technical background, the detailed instructions will be necessary so that they can maintain a certain safety level of work.

Therefore, instructions are not absolute nor will they be used eternally. Instructions should be arranged and upgraded regularly, depending on the purpose, the object personnel, and the technology to introduce.

• To perform engineering effectively applies humanly 5 senses.

At the work site, the engineers should make the best use of the human sensors such as smell, temperature, pressure, vibration, sound, shape, and colour, rather than only the remote monitoring system or equipment.

It is easy to understand from the point that the No.1 oiler give advice 3/E to be cautious about the importance of making use of the 5 senses, which we have described at the Tool Box Meeting to introduce the importance of Information Sharing.

• It is also important both to hold formal study sessions and to include teatimes or conversation (communication) when S/B of entering and departing port.

So far, we have recommended several review meetings or study sessions.

It is clear that the crews quite busy on the ship, so it is difficult to make the time for study sessions, which do not directly lead to the daily assignment or services.

However, if the crew can make good use of the extra time, it is possible to put it into practice, which is tea & break time or when entering and departing port stand-by.

For example, since the all engineers meet at teatime, they can hold study sessions about SMS or the pipeline plant system, and can share information about trouble. Similarly, when S/B of entering and departing port, since the senior engineers and junior engineers are allocated together in the engine room or the engine control room. They may have the opportunity to hold question and answer sessions related to the plant status or engine operations, and to share knowledge such as lessons learned on trouble which occur before.

Chapter 5 Correspondence in Case of Deviation

In this chapter, we will explain countermeasures for when “deviation” from the scheduled course has occurred, preventing the sailing to destination for reasons like engine trouble.

5.1 Regulation Under the Relevant Law

First, we would like to confirm Japanese domestic laws, which will be applied to the case of deviation. In Japan, Japanese Seamen’s Law as a law that is applied. Most countries other than Japan have almost the same regulations.

(1) Japanese Seamen’s Law Article 9 (fulfilment of voyage)

> When the preparation for voyage is completed, the Master must depart on a voyage on time, and also must conduct ship operation to the port of destination without changing the scheduled traffic route, except for cases when needed.

That is, the Master must sail directly to the port of destination.

In addition, the law stipulates the following as the report duty about ship operations.

(2) Japanese Seamen’s Law Article 19 (reporting about ship operation)

> If the case applies to one of following items, the Master must report to the Minister of Land, Infrastructure, Transport and Tourism,
> by following Ordinance of the Ministry of Land, Infrastructure, Transport and Tourism.
> 1. When the following occurs; ship’s collision, stranding, sinking, destruction, fire, engine trouble, and other maritime accidents.
> 2. When engaged in lifesaving or rescue of ship.
> 3. When the existence of another shipwreck is known and informed in any other way than wireless telegraphy.
> 4. When a member of the ship passes away, or goes missing.
> 5. When changes are made to the scheduled traffic route.
> 6. When the ship is detained or captured, or other accidents related to the ship occur.

As the 5 cases above indicate, when the scheduled traffic route is changed, the Master have the duty to report it.

As for private companies, changing the scheduled traffic route will cost unnecessary expenses, and will take time, which will bring about expense settlements between shipowners and charterers.

5.2 Situation Where Deviation is to be Expected

The following situations are mainly thought to be the cause of deviation shown from Figure 100 “example of deviation map.”

1. The emergency entry into the port due to the death, injuries, diseases, etc. of a crew or passenger, and dispatching other crew for replacement.
2. The search for the missing such as a crew or passenger falling into the sea.
3. The rescue of a human life or another ship
4. A maritime accident caused by engine trouble
5. Discharging stowawayetc.

etc.

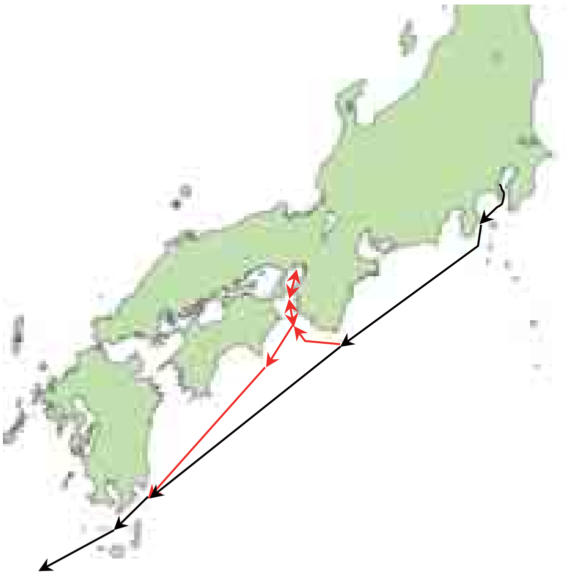

Figure 100 Example of deviation map

Deviation may occur due to reasons except for the above.

5.3 Coverage of Insurance Related to Deviation

Of course, extra fuel oil will be needed. Arrival time will be behind the estimated schedule at destination port, which will be Off Hire (hereinafter referred to as Off Hire). Since using the fuel oil which by arranged by the charterers generally, the cost will have to be settled.

From the shipowner’s position, the freight will not be paid. To make matters worse, the fuel charge excessively used will also have to be paid. If trouble like this occurs, insurance companies will assist to cover the said costs.
Figure 101, as shown below, shows the relationship among the cause described in 5.2, each cost, and types of insurance to coverage. However, among the costs to be covered by P&I insurance, regarding the costs related to “rescue of human life and other ships” and “stowaway,” which are shown with P△, first of all, our members shall try by every possible and proper means to recover from other parties such cost.
As a matter of fact, except in the case such as rescue the large ships which suffered shipwreck, it is difficult to recover the costs from a yacht or small fishing boat, stowaway and so on. If failed to recover the costs, they will be covered by P&I insurance.

In addition, please remember that the contents of Figure 101 will be deferent by the insurance contract. Therefore, we recommend you to contact the each insurance company and our club and check the details of coverage

*Compensation

		Injuries and sickness of a member of a crew and others	Search for a missing person	Rescue of human life and other ships	Engine trouble	Stowaway disembarking	Note
Off Hire		O	O	O △	O	O	
Port charge (including agency cost and others)		P	—	P	H	P	
Repair cost		—	—	—	H	—	
Cost related to changes of a member from the crew		P	—	—	—	—	
Cost during boarding for stowaway (food expense and others)		—	—	—	—	P△	
Fuel	HFO (M/T)	P	P	P△	H	P△	
	DO (M/T)	P	P	P△	H	P△	
Fresh water	FW (M/T)	P	P	P△	H	P△	
	DW (M/T)	P	P	P△	H	P△	
Lubricating oil	M/E Cyl Oil (Ltr)	P	P	P△	H	P△	
	M/E LO (Ltr)	P	P	P△	H	P△	
	G/E LO (Ltr)	P	P	P△	H	P△	

＊ *O : Off Hire insurance, H: Ship insurance, P: P&I insurance

＊ △ : *To begin with, additional costs related to the “rescue of human life and other ships” and “stowaway” need to try to be collected from the other side. If not be collected, the cost is subject to be compensation of PI.

Figure 101 Insurance coverage related to deviation

5.4 Case Study

We would like to analyse a case, an urgent medical case occurred in a container vessel, which departed from the port of Tokyo and started its voyage for Hong Kong. At the time when the case occurred the vessel was on Shiono-misaki.
Since it was an emergency case, the vessel started to deviate on Shiono-misaki, in order to transport the emergency patient to a hospital on the land area. After calling at port of Kobe temporarily, the vessel returned to its original course on Toi-misaki. Taking this case as an example, we would like to explain what the vessel and support team on shore should do.

5.4.1 Basic Information

As we have explained, the following are things to be covered by P&I insurance: the fuel or lubrication oil used excessively, the agent’s cost for having the emergency patient disembarked, and port charge. Therefore, our members need to submit the information/documents for our calculation of relevant costs to our Club.
Regarding the points below, the following is necessary information: time, location, ROB(abbreviation for Remain on Board, amount of fuel oil, lubricating oil, fresh water, and drinking water), distance sailed excessively and so on.

①	R/Up Eng. (the abbreviation of Ring Up Engine: the status of navigation) after departing from port of Tokyo, and SOP (Start of sea Passage: hereinafter referred to as SOP) that reached the planned RPM of the main engine.
②	Deviation start point
③	When arriving at port of Kobe
④	When departing from port of Kobe
⑤	Original course return point (off Toi-misaki)
⑥	Arrived outside of the port, port of destination (Hong Kong), EOP (End of Sea Passage) when starting reducing RPM.

We made simple Figure 102 and 103 as the Information necessary for calculation of deviation cost.

This will be basic information for calculating several expenses. Confirming the difference between actual time and actual ROB from the time passing Toi-misaki and ROB in the case of continuing normal voyage without deviation, we will calculate delay time and the amount of fuel used excessively.

However, the vessel was to hurry to the port of Kobe, which made the crew have many things to do; to confirm the voyage schedule and symptoms of the emergency patient, to contact related departments, and to arrange other things.

Therefore, the support team on shore should prepare the data shown in Figure 102 and 103 as a blank form, and send it to the vessel. In the vessel, all the crew have to do is to fill in the necessary information in each column. It is necessary to establish the division of labour like this.

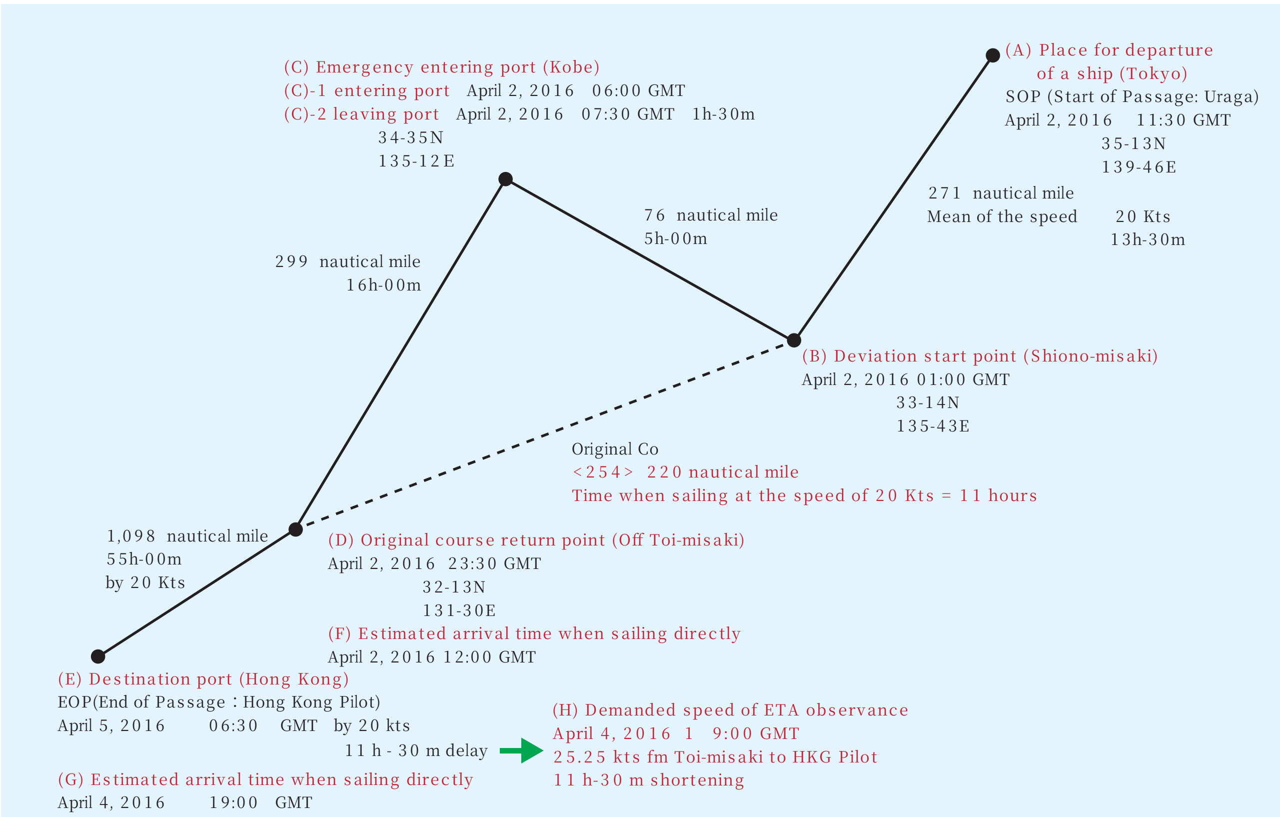

Figure 102 Information necessary for calculation of deviation cost

		(A) Port of departure of a ship (Tokyo)	(B) Deviation start	(C) -1 Arrival at Kobe	(C) -2 Departure from Kobe	(D) Original course return	(E) Port of destination (Hong Kong)
Point		SOP 35–13N 139–46E	Off Shiono-misaki 33–14N 135–43E	Off Kobe 34–35N 135–12E	Off Kobe 34–35N 135–12E	Off Toi-misaki 32–13N 131–30E	EOP 22-23N 113-54E
Date and time		April 1, 2016 11:30 GMT	April 2, 2016 01:00 GMT	April 2, 2016 06:00 GMT	April 2, 2016 07:30 GMT	April 2, 2016 23:30 GMT	April 5, 2016 06:30 GMT
Distance (N.M.: Nautical Mile(s))	To Hong Kong	1,589 N.M.	1,318 N.M.	1,397 N.M.	1,397 N.M.	1,098 N.M.	
	To Shiono-misaki	271 N.M.		–	–	–	–
	To Kobe	–	76 N.M.		–	–	–
		1,318 N.M.	220 N.M.	299 N.M.	299 N.M.		–
ROB	HFO(M/T)	1,678 M/T	1,650 M/T	1,640 M/T	1,639 M/T	1,606.0 M/T	1,492.3 M/T
	DO(M/T)	83 M/T	80 M/T	79 M/T	78 M/T	75.0 M/T	62.8 M/T
	FW(M/T)	130 M/T	125 M/T	120 M/T	119 M/T	113.0 M/T	92.7 M/T
	DW(M/T)	101 M/T	100 M/T	100 M/T	99 M/T	98.0 M/T	93.9 M/T
	M/E LO(Ltr)	50,000 Ltr	50,000 Ltr	50,000 Ltr	50,000 Ltr	50,000 Ltr	50,000 Ltr
	M/E Cyl Oil(Ltr)	28,000 Ltr	27,864 Ltr	27,820 Ltr	27,820 Ltr	27,660 Ltr	27,108 Ltr
	G/E LO(Ltr)	4,000 Ltr	3,985 Ltr	3,983 Ltr	3,982 Ltr	3,966 Ltr	3,909 Ltr
Sailing and anchorage time		SOP – deviation start 13h-30m	Shiono-misaki – Kobe 05h-00m	Kobe anchorage time 01h-30m	Kobe – Toi-misaki 16h-00m	Toi-misaki – Hong Kong 55h-00m	

Figure 103 Information necessary for calculation of deviation cost

Getting such information, we will start handling this accidents. Thus, without the facts, which will be the information for negotiation, it may be difficult to carry out negotiations equally and successfully.

One Point Advice

The summary of information, which is necessary for ROB is indicated in Figure 104.

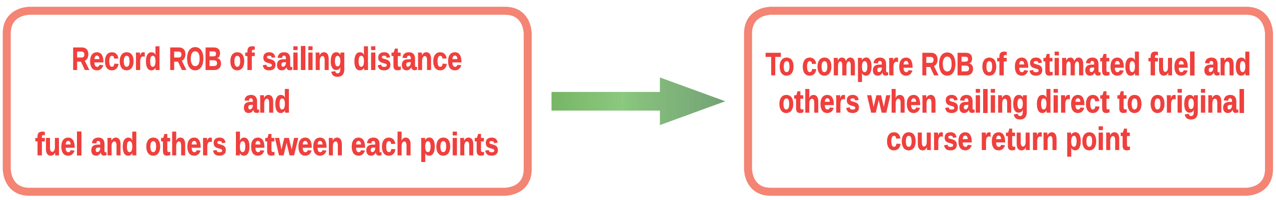

Figure 104 Information necessary for calculation of ROB such as fuel

5.4.2 Calculation of Delay and Associated Additional Fuel Consumption due to Deviation

(1) The Calculation of Delay Time (Off Hire time)

The estimation of expected arrival time of the case of direct sail, which is from deviation start point to the original course return point, and the calculation of delay time
(the estimation of expected arrival time of direct sail to Toi-misaki had the vessel not deviated)

First, calculate the estimated time of arrival in Toi-misaki, which is the sail time to Hong Kong without an emergency patient, and as scheduled (original course return point). Next, compare it to the actual passing time (original course return time), and calculate the delay time and Off Hire time.
As for the order, calculate the average speed of distance, from SOP point after departing from port of Tokyo to the passing point of Shiono-misaki (deviation start point). Next, based on actual value, estimate the expected arrival time, assuming direct sail to Toi-misaki. The summary is as follows.

Charterers occasionally gives the notice that the time from the start of deviation to original course return should be Off Hire. As this case study shows, like the voyage shown as the triangle in Figure 102, the net delay time, which is the time subtracting actual time of direct sail from the time of distance, which is from the start of deviation to the original course return, will be Off Hire.

1 Confirm the actual speed until deviation start, and indicate it in Figure 105. You can see the fact that the average speed from SOP to deviation starts point of Shiono-misaki was 20 Kts.

(A) Port of sailing SOP (Uraga NO.1 B'y)	01-Apr-16 11:30 GMT
Deviation start point (Off Shiono-misaki)	02-Apr-16 01:00 GMT
Navigation time	13h-30m
Sailing distance	271 N.M.
Mean of the speed	20 Kts

Figure 105 Confirmation of speed results up to deviation start

2 Using the above actual speed, assume and calculate the time of voyage with 20 Kts we calculated in ① , which was to Toi-misaki, and estimated time of arrival. And, show it in Figure 106. Estimated time of arrival was calculated as 2 April 2016 12:00 GMT.

(B) Deviation start point (Off Shiono-misaki)	02-Apr-16 01:00 GMT
To Toi-misaki	220 nautical mile
Estimated speed	20 Kts
Necessary time	11 h - 00 m
Off Toi-misaki	02-Apr-16
Provisional arrival estimated time	12:00 GMT

Figure 106 Estimation of estimated arrival time when sailing directly

3 Compare original course return time with the estimate time of arrival we calculated in ②. Then, we can calculate that the delay time is Net 11 hours and 30 minutes we subtracted 11 hours, which it would have taken in the case of direct sail, which is from deviation start time (2 April 2016 01:00 GMT) to original course return time (2 April 2016 23:30 GMT). This time is Off Hire, which we show in Figure 107.

ETA when sailing directly (Toi-misaki)	April 2, 2016 12:00 GMT
(D) Original course return point (Toi-misaki)	02-Apr-16 23:30 GMT
Delay time	11 h - 30 m

Off Hire time
11 hours 30minutes

Figure 107 Estimated calculation of delay time

(2) The Calculation for Consumption Amount Related to Deviation Such as Fuel

1 Like the delay time's calculation we have described, first of all, calculate the actual amount of fuel, which is from SOP to the start of deviation on the surface of fuel. As shown in Figure 108, based on the actual amount, assume the consumption amount of fuel in the case of direct sail to Toi-misaki.

	(A) Port of sailing SOP (Uraga NO.1 B'y)	(B) Deviation start point (Off Shiono-misaki)	Consumption	Consumption per hour	Consumption per day (24 h)	Estimated consumption when sailing directly (B) to (F)
	April 1, 2016 11:30 GMT	April 2, 2016 01:00 GMT	(A) - (B)			
HFO (M/T)	1,678.0 M/T	1,650.0 M/T	28.0 M/T	2.074074 M/T	50.0 M/T	22.8 M/T
DO (M/T)	83.0 M/T	80.0 M/T	3.0 M/T	0.222222 M/T	5.3 M/T	2.4 M/T
FW (M/T)	130.0 M/T	125.0 M/T	5.0 M/T	0.370370 M/T	8.9 M/T	4.1 M/T
DW (M/T)	101.0 M/T	100.0 M/T	1.0 M/T	0.074074 M/T	1.8 M/T	0.8 M/T
M/E LO (Ltr)	50,000 Ltr	50,000 Ltr	0 Ltr	0.00 Ltr	0 Ltr	0 Ltr
M/E Cyl Oil (Ltr)	28,000 Ltr	27,864 Ltr	136 Ltr	10.07 Ltr	242 Ltr	111 Ltr
G/E LO (Ltr)	4,000 Ltr	3,986 Ltr	14 Ltr	1.04 Ltr	25 Ltr	11 Ltr
Sailing time	From SOP To Shiono-misaki : 13h-30m			From Shiono-misaki To Toi-misaki sailing directly : 11h-00m		

Figure 108 Fuel consumption results from SOP up to deviation start and consumption estimation when sailing direct to Toi-misaki of deviation cost

②	Based on this estimated consumption amount, assume the amount of stock when arriving at Toi-misaki in the case of direct sail. Then, as Figure 109 indicates, compare it with the actual amount, and the calculation of additional consumption such as extra fuel.

	(F) Estimation when sailing directly ROB (Toi-misaki)	(D) Original course return (Toi-misaki)	By deviation Additional consumption
	02-Apr-16 12:00 GMT	02-Apr-16 23:30 GMT	(F) − (D)
	(B) − Estimated consumption	Actual ROB	
HFO (M/T)	1,627.2 M/T	1,606.0 M/T	21.2 M/T
DO (M/T)	77.6 M/T	75.0 M/T	2.6 M/T
FW (M/T)	120.9 M/T	113.0 M/T	7.9 M/T
DW (M/T)	99.2 M/T	98.0 M/T	1.2 M/T
M/E LO (Ltr)	50,000 Ltr	50,000 Ltr	0 Ltr
M/E Cyl Oil (Ltr)	27,753 Ltr	27,660 Ltr	93 Ltr
G/E LO (Ltr)	3,975 Ltr	3,966 Ltr	9 Ltr
Delay time			11 h - 30 m delay

Figure 109 Calculation of additional consumption such as extra fuel

If the fuel price rises suddenly and then the slow steaming voyage is conducted, actual ROB which is from SOP to deviation start, were often used for calculation. On the other hand, the fuel consumption amount of speed and unit time (day), which is stipulated in Charter Party (hereinafter referred to as C/P), is also used. This will be depending on which numerical value is to be used, which is decided based on mutual agreement in negotiating with the charterers.

5.4.3 The Case of Speed Increase Due to Arranging the Schedule of the Vessel

Like container vessels and so on, as for the ships arranging the schedule is important, it may be the case that deviation occurs during slow steaming voyage and increases speed after solving the problem in order to make arriving at port of destination on scheduled time possible.
With speed increase, of course, the fuel consumption will also increase. The shipowners may receive the claim from the charterers for the consumption amount of extra fuel, which was necessary for speed increase.
Therefore, if the charterers asks shipowners to increase speed it is necessary to calculate the consumption amount of extra fuel, which was necessary for speed increase,.
In the below case study, we would like to explain the case of achieving Hong Kong's ETA (Estimated Time of Arrival) by increasing the speed from the original course return point, which was Toi-misaki.
The Shipowners should calculate how much the amount of extra fuel will be in advance in order to avoid dispute with the charterers later. Reaching mutual agreement by offering information to the chartereres is also important.
How to calculate is shown in Figure 110. Below, the consumption amount of HFO is calculated, but since the consumption of drinking water, fresh water, lubricating oil, etc. will be depending on the speed or navigation time, we should also calculate them.

	Toi-misaki (D) – Hong Kong (E)	Toi-misaki (D) – Hong Kong (H)		(A) - (B) Toi-misaki – Hong Kong Adding by reason of speeding up Consumption of fuel and others
	Slowdown (20 Kts)navigation Consumption	Speed up (25.25 Kts) navigation Consumption	ROB when Hong Kong EOP obeys ETA	
	1,098 nautical mile	1,098 nautical mile		
	by 20.0 kts	by 25.25 kts	22-23 N	
	(A)	(B)	113-54 E	
	2d-07h-00m (55h-00m)	1d-19h-30m (43h-30m)	April 4, 2016 19:00 GMT	11 h-30 m shortening
HFO(M/T)	113.7 M/T	181.2 M/T	1,424.8 M/T	67.5 M/T
DO(M/T)	12.2 M/T	12.2 M/T	62.8 M/T	0.0 M/T
FW(M/T)	20.3 M/T	20.3 M/T	92.7 M/T	0.0 M/T
DW(M/T)	4.1 M/T	4.1 M/T	93.9 M/T	0.0 M/T
M/E LO(Ltr)	0 Ltr	0 Ltr	50,000 Ltr	0 Ltr
M/E Cyl Oil(Ltr)	552 Ltr	552 Ltr	27,108 Ltr	0 Ltr
G/E LO(Ltr)	57 Ltr	57 Ltr	3,909 Ltr	0 Ltr

Figure 110　Calculation of additional consumption such as extra fuel of speeding up

5.5　Summary

(1)　The Consumption Amount in the Case of Theoretical Calculation

Generally speaking, it is popular to calculate the estimated time of arrival at the original course return point and ROB, based on the speed stipulate in C/P and daily consumption amount of fuel. However, there are cases of slow steaming voyage or departure ⇒ R/UPEng., SOP (Start of Passage) and EOP (End of Passage), or the consumption during S/B Engine ⇒ arriving at the port with less fuel amount than the amount stipulate in C/P. There is also a way to excluding these. Everything is the matter to negotiate with the charterers, conclusion is as follows.

Conclusion:

- **Since the charteres and shipowners will discuss and judge, the vessel will report ROB of necessary points**
- **The support team on shore should support the Master so that he will not miss any information.**
- **With the copy of the C/P, ask insurance company or lawyers.**

(2) The Calculation of Off Hire Time

As we have explained in the case study, Off Hire is generally the gap between actual original course return time and estimated passing time of original course return in the case of direct sail without deviation, not from deviation start to original course return. NYPE46 also has the provision saying that Off Hire is “time thereby lost” (net loss time).

However, we also need to consider whether or not the purpose of “disembarkation of emergency patient” will be the reason for Off Hire. In the past precedent, the question was raised of whether or not illness of the crew applied the description “deficiency of men”.

Since the description “any other cause preventing the full working the vessel”, is included in NYPE 46, Time Charter 7th Edi. says that it will “probably” be Off Hire, which we should pay carefully attention.

Therefore, in order to avoid the debate which is not the main topic, changing the cause of deviation in the case study to the typical reason of Off Hire such as “the trouble of ship, equipment, or some other fixture” is one of the options.

Conclusion:

- **Like the consumption amount of fuel in the case of theoretical calculation, asking the insurance company or lawyers will enable the shipowner to reduce his work and save the time.**

(3) Important Points in the Case of Speed Increase

During deceleration voyage, if speed is increased in order to have the emergency patient disembarked, or if speed is increased after returning to original course in order to follow ETA, the consumption amount of fuel may become a problem.

It basically depends on the negotiation between the shipowners and charterers. However, since the shipowners occasionally increases speed based on their decision during an emergency and the emergency patient, which will cause deviation, the shipowners report to the chartereres and start negotiation.

On the other hand, if the shipowners does not increase speed based on their own idea, it is necessary to consult with the chareterers at the point of deviation in case of emergency. However, in the case we have introduced this time, regarding the consumption amount such as speed increase for the distance from Shiono Cape to Kobe, it will be covered by the shipowner.

Therefore, regarding the original course return, the shipowners should report the new ETA (for example, two ETAs, such as in the case of continuing deceleration voyage and in the case of voyage with maximum speed) to the charterers and should ask them to make a judgement.

That is, whether we should increase speed or not should be judged by charterers and it is important not to increase speed based on the arbitrary decision of the shipowners or vessel. It goes without saying that close contact is important in practice.

Conclusion:

- **While there are cases that are difficult to consult with the chareterers, ship-owners should ask the insurance company or lawyers is one of the options.**
- **In the case of increasing speed, whoever decided its importance is crucial. Therefore, the shipowners and chareterers should discuss in practice, and then give instructions to the vessel.**

(4) Off Hire Insurance

In conventional loss of earning insurance, the loss of time caused by a ship accident such as collision will be covered by insurance. Besides, engine trouble can be added in here as a special contract.
On the other hand, other crew casualties, lifesaving and so on will sometimes be covered by the “new off hire comprehensive compensation insurance”, which is a service of a certain non-life insurance company (new insurance).
Including this new insurance, that is called the Off Hire insurance. However, it is important to confirm the contents of coverage, since the coverage will be different depending on contract

Conclusion:

- **There are several types of contracts and special contracts in Off Hire insurance. Be sure to consult with the person in charge of insurance company and get an explanation from them.**

5.6 Relationship Between Fuel Consumption and Speed

Since the consumption amount of fuel and speed have the following relationship, we have to be careful about calculating the consumption amount of fuel in the case of increasing speed.

(1) The Relationship Between Speed and the Consumption Amount of Fuel Per Unit Time

- Ship resistance (R) is proportional to the square of vessel speed (V) and two-thirds of the square of displacement (D).

$$R \propto V^2 \qquad\qquad R \propto D^{\frac{2}{3}}$$

- As output (W) is what moves R Vm for one second, it is proportional to the consumption amount of fuel per unit time (B: ton/hour). That is, B: ton/hour is roughly proportional to the cube of power requirement.

$$W \propto RV \propto V^3$$

If the consumption amount of fuel per unit time is Ba (ton/hour) when vessel speed is Va, the consumption amount of fuel per unit time Bb (ton/hour) when vessel speed is Vb can be calculated with the following formula. That is, **The consumption amount of fuel per unit time will be the cube of speed ratio.** (speed twice: 10 knots ⇒ If 20 knots, the consumption amount of fuel will be 8 times the amount when 10 knots)

$$Ba = K \times Va^3 \quad \Rightarrow \quad K = \frac{Ba}{Va^3}$$

$$Bb = K \times Vb^3 \quad \Rightarrow \quad K = \frac{Bb}{Vb^3}$$

$$\Rightarrow \frac{Ba}{Va^3} = \frac{Bb}{Vb^3} \Rightarrow Bb = \frac{Ba}{Va^3} \times Vb^3$$

K : constant

$$Bb = Ba \times \left(\frac{Vb}{Va}\right)^3$$

(2) The Relationship Between Speed and the Consumption Amount of Fuel in the Case of Sailing a Certain Distance With a Certain Amount of Displacement.

If we sail the same distance with increasing speed, compared with before increasing speed, navigation time will be shortened. Therefore, the following will be established.

- All the amount of fuel (F) needed for sailing a certain distance (Dist) with a certain amount of displacement will be indicated as the product the consumption amount of fuel per unit time by necessary time. Since necessary time, however, will be inversely proportional to speed, **which will be proportional to the squared amount of speed.**

Necessary time by $Va = \frac{Dist}{Va}$ time

Necessary time by $Vb = \frac{Dist}{Vb}$ time

Fuel consumption by Va: $$Fa = \frac{Dist}{Va} \times Ba = \frac{Dist}{\cancel{Va}} \times K \cdot Va^{\cancel{3}\,2} = K \cdot Dist \cdot Va^2$$

Necessay time by Vb: $$Fb = \frac{Dist}{Vb} \times Bb = \frac{Dist}{\cancel{Vb}} \times K \cdot Vb^{\cancel{3}\,2} = K \cdot Dist \cdot Vb^2$$

$$K \cdot Dist = \frac{Fa}{Va^2} = \frac{Fb}{Vb^2}$$

$$Fb = Fa \times \left(\frac{Vb}{Va}\right)^2$$

5.7 Example Format of Sea Protest

Regarding the case study , we would like to introduce the reference example of Sea Protest as follows.
Since this is not an accident that occurs frequently, you can also reduce the work load such as making a maritime accident report by consulting the insurance company.

= Reference Example =

During the 18th outward voyage, a vessel loading 750 containers and 10,225 kilotons, forward draft 8.85 meters, and stern 10.18 meters, departed from the port of Tokyo on 1 April 2016 (Japan time). While heading for Hong Kong, in the sea area, nearby 33:25 north latitude and 136:35 east longitude, a crew experienced discomfort in his right lower quadrant of abdomen. As emergency measures, at 10:00 on 2 April (Japan time), for the sake of emergency disembarkation at Shiono-misaki (33:14 north latitude and 135:43 east longitude) the vessel headed for the port of Kobe, changing the scheduled traffic route. From 15:00 to 16:30 on 2 April (Japan time), we had him disembarked at the port of Kobe.

Afterwards, at 08:30 on 3 April (Japan time), the vessel returned to the scheduled traffic route off Toi-misaki (32:13 north latitude and 131:30 east longitude), and headed for Hong Kong. We would like to report the above, since the vessel changed scheduled traffic route for the above reasons.

European container vessels

Summary

From chapter 1 to 4, we have explained statistics, case studies, risk prediction, and resource management. As you see from the case studies, the cause of accident has been composed of several factors.
In other words, the accident occurred due to a series of “error” management conditions: the tiny mistake caused by lack of understanding for system, and the incorrect Planned Maintenance System caused by lack of understanding for reason and purpose of maintenance.
Therefore, the preventive measures were not able to solve the problem with only one correction to make. As a result, we could not find a landmark solution just like a miracle drug. Thus, we should be on our guard and protect ourselves, not missing error chain so that we can prevent accidents.
Important point is to make efforts to establish something extra [+α], which is state monitoring, maintenance, and educational system, as well as ERM ability requirements.

In short, we don’t have any miracle drug, and it is necessary to make steady efforts step by step.

In chapter 5, we have explained how to deal with deviation, but when accidents occur, the vessel will be so busy that the crews will have many things to do. In order to grasp the situation, the shipowners cannot but depend on the vessel’s report, they should establish the system that support team on shore, and can reduce and assist the work in the vessel as much as possible.

To make steady efforts step by step