Conclusion

Safety is only a result that avoids all dangers. Thus, it is natural to think ‘safety does not exist’ in the world. If the precision of planning to avoid danger becomes greater, it will be closer to realizing safety. Because of that, it cannot disregard the PDCA method.

Therefore, the method for measuring the Safety Management System and the SMS manual is very rational. However, in order to organize this system which is embedded within safety management performance, it requires a tremendous amount human energy. It is essential that we think of this energy as safety culture. While thinking of this culture, it needs to consider the pyramid consisting of three items of ‘Science’, ‘Technology/Skill’ and ‘Technician’ which support safety.

Keeping that in mind, in analysing these cases, if it does not analyse by stepping into the issue of ‘why such risky action was taken?’ with the Human Characteristics and, further, by taking a preventive measure, questioning ‘what it should do in order not to be involved’, a similar accident could reoccur.

It is important to precisely analyse the individual sequence of events before an accident occurs, to extract and examine the insufficient management which lays hidden in the background and to lead effective preventive measures in order to exclude those factors. The author hopes you now recognize the importance of ‘preventative type’ safety measures. Last but not least, for safe navigation, the importance of condition monitoring such as basic watch ‘lookout’ and ‘round watch’ should always be at the forefront of ones mind.

List of References

(1) Marine Accident and Incident Reports by Japan Transport Safety Board of Ministry of Land, Infrastructure, Transport and Tourism
Report search site：http://jtsb.mlit.go.jp/jtsb/ship/index.php

(2) Class NK
- Class NK bulletin ’Summary of damage’ from fiscal year 2009 to 2014
- No. 292, 296, 301, 304, 309 and 312

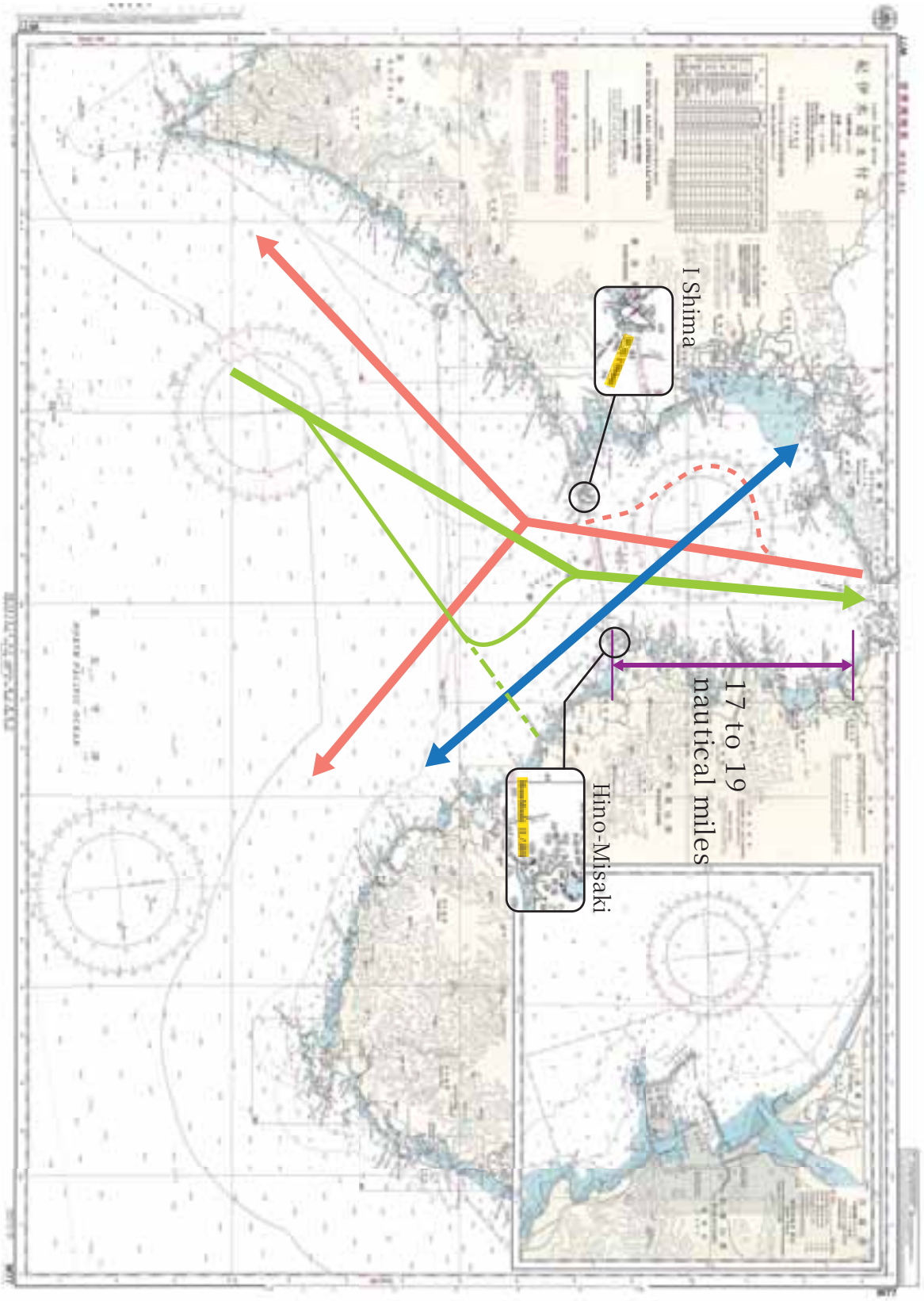
(3) Nautical Charts published by the Japan Coast Guard and the Japan Hydrographic Association
- Fig. 30 The Kii Suido (Strait)
- Fig. 31 Tokyo Bay

List of Attachments

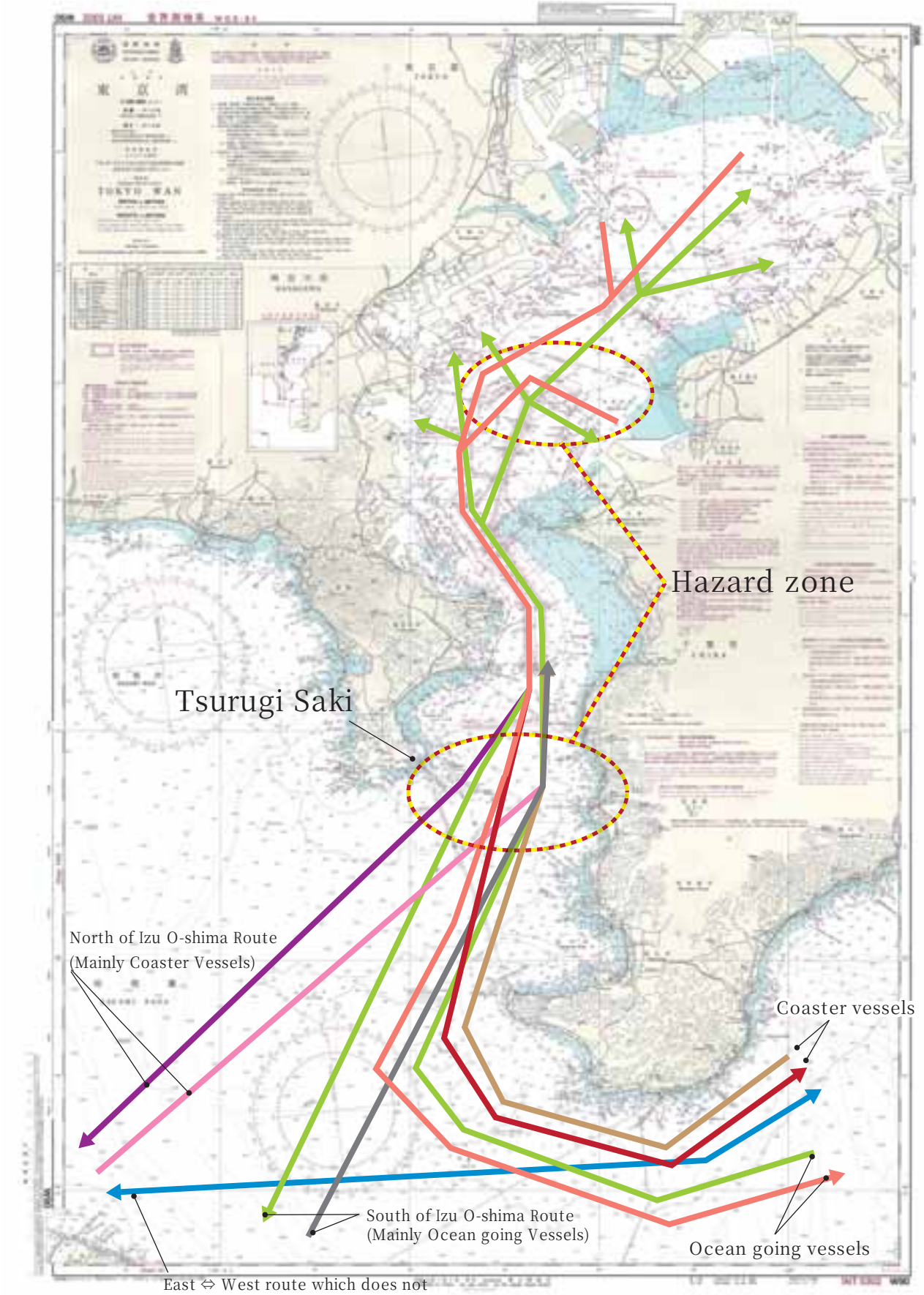
Attachment ①：The Kii Suido (Strait)　Traffic System Chart (Enlarged Drawing of Fig. 30)
Attachment ②：Tokyo Bay　Traffic System Chart (Enlarged Drawing of Fig. 31)
Attachment ③：4 Cycle Diesel Engine of Vessel
Attachment ④：Additional Engine Trouble (3 Cases)

Attachments

Attachment ① : The Kii Suido (Strait)　Traffic System Chart (Enlarged Drawing of Fig. 30)



Attachment ② : Tokyo Bay Traffic System Chart (Enlarged Drawing of Fig. 31)



Attachment ③ : 4 Cycle Diesel Engine of Vessel

The basic structure of a ship's 4 cycle diesel engine is identical to that of a car engine. As shown in Fig. 50, it constitutes a power output section (upper part) and driving mechanism (lower part). The power output section is comprised of a cylinder liner and piston. This section is where the supplied fuel combusts. The piston slides up and down within the cylinder, which has a combustion chamber located at the top. Fuel is supplied to the combustion chamber, where power is generated via the combustion of fuel. The driving mechanism constitutes a connecting rod and a crankshaft. This section generates propulsion powered by the engine. The 'power' which the piston obtains in the combustion chamber is transmitted to the crankshaft via the connecting rod. The reciprocating motion of the piston is transferred into rotary motion via the crankshaft. This then becomes the vessel's propulsion power, which is the driving power. If the power output section or driving mechanism is damaged, propulsion power cannot be obtained. Therefore, this affects the ship's navigation.

The characteristics of a crankcase will be described. The crankcase can be defined as a box-shaped housing where the crankshaft is stored. Because the housing has a door, it is possible to conduct internal inspection. The door is small, however, crew can monitor the state of the engine's internal structure sufficiently by using a hand mirror and adjusting the position of the crankshaft.

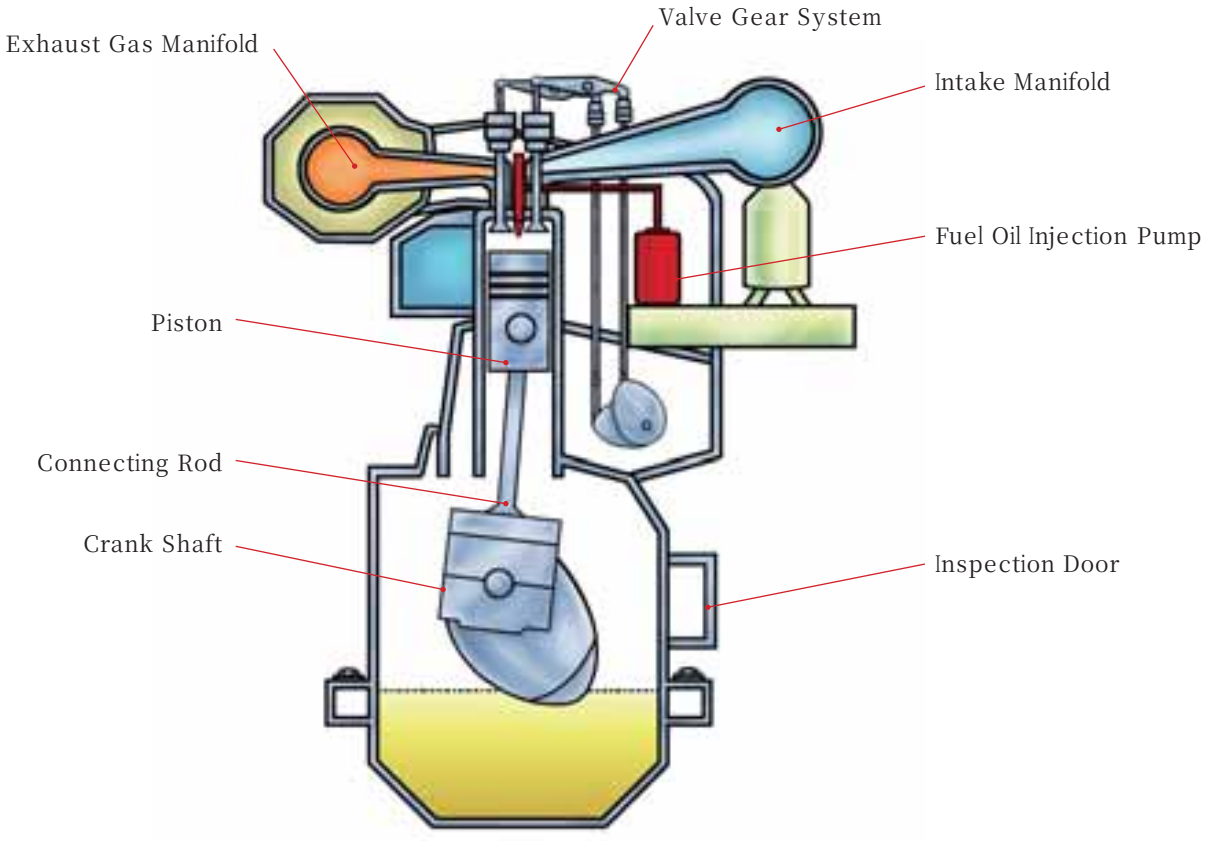


Fig. 50　4 Cycle Diesel Engine of Vessel

Attachment ④ : Cases of Additional Engine Troubles (3 Cases)

【Reference Information】

According to Marine Accident and Incident Reports by the Japan Transport Safety Board, three cases of operation disability due to engine trouble, together with our accident analysis will be introduced.

【Case ④　Accident summary】

On starting up the main engine in preparation for entering port following anchorage, there was an abnormal noise.
As a result of the inspection of each of the parts carried out by the crew, it was acknowledged that water was gushing out from the No.6 cylinder indicator valve.
Due to the leakage of cooling water into the cylinder, caused by a broken hole in the turbo charger casing, following main engine start-up, this led to the bending and consequent damage of the connecting rod.

Analysis by Japan Transport Safety Board		Analysis by our Club		
Items	Details	Items	Details	Remarks
Cause Analysis	<Relationship with hull, engine, etc.> Yes <Analysis of detected items> ● Regarding the vessel, which was anchoring, due to a hole that appeared in the turbo charger casing of the main engine, cooling water leaked into the cylinder, she heaved up anchor and tried starting the main engine in preparation work for entering port, the connecting rod had sustained bending damage and the main engine could not operate, which presumably led to service incapacity. ● When measuring the thickness of the turbo charger casing, which was carried out approximately two months prior to this incident, it was detected there was a thin part. If the use limit value and past history were confirmed and the casing had been replaced on this occasion, the occurrence of such an incident may have been prevented. ● It is presumable that the trouble can be prevented, if the blowing air operation is carried out by opening the indicator valve before staring the main engine.	Direct cause	Due to a hole that appeared in the turbo charger casing of the main engine, cooling water leaked into the cylinder. When starting main engine operation, the main engine could not operate because the connecting rod sustained bending damage.	(Report)
		Indirect cause	Although the following instruction existed, it was not strictly adhered to. ● Instruction for maintenance of turbo charger ● Main engine operation instruction There was no recognition as per below: ● Recognition 'of development to engine trouble, when using a casing that is beyond the its usage thickness limit' ● The recognition of 'why does the thickness wear and tear of the casing progress?' ● The recognition of 'whether bending damage of the connecting rod will be sustained by liquid compression when the main engine is suddenly started' ● Could not recognise the signs of an accident by round inspection?	(Report) (Report) (Assumption) (Assumption) (Assumption)
		Root cause	There were no guidelines as per below: ● ‘ Cooling water treatment guidance that may affect the thickness reduction of the turbo charger'	(Assumption)

Analysis by Japan Transport Safety Board		Analysis by our Club		
Items	Details	Items	Details	Remarks
Preventive measures	The following are considered to be useful items for prevention of similar trouble in the future. ● Measure the thickness of the turbo charger casing and replace with a new one in the event that a thin part beyond use limit is detected. ● Before starting and after stopping the main engine, carry out air blowing operation by opening the indicator valve to check if there is no contamination inside the cylinder. ● Appropriate water quality treatment of cooling water by injecting anti corrosive agent	Preventive measures	(1)A superintendent of the vessel is to issue a safety notice as follows and calls for attention to compliance of work instructions regarding maintenance and engine operation. ● ‘ Strictly utilize maintenance instructions of the ship, in accordance with the maintenance instructions of the turbo charger manufacturer instruction manual'. ● ‘ Operate strictly based on operation instructions of the vessel which were created in accordance with the main engine manufacturer instruction manual.' (2)A superintendent of the vessel must call for attention of the following. A safety poster is available. ● ‘ Importance of round inspection utilizing the five human senses' (3)A superintendent of the vessel is to create the guideline and establish a system of corrosion inhibition. ● ‘ Cooling water treatment guidance that may affect the thickness reduction of the turbo charger' (4)A superintendent of the vessel is to train crew thoroughly as per follows: ● ‘ Helping them understand the structure of a turbo charger, and ask what kind of accident could be predicted in the case of using it beyond the thickness use limit' ● ‘ Why does the thickness of the casing deteriorate through wear and tear? What kind of attention and management is necessary in order to restrain it?' ● ‘ Help them understand the structure of the main engine and ask as to what kind of accident could occur in the case of suddenly starting the main engine when liquid enters the cylinder.' ● ‘ Round inspection utilizing the five human senses'	Engine Management Engine Management Monitoring the situations Engine Management Education Education Education Education

Table 51　Engine Trouble Case ④

《Point of cause》　Breach of maintenance instructions, breach of procedure, lack of education and training, insufficient round inspection, etc.

【Case ⑤　Accident summary】

During navigation, the lubricant oil low pressure alarm for the main engine reverse and reduction gear was activated. Although the electric lubricating oil pump for back-up automatically started, the lubricating oil pressure indicated 0kg/cm2. Once the pump was stopped and re-started, the pressure increased once again, however, it went down immediately following that. Following the result of the overhaul inspection of the LO strainer for reverse and reduction gear by the crew, they abandoned main engine operation, because traces of metallic powder were detected.
Also, as a result of the inspection of the reverse and reduction gear conducted by the engine manufacturer, damage to the needle bearing of the directly-connected LO pump drive gear shaft and in the inner race, in the bush of forward and reverse clutch shaft and bearing metal was discovered.

Analysis by Japan Transport Safety Board		Analysis by our Club		
Items	Details	Items	Details	Remarks
Cause Analysis	<Relationship with crew, etc.> Yes <Relationship with hull, engine, etc.> Yes <Analysis of detected items> ● During its navigation, damage to needle bearing of LO pump of reverse and reduction gear caused the decrease in oil pressure. Due to the shortage of LO supply quantity, the main engine could not operate and it seemed that her service became unavailable. ● The needle bearing of the LO pump in the main engine had been used since her first voyage, and there would be a possibility that the bearing caused the damage because of ageing.	Direct cause	Damage to needle bearing of LO pump of reverse and reduction gear caused the decrease in oil pressure. Then, because of the lack of LO supply quantity, the main engine could not operate.	(Report)
		Indirect cause	(1)Although instructions existed for maintenance of LO pump directly connected to driving shaft of reverse and reduction gear of main engine, there were not strictly adhered to. (2)There was no recognition as per below: ● Recognition 'of development to engine trouble, when using a needle bearing of LO pump that is beyond the time by when it should be replaced.' ● Could not recognise the signs of an accident by round inspection?	(Report) (Assumption) (Assumption)
		Root cause	The following instructions for maintenance were not established. ● 'Check operation details such as check valve in LO system'	(Assumption)

Analysis by Japan Transport Safety Board		Analysis by our Club		
Items	Details	Items	Details	Remarks
Preventive measures	The following are considered to be useful items for prevention of similar trouble in the future. ● To inspect the needle bearing by overhauling the LO pump of reverse and reduction gear regularly and to exchange the bearing within the time described in the instruction manual.	Preventive measures	(1)A superintendent of the vessels creates the following guideline of maintenance and instructs those on the whole of the vessel thoroughly. ● 'Regarding the confirmation of small-part operations such as check valve, specifically what and how should it be carried out?' (2)A superintendent of the vessel is to issue a safety notice as follows. ● 'Strictly utilize maintenance instructions of the ship, in accordance with the maintenance instructions of the LO pump manufacturer instruction manual.' (3)A superintendent of the vessel must call for attention of the following: ● 'Importance of round inspection utilizing the five human senses' (4)A superintendent of the vessel is to train crew thoroughly as per follows: ● 'Help them understand the structure of the LO pump, and ascertain as to whether they know what kind of accident could occur in the event of using it beyond its replacement hours.' ● 'Round inspection utilizing the five human senses'	Understanding of structure Engine Management Monitoring the situations Education Education

Table 52 Examples of Engine Trouble ⑤

《Point of cause》 Breach of maintenance instruction, poor control of check valve (backflow prevention) in LO system, lack of education and training, insufficient round inspection, etc.

【Case ⑥　Accident summary】

During navigation, there was an abnormal noise from the engine room, and the crew discovered the leakage of LO in the vicinity of main engine No.3 cylinder. When the crew overhauled the cylinder head cover of No.3 cylinder, following the main engine manufacturer's instruction, the crew discovered one of two missing intake valves.
As a result of overhauled work on the cylinder head conducted by the main engine manufacturer, it was detected that one intake valve cotter passed through the top part of the piston by dropping into the cylinder, after the cotter became disengaged from the mounting part due to wear and tear of a piece of cotter of the intake valve (two-piece fittings which are fixed in order not to drop the valve by being settled in the artificial groove portion on the valve shaft part of the intake/exhaust valve). In addition, through further detailed inspection, damage to the turbine nozzle ring and rotor of the turbo charger was discovered.

Analysis by Japan Transport Safety Board		Analysis by our Club		
Items	Details	Items	Details	Remarks
Cause Analysis	＜Relationship with hull, engine, etc.＞ Yes ＜Analysis of detected items＞ ● During navigation, a piece of cotter which was used in the intake valve of main engine No.3 cylinder dropped off through wear and tear and the intake valve fell into the cylinder. Then, damage to the piston and so forth was caused by it being sandwiched by both flanks of the cylinder head and top part of the piston, which, presumably, meant that the main engine could not operate properly and hence the termination of the shipping service on that occasion.	Direct cause	● A piece of cotter which was used in the intake valve of main engine No.3 cylinder dropped off through the wear and tear and the intake valve fell into the cylinder.	(Report)
		Indirect cause	● No recognition of 'when the cotter and cotter contact surface of the intake and exhaust valve will chafe leading to engine failure'	(Assumption)
			● Could not recognise the signs of an accident by round inspection?	(Assumption)
		Root cause	The following guideline was not established. ● Guidelines for maintenance regarding 'overhauling, measurement and recording of each part, from the important equipment, should start after vessel purchase'	(Assumption)
			● Guidance of maintenance 'what we do with which parts specifically, regarding the detailed maintenance of accessories and related parts'.	(Report)
			● Guideline of maintenance of 'measurement inspection in order to grasp wear and tear at the part of the cotter, when carrying out overhaul maintenance'.	(Assumption)

Analysis by Japan Transport Safety Board		Analysis by our Club		
Items	Details	Items	Details	Remarks
Preventive measures	The following are considered to be useful items for prevention of similar trouble in the future. ● When maintaining by opening and closing cylinder head of main engine, thoroughly inspect the cotter and cotter contact surface of the intake and exhaust valves.	Preventive measures	(1)A superintendent of the vessel is to create the guideline and establish a system of detailed inspection maintenance. ● Guidelines for maintenance regarding 'overhauling, measurement and recording of each part, from the important equipment, should start after vessel purchase' ● Guidance of maintenance 'what we do with which parts specifically, regarding the detailed maintenance of accessories and related parts'. ● Guideline of maintenance of 'measurement inspection in order to grasp wear and tear at the part of cotter, when carrying out open maintenance'. (2)A superintendent of the vessel must call for attention of the following: A safety poster is available. ● 'Importance of round inspection utilizing the five human senses' (3)A superintendent of the vessel is to train crew thoroughly as per follows: ● 'Allow the crew to learn about the structure around the cylinder cover and educate them as to what kind of trouble may occur in the event of maintenance failure' ● 'Round inspection utilizing the five human senses'	Engine Management Engine Management Understanding of structure Monitoring the situations Education Education

Table 53　Examples of Engine Trouble ⑥

《Point of cause》　No overhaul of important equipment, insufficient time management for maintenance, under-management of parts regarding accessories of important equipment, lack of education and training, insufficient round inspection, etc.

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

● Principal Office（Tokyo） 2-15-14, Nihonbashi-Ningyocho Chuoh-ku, Tokyo 103-0013, Japan
Tel：03-3662-7229 Fax：03-3662-7107

● Kobe Branch 6th Floor Shosen-Mitsui Bldg. 5, Kaigandori Chuoh-ku, Kobe, Hyogo 650-0024, Japan
Tel：078-321-6886 Fax：078-332-6519

● Fukuoka Branch 6th Floor Meiji-Dori Business Center 1-1, Shimokawabata-machi, Hakata-ku, Fukuoka 812-0027, Japan
Tel：092-272-1215 Fax：092-281-3317

● Imabari Branch 2-2-1, Kitahorai-cho, Imabari, Ehime 794-0028, Japan
Tel：0898-33-1117 Fax：0898-33-1251

● Singapore Branch 80 Robinson Road #14-01B SINGAPORE 068898
Tel：65-6224-6451 Fax：65-6224-1476

● Japan P&I Club (UK) Services Ltd 38 Lombard Street, London EC3V 9BS U.K.
Tel：44-20-7929-3633 Fax：44-20-7929-7557

Translated by: YUZEN Translation LLC Illustrator: Ms. Makoto Kiryu