Reference Information

(1) Planned Managing System, Main Engine Inspection Measurement Sheet, Check List, Reminder (Technical Information) etc.

(refer to Reference ⑥ - ⑩)

About Planned Maintenance System, each company strictly stipulates in SMS manual with the format shown in Reference from ⑥ to ⑩ .
In machinery manufacturer's instruction manual, the recommended interval of maintenance is described and recommended for each component parts. Its purpose is that crew can operate the machinery safely and efficiently. However, the load on machinery will be depending on the operation environment such as operation load, operation pattern, sea service area, and fuel oil and lubricating oil to be used, and etc.

Therefore, firstly crew must calculate the machinery working hours on board. And then they must comprehensively compare and evaluate its state based on the manufacture instruction manual, the working hours, and the measurement record at periodic overhaul. As we recommended in chapter 1, about the better maintenance, they should check both the instruction manuals and the most updated service news which are summarised the experience, lessons learned, regulations and etc..

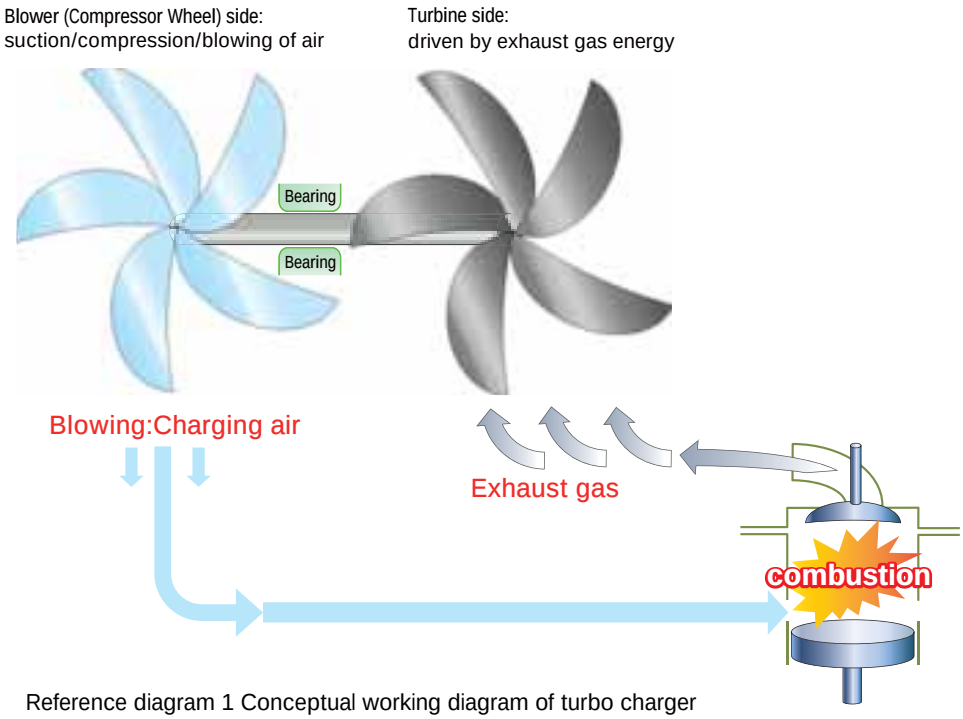
Moreover, firstly the shipmanagement department also should comprehensively assess the machinery state, each company's individual experience, the crew technical level, and etc. based on principles of science and technology (engineering). So then some companies study and individually adjust the maintenance interval which is earlier or later than the manufacturer's recommendation, based on the result of each company's assessment and management policy by their own responsibility and know-how.
That is, it is the know-how of maintenance. Once again, this must be one of the best management methods to avoid trouble. However, it must not be the know-how with lowest safety.

(2) Reference Information

We would like to explain the technical information for the people who are not familiar with or do not have the technical back ground.

① Turbo Charger

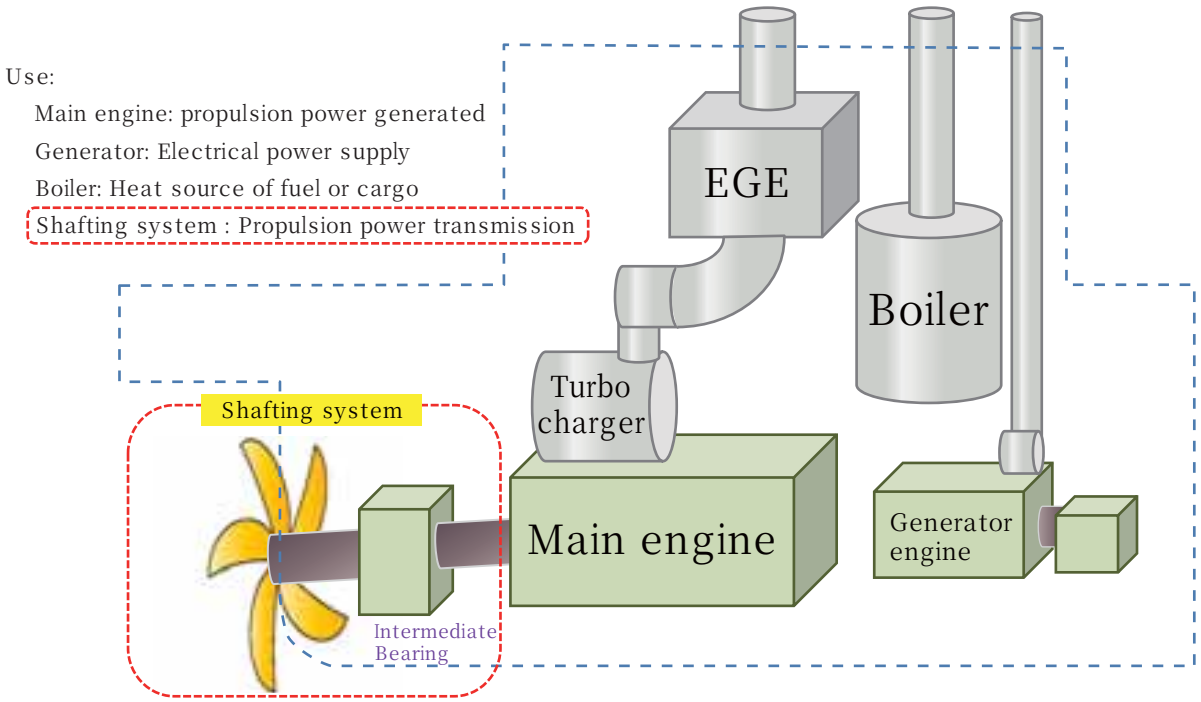
A turbo charger is ultra-high-speed rotary machine (turbine with 10,000 rpm or more) to supply a lot of combustion air to the engine using kinetic energy of the exhaust gas, which is also used for automobile engine.
The mechanism is the one which has pinwheels at both ends of the shaft, which is supported by bearing. The structure is simple; after the combustion in the engine, the exhaust gas will be sent to one side of the pinwheels (turbine) so that the momentum of exhaust gas (kinetic energy) will be used efficiently. Then, the shaft which rotates with pinwheel will suction air with the other pinwheel (compressor wheel), compresses air it, and blow air it into the engine. However, above mentioned high-speed rotation and using exhaust gas becomes the cause of trouble.



Reference diagram 1 Conceptual working diagram of turbo charger

② Intermediate Bearing

Intermediate shaft conveys the power generated in the main engine to propeller. (red dashed line of Reference diagram 2) Intermediate bearing stops that the intermediate shaft rotate like jump rope with deflection caused by its own weight and centrifugal force. It also maintains the shaft centre to convey axial rotation force to propeller precisely without loss, and supports shafts its own weight.



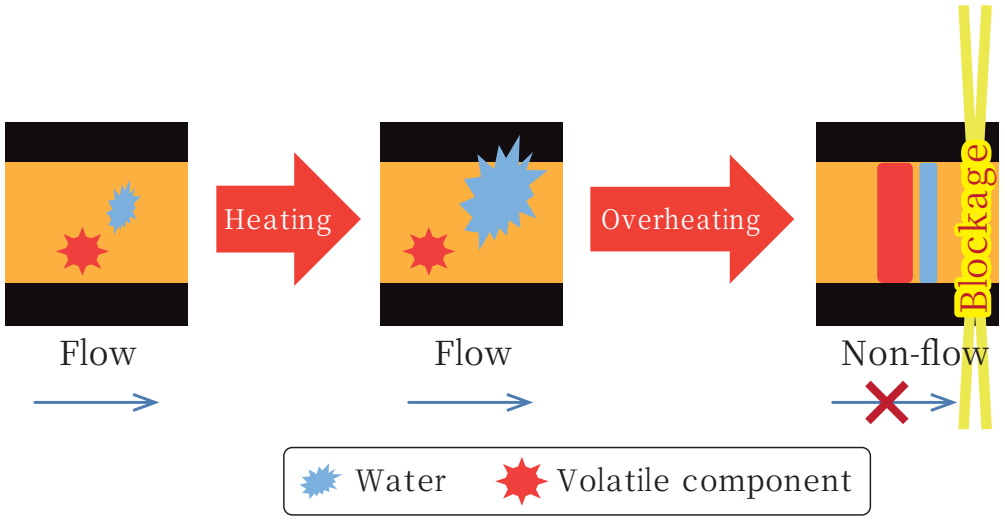
Reference diagram 2 conceptual diagram of Intermediate bearing

③ Marine Fuel Oil

③-1 HFO（Heavy Fuel Oil）・・・Why to be Heated?

- Solid oil with low temperature or normal temperature
  ⇒ it is a similar image to lard or butter which melts with heating while cooking.
- HFO is the product that we diluted for appropriate viscosity by mixing light oil with residuals oil leftover from crude oil fractions like asphalt.
  Under the normal temperature, HFO is no fluidity in a solid status.
- Therefore, if you don't heat HFO up from 120 ℃ to 130 ℃, it will not get to the state or viscosity of stable combustion.

Reference diagram3-1
Heating Butter



Reference diagram 3-2 Mechanism of vapour lock

③-2 MDO(Marine Diesel Oil)・・・Why Does Too Much Heating Cause Vapour Lock?

- MDO: As the viscosity of MDO is low enough, we can use MDO under the normal temperature, without heating. It includes volatile components and water.
- If we heat it to around 100 degrees, volatile components will be gasified, water will be evaporated.
- If the gas and water vapour are expanded in the pipe, after overheating the flow of MDO will be blocked .

③-3 TFO (Thin Fuel Oil)

- If we add fuel of low viscosity to that of high viscosity, the oil will have intermediate properties of two oils, becoming thin, and the viscosity becoming lower.
- This image is similar to a solution made by mixing smooth and fresh water with concentrated Calpis (Japanese milk-based soft drink) or liquid detergent.

④ Photographs

The following photographs excerpts from “summary of damage” in bulletin of Class NK.

④ - 1 Broken / Damaged /Scratch of Turbocharger Reference Materials *4, *8

Turbo charger

a) Broken nozzle ring.
Damage requiring towing
in fiscal year 2014 / reference *4

b) Broken turbine blade
Damage leading to speed reduction
in fiscal year 2014 / reference *4

c) Damaged nozzle ring (Over run)
Damage leading to speed reduction
in fiscal year 2014 / reference *4

d) Scratch on turbocharger rotor shaft
Damage leading to speed reduction
in fiscal year 2014 / reference *4

e) Scratch of impeller due to contact with casing
Damage leading to speed reduction
in fiscal year 2013 / reference *8

f) Broken turbine blade
Damage leading to speed reduction
in fiscal year 2013/ reference *8

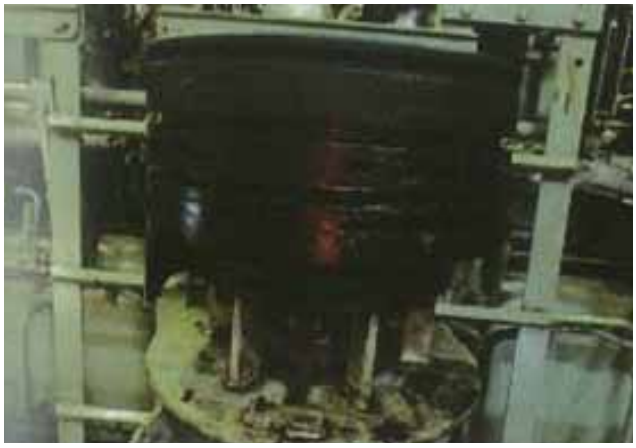
④-2 Broken / Damaged/ Wornout of Cylinder Unit related Parts

・・・Reference Materials *4, *8, *9

Combustion chamber

a)Broken piston ring
Damage requiring towing
in fiscal year 2014 / reference*4

b) Wornout cylinder liner
Damage requiring towing
in fiscal year 2014 / reference*4



c) Damaged piston (Blow-by)
Damage requiring towing
in fiscal year 2013 / reference*8

d)Broken piston ring
Damage requiring towing
in fiscal year 2013 / reference*8

e) Broken piston ring
Damage leading to speed reduction
in fiscal year 2012 / reference*9

f) Wornout plunger
Damage leading to speed reduction
in fiscal year 2012 / reference*9

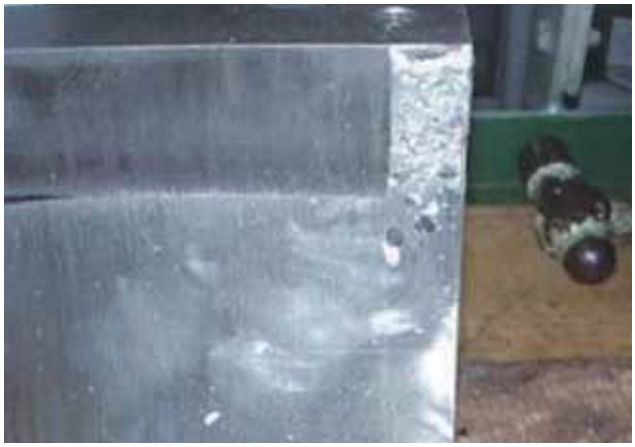
④-3 Burnout / Damage of Shafting Arrangement System (Intermediate Bearing & CPP)

・・・Reference Materials *8,*9,*10

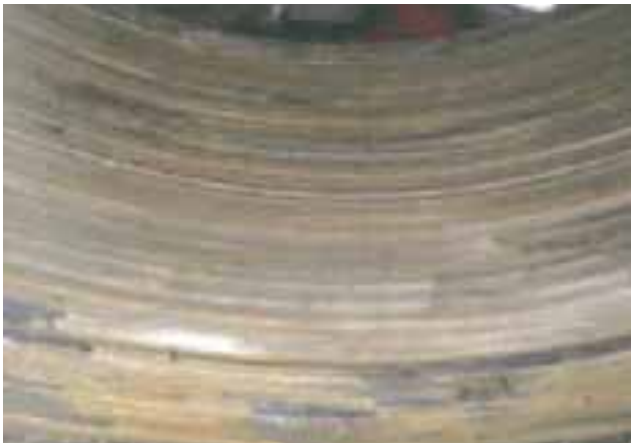
Shafting

a) Burn-out Intermediate shaft bearing (Over-heated)
Damage requiring towing
in fiscal year 2013 / reference*8

b)Broken intermediate shaft
Damage requiring towing
in fiscal year 2012 / reference*9



c) Burn-out Intermediate shaft bearing metal(Over heated)
Damage leading to speed reduction
in fiscal year 2012 / reference*9



d) Burned-out intermediate shaft bearing metal (Over heated)
Damage leading to speed reduction
in fiscal year 2011 / reference*10

e) Burned-out intermediate shaft bearing metal (Over heated)
Damage leading to speed reduction
in fiscal year 2011 / reference*10

f) Bent and damaged guy rod of CPP
Damage leading to speed reduction
in fiscal year 2011 / reference* 10

List of References

*1) Japan Coast Guard “Current State and Countermeasures of Maritime Accidents” 2009 - 2014

*2) Japan Marine Engineers' Association club bulletin No.831 Prefatory note “Engine trouble and human factors” Masaru Nomura

*3) Japan Marine Accident Tribunal “Report of Marine Accident ” 2009 - 2014

*4) Class NK club bulletin No.312 “Summary of damages in 2014”

*5) Marine Accidents Inquiry Agency “Analyse of maritime accidents of coastal cargo ship ~ vol.2 stranding・engine trouble~2005”

*6) Made by our Club, based on Class NK club bulletin No292, 296, 301, 304, 309, 312 “Summary of damages” 2009 - 2014

*7) The Japan Institute of Marine Engineering “Damage accident & cause of turbo charger” by Masaki KawaseVol.51 No.2 (2016) P76-P82

*8) Class NK club bulletin Summary of damages 2013 No309

*9) Class NK club bulletin Summary of damages 2012 No304

*10) Class NK club bulletin Summary of damages 2011 No301

*11) Class NK club bulletin Summary of damages 2009 No292

*12) DVD “Marine Boiler Water/Cooling Water Management and Distilling plants” produced by JSU, IMMAJ, JMEA

*13) Kaibundo Publishing Co., Ltd. “Basic and Practice for Marine Boiler” joint authors, Yoshiharu Itami, Eiichi Nishikawa, Masayoshi Umeda

*14) DVD “Management of Marine Fuels and Lubricating Oils” produced by JSU, IMMAJ, JMEA

*15) –Marine Fuel- for Large & Medium Diesel Engine of Marine and Land. How to use the low grade fuel oil and air pollution Nobuyuki Awai, Osamu Hanashima, Saiji Yokosawa [authors] SANKAKIDO publishing Co.,Ltd.

*16) The Japan Shipping Exchange, Inc. The Mariner’s Digest 2007 “Domestic Laws are Much STRICTER than MARPOL”

*17) DVD “BUNKERING” produced by JSU, IMMAJ, MOL Engineering.

*18) DVD “Engine-room Resource Management (ERM)” General Incorporated Foundation, The Maritime Human Resource Institute

*19) Courtesy of Capt. S. Q Naqvi - Petro Inspect (Bunker Detective)

*20) Japan P&I Loss Prevention Bulletin “No.35 Thinking Safety =Bridge Resource Management and Engine room Resource Management=”

List of Attachment

Reference No.	Reference name	Figure number
Reference ①	Example of boiler water control record book (monthly) (Boiler Water and Cooling Water Analysis and Cooling Water Treatment Record)	Figure 43
Reference ②	Estimated viscosity when mixing HFO and MDO	Figure 54
Reference ③	Relationship between Temperature and Viscosity for Marine Fuels	Figure 55
Reference ④	Bunkering plan (sample)	Figure 74
Reference ⑤	Letter of protest (sample: English ⑤)	Chapter 3.3
Reference ⑥ -1, 2	Main Engine and Disel Generator Working Hours Record (sample: ⑥ -1, 2)	—
Reference ⑦	Piston Grooves & Rings Reading (sample)	—
Reference ⑧	Piston Inspection Record(Sample)	—
Reference ⑨	Piston Inspection items through Scavenge Ports (sample)	—
Reference ⑩	Manufacturer service information (sample)	—

Boiler Water and Cooling Water Analysis and Cooling Water Treatment Record

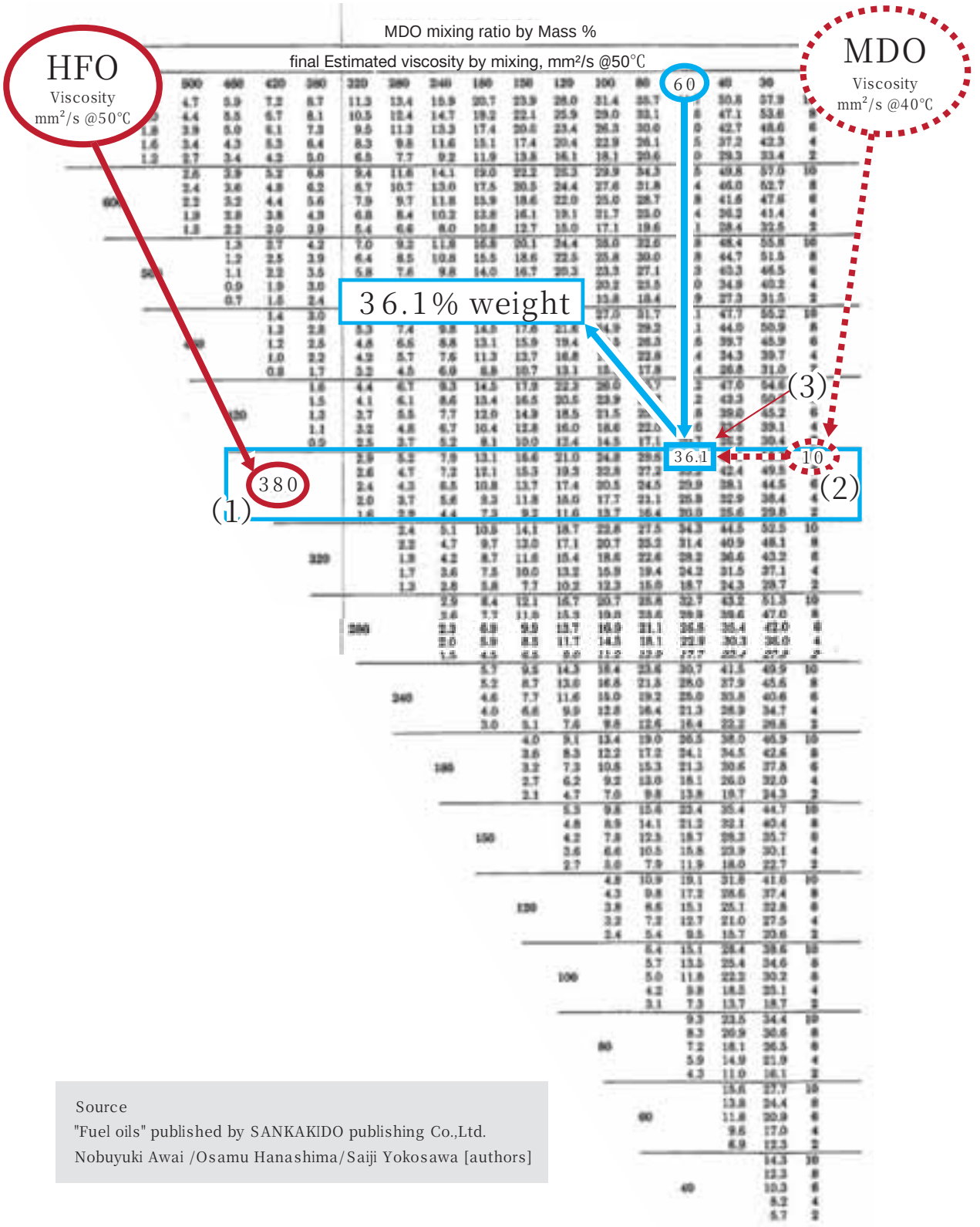
M.V. _____ VOY. _____ Chief Engineer: _____

Date	Boiler Water								Cooling Water						Remarks
	Test Result					Consumed (M.T)	Blow (Tons)	Remarks	Main Engine			Aux Engine			
	PH (PPM)	CL (PPM)	PO4 (PPM)	P-ALK	M-ALK				ppm PH	ppm CL	Supply Quantity m3	ppm PH	ppm CL	Supply Quantity m3	

Figure 43 Example of boiler water control record book (monthly)

Figure 43 Example of boiler water control record book (monthly)

Reference ② (Figure 54)



Source
"Fuel oils" published by SANKAKIDO publishing Co.,Ltd.
Nobuyuki Awai /Osamu Hanashima/Saiji Yokosawa [authors]

Figure 54　Estimated viscosity when mixing HFO and MDO / reference*15

Reference ③ (Figure 55)

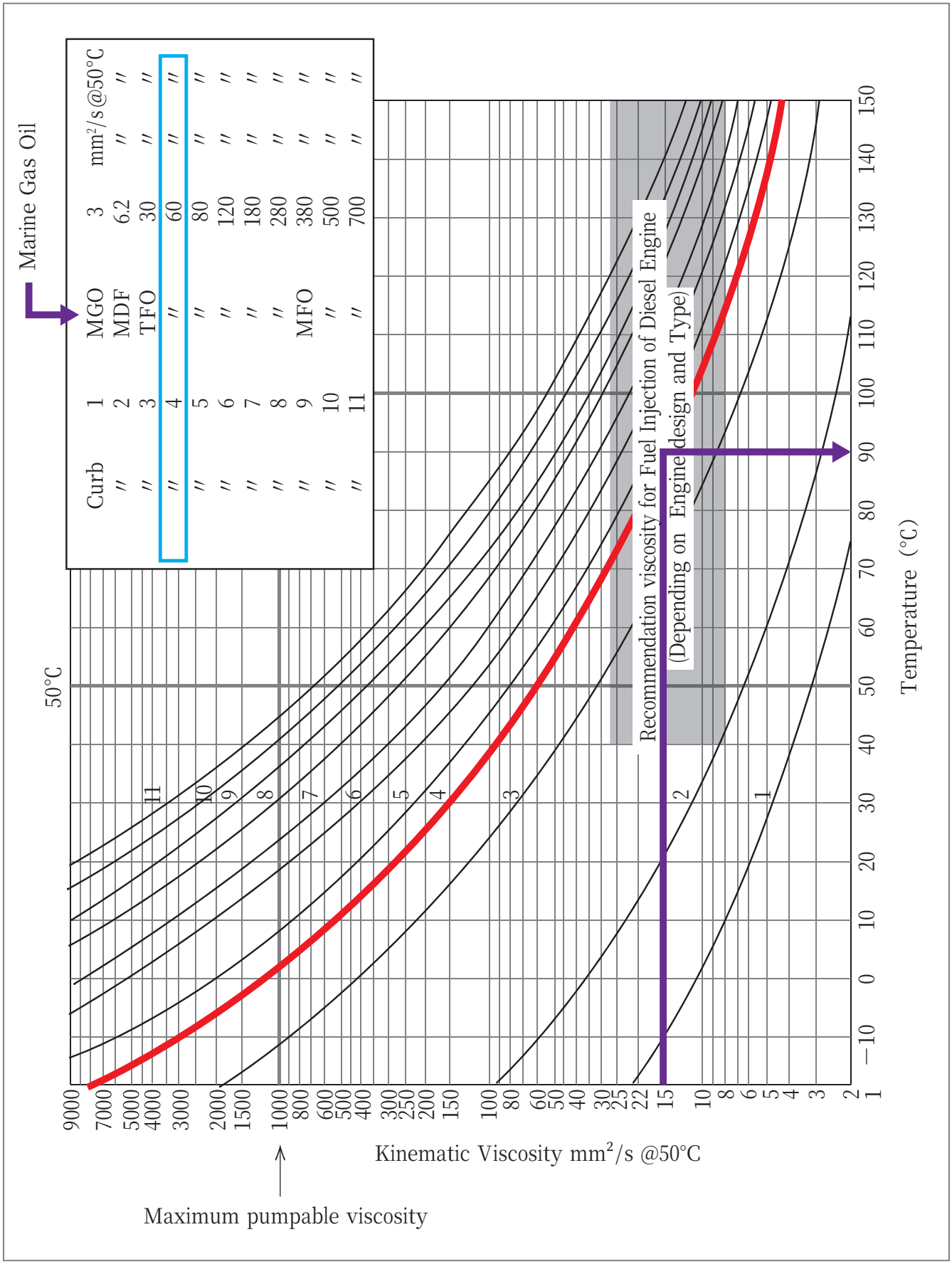


Figure 55 Relationship between Temperature and Viscosity for Marine Fuels / reference*15

Bunker PLAN (Sample)
((LOCATION))

Date: _____

NAME OF OIL: QUANTITY: TIME OF START: DRAFT: F A: TRIM: Rate of loading at start of transfer-
Maximum Rate of loading :
TIME OF STOP: Rate of loading when Topping off:

NAME OF OIL QUANTITY: FILLING TEMPERATURE: Max allowed manifold pressure

TRANSFER SEQUENCE	TANK		FULL CAPACITY -100%		90% OF FULL CAPACITY		QUANTITY OF SCHEDULE			BEFORE TRANSFER		AFTER TRANSFER		QUANTITY OF (KL)	
	NO.	PCS	SOUNDING (CM)	QUANTITY (kl)	SOUNDING (CM)	QUANTITY (kl)	SOUNDING (CM)	QUANTITY (kl)	QUANTITY (kl)	SOUNDING (CM)	QUANTITY (kl)	SOUNDING (CM)	QUANTITY (kl)	OIL TEMP	Q15°C

MASTER:_____ CHIEF ENGINEER:_____ FIRST ENGINEER:_____

Date: insert “issue date”
Vessel NAME : input MV “( )”
VOY Number:
PORT : input “ PORT NAME ”
TO : input “ BARGE NAME ”
  : insert MASTER BARGE NAME”

LETTER OF PROTEST

BUNKER SHORT SUPPLY

Dear Sirs,

This is informed you that on completion of bunkering FUEL OIL (380 cSt) at the port of “input PORT NAME” on DD/MM/YYYY, bunker short supply were found against ship’s requested quantity of bunker oil.

Ships ordered figure (A)	: ○○○ metric tons
Barge figure (B)	: ○○○ metric tons
Difference (Discrepancy between both figure) (C=A-B)	: ○○○ metric tons

Therefore, in behalf of the Owners and Charterers, I, Chief Engineer of MV “( )”, wish to lodge this protest on the difference of the above figures, and reserve the right to take all such further action as may be considered necessary to protect the interests of both parties.

Please kindly acknowledge by signing this letter.
Yours Faithfully,

---------- ----------

MASTER OF “input BARGE NAME” CHIEF ENGINEER OF MV( )

Main Engine and Disel Generator Working Hours Record(sample)

Automatically calculated values (Based on entry from Sheet 2)

M.V. _____ MONTH: _____

UPPER COLUNM: Run Hours at the end of this month
LOWER COLUNM: Recommended Running HR until next O.H

MAIN ENGINE - Working Hour since last overhaul

Cyl' No. / Parts	Maintenance Interval	Cyl 1	Cyl 2	Cyl 3	Cyl 4	Cyl 5	Cyl 6	Cyl 7	Cyl 8	Cyl 9	Cyl 10	Cyl 11	Cyl 12	Remarks
Liner		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Piston		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	TOTAL WORK. HRS
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FO Pump		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
In-take-V		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Exh'V		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
F.O.V.		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Starting・V		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Safety・V		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Indicator V		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
T/C		No.1	0.0		No.2	0.0		No.3	0.0		No.4	0.0		

DIESEL GENERATOR - Working Hour since last overhaul

D/G No. / Parts	Maintenance Interval	D/G 1	D/G 2	D/G 3	D/G 4
Piston		0.0	0.0	0.0	0.0
		0.0	0.0	0.0	0.0
Cyl cover		0.0	0.0	0.0	0.0
		0.0	0.0	0.0	0.0
Intake V		0.0	0.0	0.0	0.0
		0.0	0.0	0.0	0.0
Exh V		0.0	0.0	0.0	0.0
		0.0	0.0	0.0	0.0
FO pump		0.0	0.0	0.0	0.0
		0.0	0.0	0.0	0.0
F.O V		0.0	0.0	0.0	0.0
		0.0	0.0	0.0	0.0
T/C		0.0	0.0	0.0	0.0
		0.0	0.0	0.0	0.0
Crank Bearing Bolt		0.0	0.0	0.0	0.0
		0.0	0.0	0.0	0.0
Main Bearing		0.0	0.0	0.0	0.0
		0.0	0.0	0.0	0.0
Crank pin Bearing		0.0	0.0	0.0	0.0
		0.0	0.0	0.0	0.0
Total W/H		0.0	0.0	0.0	0.0

Remarks

Chief Engineer:_____

Data Entry Sheet for Running Hours

Main Engine - Accumulated Working Hours at the end of last month

Parts \ Cyl' No.	Maintenance Interval	Cyl 1	Cyl 2	Cyl 3	Cyl 4	Cyl 5	Cyl 6	Cyl 7	Cyl 8	Cyl 9	Cyl 10	Cyl 11	Cyl 12
Liner													
Piston													
FO pump													
In-take-V													
Exh'V													
F.O.V.													
Starting・V													
Safety・V													
Indicator V													
T/C		No.1			No.2			No.3			No.4		

Diesel Generator - Accumulated Working Hours at the end of last month

Parts \ D/G No.	Mainytenance Interval	D/G 1	D/G 2	D/G 3	D/G 4
Piston					
Cyl cover					
Intake V					
Exh V					
FO pump					
F.O V					
T/C					
Crank Bearing Bolt					
Main Bearing					
Crank pin Bearing					
D.G. Running Hour Details					
End of last monthTTL W/H					
Current month W/H					

M.E. Running Hour Details	
End of last monthTTL W/H	
Current month W/H	

Chief Engineer:_____

Reference ⑦

Piston Grooves & Rings Reading (sample)

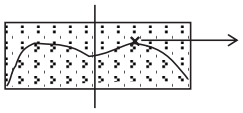
MAIN ENGINE NO.
NO. DIESEL GENERATOR ENGINE

CYL.OR ENG NO. NO. CYL
TYPE OF ENG.

M.V. DATE

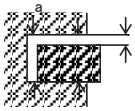
PORT

		PISTON GROOVE					PISTON RING WIDTH			PISTON RING THICKNESS				
		F	A	P	S	ORIGINAL	A	B	C	A	B	C	ORIGINAL	USING RING (NEW,OLD)
1	a													
	b													
2	a													
	b													
3	a													
	b													
4	a													
	b													
5	a													
	b													
PISTON X														



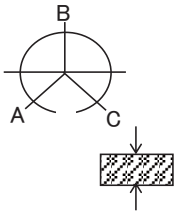
LIMIT
mm

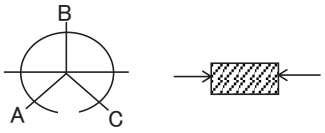
ORIGINAL
TOP RING
OTHER



LIMIT ORIGINAL

TOP
2ND
3RD
4TH
5TH





UNIT in mm

PISTON RING WEAR

TOTAL RUNNING HRS SINCE LAST EXAMINATION	
MAX.WEAR DOWN SINCE LAST EXAMINATION	
MAX. WEAR PER 1000 HRS SINCE LAST EXAMINATION	
LASTED CYL.OIL FEED RATE (g/ps/hr)	
REMARKS:	

Piston Inspection Record(Sample)

Vessel: M.V.		no.:			Builder / no.:									
Number of cylinders:	Eng. type:	Eng. hrs		Checked by: 1/E		Port:		Date: DD MM YYYY						
Weeks pr. port calls:		Normal service load (% of MCR): xx %			Lubricator type :									
Cyl. oil consump. (l/24 hrs):	at load % xx%	Cyl. oil type:			Position:		Exhaust		Manoeuvre					

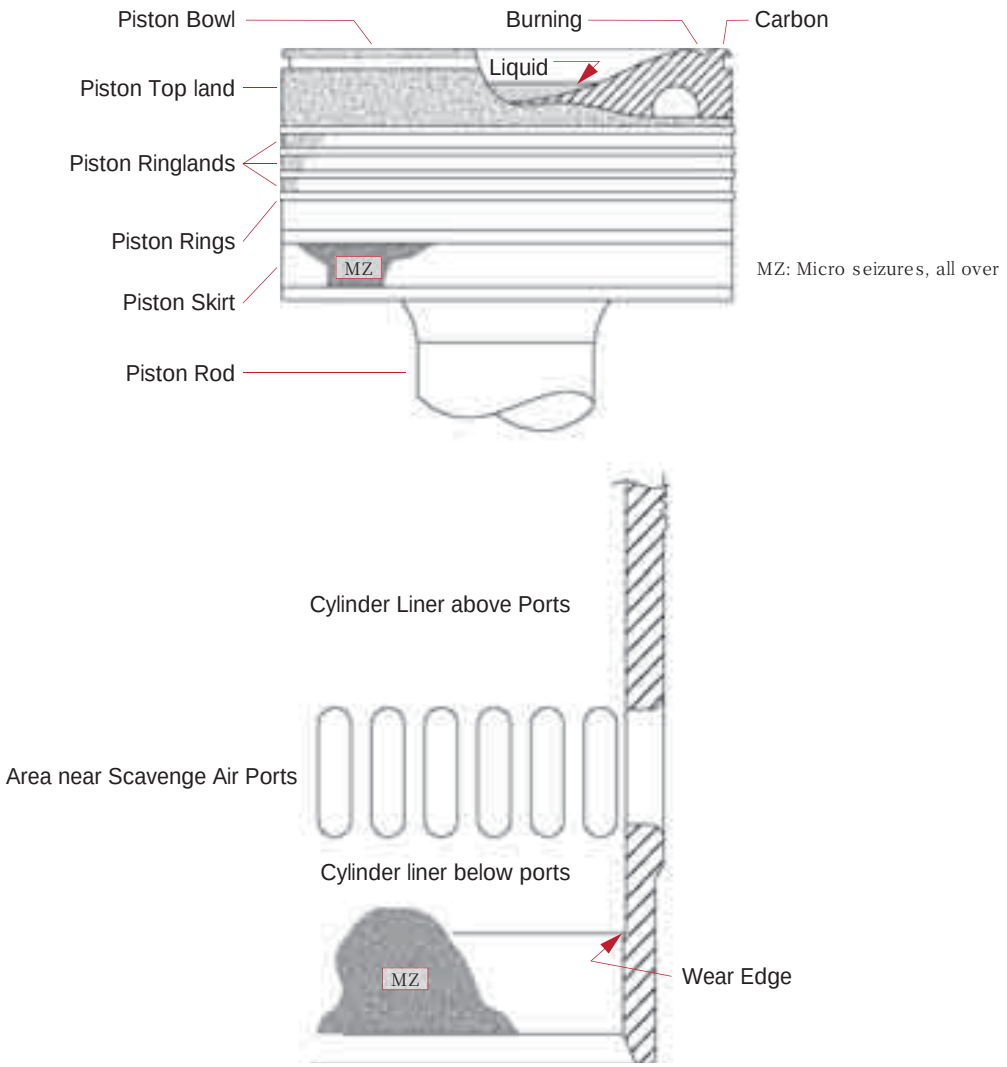
	Condition and Symbol	Engine Part	CYLINDER NO. 1	2	3	4	5	6	7					
	Intact - * Burning - BU Leaking oil - LO Leaking water - LW	Piston crown	*	*	*	*	*	*	*					
Deposits	No deposit - * Light deposit - LC Medium deposit - MC Excessive deposit - EC Polished deposit - PC	Topland	LC	LC	LC	LC	LC	LC	*					
		Ringland 1	*	*	LC	*	LC	LC	*					
		Ringland 2	*	*	*	*	*	LC	*					
		Ringland 3	*	*	*	*	*	*	*					
Ring breakage	Intact - * Collapsed - C Broken opposite ring gap - BO Broken near gap - BN Several pieces - SP Entirely missing - M	Ring 1	*	*	*	*	*	BN	*					
		Ring 2	*	*	*	*	*	*	*					
		Ring 3	*	*	*	*	*	*	*					
		Ring 4	*	*	*	*	*	*	*					
Ring movement	Loose - * Sluggish - SL Sticking - ST Sharp Edge - SE	Ring 1	*	*	*	*	*	SE	*					
		Ring 2	*	*	SE	*	*	SE	*					
		Ring 3	*	*	SE	*	*	SE	*					
		Ring 4	*	*	SE	*	*	SE	*					
Surface condition	Clean, smooth - * Running surface, Black,overall - B Running surface, Black, partly - (B) Black ring ends > 100 mm - BR Scratches (vertical) - S Micro-seizures (local) - mz Micro-seizures (all over) - MZ Micro-seizures, still active - MAZ Old MZ - OZ Machining marks still visible - ** Wear-ridges near scav. ports - WR Scuffing - SC Clover-leaf wear - CL Rings sharp-edged Top/Bot. - T/B	Ring 1	*	*	*	*	*	*	*					
		Ring 2	*	*	*	*	*	*	*					
		Ring 3	*	*	*	*	*	*	*					
		Ring 4	*	*	*	*	*	*	*					
		Piston skirt	*	*	*	*	*	*	*					
		Piston rod	*	*	*	*	*	*	*					
		Cylinder liner abv. scav. ports	(B)	(B)	B	(B)	(B)	(B)	*					
		Cylinder liner near scav. ports	*	*	*	(B)	(B)	(B)	*					
Lubrication condition	Optimal - * Too much oil - O Slightly dry - D Very dry - DO Black oil - BO	Ring 1	*	*	*	*	*	*	*					
		Ring 2	*	*	*	*	*	*	*					
		Ring 3	*	*	*	*	*	*	*					
		Ring 4	*	*	*	*	*	*	*					
		Piston skirt	*	*	*	*	*	*	*					
		Piston rod	*	*	*	*	*	*	*					
		Cylinder liner	*	*	*	*	*	*	*					
Deposits	No Sludge - * Sludge - S Much sludge - MS	Scavenge box	*	*	*	*	*	*	*					
		Scav. receiver	*	*	*	*	*	*	*					
	Intact - *	Flaps and nonreturn valves	Normal condition											
Piston Ring Gap	Piston Ring No.1													
	Piston Ring No.2													
	Piston Ring No.3													
	Piston Ring No.4													
Running hrs since liner installed (hrs)														
Liner wear per 1000hrs (mm)														
Max Liner Wear (mm)														
Stuff. Box leakage quantity / day (ltr)														
Cyl. Oil consumption /day (ltr)														
Cyl. lubricator stroke for each unit			Total stroke :											
Date last unit was overhauled			DD MM YYYY	DD MM YYYY	DD MM YYYY	DD MM YYYY	DD MM YYYY	DD MM YYYY	DD MM YYYY					
Running hours since last overhaul														

Remarks :

Noted by : _____

Reference ⑨

Piston Inspection items through Scavenge Ports (sample)



Reference ⑩

Manufacturer service information

(Key point for handling, revision as required, emergency information and etc..)

Assembling Piston rod (Tightening) (sample)

We have recently experienced cracking in the spacer ring for hydraulic jack for tightening of piston rod due to irregular fitting of the washer.

The side face of washer tapers off at the bottom end in order to prevent a contact with the piston rod when the washer is mounted. If the washer is mounted upside down, the washer can not be tightened correctly due to contact with the piston rod, and consequently, there is a possibility of cracking of spacer ring for hydraulic jack.

We therefore would like to ask you to pay attention to check if the washer is correctly fitted/tightened when the tightening nut for piston rod is tightened by hydraulic jack on the engines in question.