

KEMEL COMPACT Seal Type KEMEL CX, DX & AX

INSTRUCTION MANUAL

(April, 2022)

This manual is produced based on a typical lubrication diagram for stern tube system installed with Type KEMEL CX & DX seals. For correct understanding and operation of the ship's system, read this booklet together with the seal drawing and the piping diagram available in the finished plan.

For Air Seal (Type KEMEL AX), some of the contents are not applied. Read articles applicable to Type KEMEL AX. (See notes in P. 2 for symbol marks.) Also read Instruction Manual for Air Seal besides this booklet.

The contents of this manual might change without prior notice.

EKK EAGLE INDUSTRY CO.,LTD.

Marine Division

<http://www.kemel.com>

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[NOTE]

- ① Check the seal model (Type CX, DX or AX) and the details in the seal drawings available in the finished plan.
- ② This manual describes basic operation of stem tube system based on the typical lubrication diagram. Confirm correction operation of stem tube system in the ship's diagram.
- ③ In this booklet, all of water or oil pressures related to stem tube system are based on the "PRESSURE ABOVE SHAFT CENTERLINE" unless it is specified.
- ④ To prevent accidents or damage through misuse, caution symbols are placed appropriately throughout this manual. The table below explains the meaning of each symbol.

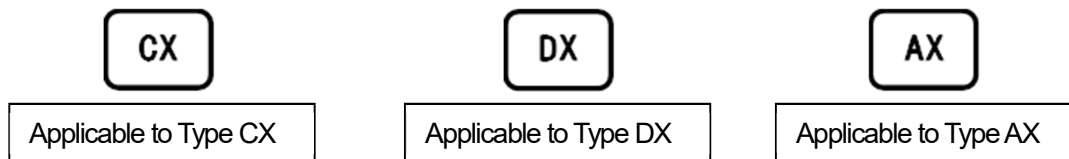
**Make sure
you read the
following.**



 CAUTION	To realize the full performance of seals, the areas marked with this symbol should be read carefully and understood.
 FOLLOW	This symbol marks advice that should be followed.

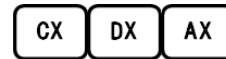
If above symbols are ignored, there is a possibility that personal or physical damage may occur.

- ⑤ Each article applicable to Type CX, DX or AX seals is marked with symbols shown below. Read articles applied to the seal system installed on the ship.



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1. STRUCTURE

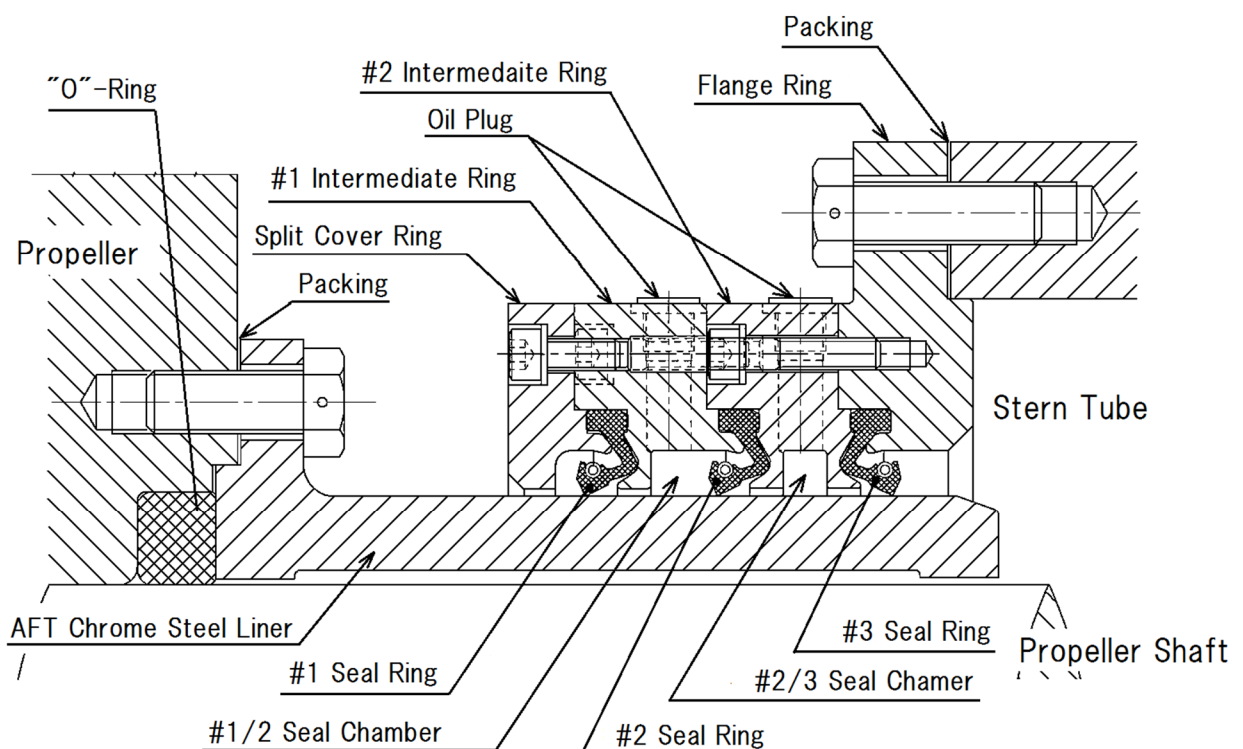


The KEMEL COMPACT Seal (Type CX) is composed of AFT seal and FWD seal. AFT seal consists of 3 (three) seal rings and FWD seal consists of 2 (two) seal rings. A special version of AFT seal, the KEMEL Double Security COMPACT Seal (Type DX) consists of 4 (four) seal rings. The KEMEL Air Seal (Type AX) has 4 (four) seal rings, as same structure as Type DX, and fitted with air control unit for the seal system.

KEMEL seal rings have a design of knuckle-shape cross section achieving a higher ability to follow radial movement of rotating shaft. Seal rings are available in two types of material; FKM-VITON (fluoric rubber) and NBR (nitrile-butadiene rubber). FKM-VITON seal rings have particularly excellent heat resistant properties. Seal rings have a unique own design in the shape and material. Therefore, be sure to request KEMEL COMPACT SEALS when you replace seal rings for maintenance and repair.

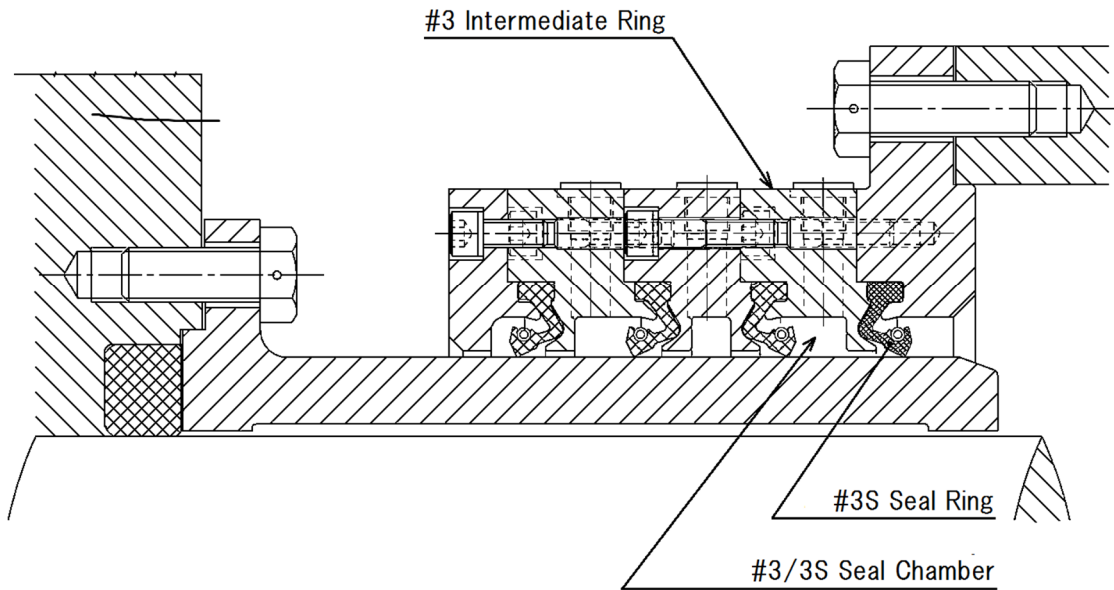
1.1 AFT SEAL

The AFT SEAL can be broadly divided into the casing, which is fixed to the hull, and the chrome steel liner, which is fixed to the propeller hub and rotates with the propeller shaft. The casing is composed of three kinds of metal rings; flange ring, intermediate ring and cover ring, which are tightened to each other with bolts. Three or four seal rings are assembled between the metal rings with their pointed ends (lip section) touching the chrome steel liner. The lips are pressed hard against the rotating liner and maintain a seal effect through water pressure, oil pressure, elasticity of the seal ring and tightening force of the springs. The seal rings are numbered 1, 2, 3 in order from the propeller. The #1 and #2 seal rings close out seawater, while the #1 seal ring also has the function of protecting the inside of the stern tube from foreign matter in the seawater. Lubricant oil in the stern tube is sealed in with the #3 seal ring.



Type CX with 3 seal rings – Cross Section

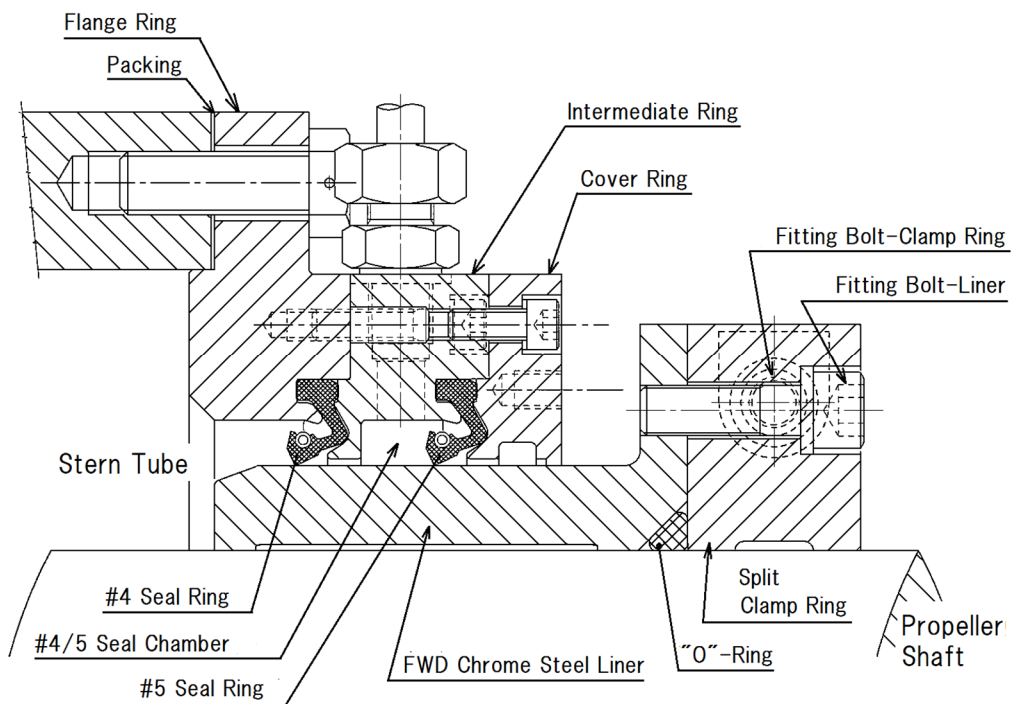
The Double Security Type DX has an additional construction of the #3S seal ring and the #3 intermediate ring on the Type CX. The #3S seal ring is a stand-by spare of the #3 seal ring. The #3S seal ring can be immediately brought into service by valve operation in engine room whenever is necessary. Type AX seal has the same structure as Type DX.



Type DX & AX with 4 seal rings – Cross Section

1.2 FORWARD SEAL (FWD Seal)

The FORWARD SEAL is of similar construction to the AFT Seal except that it is composed of two seal rings. The casing is fixed to the hull in engine room. The chrome steel liner is tightened with bolts to the split clamp ring mounted to the propeller shaft. The seal rings are numbered 4 and 5 in order from the stern tube. The #4 seal ring seals the lubricant oil in the stern tube. The #5 seal ring keeps oil filled in the chamber between the #4 and the #5 seal rings. The same construction is used on FWD seals of Type CX, DX or AX.



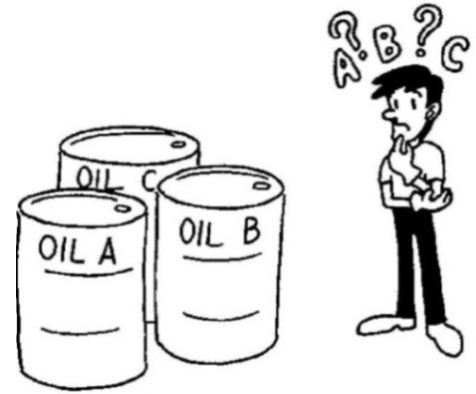
FWD Seal (Type CX · DX · AX) - Cross Section

2. LUBRICATION

CX DX AX

2.1 LUBRICANT OIL

For selection of stern tube oil, oils listed in “LUBRICANT LIST FOR STERN TUBE SEALS” are recommended. For compliance with US rule VGP2013, oils listed in “BIODEGRADABLE OIL (EAL) FOR STERN TUBE SEALS” are recommended. Listed oils are compatible to seal material confirmed by the tests. The compatibility tests will be made on request for lubricant oils not listed. Application of non-compatibility oil can damage the seal rings causing earlier leakage. Also see notes in page 23. For the latest oil list, please check our website (<http://www.kemel.com>).



2.2 OILING

CX DX AX

Oil lubrication is made to stern tube bearing, AFT seal chambers and FWD seal chambers. - See typical diagrams of stern tube piping with Type CX in P 6.

2.2.1 Stern Tube Bearing

CX DX

There are two methods for oiling the stern tube bearing; by a natural circulation without pumps through the gravity tank or by a forced circulation with pumps. Confirm the oiling system in the ship's piping diagram for operation. (See “Air Seal Instruction Manual” for lubrication of Type AX.)



FOLLOW

The oiling pressure to the stern tube, for bearing lubrication, is set higher than seawater pressure by 0.03 – 0.05MPa, applied to shaft center line at fully loaded condition.



CAUTION

In cases where both High and Low level tanks are provided, use High tank in deep draft and Low tank in shallow draft. Confirm operation of switching over High & Low tanks in the ship's piping diagram.



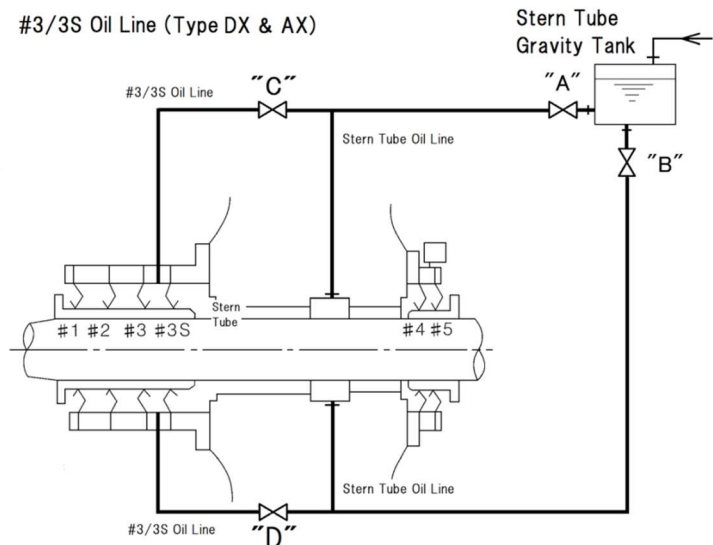
CAUTION

For the Low Pressure System, stern tube lubricant oil pressure can be the same or lower than the seawater pressure ($P_{st} \leq P_{sw}$). Check ship's piping diagram for the stern tube before use.

2.2.2 AFT Seal chamber between #3 & #3S seal rings in Type DX & AX seals

DX AX

Oil lines are provided to AFT seal chamber between the #3 and the 3S seal rings as shown in the diagram below. The #3 seal ring is put into operation and the #3S seal ring is kept reserved as a stand-by spare while valves “C” and “D” opened. The #3S seal ring is in operation with “C” and “D” closed. In case the #3 seal ring starts to have oil leakage, the #3S seal ring is activated to stop it. This operation enables continuation of ship's operation without having immediate repair of the seal. Operate the #3 seal ring initially. Confirm valve positions and the numbers in the ship's piping diagram.



	Valve “C”	Valve “D”
#3 in Operation	Opened	Opened
#3S in Operation	Closed	Closed

Fully close both “C” & “D” valves to activate the #3S. Valve operation of “One closed & the other opened” or “Crack-open” do not activate the #3S.

2.2.3 AFT Seal chambers between #2 & #3, #1 & #2 sealing rings

CX DX

Depending on the specification, there are two method of oiling to #2/3 seal chamber either via oil pipe line from engine room or without oil pipe line from engine room or without oil pipe line. Confirm the system in ship's piping diagram. There is no oil pipe to #1/2 seal chamber.



FOLLOW

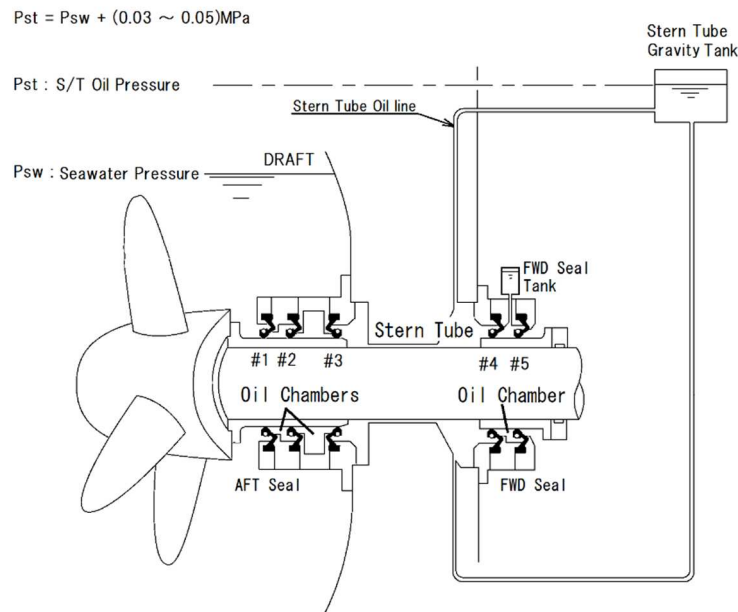
In case of no oil piping from engine room to AFT seal chamber between the #2 & #3 seal rings

Feed lubricant oil during dry-docking to #1/2 and #2/3 seal chambers through the oiling holes on the #1 and #2 intermediate rings. Replace oil in chambers at each dry-docking.

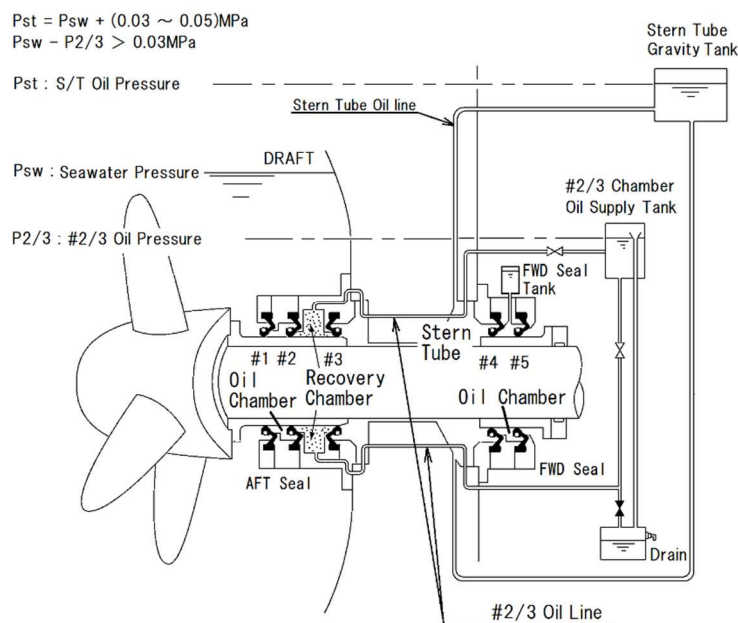
In the case of oil piping is installed, for AFT seal chamber between the #2 & #3 seal rings

Feed lubricant oil during dry-docking to #1/2 and #2/3 seal chambers through the oiling holes on the #1 and #2 intermediate rings. Keep oil pressure in #2/3 seal chamber at least 0.03MPa lower than seawater pressure at the center of the shaft under actual aft draft. The system may require adjustment of the oil pressure for a deep draft or a shallow draft. Confirm the operation in ship's diagram for the stern tube. Also refer to Article 6.2 in this manual. Replace oil in the chamber at each dry-docking.

Example Stern Tube Piping for CX - without #2/3 Oil Line



Example Stern Tube Piping for CX - with #2/3 Oil Line

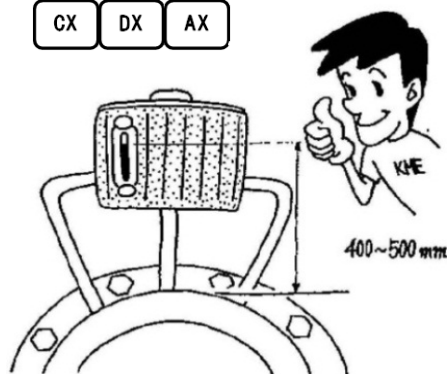


Note. Same arrangement of #2/3 oil line is applied to DX Type. See the diagram in P. 26.

2.2.4 FWD SEAL chamber between #4 & #5 sealing rings

CX DX AX

- Oiling the chamber between the #4 & #5 seal rings on the FWD SEAL is made via gravity tank or by forced circulation with pumps.
- In case the gravity tank is used, Oil Circulator is generally installed in the seal chamber between the #4 & #5 seal rings.
- In some cases of forced circulation, oiling is made by pumps used commonly for stern tube bearing lubrication via branch line of the main circulation.



CAUTION

In case of the gravity tank with Oil Circulator, adjust the tank height so that oil level in the tank is maintained at 400mm-500mm above the top of the casing for effective circulation of the lubricant oil. Periodically examine the oil level and refill or remove oil whenever is necessary. Drain hole is provided at the bottom of FWD seal casing.



FOLLOW

In case of forced circulation, adjust the oil pressure by a needle valve, a by-pass valve or an orifice etc. and examine oil circulation through a sight glass. Confirm the correct operation in the ship's diagram.

2.3 OIL PRESSURE TEST

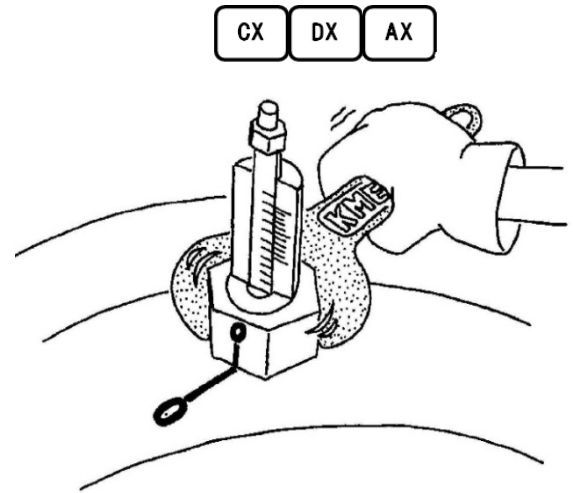
CX DX AX

Oil pressure test is generally conducted for AFT and FWD seal while the ship is in dry-dock. The each procedure for Type CX and DX with #2/3 Oil Line or without, and Type AX is shown in the respective page below.

Seal Model	Reference Page	
	AFT seal without #2/3 Oil Line	AFT seal with #2/3 Oil Line
CX	P.28	P.29
DX	P.30	P.31
AX	Refer to Air Seal Instruction Manual	

3. WEAR-DOWN GAUGE

Wear-down gauge is used to measure stern tube bearing wear. Measurements are made at "Top" and "Bottom" positions of AFT seal casing where oiling hole and oil drain hole are provided. Conduct initial measurements at the time of new building ship after completing installation of main engine, intermediate shafts, propeller shaft, propeller & stern tube seal. Conduct measurements thereafter during dry-docking, and compare the values measured with previous measurements. The difference in the measurements, this time and the previous, is the value of shaft-drop which indicates the value of stern tube bearing wear.
– See location of measuring holes in the seal drawing.



When AFT seal is detached (or opened) or the shaft is moved, measurements should be taken before and after detached or moved. All measurements are taken with a regular turning position; such as the #1 cylinder piston of the main engine in the top position, or "A" blade of the propeller in the top position etc.



CAUTION

The measurements should be taken at the regular turning position of the shaft each time. Confirm the position (the #1 cylinder piston or "A" blade Top), and correct it if necessary, before taking measurements.



CAUTION

Remove oil plug & copper packing on the hole and clean up all mating faces for measurement.



CAUTION

Alignment marks are on the oiling and drain holes for measurement. Alignment marks are also on the wear-down gauge. Conduct measurements with both marks aligned.



CAUTION

When the chrome steel liner is skimmed with the shaft removed, the after values will increase by the amount of the skimming.



CAUTION

For underwater survey, instruct the diver to take the measurements at the holes indicated in the seal drawing. The procedures are as same as above descriptions. In case of Type AX, stop air blowing for measurements. (Make sure no continuous seawater leakage at the drain tank after the air stopped.)



4. REPAIR

CX DX AX

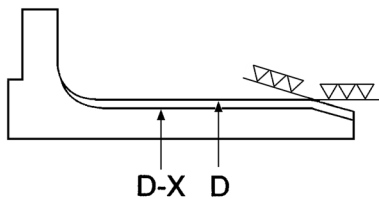
After a long period of use, the seals will require repair such as replacement of seal rings, skimming of outer surfaces of liners or renewal of the liner, replacement of sheet packing, "O"-rings and other parts due to wear and tear. For the purpose of maintenance, it is recommended that replacement of seal rings together with other worn parts within the period of 5 years after new installation or replacement. Repair methods include replacement of seal rings and other worn parts with propeller and tail shaft removed, and bonding repair where seal rings are replaced without removing propeller and tail shaft as an emergency measure.

4.1 REPLACEMENT WITH PROPELLER & TAIL SHAFT REMOVED

Replacement of seal rings, "O"-rings, packing and other consumable parts are generally done during dry-docking when the propeller and propeller shaft have been removed. The aft and forward chrome steel liners can be reused by skimming to remove wear grooves and surface damage until the allowable limit shown in the table below. When there is no skimming allowance remaining, the liner must be replaced.

<Table: Machining Allowance of Chrome Steel Liner>

SEAL SIZE D (mm)	140	160	180	200	220	240	260	280	300	330	355	380	400	420	450	480
Allowance X (mm)	2.5	2.5	2.6	2.6	2.7	2.7	2.8	2.8	2.9	3.0	3.0	3.1	3.1	3.2	3.3	3.4
SEAL SIZE D (mm)	500	530	560	600	630	670	710	750	800	850	900	950	1000	1060	1120	1180
Allowance X (mm)	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.4	4.5	4.6	4.8	4.9	5.0	5.2



Example for Seal Size 600

$$D - X = 596.3\text{mm (Min. Diameter)} \Rightarrow D = 600, X = 3.7$$

Renewal of the liner is necessary when the diameter after skimming become smaller than the minimum diameter.



FOLLOW

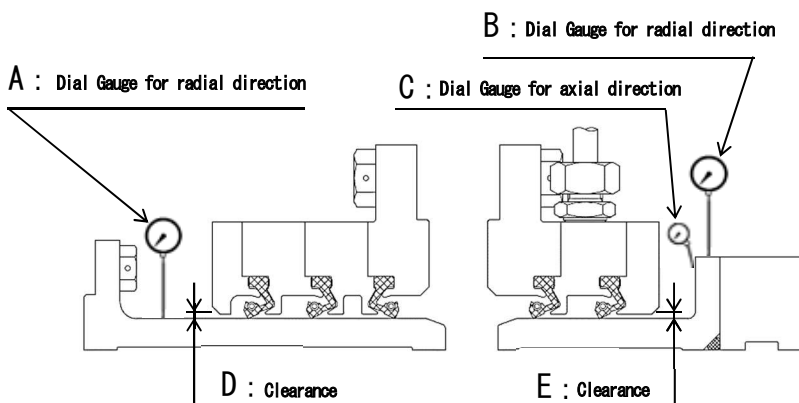
Check that "stainless" steel bolts, washers and securing wires are used for AFT seal assembly & the installation. (Use magnet if uncertain.) Material specification is given in the seal drawings.



CAUTION

Adjust seal alignments in accordance with the table below, to achieve longer service life of the seal;

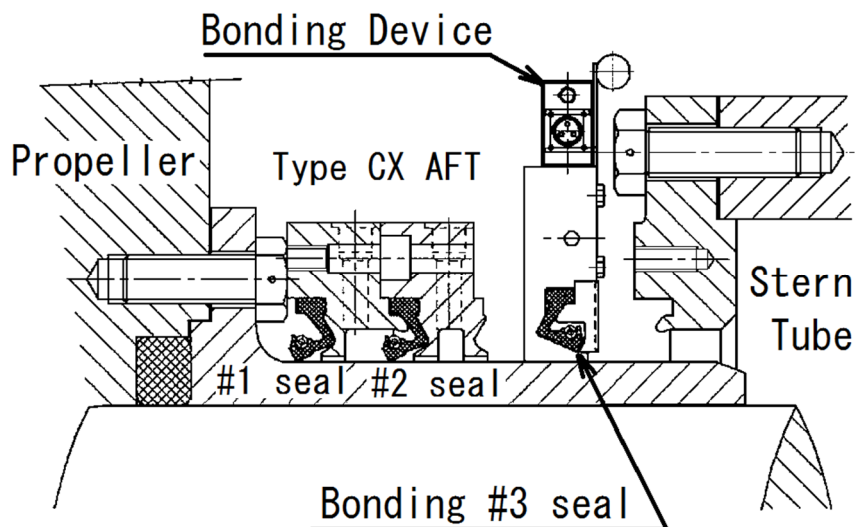
Measuring item	Position	Size 670 and below	Size 710 and above
Eccentricity	A, B	0.2mm (T.I.R.)	0.3mm (T.I.R.)
Squareness	C	0.1mm (T.I.R.)	0.15mm (T.I.R.)
Clearance	D, E	0.5mm (Circum. variation)	0.7mm (Circum. variation)



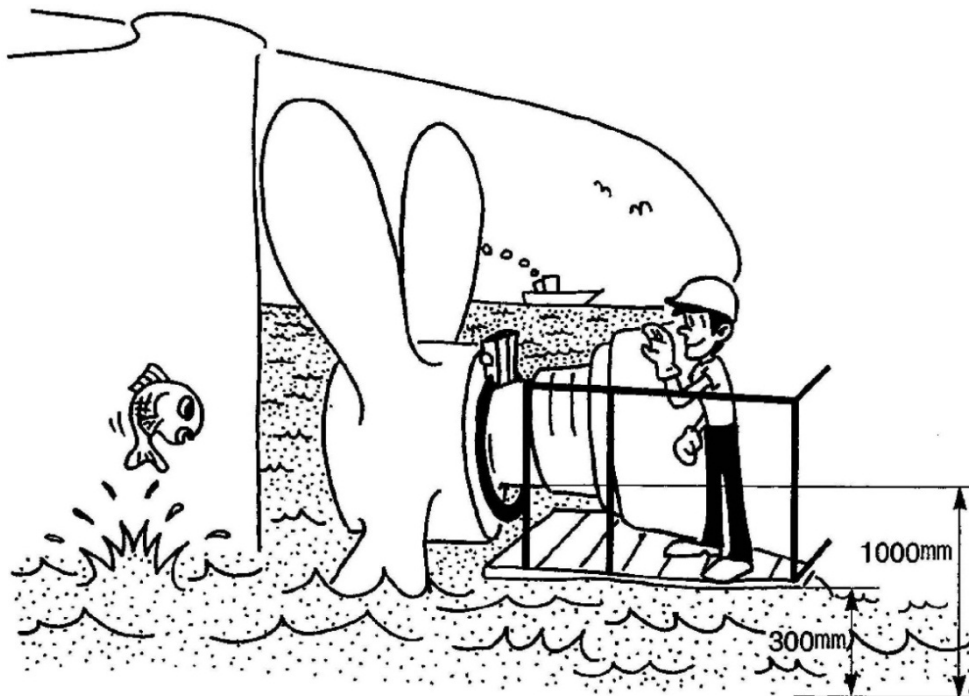
In case adjusting liner eccentricity by turning shaft is not available, achieve even clearances between liner bore and shaft surface by using feeler gauge for the adjustment.

4.2 BONDING REPAIR

Bonding repair is the method of replacing the seal rings by vulcanizing the new seal rings. The repair can be done with the propeller and the shaft in place while the ship is generally in dock. One piece new seal ring is cut apart and is vulcanized on the shaft to be rebuilt in one piece. This method allows repair of the aft and forward seal rings in a short time. Bonding repairs are carried out by KEMEL or its authorized agents using KEMEL's special bonding compound and the device.



It is possible to conduct bonding repairs on the AFT seal while afloat. For the repair, the ship must be trimmed so that the propeller shaft is exposed above water as shown in the sketch below. It also requires the construction of scaffolding at least 300mm above sea level. Further information is available whenever is necessary.



5. OPERATING GUIDELINE



- ① KEMEL COMPACT Seals Type CX, DX or AX consume small amount of oil with the seal in good condition, due to lubrication at the seal lip. This is a mechanical leakage unavoidable in the lip type seals run on rotating shafts, forming hydro-dynamic oil film from the rotation speed at the running face. The oil film protects the seal lip from dry-working causing heat damage of the seal rubber and ensures the service life, whereas lack of forming oil film creates damage at the seal lip in a short period, resulting in an excessive level of oil leakage at an earlier stage.
- ② The amount of oil consumption (or of the mechanical leakage) varies from invisible to visible level, depending on the service period, sea condition, ship's draft, rotation speed, kind of ship, oil viscosity & etc. In general, the amount increases with the length of service period. No oil leakage, however, should appear while the shaft is stopped.
- ③ Seawater may ingress into stern tube system, without having seal damage, by an effect of pressure unbalance in AFT seal at rough sea causing large changes of ship's draft. Besides, the system oil may be contaminated by accumulated water in case the oil has not been replaced for a long time.

With noting above characteristics, stern tube system should be operated and monitored as per the guideline shown in the table below;

Lubricating point	Monitoring items	Cautious Value	Monitoring Interval	Remark
Stern Tube Bearing	Oil Consumption	4 L/day	Daily	Total consumption, from the #3 seal ring (or the #3S) in AFT seal + the #4 seal ring in FWD seal.
	Water Content	2 %	6 months	Applicable to white metal bearing, but not applicable to synthetic or other bearing materials.
	Bearing Temperature	55°C	Daily	Applicable to white metal bearing, but not applicable to synthetic or other bearing materials.
FWD seal (#4/5 seal chamber)	Oil Consumption	1 L/day	Daily	From the #5 seal ring in FWD seal.
	Oil Temperature	80°C	Occasional	Applicable to approved lubricant oils.
AFT seal**	Oil level	-	Daily	See 6-2, B & C for operating guideline. **Disregard if #2/3 Oil Line is not provided.

<Examination of oil condition and renewal oil>

Stern Tube Bearing

Recommend periodical analysis of stern tube bearing oil done by the oil maker to keep good lubricating condition. Follow oil maker's advice of the sampling method, the interval of the analysis and renewal oil, based on analysis report.

FWD seal

- In case the capacity of FWD seal tank is 10 – 20 liters, recommend periodical renewal of oil in FWD seal in every 3 – 6 month (about 2,000 – 4,000 operation hours). In case of EAL, recommend renewal in every 3 months or earlier depending on oil condition. See P. 32 for replacing oil in KEMEL Oil Circulator system.
- In case of a larger capacity of FWD seal tank, carry out oil analysis (Viscosity, Oxidization, Oil Color etc.) and renewal as per oil maker's advice and recommendation. Oil analysis of metallic inclusion is not necessary for FWD seal.
- In some cases of forced circulation, oiling is made by pumps used commonly with stern tube bearing lubrication via by-pass line from stern tube circulation. In such a system, oil analysis of FWD seal is not necessary. The analysis of stern tube bearing oil is sufficient.

AFT seal (with #2/3 line)

Oil analysis of AFT seal lubrication line is not necessary. Check AFT seal drain in every port call, and discharge contamination & refill oil if necessary.

<Laying-Up vessel>

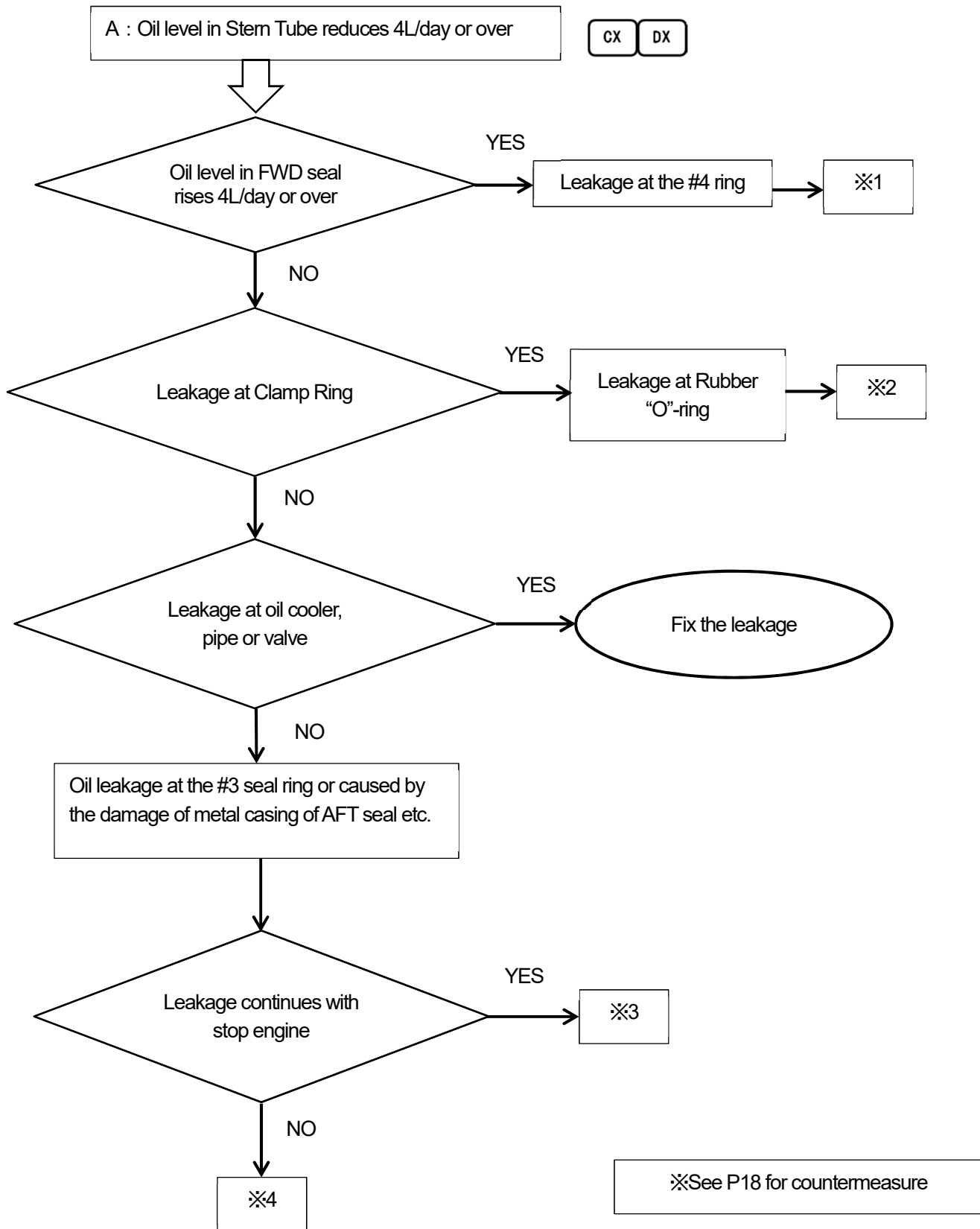
Consult with KEMEL for the maintenance in an event of Laying-Up vessel.

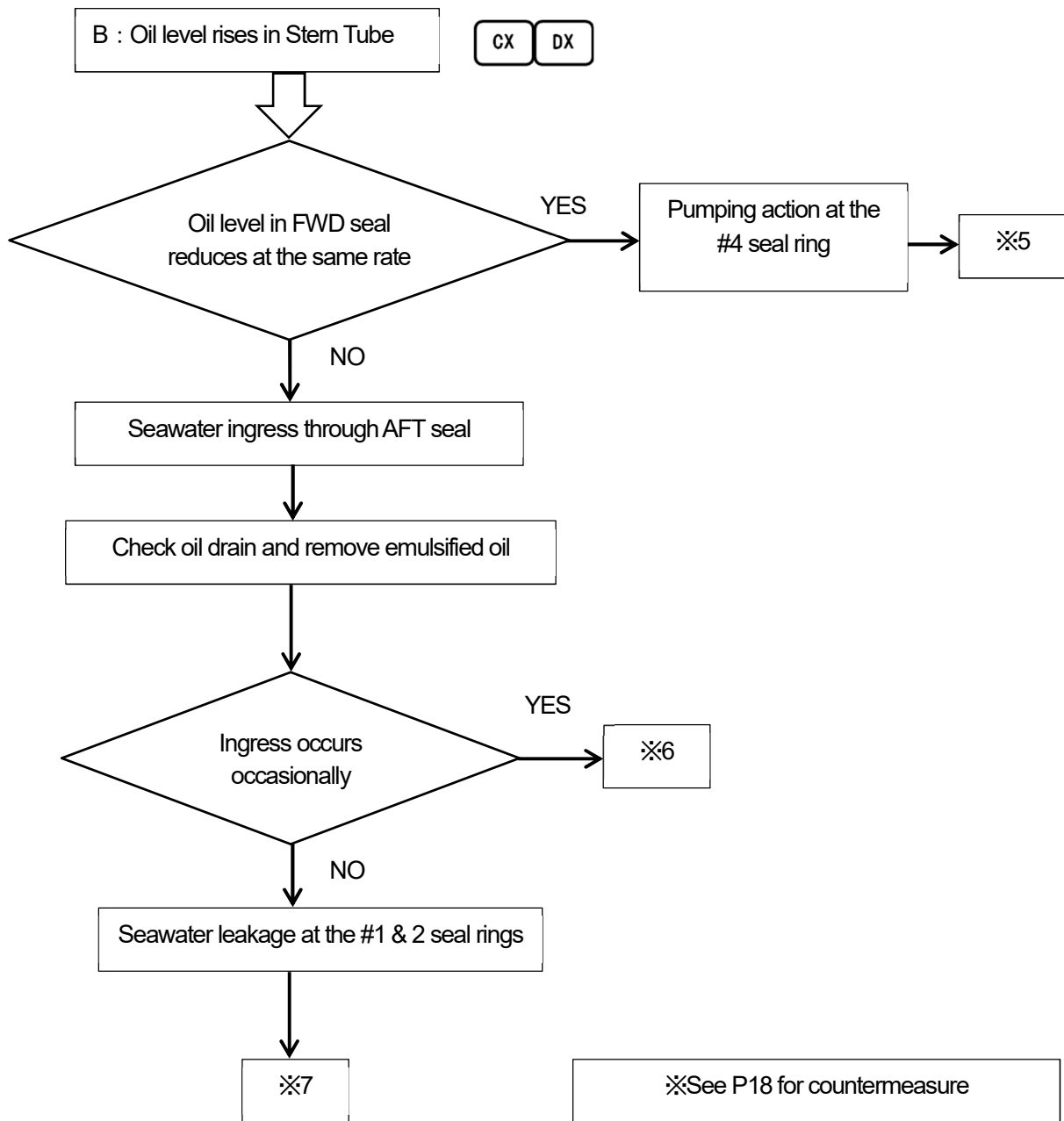
6. TROUBLE SHOOTING

CX DX AX

The article applies to Type CX & DX, and partly applies to Type AX.

6.1 Type CX · DX without #2/3 Oil Line





6.2 Type CX & DX with #2/3 Oil Line

CX DX AX

Type AX has no oil lines to #2/3 chamber. However, some diagrams in 6.2 are partly applied. Follow symbols.

#2/3 Oil Line

CX DX

<Purpose>

- ① Reduction of working load on AFT seal and improvement of lubrication in the oil chamber.
- ② Monitoring AFT seal condition.
- ③ Recovery of leaking seawater and oil into #2/3 Oil Tank located at the low level.

<Oil Level in #2/3 tank>

Adjust the oil level, if necessary, based on the AFT draft to keep the pressure balance shown below;

Recommended pressure balance : $P_{sw} - P_{\#2/3} > 0.03\text{MPa}$

P_{sw} : Seawater head pressure above shaft centerline, by present AFT Draft

$P_{\#2/3}$: Oil head pressure in #2/3 Oil Line, above shaft centerline

0.03MPa : Pressure difference, at shaft centerline

<Operation Notice>

AFT seal may have occasional seawater ingress or oil leakage into #2/3 Oil Line, without having seal damage, due to pressure unbalance around seal area in certain circumstances described below;

- ① Insufficient pressure from seawater given to #1 & 2 seal rings due to a shallow draft.
- ② Rough weather condition
- ③ Excessive shaft vibration by propeller racing, propeller damage or other effects

In such a case, #2/3 Oil Line may be operated with lowering oil level in the tank or by closing temporarily the Inlet & Outlet valves for isolation until the situation recovers.

<Leak Test by using #2/3 Oil Line in afloat condition, with main engine stopped>

In case of remarkable oil level changes in #2/3 Oil Line while at sea, AFT Seal can be tested by the procedure below

- ① Discharge oil in the tank on #2/3 Oil Line completely.
- ② Close Inlet & Outlet valves on the line.
- ③ Leave the drain valve opened for several hours.
- ④ Examine if continuous seawater or stern tube oil drained.

Test Results

Continuous discharge of seawater

Possible cause

⇒ damage of the #1 & 2 seal ring

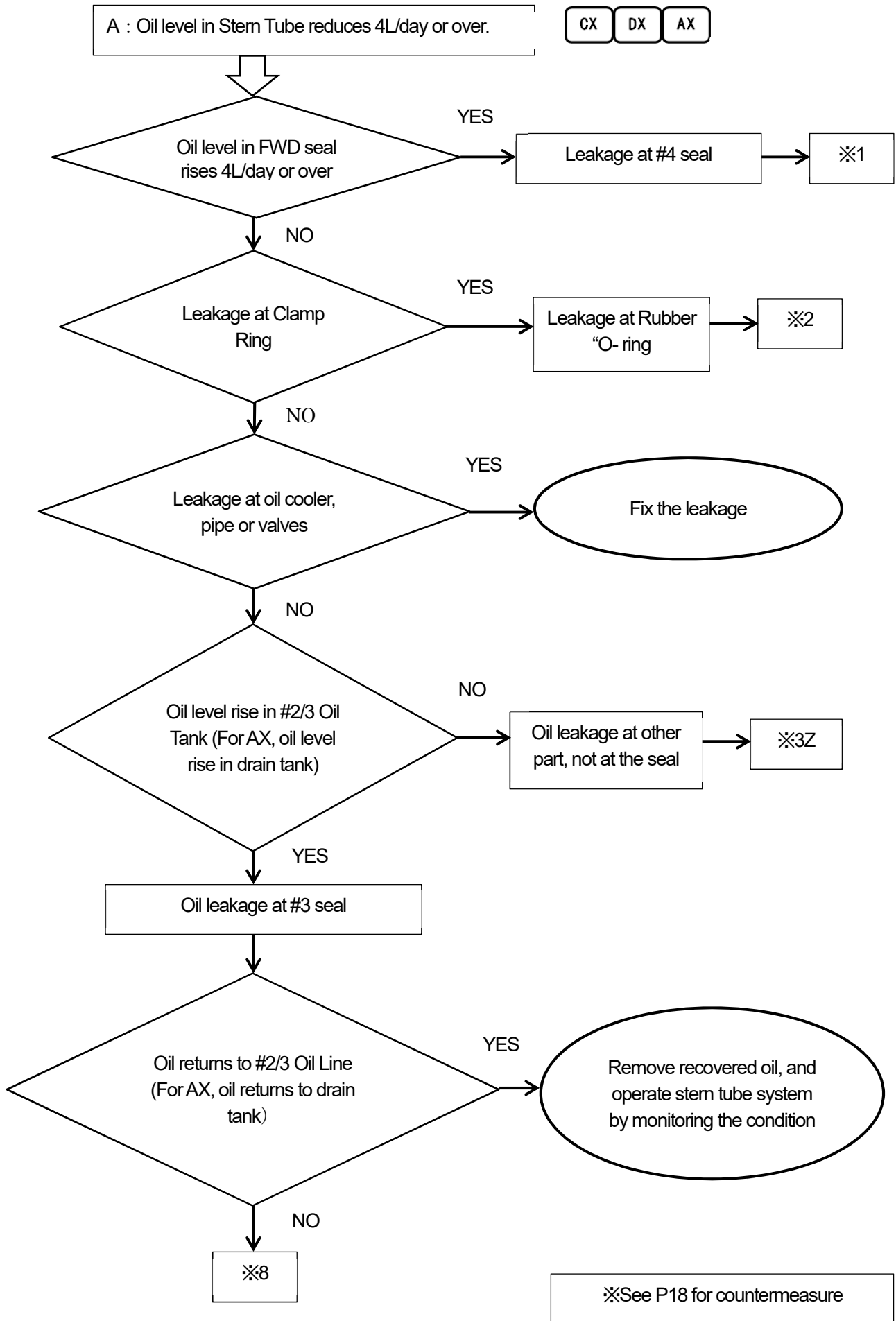
Continuous discharge of oil

⇒ damage of the #3 seal ring (or the #3S if in use)

No liquid discharged after complete drain

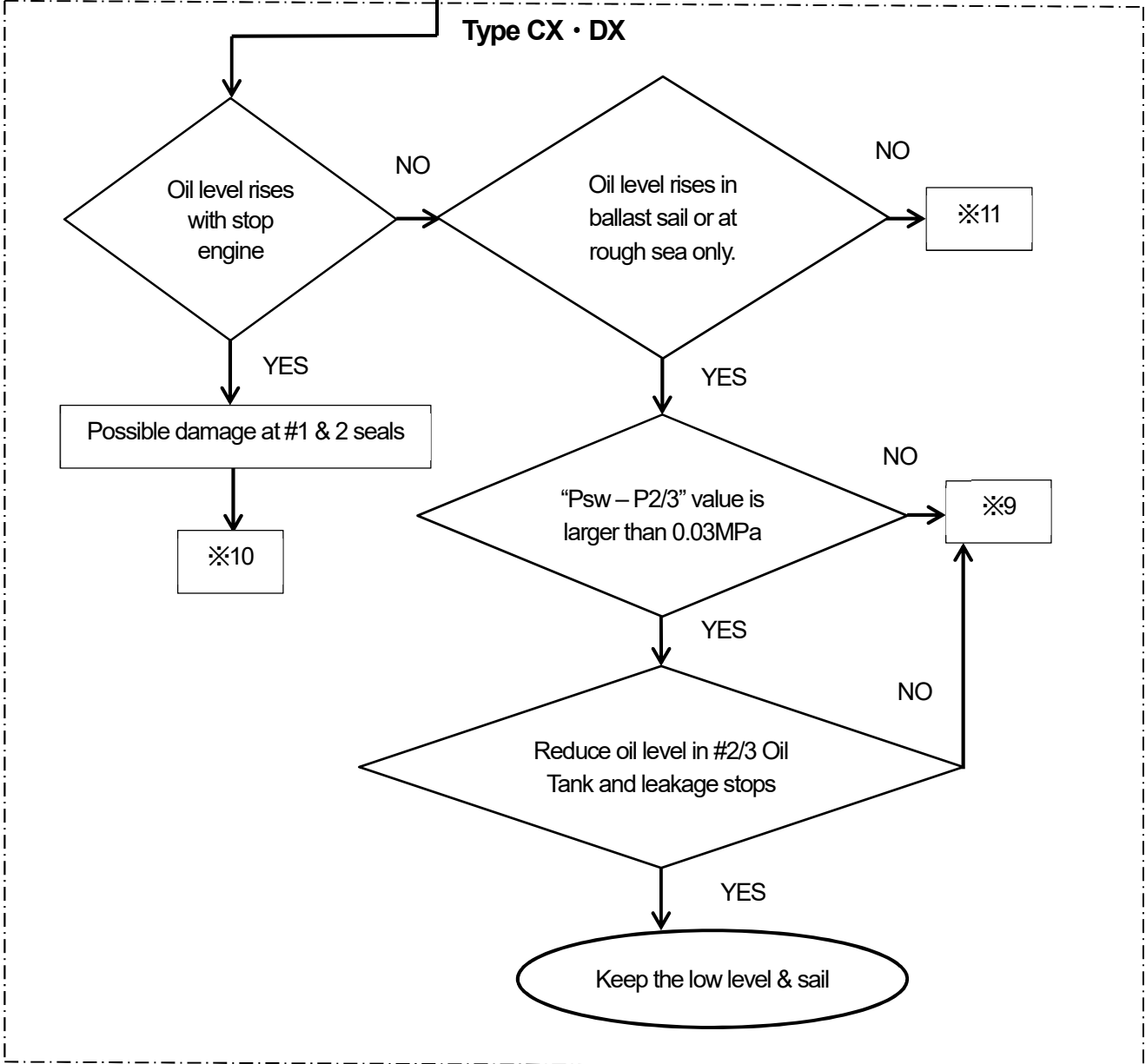
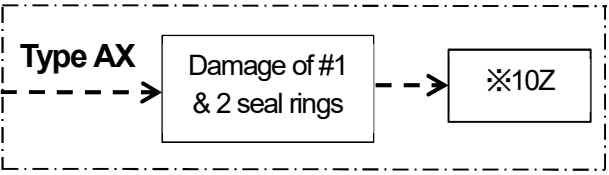
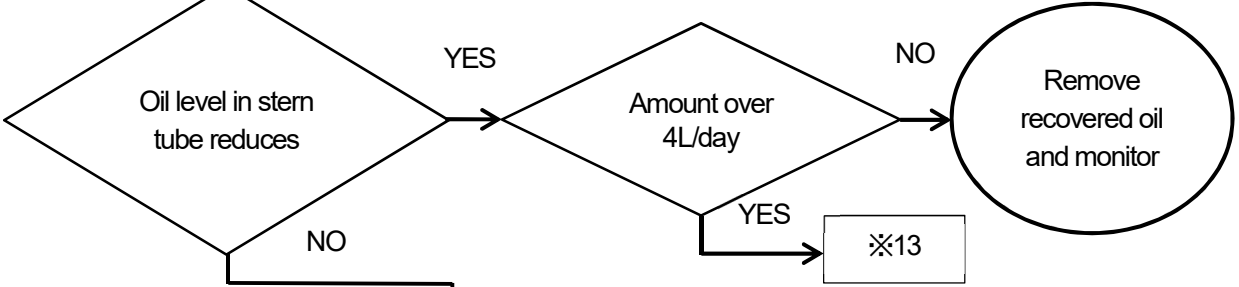
⇒ No damage. Operate #2/3 Oil Line normally. Keep monitoring.

Note: Refer P25 & P26 for pressure setting. Also refer P27 Operation notice for dry-docking.



B : Oil level rises in #2/3 Oil Tank. (The level rises in Drain Tank, for Type AX).

CX DX AX



※See P18 for countermeasure

C : Oil Level reduce in #2/3 Oil Tank

CX DX

Oil migration from low pressure to high pressure side can happen by "Pumping Effect" in AFT seal area, caused by fluctuating pressures while main engine running. The phenomenon is not caused by seal damage. Do not refill oil till the level is stabilized at a lower point. If necessary, keep the oil at the lowest level available in #2/3 Oil Tank, but should not be lowered below top level of the shaft, and observe the situation.

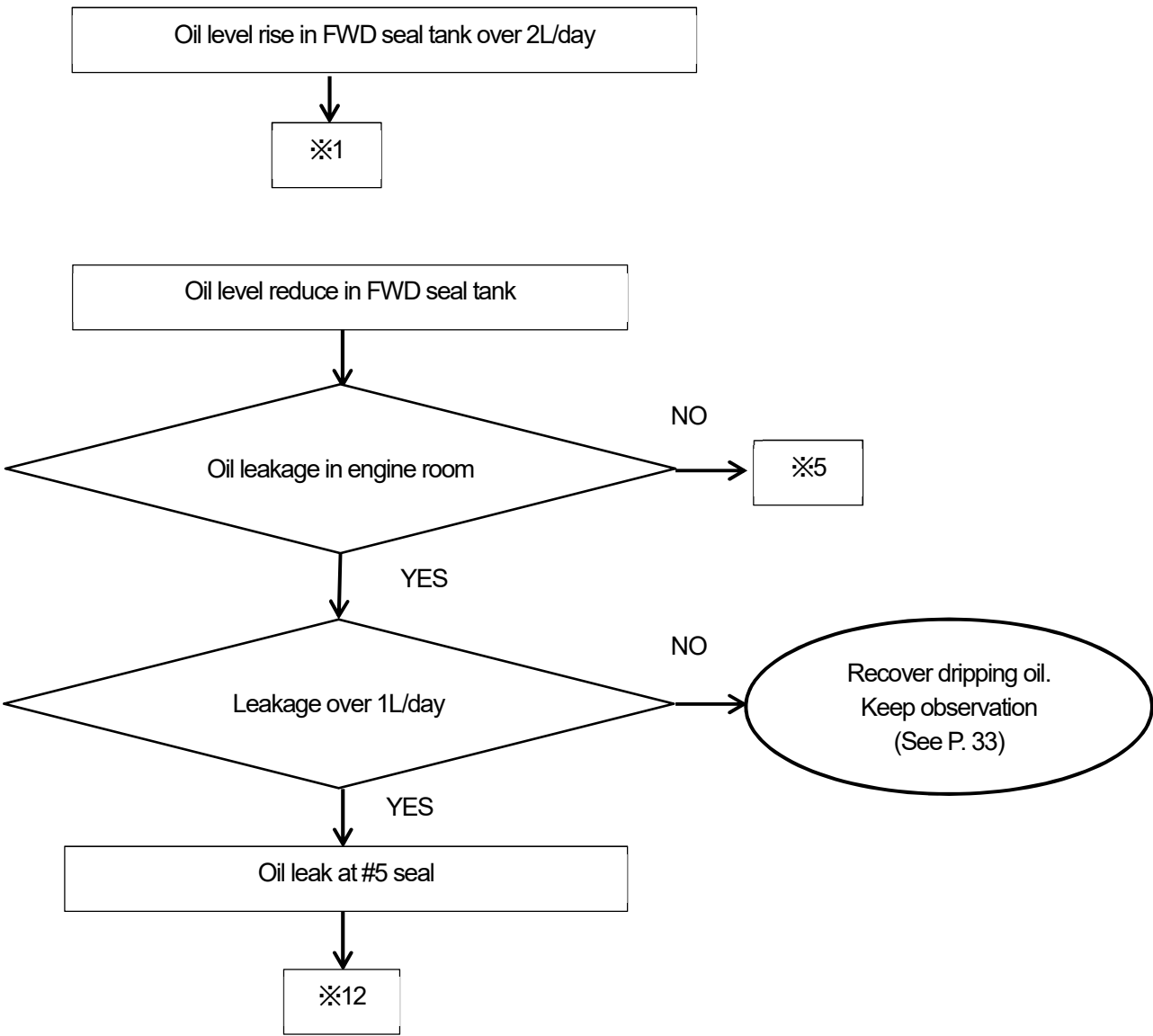
<Other Notice>

- ① Temporarily close the valves on #2/3 Oil Line, if the pressure difference "Psw - P2/3" is smaller than 0.03MPa.
- ② Close the valves on #2/3 Oil Line when entering dock.
- ③ Open the valves on #2/3 Oil Line when the draft reaches deep enough for the 0.03MPa pressure difference after undocking.

6.3 FWD Seal

CX DX AX

The diagram applies to Type CX, DX & AX.



※See P18 for countermeasure

<COUNTER MEASURES>

CX DX AX

No.	Seal Model	COUNTER MEASURES
※1	CX · DX · AX	Recovery of leaking oil. Renew the #4 seal at convenient opportunity
※2	CX · DX · AX	Renewal of Rubber "O" ring.
※3	CX · DX	For CX, minimize the leakage by reducing stem tube oil pressure slightly lower than seawater level. Carry out diver inspection. Renew AFT seal at the earliest opportunity. For DX, activate the #3S and observe the situation. If improved, continue operation with the #3S. If not improved, minimize the leakage as stated above.
※3Z	DX · AX	Minimize the leakage by reducing stem tube oil pressure slightly lower than seawater level. Carry out diver inspection. Renew AFT seal at the earliest opportunity.
※4	CX · DX	Record daily oil consumption. In case the amount exceeds 4L/day, repair the seal at the earliest opportunity. For DX, activate the #3S. Observe the situation, If it is improved, continue operation with the #3S.
※5	CX · DX · AX	Pumping effect at FWD seal. There is no seal damage. Fill oil in FWD seal tank before reaching low level.
※6	CX · DX	Increase stem tube oil pressure by installing a potable (temporarily) tank at a higher level, 2~3m above, if rough weather is expected. Renew oil by draining contaminated oil.
※7	CX · DX	Install a potable (temporarily) tank, and raise stem tube oil pressure gradually; by 1m step of a height. Keep the height where the ingress stops.
※8	CX	Close inlet & outlet valves on #2/3 Oil Line, and then take measure ※3. Open the valves for preventing oil leakage in port, with main engine stopped, and for recovery of leaking oil in #2/3 Oil Line while the vessel is in port.
	DX · AX	Activate the #3S. Observe the situation, If it is improved, continue operation with the #3S.
※9	CX · DX	Close inlet & outlet valves on #2/3 Oil Line in ballast sail or at rough sea. Re-open the valves in full loaded condition or at moderate sea. Examine oil drain periodically and drain out contaminated oil. In case of continuous seawater ingress with an un-controllable amount, follow instruction ※10.
※10	CX · DX	Close inlet & outlet valves on #2/3 Oil Line. Install a portable (temporarily) tank at 3~5m above the normal level to increase stem tube oil pressure for preventing seawater ingress into the stem tube, after closing the valves on #2/3 Oil Line.
※10Z	AX	Increase Air Flow Rate; 1.5 - 2 times as much as normal rate.
※11	CX · DX	Recover leaking seawater through #2/3 Oil Line by the inlet & outlet valves kept opened. In case of continuous seawater ingress with an uncontrollable amount, follow instruction ※10.
※12	CX · DX · AX	Renewal of the #5 seal in the next dock or in a suitable port for inspection and corrective measures.
※13	CX	Recover leaking oil through #2/3 Oil Line. Lower stem tube oil pressure to improve the leakage. Repair the seal at the earliest opportunity.
	DX · AX	Activate the #3S ring. Observe the situation. Continue operation with the #3S.

Counter measures above do not include operation of "Air Control Unit" for Type AX. See "Air Seal Instruction Manual" for the operation.

6.4 **DAILY RECORD**



It is recommended that the vessel produce a suitable record form for monitoring the system based on the ship's piping diagram. Typical examples of daily record forms for Type CX and DX are shown in Page 20. The article applies to Type CX and DX. (See "Air Seal Instruction Manual" for Type AX.)

In case the examples do not match to the ship's piping diagram, a suitable form should be produced by using each sample shown in the page below

- 6.4.1 Stem Tube Bearing — see P.21
- 6.4.2 FWD seal — see P.22
- 6.4.3 #2/3 Oil Line — see P.22
- 6.4.4 Other particulars — see P.22

In case of a question about producing record form, send the piping diagram to KEMEL which address is shown in the back cover of this instruction.

The daily record filled by the ship with the piping diagram may be sent to KEMEL at techservice@kemel.com for prompt investigation and trouble shooting.

Examples of Daily Record

1. Type CX (Natural Circulation, with #2/3 Oil Line)

Jan. 2013 CX

Day	Stem Tube Lubrication Line				MERFM	#2/3 Oil Line				Other Particulars				
	Oil Level (L)	Quantity drained (L)	S/T Oil pressure (MPa)	S/T Bearing Temp (°C)		Valve		Drain		Oil level in #2/3 Oil Tank above shaft centerline (M)	AFT Draft (M)	Sea condition	Remark	
						Inlet	Outlet	Color	Quantity drained (L)					
1	200	0	0.12	42	7	25	open	open	clear	0.5	1	11	Mod.	Example
2							open/close	open/close	clear/white					

NOTE1. Indicate condition of drain in every port, if daily check is not available.

NOTE2. Indicate valve operation for #2/3 Oil Line on daily basis.

2. Type DX (Forced Circulation, with #2/3 Oil Line)

DX

Jan. 2013

Day	Stem Tube Lubrication Line				MERFM	#2/3 Oil Line				Other Particulars						
	Oil Level (L)	Pump	Quantity drained (L)	S/T Oil pressure (MPa)		Bearing Temp (°C)	Valves on #3/3S Oil Line		Valves		Oil level in #2/3 Oil Tank above shaft centerline (M)	AFT Draft (M)	Sea condition	Remark		
							Inlet	Outlet	Inlet	Outlet					Color	Quantity drained (L)
1	1200	run	0	0.12	103	25	open	open	open	open	clear	0.5	Ex.	11	Mod.	Example
2		run /stop					open /close	open /close	open /close		clear/white					

NOTE1. Indicate condition of drain in every port, if daily check is not available.

NOTE2. Indicate valve operation for #2/3 Oil Line on daily basis.

NOTE3. Indicate valve operation for #3/3S Oil Line on daily basis.

NOTE4. FWD seal lubricated via a bypassing line from stem tube bearing lubrication, oil returns to sump tank.

6.4.1 Lubrication line for Stern Tube Bearing

For Type CX

1. Natural Circulation with two tanks without pumps

CX

Date	Stern Tube Lubrication Line							
	Oil Level (L)		Tank in use	Quantity drained (L)	Drain color	S/T Oil pressure (MPa)	Bearing Temp. (°C)	M/E RPM
	Gravity Tank High	Gravity Tank Low						
			high/low		clear/white			
			high/low		clear/white			

NOTE1. Indicate condition of drain in every port, if daily check is not available.

2. Forced Circulation with two tanks with pumps

CX

Date	Stern Tube Lubrication Line							
	Oil Level (L)	Tank in use	Pump	Quantity drained (L)	Drain Color	S/T Oil Pressure (MPa)	Bearing Temp. (°C)	M/E RPM
	Sump Tank							
		high/low	run/stop		clear/white			
		high/low	run/stop		clear/white			

NOTE1. Indicate condition of drain in every port, if daily check is not available.

For Type DX

1. Natural Circulation with two tanks without pumps

DX

Date	Stern Tube Lubrication Line									
	Oil Level (L)		Tank in use	Quantity drained (L)	Drain Color	S/T Oil Pressure (MPa)	Bearing Temp. (°C)	M/E RPM	Valves on #3/3S Oil Line	
	Gravity Tank High	Gravity Tank High							Inlet	Outlet
			high/low		clear/white				open/close	open/close
			high/low		clear/white				open/close	open/close

NOTE1. Indicate condition of drain in every port, if daily check is not available.

NOTE2. Indicate valve operation for #3/3S Oil Line on daily basis.

2. Forced Circulation with two tanks with pumps

DX

Date	Stern Tube Lubrication Line									
	Oil Level (L)	Tank in use	Pump	Quantity drained (L)	Drain Color	S/T Oil Pressure (MPa)	Bearing Temp. (°C)	M/E RPM	Valves on #3/3S Oil Line	
	Sump Tank								Inlet	Outlet
		high/low	run/stop		clear/white				open/close	open/close
		high/low	run/stop		clear/white				open/close	open/close

NOTE1. Indicate condition of drain in every port, if daily check is not available.

NOTE2. Indicate valve operation for #3/3S Oil Line on daily basis.

6.4.2 FWD Seal

CX DX

FWD Seal	
Oil Level (L)	
FWD seal Tank	

- ① The lubrication for FWD seal is made either by the gravity tank or by bypassing stern tube line with forced circulation.
- ② Add the column on the left to the suitable format in 6.4.1 for gravity tank system.
- ③ No column required for bypassing system, in which the lubricating oil returns to the sump tank.

6.4.3 #2/3 Oil Line, with two gravity tanks

CX DX

#2/3 Oil Line							
Oil Level (L)		Tank in use	Valves		Drain		Oil level in #2/3 Oil Tank above shaft center-line (M)
#2/3 Oil Tank High	#2/3 Oil Tank Low		Inlet	Outlet	Color	Quantity drained (L)	
		high/low	open/close	open/close	clear/white	clear/white	
		high/low	open/close	open/close	clear/white	clear/white	

NOTE1. Indicate condition of drain in every port, if daily check is not available.

NOTE2. Indicate valve operation for #2/3 Oil Line on daily basis.

6.4.4 Other Particulars

CX DX

Other Particulars		
AFT Draft (M)	Sea Condition	Re-marks

A suitable format should include data of AFT draft & Sea condition

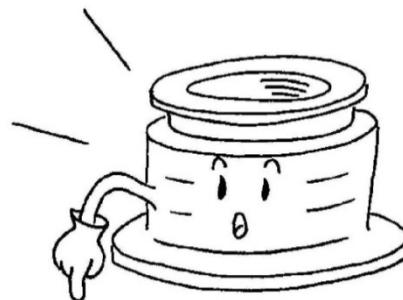
7. POINTS THAT MUST BE FOLLOWED

CX DX AX

FOLLOW

During installation

- Check alignments of the seal to the hull.
- Make sure waste, dust, paint, etc. do not enter the seal.
- Do not cause shock to the seal.
- Do not put heavy items on top of the seal.
- Do not expose the seal to high temperatures when welding etc.
- Use “Stainless Steel Screw Bolts” for installing AFT seal and the liner. (Use a magnet for test.)



Before oiling

- Flush out any waste, dust, paint, etc. from the piping.
- Do not use volatile oils such as gasoline or toluene for cleaning seal rings.

Before turning shaft

Fill the sealing system with approved lubricant oil. (Refer to the recommended lubricant oil list.)
Set the oil pressure of each part as designated. (Refer to the piping diagram on board.)

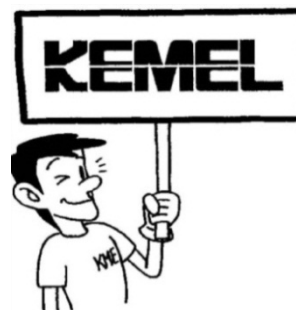
For dry-docking

In case #2/3 Oil Line is provided on AFT seal, close inlet and outlet valves on the line before entering dry-dock. (When the seawater pressure decreases, the lubricant oil in the #2/3 Oil Line may leak outside the ship due to the lack of seawater pressure.)

Request authorized bonding repair and original parts

When the seal requires bonding repair, ask for “KEMEL” or its authorized agent. Keep copy of repair report issued by the service engineer for future reference. Also install KEMEL’s original parts for all of repairs.

Note that bonding repair by non-authorized service providers or any repair by using non-original or non-approved parts on essential components; such as sealing ring, liner or seal housing, do not guarantee the seal system being in normal operating condition after it is put back into operation.



Notes for P. 5 Lubricant Oil

Compatibility Test

KEMEL conduct compatibility test of the seal by request of oil maker supplying tested oil. It examines 4 (four) particulars; i. e. changes in elongation, tensile strength, volume and hardness of seal elastomer after the test sample immersed in the oil for some period, to confirm no-harmful effects on the seal material by the oil. The method conforms to JIS K-6258 test standard (equivalent to ISO 1817:1999). Other than the compatibility, oil users should obtain information of oil properties and the characteristics from the oil maker to select appropriate lubricant for the stern tube system.

Compliance with US rule VGP2013 for stern tube

The rule requires vessels calling US ports to use EAL (Environmentally Acceptable Lubricant) for Oil-to-Sea interface including stern tube. The vessel must follow the rule with proper documentation. For details, visit the web site “Vessel General Permit | Vessels | US EPA” on internet.

8. USEFUL HINTS

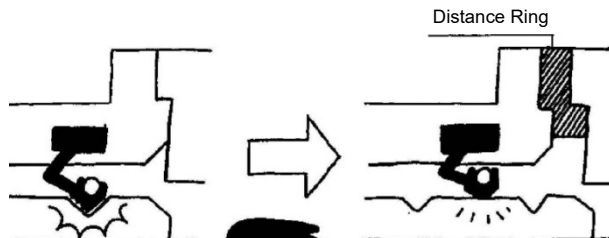
CX DX AX



REFERENCE

• Use of Distance Ring

After a certain period of service, the liner is grooved by seal rings run on the outer surface. A deep groove may disturb oil or water tight of seal ring in case of the renewal by bonding method which does not allow skimming the surface for reconditioning.



In such a case, a split distance ring is installed between stern tube hub and AFT seal flange so that new seal rings run on the new surface with no grooves.

(In case the distance ring is pre-installed, the same effect is available with the removal.)



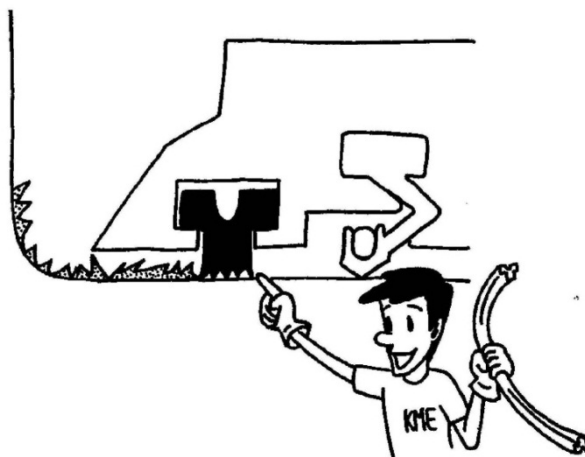
CAUTION

Make sure to use an appropriate length of the fitting bolt for the depth of existing screw holes on stern tube hub when installing or removing the distance ring. Further, distance rings should be cleaned and protected with an anti-rust treatment after removal and stored carefully together with the bolt.

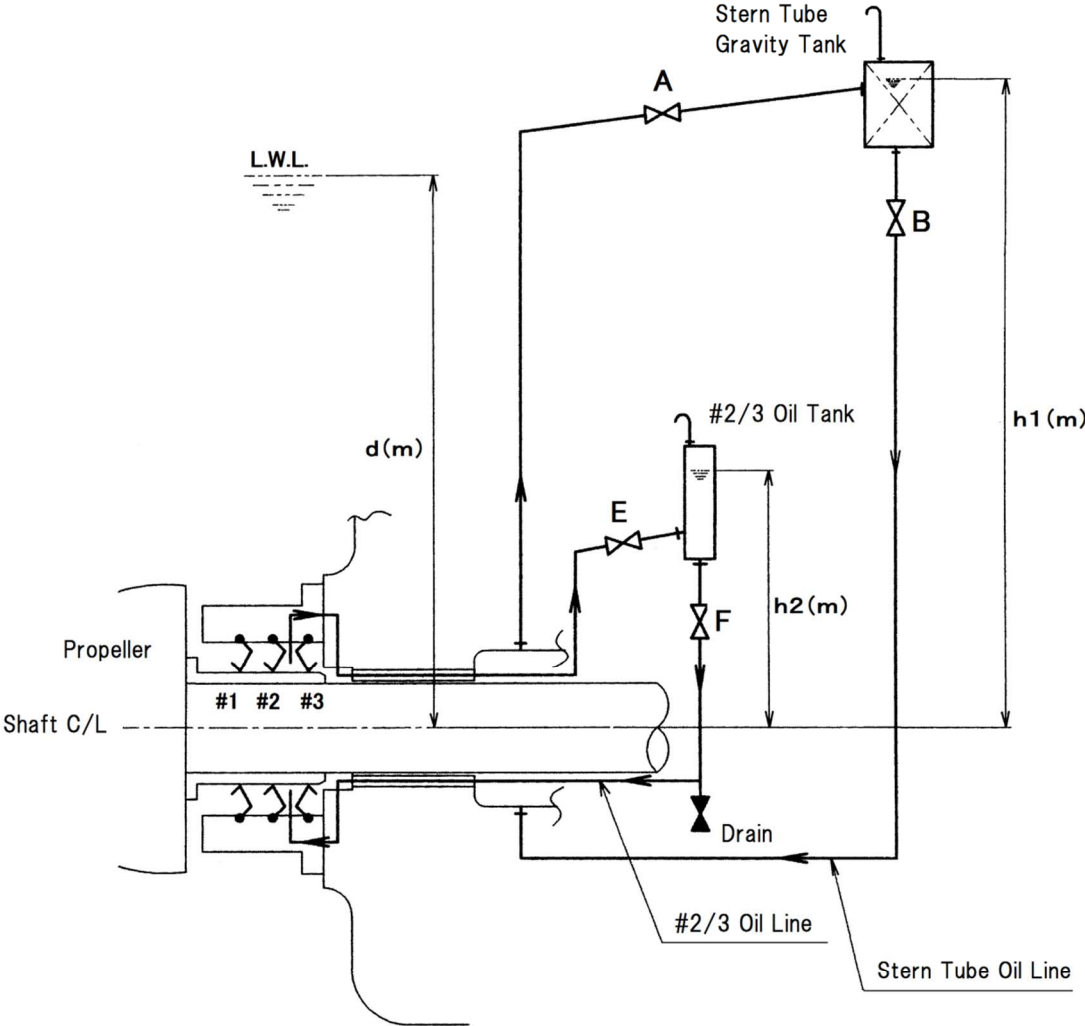
For the FWD seal, the working position on the liner can be changed by moving the set position of the clamp ring in axial direction.

• Net Stopper

The Net Stopper protects the #1 seal ring from fishing nets. It is necessary to renew the rubber stopper contained in the net stopper.



Pressure Setting for Stern Tube Seal
(Type CX with #2/3 Oil Line)



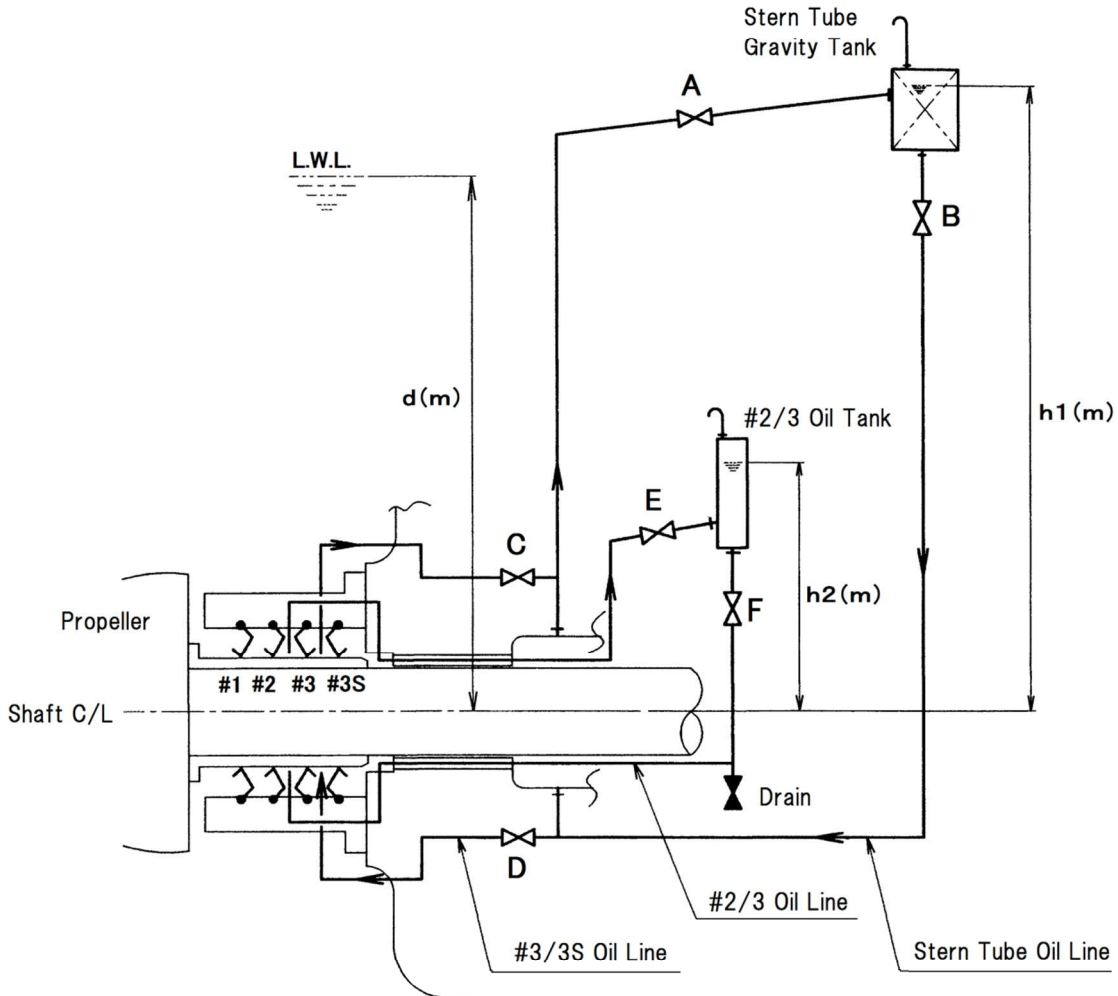
Seawater Pressure $P_{sw} = d(m) \times 1.025/100 \text{ MPa}$
 Stern Tube Oil Press. $P_{st} = h1(m) \times 0.9/100 \text{ MPa}$
 #2/3 Oil Press. $P_{2/3} = h2(m) \times 0.9/100 \text{ MPa}$

Pressure Setting Stern Tube
 $P_{st} = P_{sw} + (0.03 \sim 0.05) \text{ MPa}$ P_{sw} : Designed Max. Draft, above shaft centerline.

Recommended pressure balance for operating #2/3 Oil Line
 $P_{sw} - P_{2/3} > 0.03 \text{ MPa}$ P_{sw} : Aft Draft actual, above shaft centerline.
 Valves "E" & "F" may be temporally closed while the vessel at sea in case of the pressure balance become smaller than 0.03MPa due to a shallow draft. (See P.14 for details.)

Pressure Setting for Stern Tube Seal
(Type DX with #2/3 Oil Line)

DX



Seawater Pressure $P_{sw} = d (m) \times 1.025/100 \text{ MPa}$
 Stern Tube Oil Press. $P_{st} = h_1 (m) \times 0.9/100 \text{ MPa}$
 #2/3 Oil Press. $P_{2/3} = h_2 (m) \times 0.9/100 \text{ MPa}$

Pressure Setting Stern Tube
 $P_{st} = P_{sw} + (0.03 \sim 0.05) \text{ MPa}$ P_{sw} : Designed Max. Draft, above shaft centerline.

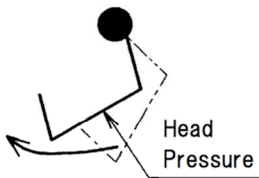
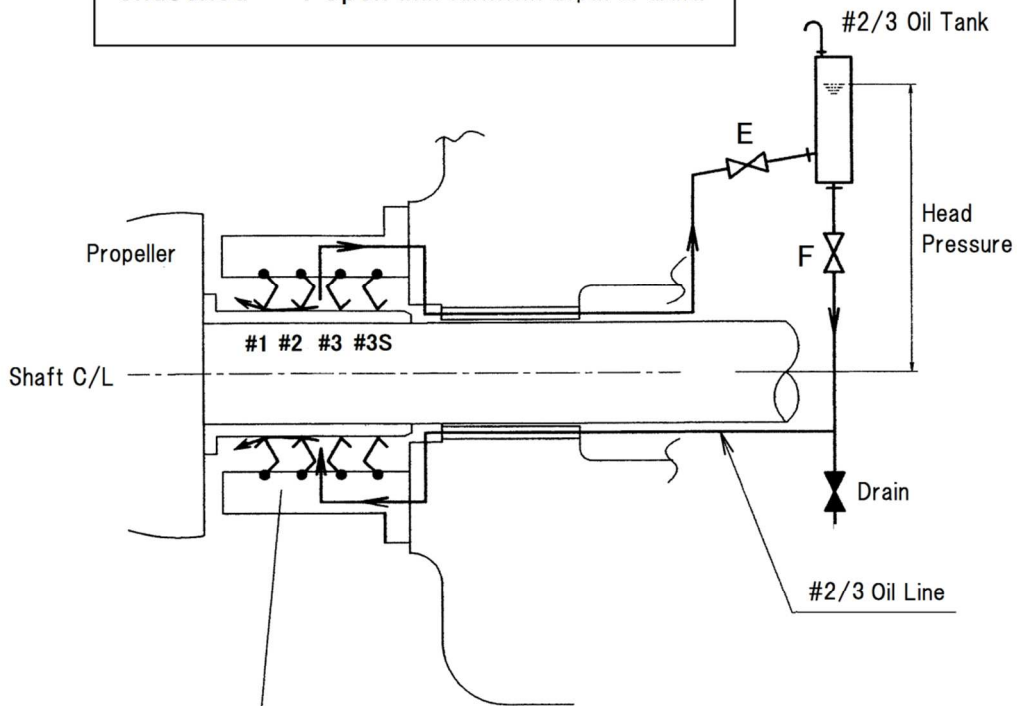
Recommended pressure balance for operating #2/3 Oil Line
 $P_{sw} - P_{2/3} > 0.03 \text{ MPa}$ P_{sw} : Aft Draft actual, above shaft centerline.
 Valves "E" & "F" may be temporarily closed while the vessel at sea in case of the pressure balance become smaller than 0.03MPa due to a shallow draft. (See P.14 for details.)

Operation Notice for dry-docking - #2/3 Oil Line

(Type CX & DX)

Operation of "E" & "F" valves

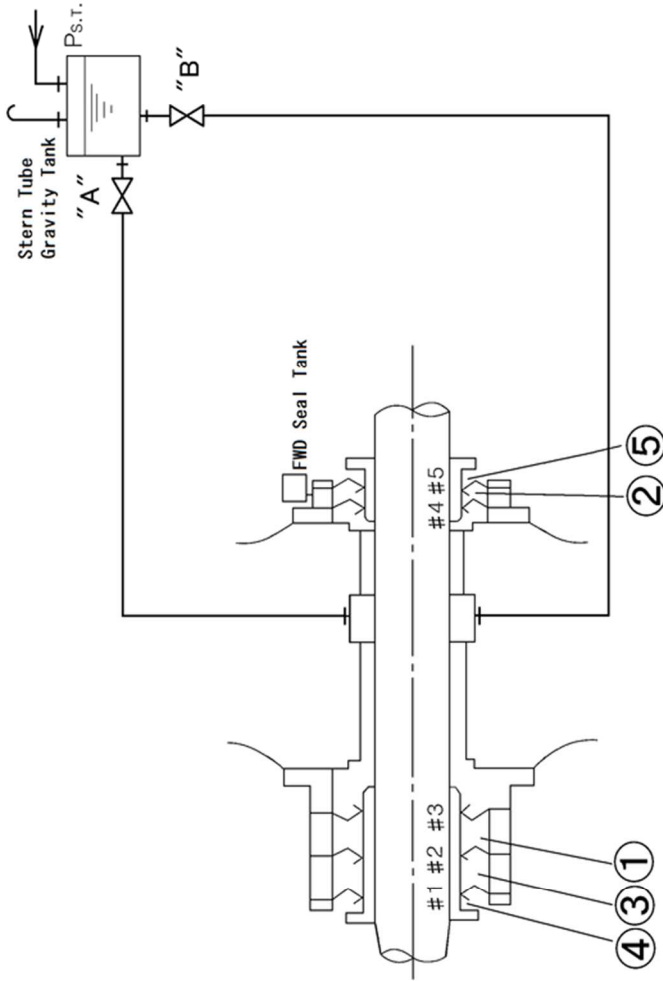
Enter dock : Closed
 During dock : Closed
 Undocked : Open with sufficient depth of draft.



#1 & #2 seal rings maintain water tight by head pressure from the draft.

The back pressure in #2/3 oil line lifts #1 & 2 seal rings can cause oil leak in dry-dock due to no water pressure from the draft.

TEST ORDER (Typical Piping Diagram - Deviations from actual diagram exist.)



1. Test each seal ring in order of above numbering and procedures shown on the left.
2. Operate stern tube circulation pump for the test, if it is provided.
3. Use low pressure line for the test in case high & low pressure lines are provided on stern tube line.
4. Investigate the cause of leakage and take proper treatments in case it is found at the test.

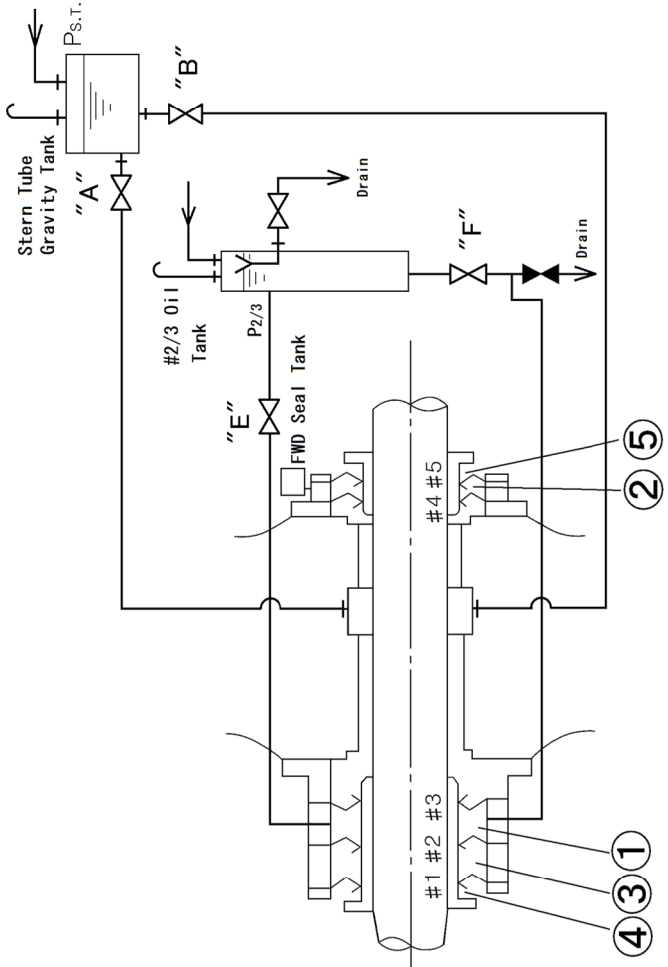
REMARKS

1. Carry out pressure test after completion of flushing pipes.
2. Take wear-down readings before and after overhauling AFT seal for repair ship.
3. Protect seals all the time from sand blasting, painting, welding, chemicals, excessive heat & etc.
4. Use stainless steel fitting bolts for AFT seal installation.
5. Secure all the fitting bolts and plugs for AFT seal by using stainless steel wire.

Test Order	Seal Ring	Procedure
①	#3	<ol style="list-style-type: none"> 1) Fill stern tube, and pressurize. 2) Remove bottom plug between #2 & 3 seal rings on AFT seal casing. 3) Clean up seal casing / liner / oil holes to remove oil wet. 4) Leave the plug opened for over 1 hour. 5) Confirm no oil leaking through the bottom hole. 6) Confirm no oil leaking at other area, i.e. sheet packing, "O" ring & etc.
②	#4	<ol style="list-style-type: none"> 1) Same as #3 seal ring. 2) Remove bottom plug between #4 & 5 seal rings on FWD seal casing. 3) Clean up seal casing / liner / oil holes to remove oil wet. 4) Leave the plug opened for over 1 hour. 5) Confirm no oil leaking through the bottom hole. 6) Confirm no oil leaking at other area, i.e. sheet packing, "O" ring & etc.
③	#2	<ol style="list-style-type: none"> 1) Leave bottom plug between #2 & 3 opened. 2) Plug bottom hole between #1 & 2. 3) Remove two plugs on top between #1 & 2, for oil filling and air venting. 4) Fill oil chamber between #1 & 2 through the top hole. 5) Clean up seal casing / liner / oil holes to remove oil wet. 6) Confirm no oil leaking through the bottom hole between #2 & 3. 7) Plug bottom hole between #2 & 3. 8) Fill oil chamber between #2 & 3.
④	#1	<ol style="list-style-type: none"> 1) Same as #2. 2) Same as #2. 3) Same as #2. 4) Same as #2. 5) Same as #2. 6) Confirm no oil leaking out. 7) Confirm all of oil holes no entire AFT seal plugged after the test.
⑤	#5	<ol style="list-style-type: none"> 1) Plug all of oil holes between #4 & 5 on FWD seal casing. 2) Fill oil chamber between #4 & 5. 3) Clean up seal casing / liner / oil holes to remove oil wet. 4) Confirm no oil leaking out. 5) Confirm all of oil holes no entire FWD seal plugged after the test.
	Notice for dry-docking	None

Test Order	Seal Ring	Procedure
①	#3	1) Keep valves "E" & "F" closed. 2) Fill stern tube, and pressurize. 3) Remove bottom plug between #2 & 3 seal rings on AFT seal casing. 4) Clean up seal casing / liner / oil holes to remove oil wet. 5) Leave the plug opened for over 1 hour. 6) Confirm no oil leaking through the bottom hole. 7) Confirm no oil leaking at other area, i.e. sheet packing, "O" ring & etc.
②	#4	1) Same as #3 seal ring. 2) Same as #3 seal ring. 3) Remove bottom plug between #4 & 5 seal rings on FWD seal casing. 4) Clean up seal casing / liner / oil holes to remove oil wet. 5) Leave the plug opened for over 1 hour. 6) Confirm no oil leaking through the bottom hole. 7) Confirm no oil leaking at other area, i.e. sheet packing, "O" ring & etc.
③	#2	1) Leave bottom plug between #2 & 3 opened. 2) Plug bottom hole between #1 & 2. 3) Remove two plugs on top between #1 & 2, for oil filling and air venting. 4) Fill oil chamber between #1 & 2 through the top hole. 5) Clean up seal casing / liner / oil holes to remove oil wet. 6) Confirm no oil leaking through the bottom hole between #2 & 3. 7) Plug bottom hole between #2 & 3. 8) Fill oil chamber between #2 & 3 with "E" & "F" valves closed.
④	#1	1) Same as #2. 2) Same as #2. 3) Same as #2. 4) Same as #2. 5) Same as #2. 6) Confirm no oil leaking out. 7) Confirm all of oil holes no entire AFT seal plugged after the test.
⑤	#5	1) Plug all of oil holes between #4 & 5 on FWD seal casing. 2) Fill oil chamber between #4 & 5. 3) Clean up seal casing / liner / oil holes to remove oil wet. 4) Confirm no oil leaking out. 5) Confirm all of oil holes no entire FWD seal plugged after the test.
Notice for dry-docking		1) Close valves "E" & "F" on #2/3 Oil Line before docking. 2) Do not open the valves while the ship in dock. 3) Keep "E" & "F" closed with a shallow draft after the ship is undocked. 4) Open "E" & "F" after draft level become greater than oil level in #2/3 Oil Tank.

TEST ORDER (Typical Piping Diagram - Deviations from actual diagram exist.)



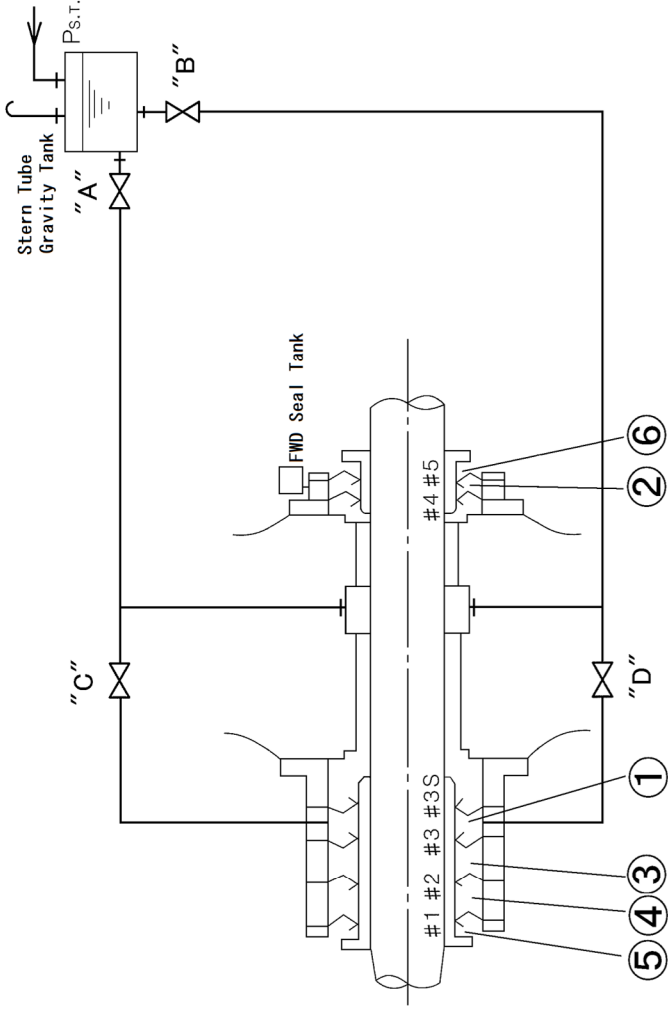
1. Test each seal ring in order of above numbering and procedures shown on the left.
2. Operate stern tube circulation pump for the test, if it is provided.
3. Use low pressure line for the test in case high & low pressure lines are provided on stern tube line.
4. Investigate the cause of leakage and take proper treatments in case it is found at the test.

REMARKS

1. Carry out pressure test after completion of flushing pipes.
2. Take wear-down readings before and after overhauling AFT seal, for repair ship.
3. Protect seals at the time from sand blasting, painting, welding, chemicals, excessive heat & etc.
4. Use stainless steel fitting bolts for AFT seal installation.
5. Secure all the fitting bolts and plugs for AFT seal by using stainless steel wire.

Test Order	Seal Ring	Procedure
①	#3S	1) Close valves "C" & "D". 2) Fill stern tube, and pressurize. 3) Remove bottom plug between #3 & 3S seal rings on AFT seal casing. 4) Clean up seal casing / liner / oil holes to remove oil wet. 5) Leave the plug opened for over 1 hour. 6) Confirm no oil leaking through the bottom hole. 7) Confirm no oil leaking at other area, i.e. sheet packing, "O" ring & etc.
②	#4	1) Same as #3 seal ring. 2) Same as #3 seal ring. 3) Remove bottom plug between #4 & 5 seal rings on FWD seal casing. 4) Clean up seal casing / liner / oil holes to remove oil wet. 5) Leave the plug opened for over 1 hour. 6) Confirm no oil leaking through the bottom hole. 7) Confirm no oil leaking at other area, i.e. sheet packing, "O" ring & etc.
③	#3	1) Plug all of oil holes / drain holes between #3 & 3S on AFT seal casing. 2) Open valves "C" & "D", to apply pressure in chamber between #3 & 3S. 3) Remove bottom plug between #2 & 3 on AFT seal casing. 4) Clean up seal casing / liner / oil holes to remove oil wet. 5) Leave the plug opened for over 1 hour. 6) Confirm no oil leaking through the bottom hole.
④	#2	1) Leave bottom plug between #2 & 3 opened. 2) Plug bottom hole between #1 & 2. 3) Remove two plugs on top between #1 & 2, for oil filling and air venting. 4) Fill oil chamber between #1 & 2 through the top hole. 5) Clean up seal casing / liner / oil holes to remove oil wet. 6) Confirm no oil leaking through the bottom hole between #2 & 3. 7) Plug bottom hole between #2 & 3. 8) Fill oil chamber between #2 & 3.
⑤	#1	1) Same as #2. 2) Same as #2. 3) Same as #2. 4) Same as #2. 5) Same as #2. 6) Confirm no oil leaking out. 7) Confirm all of oil holes no entire AFT seal plugged after the test.
⑥	#5	1) Plug all of oil holes between #4 & 5 on FWD seal casing. 2) Fill oil chamber between #4 & 5. 3) Clean up seal casing / liner / oil holes to remove oil wet. 4) Confirm no oil leaking out. 5) Confirm all of oil holes no entire FWD seal plugged after the test.
Notice for dry-docking		None

TEST ORDER (Typical Piping Diagram - Deviations from actual diagram exist.)



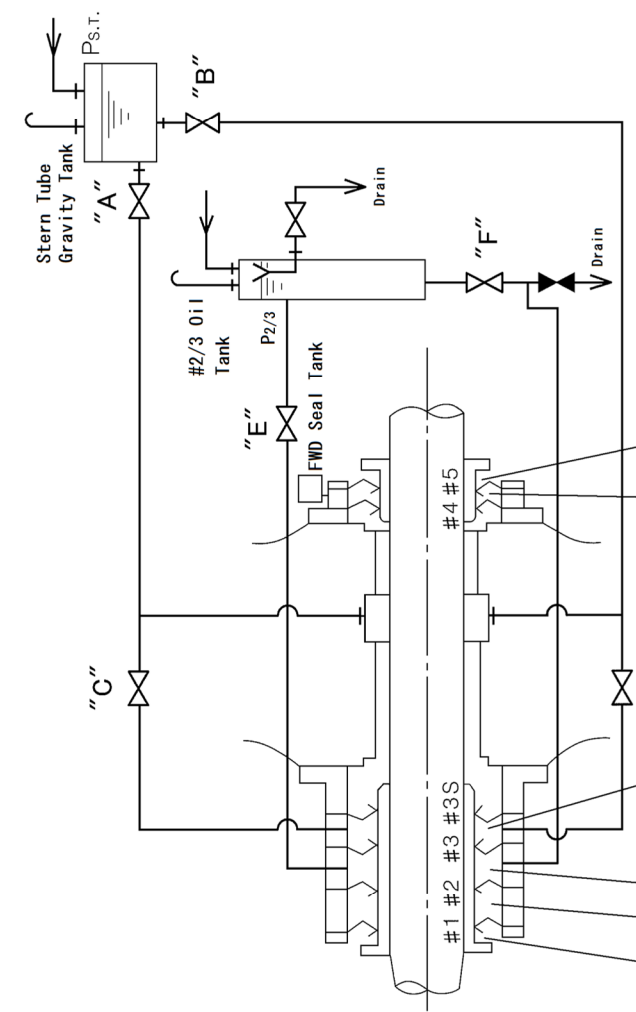
1. Test each seal ring in order of above numbering and procedures shown on the left.
2. Operate stern tube circulation pump for the test, if it is provided.
3. Use low pressure line for the test in case high & low pressure lines are provided on stern tube line.
4. Investigate the cause of leakage and take proper treatments in case it is found at the test.

REMARKS

1. Carry out pressure test after completion of flushing pipes.
2. Take wear-down readings before and after overhauling AFT seal, for repair ship.
3. Protect seals all the time from sand blasting, painting, welding, chemicals, excessive heat & etc.
4. Use stainless steel fitting bolts for AFT seal installation.

LEAK TEST PROCEDURE in dry-dock (KEMEL Double Security COMPACT Seal Type DX with #2/3 Oil Line)

DX

Test Order	Seal Ring	Procedure
①	#3S	<p>TEST ORDER (Typical Piping Diagram - Deviations from actual diagram exist.)</p>  <p>1) Close valves "C" & "D". 2) Keep valves "E" & "F" closed. 3) Fill stern tube, and pressurize. 4) Remove bottom plug between #3 & 3S seal rings on AFT seal casing. 5) Clean up seal casing / liner / oil holes to remove oil wet. 6) Leave the plug opened for over 1 hour. 7) Confirm no oil leaking through the bottom hole. 8) Confirm no oil leaking at other area, i.e. sheet packing, "O" ring & etc.</p>
②	#4	<p>1) Same as #3 seal ring. 2) Same as #3 seal ring. 3) Same as #3 seal ring. 4) Remove bottom plug between #4 & 5 seal rings on FWD seal casing. 5) Clean up seal casing / liner / oil holes to remove oil wet. 6) Leave the plug opened for over 1 hour. 7) Confirm no oil leaking through the bottom hole. 8) Confirm no oil leaking at other area, i.e. sheet packing, "O" ring & etc.</p>
③	#3	<p>1) Plug all of oil holes / drain holes between #3 & 3S on AFT seal casing. 2) Open valves "C" & "D", to apply pressure in chamber between #3 & 3S. 3) Remove bottom plug between #2 & 3 on AFT seal casing. 4) Clean up seal casing / liner / oil holes to remove oil wet. 5) Leave the plug opened for over 1 hour. 6) Confirm no oil leaking through the bottom hole.</p>
④	#2	<p>1) Leave bottom plug between #2 & 3 opened. 2) Plug bottom hole between #1 & 2. 3) Remove two plugs on top between #1 & 2, for oil filling and air venting. 4) Fill oil chamber between #1 & 2 through the top hole. 5) Clean up seal casing / liner / oil holes to remove oil wet. 6) Confirm no oil leaking through the bottom hole between #2 & 3. 7) Plug bottom hole between #2 & 3. 8) Fill oil chamber between #2 & 3 with "E" & "F" valves closed.</p>
⑤	#1	<p>1) Same as #2. 2) Same as #2. 3) Same as #2. 4) Same as #2. 5) Same as #2. 6) Confirm no oil leaking out. 7) Confirm all of oil holes no entire AFT seal plugged after the test.</p>
⑥	#5	<p>1) Plug all of oil holes between #4 & 5 on FWD seal casing. 2) Fill oil chamber between #4 & 5. 3) Clean up seal casing / liner / oil holes to remove oil wet. 4) Confirm no oil leaking out. 5) Confirm all of oil holes no entire FWD seal plugged after the test.</p>
Notice for dry-docking		<p>1) Close valves "E" & "F" on #2/3 Oil Line before docking. 2) Do not open the valves while the ship in dock. 3) Keep "E" & "F" closed with a shallow draft after the ship is undocked. 4) Open "E" & "F" after draft level become greater than oil level in #2/3 Oil Tank.</p>

- REMARKS**
1. Carry out pressure test after completion of flushing pipes.
 2. Take wear-down readings before and after overhauling AFT seal, for repair ship.
 3. Protect seals all the time from sand blasting, painting, welding, chemicals, excessive heat & etc.
 4. Use stainless steel fitting bolts for AFT seal installation.
 5. Secure all the fitting bolts and plugs for AFT seal by using stainless steel wire.

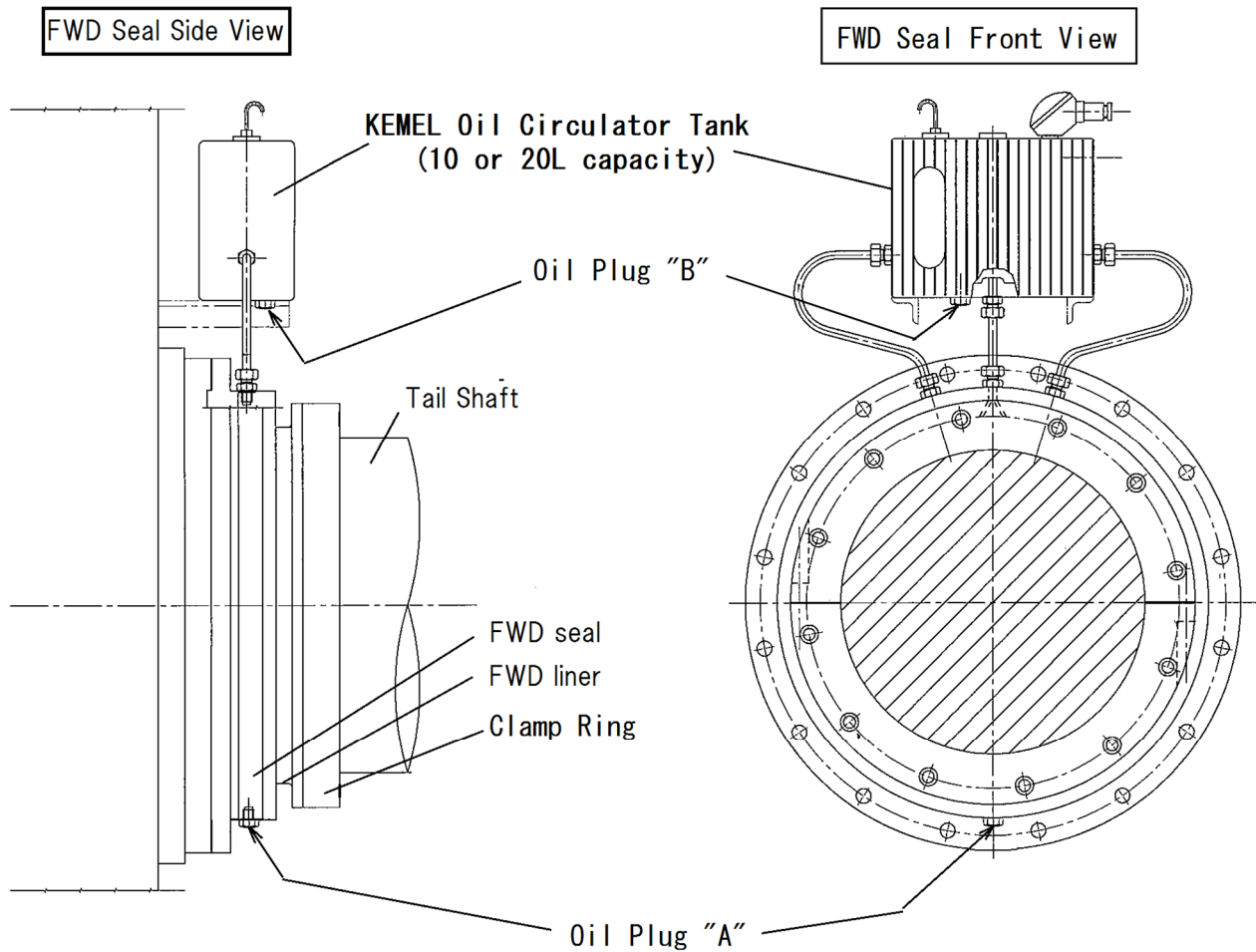
Removal oil in Oil Circulator Tank for replacement

(Appendix(1) of Operating Guideline P. 11)

Oil removal in FWD seal is available by opening oil plugs shown below;

1. Open oil plug "A" to drain oil in FWD seal chamber and the tank.
2. Open oil plug "B" to drain oil remained in the tank bottom.
3. Open the top cover of the tank to clean the inside if find necessary
4. Total capacity of the oil is about 10 – 20 L.

Sketch stern tube FWD seal



Recovery method of oil dripping from FWD Seal to Engine Room

(Appendix(2) of Trouble Shooting 6.3 FWD Seal P. 17)

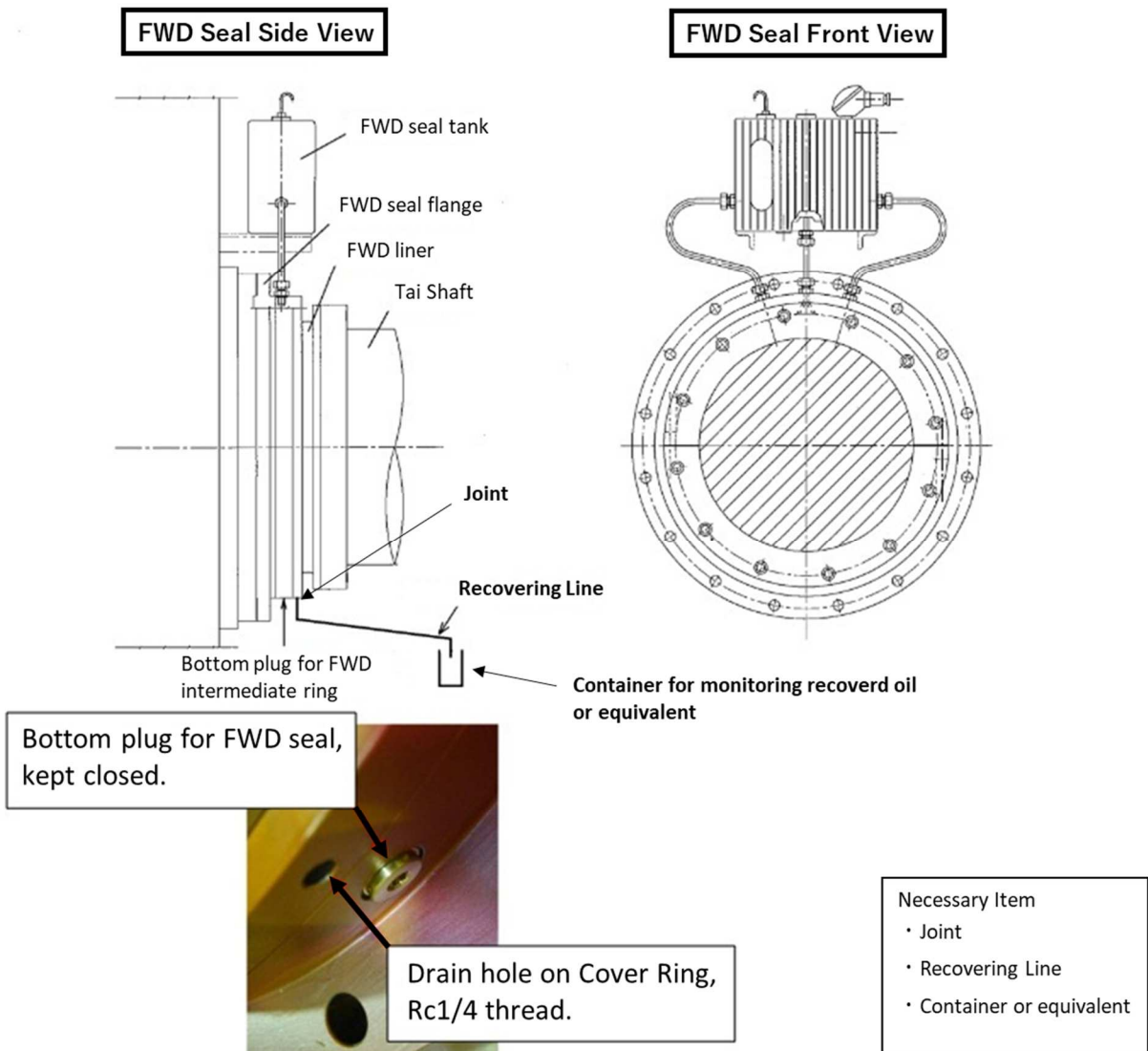
FWD Seal(size 450 and above) has a thread hole for recovering the dripping oil from FWD seal to engine room.

Monitor the amount of the collected oil according to the figure below if necessary.

[Reference]

A Lip type seal has noticeable level of oil leakage without having seal damage, due to lubrication at the lip part while the shaft in rotation.

Especially, the #5 seal ring of FWD seal tends to have a noticeable leakage by lubrication because of the low oil pressure in front side, i.e. low tightening force.



— MEMO —

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