





### III MACHINERY PART



## I N D E X

### **SECTION 1 GENERAL DESCRIPTION**

1.1	GENERAL	M1 — 1
1.2	MACHINERY PARTICULAR	M1 — 2
1.3	SHOP TEST	M1 — 11
1.4	FUEL OIL CONSUMPTION OF MAIN ENGINE	M1 — 13

### **SECTION 2 MAIN PROPULSION UNIT**

2.1	GENERAL	M2 — 1
2.2	CONSTRUCTION AND MATERIAL	M2 — 1
2.3	FITTING AND ACCESSORY	M2 — 10

### **SECTION 3 SHAFTING AND PROPELLER**

3.1	GENERAL	M3 — 1
3.2	SHAFTING	M3 — 1
3.3	INTERMEDIATE SHAFT BEARING	M3 — 1
3.4	STERN TUBE BEARING AND SEAL	M3 — 2
3.5	PROPELLER	M3 — 2
3.6	MATERIAL	M3 — 3

### **SECTION 4 STEAM GENERATING PLANT**

4.1	GENERAL	M4 — 1
4.2	AUXILIARY BOILER	M4 — 1

### **SECTION 5 ELECTRIC GENERATING PLANT**

5.1	GENERAL	M5 — 1
5.2	MAIN DIESEL GENERATOR ENGINE	M5 — 1

**SECTION 6 PUMP**

6.1	GENERAL	M6 — 1
6.2	CENTRIFUGAL PUMP	M6 — 1
6.3	ROTARY PUMP	M6 — 3
6.4	RECIPROCATING PUMP	M6 — 4
6.5	MONROS PUMP	M6 — 4
6.6	OTHER PUMP	M6 — 5

**SECTION 7 AIR COMPRESSOR AND FAN**

7.1	MAIN AIR COMPRESSOR	M7 — 1
7.2	EMERGENCY AIR COMPRESSOR	M7 — 2
7.3	MAIN AIR RESERVOIR	M7 — 2
7.4	EMERGENCY AIR RESERVOIR	M7 — 2
7.5	ENGINE ROOM VENTILATING FAN	M7 — 2

**SECTION 8 HEAT EXCHANGER**

8.1	COOLER AND CONDENSER	M8 — 1
8.2	OIL HEATER	M8 — 3

**SECTION 9 FRESH WATER GENERATOR**

9.1	GENERAL	M9 — 1
9.2	FITTING AND ACCESSORY	M9 — 1

**SECTION 10 PIPING GENERAL**

10.1	GENERAL	M10— 1
10.2	SEA CHEST	M10— 2
10.3	VALVE AND COCK	M10— 3
10.4	PIPING SCHEDULE	M10— 5
10.5	STRAINER	M10— 8
10.6	SEA WATER DISTRIBUTION CHART	M10—10
10.7	PIPING SYSTEM	M10—11



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**SECTION 11 INSULATION AND PAINTING**

11.1	INSULATION	M11 — 1
11.2	PAINTING	M11 — 3

**SECTION 12 MISCELLANEOUS EQUIPMENT**

12.1	OIL PURIFYING DEVICE	M12 — 1
12.2	BILGE SEPARATOR	M12 — 2
12.3	ENGINEER'S WORKSHOP AND STORE ROOM	M12 — 3
12.4	LIFTING GEAR AND TOOL	M12 — 3
12.5	TANK IN ENGINE ROOM	M12 — 3
12.6	FLOOR, LADDER AND GRATING	M12 — 6
12.7	VENTILATION FOR ENGINE ROOM	M12 — 6
12.8	FIRE FIGHTING SYSTEM IN ENGINE ROOM	M12 — 7
12.9	INCINERATOR	M12 — 7
12.10	NAME PLATE AND CAUTION PLATE	M12 — 7

**SECTION 13 AUTOMATION AND REMOTE CONTROL**

13.1	GENERAL	M13 — 1
13.2	MAIN ENGINE REMOTE CONTROL SYSTEM	M13 — 1
13.3	ENGINE CONTROL ROOM	M13 — 2
13.4	ALARM SYSTEM	M13 — 2
13.5	INSTRUMENTATION AND CONTROL IN ENGINE CONTROL ROOM	M13 — 4

**SECTION 14 SPARE PARTS**

14.1	GENERAL	M14 — 1
14.2	MAIN ENGINE	M14 — 1
14.3	SHAFTING AND PROPELLER	M14 — 4
14.4	STEAM GENERATING PLANT	M14 — 4
14.5	DIESEL GENERATOR ENGINE	M14 — 5
14.6	PUMP	M14 — 6
14.7	MAIN AIR COMPRESSOR	M14 — 8
14.8	HEAT EXCHANGER	M14 — 8
14.9	OTHER MACHINERY	M14 — 8



## **SECTION 15 TOOLS AND OUTFITS**

15.1	GENERAL	M15- 1
15.2	MAIN ENGINE	M15- 1
15.3	SHAFTING AND PROPELLER	M15- 2
15.4	AUXILIARY BOILER	M15- 2
15.5	DIESEL GENERATOR ENGINE	M15- 2
15.6	HEAT EXCHANGER	M15- 2
15.7	OTHER MACHINERY	M15- 2
15.8	GENERAL TOOLS AND OUTFITS	M15- 3



## **SECTION 1 GENERAL DESCRIPTION**

### **1.1 GENERAL**

The vessel shall be arranged for single screw propulsion with directly coupled diesel propelling machinery located in the engine room aft.

The main propulsion unit shall consist of one (1) set marine diesel engine, driving a propeller through a line of shafting.

The main engine and aux. boiler shall be able to use the heavy fuel oil of 380 cSt at 50°C.

The main diesel generator engine shall be able to use the heavy fuel oil of 380 cSt at 50°C. Diesel oil shall be used at starting, stopping, low load condition and furious load change condition of diesel gene. engine in accordance with the engine operation manual.

The steam generating plant shall consist of one (1) aux. boiler.

The electric generating plant shall consist of three (3) diesel generator sets.

**1.2 MACHINERY PARTICULAR**

Rule		ABS						
Kind of Ship		63,000 M.T. D/W TYPE BULK CARRIER						
<b>Hull</b>								
Dimension	m	Lpp 195.00	B 32.24	D 19.15	d (Ext.) 13.418			
Tonnage	Ton	G.T.	35,832	D.W.	63,347 M.T.			
Speed	knot	Sea Trial	15.653	Service	14.5	abt.		
<b>Main Engine</b>								
Type & No. of Set		HITACHI-MAN B&W, 2 stroke cycle , single acting, direct reversible, crosshead type diesel engine with turbocharger 6S50ME-B9.3 × 1 set						
Output × Speed	Maximum Rating	kW × min <sup>-1</sup>	7,560 × 99.0			Turbocharger MET48MB × 1 set		
	Normal Rating	kW × min <sup>-1</sup>	6,425 × 93.8 (85 %)					
Brake Mean Effective Press. at Max. Rating		MPa	1.76					
Mean Piston Speed at Max. Rating		m/s	7.31					
Cylinder No. & Size		mm	6 × φ 500 × 2,214					
Turning Motor		kW × min <sup>-1</sup>	2.2 × 1,200					
			HITACHI ZOSEN CORPORATION					
<b>Shafting</b>								
Thrust Shaft		No. × mm	Attached to Main Engine					
Intermediate Shaft		No. × mm	1 × φ 415 × 5,950					
Propeller Shaft		No. × mm	1 × φ 500 × 6,550					
Stern Tube Seal			WARTSILA JAPAN LTD. OLS4 0530					
<b>Propeller</b>								
Type & No. of Set		5 Bladed Solid Type ( Ni- Al- Br ) × 1 set						
Diameter × Pitch		mm	φ 6,300 × 4,561.6 (0.7R) 4,488.3 (MEAN)					
Exp. Area Ratio × Boss Ratio		—	0.4700 × 0.1524					
Skew Angle		deg.	25					
			NAKASHIMA PROPELLER CO., LTD.					



Auxiliary Boiler					
Type & No. of Set		Composite system vertical type boiler GK-2032-1100/680 × 1 set			
Steam Pressure & Temperature	— × °C	(Design) 0.8 MPa× Saturated (Work.) 0.55 MPa× Saturated			
Heating Surface	m <sup>2</sup>	(Oil burning side) (Exh. gas side) 33.2 × 198.4			
Evaporation	kg/h	(Oil burning side) (Exh. gas side) 1,100 × 680 ( M/E 85 % Load )			
Feed Water Temp.	°C	abt. 60			
Burner Type		Forced Draft Type Pressure Atomizing Burner			
		MIURA CO., LTD.			

Service	No.of Set	Type	Capacity (m <sup>3</sup> /h×MPa)	Motor (kW×min <sup>-1</sup> )	
No.1 Cooling Sea Water Pump	1	Self Priming MD. V. Cent.	(T.H.) 560× 20 m	55×1800	TAIKO KIKAI EMCE-260C
No.2 Cooling Sea Water Pump	1	MD. V. Cent.	(T.H.) 560× 20 m	55×1800	Do. EMC-260C
Jacket Cooling Fresh Water Pump	2	MD. V. Cent.	(T.H.) 102× 40 m	22×1800	Do. ESC-150D
Main Air Comp. Cooling F.W. Pump	2	MD. H. Cent.	(T.H.) 3.2× 25 m	1.5×3600	Do. TMC-32
Main Lubricating Oil Pump	2	MD.V. Cent.	(D.P.) 220 × 0.42	55×1800	Do. C1T-200
Fuel Oil Booster Pump	2	MD. H. Gear	(D.P.) 2.9 × 0.4	1.5×1200	TAIKO KIKAI NHG-5MA
Main Engine Fuel Oil Circulating Pump	2	MD. H. Gear	(D.P.) 4.2 × 1.0	3.7×1200	Do. HHC-6MA
Fuel Oil Transfer Pump	1	MD. H. Gear	(D.P.) 15 × 0.3	5.5×1200	Do. NHG-15
Diesel Oil Transfer Pump	1	MD. H. Gear	(D.P.) 4 × 0.3	2.2×1200	Do. NHG-6MA
Lubricating Oil Transfer and L.O. Purifier Supply Pump	1	MD. H. Gear	(D.P.) 4 × 0.3	1.5×1200	Do. NHG-4
Diesel Gene. Fuel Oil Circulating Pump	2	MD. H. Gear	(D.P.) 1.6 × 0.9	1.5×1200	TAIKO KIKAI HHC-2.5MA
Diesel Gene. Diesel Oil Booster Pump	1	MD. H. Gear	(D.P.) 1.5 × 0.75	3.7×1200	Do. HHC-4MA
Stern Tube Lubricating Oil Pump	2	MD. H. Gear	(D.P.) 0.5 × 0.2	0.4×1200	Do. NHG-0.5
Diesel Gene. Lub. Oil Priming Pump	3	MD. H.Screw	(D.P.) 2.5 × 0.2	0.94×3600	※
D/G L.O. Purifier Supply Pump	1	MD. H. Gear	(D.P.) 0.6 × 0.3	0.4×1200	TAIKO KIKAI NHG-1
Bilge & Ballast Pump	1	Self Priming MD. V. Cent.	(T.H.) 220/90×20/70 m	50×1800	TAIKO KIKAI ESCE-200D
Fire & G.S. Pump	1	Self Priming MD. V. Cent.	(T.H.) 220/90×20/70 m	50×1800	Do. ESCE-200D
Ballast Pump	2	MD. V. Cent.	(T.H.) 900× 25 m	90×1800	Do. EMD-350C
Bilge Pump	1	MD. H. Recipro.	(T.H.) 2 × 30 m	0.75×1200	Do. LD-2NX
Sludge Pump	1	MD. H. Monros	(T.H.) 2.5 × 41 m	1.5×1200	Do. HNP-301
Ref. Mach. Cooling Sea Water Pump	1	MD. H. Cent.	(T.H.) 40 × 35 m	7.5×3600	TAIKO KIKAI TMC-65B

Service	No.of Set	Type	Capacity (m <sup>3</sup> /h × MPa)	Motor (kW × min <sup>-1</sup> )	
Drinking Water Pump	1	MD. V. Cent.	(T.H.) 5 × 50 m	3.7 × 3600	TAIKO KIKAI TMV-32
Fresh Water Pump	1	MD. V. Cent.	(T.H.) 5 × 50 m	3.7 × 3600	Do. TMV-32
Hot Water Circulating Pump	1	MD. H. Cent.	(T.H.) 2 × 10 m	0.4 × 1800	Do. TMC-32
Boiler H.F.O./M.G.O. Burning Pump	1	MD. H. Trochoid	(D.P.) 268 ℓ/h × 1.8	0.75 × 3600	※
Boiler Pilot Burner Pump	1	MD. H. Trochoid	(D.P.) 40 ℓ/h × 0.8	0.09 × 3600	※
Boiler Forced Draft Fan	1	MD. Turbo	23 m <sup>3</sup> /min × 2.94 kPa	2.2 × 3600	※
Boiler Feed Water Pump	2	MD. H. Cent.	(T.H.) 4 × 100 m	5.5 × 3600	TAIKO KIKAI 2MF-52M
Fuel Oil Purifier	2	MD. V. Centrifuge	2,100 ℓ/h (380 cSt at 50°C)	5.5 × 1800	MITSUBISHI KAKOKI SJ25H
Lubricating Oil Purifier	1	MD. V. Centrifuge	2,400 ℓ/h	5.5 × 1800	Do. SJ25H
D/G Lubricating Oil Purifier	1	MD. V. Centrifuge	1,300 ℓ/h	3.7 × 1800	Do. SJ15H
D/G Lubricating Oil By-pass Filter	3		*		※
Engine Room Ventilating Fan	2	Reversible MD. V. Axial	650 m <sup>3</sup> /min × 0.29 kPa	7.5 × 1200	TAIYO ELECT. FA-B-90-3
Engine Room Ventilating Fan	1	MD. V. Axial	650 m <sup>3</sup> /min × 0.29 kPa	7.5 × 1200	Do. FA-B-90-3
Auxiliary Blower	2	MD. Turbo		37 × 3600	Attach to M/E
Motor for M/E hydraulic system	2	MD.		65 × 1800	Attach to M/E
Bilge Separator	1	with Content meter	2 m <sup>3</sup> /h		TAIKO KIKAI USH-20
M.G.P.S.	1	Strainer type Cu-Fe ion			CONHIRA HPGTO-560
Shaft Grounding Equipment	1				NIPPON CORROSION
Ballast Water Treatment System	1	Electrolysis	ECS1000B × 2		TECHCROSS

Service	No. of Set	Type	Capacity (m <sup>3</sup> /h × MPa)	Motor (kW × min <sup>-1</sup> )	
Overhead Travelling Crane	1	MD.	3 ton	2.2 × 900 0.2 × 1800 0.2 × 1800 —	SEKIGAHARA MAA-030059
Lathe	1	MD.	Center distance 600 mm	2.2 × 1800	KUSAKABE KL36B-60
Drilling Machine	1	MD.	φ 21	0.4 × 1800	Do. KD-21
Grinding Machine	1	MD. 2—Wheels	AC440V 3 φ 60Hz φ 255 × 25t	0.75 × 1800	Do. KGL-10
Electric Welder	2	A.C. Arc Type	300 Amp		
Gas Cutting Machine	1	Acetylene Type	Oxygen B. × 2 Acetylene B. × 1	Hose: Each 25 m × 3	Foreign made
Chain Block	1 2 3		3 ton 1 ton 0.5 ton		
Control Room Air Conditioner	1	With E. heater Packaged Type (R404a)	11.3 kW	2.2 × 3600	USHIO REINETSU UAP-2HS4PL4-1
Water-based Local Fire Fighting System	1	Low Press. Type			KASHIWA
Sewage Treatment Unit	1				TAIKO KIKAI SBH-25
Ballast Eductor	1		100 m <sup>3</sup> /h		
Bilge Eductor	1		50 m <sup>3</sup> /h		
F.O. Tank Pre-heating Unit	1				HOKUSHIN
F.O. Shifter Pump	1	MD. H. Gear	(D.P.) 7.2 × 0.49	3.7 × 1800	※ 100%Capa.
Fresh Water Generator	1		15 T/D		MIURA WM-15DK
Distillate Pump	1	MD. H. Cent.	(T.H.) 1.05 × 30 m	0.75 × 3600	※
Ejector Pump	1	MD. H. Cent.	(T.H.) 18 × 48 m	5.5 × 3600	※
Waste Oil Incinerator	1		349 kW		MIURA BGW-30N
Waste Oil Pump	1	MD. H. Trochoid	160 ℓ/h × 0.2 MPa	0.1 × 1800	※
Exhaust & Cooling Fan	1	MD.	95 m <sup>3</sup> /min × 2.65 kPa	7.5 × 3600	※
Burning Fan	1	MD.	11.4 m <sup>3</sup> /min × 1.18 kPa	1.5 × 3600	※

Service	No.of Set	Type	Capacity (m <sup>2</sup> )	Motor (kW × min <sup>-1</sup> )	
Jacket Cooling Fresh Water Cooler	1	Plate	11.40		HISAKA WORKS LX-125B-NPM-59
Main Lubricating Oil Cooler	1	Plate	110.39		Do. LX-595B-NPM-135
Diesel Gene. Cooling F.W. Cooler	2	Plate	17.00		Do. UX-195B-NPM-87
Main Engine M.G.O. Cooler	1	Plate	1.40		Do. UX-196B-NJM-9
Diesel Generator M.G.O. Cooler	1	Plate	1.00		Do. UX-116B-NJM-7
F.O. Refiner	1	Select	E.F. 5 μ		IRIS MARINE FR-D50W
M/E F.O. 2nd Filter	1		ABS.50μ 4.2m <sup>3</sup> /h		KANAGAWA KIKI PGC/J-W50LL/2
D/G F.O. 2nd Filter	1		E.F.10μ 1.6m <sup>3</sup> /h		Do. PGA/J-W10SL/2
Auxiliary Condenser	1	H. Shell & Tube	10		SHOWA 300U-2F
Shifter Fuel Oil Heater	1	Steam Heat	STM 0.55MPa 55 → 85°C		KAJIWARA B150/40 × 15-20
Purifier Lub. Oil Heater	1	Steam Heat	STM 0.55MPa 45 → 90°C		Do. XLV90-150
D/G Purifier Lub. Oil Heater	1	Steam Heat	STM 0.55MPa 45 → 90°C		Do. XLV90-50
Purifier Fuel Oil Heater	2	Steam Heat	STM 0.55MPa 55 → 98°C		Do. B125/40 × 15-14
Main Engine Fuel Oil Heater	1	Steam Heat	STM 0.55MPa 105 → 140°C		Do. B125/80 × 15-14
Boiler Fuel Oil Heater	1	Electric Heat		7 kW	※
Diesel Gene. Fuel Oil Heater	1	Steam Heat	STM 0.55MPa 105 → 140°C		KAJIWARA B100/60 × 15-9
Calorifier Unit	1	Steam Heat	STM 0.3MPa 10 → 70°C		HARISON SANGYO CFT-300XX-S
Main Engine Warm-up Heater	1	Steam Heat	2 STM 0.55MPa		SHOWA 300A-P
Main Air Reservoir	2	Cylindrical	5.0 m <sup>3</sup> × 2.9 MPa		IMABARI SHIPBUILDING AR-5.0V
Emergency Air Reservoir	1	Cylindrical	150 ℓ × 2.9 MPa		※
Control Air Dryer	1	Membrane	50 Nm <sup>3</sup> /h		HARISON SANGYO UMS-XC2V-T

Service	No.of Set	Type	Full Capacity (m <sup>3</sup> )	Heat. Ratio (m <sup>2</sup> /m <sup>3</sup> )	
Heavy Fuel Oil Settling Tank	1		18.684	0.3	Integrated
Heavy Fuel Oil Service Tank	1		18.945	0.3	Integrated
Low Sulphur Fuel Oil Settling Tank	1		10.661	0.3	Integrated
Low Sulphur Fuel Oil Service Tank	1		10.810	0.3	Integrated
Diesel Oil Service Tank	2		10.770		Integrated
Sludge Tank	1		2.070(2.07)	0.1	
Fuel Oil Drain Tank	1		3.340(3.34)	0.1	In Double Bottom
Fuel Oil Overflow Tank	1		15.370	0.03	In Double Bottom
Waste Oil Tank	2		1.400(1.22)	0.5	
Main Engine Lub. Oil Storage Tank	1		21.274		Integrated
Main Engine Lub. Oil Settling Tank	2		No.1 8.540 No.2 8.619	0.2	Integrated
Main Engine Lub. Oil Sump Tank	1		17.796		In Double Bottom
Diesel Gene. Lub. Oil Storage Tank	1		6.893		
Diesel Gene. Lub. Oil Settling Tank	2		No.1 2.900 No.2 2.877	0.2	
Diesel Gene. Lub. Oil Sump Tank	Each 1		1.100		In Common Bed
Cylinder Oil Alarm Chamber	1		0.02		
Cylinder Oil Storage Tank	2		No.1 15.159 No.2 30.694		Integrated

( ) Capacity is written on IOPP supplement

Service	No.of Set	Type	Full Capacity (m <sup>3</sup> )	Heat. Ratio (m <sup>2</sup> /m <sup>3</sup> )	
Stern Tube Lub. Oil Sump Tank	1		1.420		In Double Bottom
Stuffing Box Drain Tank	1		1.088(1.08)		
Scavenging Box Drain Tank	1		0.478(0.47)	0.1	
Jacket Cool. F.W. Expansion Tank	1		2.016		
Deaeration Tank	1		0.050		※
Fresh Water Pressure Tank	1	Cylindrical	1.081		
Drinking water Pressure Tank	1	Cylindrical	1.081		
Cascade Tank	1		2.898		With Inspect. Section
Bilge Primary Tank	1		2.646		
Bilge Tank	1		23.820(23.82)		In Double Bottom
Bilge Sludge Tank	1		20.360(20.36)	0.01	In Double Bottom
Clean Drain Tank	1		12.580		In Double Bottom

( ) Capacity is written on IOPP supplement



## Abbreviation :

abt.	About
D.	Driven
MD.	Motor Driven
Cent.	Centrifugal
*	Pending
Vert.	Vertical
Hor.	Horizontal
F.A.	Free Air
D.P.	Discharge Pressure
T.H.	Total Head
※	Maker's supply





### 1.3 SHOP TEST

As regards under said machinery installed in the engine room, the under said running test shall be executed at the Maker's shop to demonstrate workmanship, proper working order and performance in accordance with the shop test projects.

In case electric current of 60 Hz shall not be available, auxiliaries driven by electric motors shall be tested by supplying available electric current and results on performance shall be converted into these for 60 Hz by proper calculation.

Necessary data shall be recorded during these tests and the results shall be submitted to the Owner.

#### For main engine

##### (1) Ahead running load test

1/2 load	1/2 hour
3/4 load	1/2 hour
Normal rating	1 hour
Maximum rating	1/2 hour

At normal rating load the fuel oil consumption test shall be conducted.

##### (2) Governor test

##### (3) Minimum revolution test

##### (4) Starting test and astern confirmation test

##### (5) Emergency trip test

##### (6) Overhaul inspection

During the shop test, the diesel oil shall be used and the lub. oil shall be used in accordance with Maker's standard.



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### For diesel generator engine

#### (1) Ahead running load test

1/2 load	( Data only )
Maximum rating	1 hour
10% over load	1/3 hour

#### (2) Governor test

#### (3) Starting test ( Data only )

#### (4) Parallel running test

#### (5) Emergency trip test

#### (6) Fuel oil consumption measuring

These shop tests shall be carried out after coupling the engine with generator at the engine Maker's shop. The said load shall mean the generator load.

### For pump and air compressor

#### (1) Performance test

Performance test shall be carried out for each set but in case two or more than two sets of same kind and capacity are installed, performance test shall be carried out only for one set.

#### (2) Continuous running test

Continuous running test at full load for each set shall be carried out.

The said tests shall be executed according to the Maker's usual practice by using available facilities in the Maker's shop.

### For oil purifier

The shop test shall be carried out according to the Maker's standard and usual practice.

### For fresh water generator

The shop test shall not be carried out.

The operating test shall be carried out onboard during sea trial.



#### 1.4 FUEL OIL CONSUMPTION OF MAIN ENGINE

The fuel oil consumption of main engine shall be measured at shop test burning diesel oil.

The figure shall be 160.5 g/kW•h at normal rating on the basis of fuel net calorific value of 42,700 kJ/kg and ISO Standard Reference Conditions (Complying with MARPOL 73/78 ANNEX VI Reg.13 - Tier II restriction). This consumption figure shall be subject to a tolerance of 5 %

##### ISO condition

Suction air temperature	25°C
Sea water temperature	25°C
Barometric pressure	1000 hPa



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## **SECTION 2 MAIN PROPULSION UNIT**

### **2.1 GENERAL**

The main propulsion unit shall consist of MAN B&W marine diesel engine, 2-stroke, single acting, direct reversible crosshead diesel engine with exhaust turbocharger ( model 6S50ME-B9 ).

### **2.2 CONSTRUCTION AND MATERIAL**

The materials and dimensions for diesel engine and its equipment shall be in accordance with Japanese Industrial Standard ( JIS ) and Maker's standard.

#### **2.2.1 Bedplate and main bearing**

The bedplate consists of high, welded, longitudinal girders and welded cross girders with bearing supports.

For fitting to the engine seating, long, elastic holding down bolts tightened by hydraulic tools are to be used.

The oil pan, which is integrated in the bedplate, collects the return oil from the forced lubricating and cooling oil system.

The main bearings consist of Tin-aluminium shells. The bottom shell can, by means of special tools and hydraulic tools for lifting the crankshaft, be rotated out and in. The shells are kept in position by a bearing cap and are fixed by long elastic studs, with nuts tightened by hydraulic tools

#### **2.2.2 Frame box**

The frame box is of welded design. On the exhaust side, it is provided with a relief valve for each cylinder while, on the camshaft side, it is provided with a large door for each cylinder. The crosshead guides are welded to the frame box.

For each cylinder, a slotted pipe for collecting part of the cooling oil outlet from the piston is bolted into the frame box.

The frame box, bedplate and cylinder frame are tightened by twin stay bolts. The stay bolts are tightened hydraulically with use of jacks.



### 2.2.3 Cylinder frame, cylinder liner and stuffing box

The cylinder frame unit is of welded type or cast iron (depending on production facility) with integrated camshaft frame. Together with the cylinder liner, they form the scavenge air space. At the chain drive, the upper part of the chain wheel frame is fitted. On the camshaft side of the engine, the cylinder frame units are provided with covers for cleaning the scavenge air space and for inspection of the scavenge ports and piston rings.

The gallery brackets are bolted onto the cylinder frame. Furthermore, the outer part of the telescopic pipe is fitted for the supply of piston cooling oil.

A piston rod stuffing box for each cylinder unit is fitted at the bottom of the cylinder frame. The stuffing box is provided with sealing rings for scavenge air, and with oil scraper rings to prevent oil from entering the scavenge air space.

The cylinder liner is made of boron cast iron alloy. The cylinder liner is bore cool type. The cylinder liner has scavenge ports and drilled holes for cylinder lubrication.

### 2.2.4 Cylinder cover

The cylinder cover is of cast or forged steel (depending on production facility), made in one piece, and has bores for cooling water. It has a central bore for the exhaust valve and bores for fuel valves, safety valve, starting valve and indicator valve.

The cylinder cover is tightened to the cylinder frame with studs and nuts by hydraulic jacks.

### 2.2.5 Crankshaft

The crankshaft is of the semi-built type, made of forged steel throws.

The crankshaft is built integral with the thrust shaft and is, on the aft end, provided with a flange for the turning wheel and for coupling to the intermediate shaft. At the fore end, the crankshaft can be provided, if needed, with a flange for a counterweights and/or a tuning wheel with additional price.

### 2.2.6 Axial vibration damper

The engine is fitted with an axial vibration damper, which is mounted on the fore end of the crankshaft.

The damper consists of a piston and a split-type housing located forward of the foremost main bearing. The piston is made as an integral collar on the main journal, and the housing is fixed to the main bearing support.



### 2.2.7 Thrust bearing

The thrust bearing is of the B&W-Michell type, and consists of a thrust collar on the crankshaft, a bearing support, and segments with white metal.

The propeller thrust is transferred through the thrust collar, the segments, and the bedplate to engine seating and end chocks.

The thrust bearing is lubricated by the engine's main lubricating oil system.

### 2.2.8 Connecting rod

The connecting rod is made of cast or forged steel (depending on production facility) and provided with bearing caps for the crosshead and crankpin bearings.

The crosshead and crankpin bearing caps are secured to the connecting rod by studs and nuts which are tightened by hydraulic jacks.

The crosshead bearing consists of a set of Tin-aluminium shells. The crosshead bearing cap has an angular cut-out for the piston rod.

The crankpin bearing consists of Tin-aluminium shells.

Lubricating oil is supplied through ducts in the crosshead and connecting rod.

### 2.2.9 Piston, piston rod and crosshead

The piston consists of piston crown and piston skirt. The piston crown is made of heat-resistant steel and has four ring grooves which are hard-chrome plated on both the upper and lower surfaces of the grooves. The piston skirt is of cast iron and provided with bronze bands.

The piston rod is of forged steel and is surface-hardened on the running surface for the stuffing box. The piston rod is connected to the crosshead with four screws. The piston rod has a central bore which, in conjunction with a cooling oil pipe, forms inlet and outlet for cooling oil.

The crosshead is of forged steel and is provided with guide shoes with white metal on the running surface.

The telescopic pipe for oil inlet and the pipe for oil outlet are mounted on the top of the guide shoes.



### 2.2.10 Exhaust valve and valve gear

The exhaust valve consists of a housing with gas channel and spindle guide. The housing is water cooled and made of cast iron. Between the cylinder cover and the housing, there is a bottom piece.

The bottom piece is water cooled on its outer surface.

The valve spindle is of heat resistant steel with “hard metal” welded onto the seat, and is provided with small vane wheel on which the exhaust gas acts during operation, thus making spindle rotate slightly.

The hydraulic system consists of an actuator, activated by a cam on the camshaft, a high-pressure pipe, and an oil cylinder for the exhaust valve spindle, mounted on top of the housing. The hydraulic system opens the exhaust valve, while the closing force is provided by an air spring. The closing of the exhaust valve is damped by means of an oil cushion on top of the spindle.

The exhaust valve close timing is controlled by not only the cam but also the electronic valve (ELFI-V valve), which is electronically controlled by the Cylinder Control Units of Engine Control System.

### 2.2.11 Fuel valve, starting air valve, and indicator valve

Each cylinder cover is equipped with two fuel valves, one starting valve and one indicator valve. The opening of the fuel valve is controlled by the fuel oil high pressure created by the fuel pumps, and the valve is closed by a spring.

The fuel valves are equipped with a slide and circulating bore, to ensure an adequate flow of heated oil through the fuel pump housing and fuel valves at all loads including stopped engine. By means of the “built-in” circulation of preheated fuel oil, the fuel pumps and fuel valves can be maintained at service temperature, also while the engine is stopped. Consequently, it is not necessary to change to diesel oil when entering harbour, provided that the circulating pump is kept running and preheating of the circulated fuel oil is maintained.

The starting valve is opened by control air from the starting air distributor and closed by a spring.

The engine is fitted with an indicator valve to which the PMI pressure transducer can be connected.



#### 2.2.12 Fuel oil pressure booster and fuel oil high pressure pipe

The engine is provided with one hydraulically activated fuel oil pressure booster for each cylinder. The fuel oil pressure booster consists of a pump housing, a hydraulic piston and plunger. In order to prevent fuel oil from being mixed with the servo oil, the fuel oil pressure booster is provided with a sealing device.

The fuel oil injection is controlled by electronic valve (ELFI-V valve), which is electronically controlled by the Cylinder Control Units of Engine Control System.

The fuel oil high-pressure pipes are equipped with protective hoses and are neither heated nor insulated.

#### 2.2.13 Hydraulic Cylinder Unit (HCU)

The HCU consists of a base plate on which a distributor block is mounted.

The distributor block is fitted with one accumulator to ensure that the necessary hydraulic oil peak flow is available for the electronic fuel injection.

The distributor block serves as a mechanical support for the hydraulically activated fuel oil pressure booster and Alpha lubricator.

There is one HCU per two cylinders. The HCU is equipped with two fuel oil pressure boosters, two ELFI-V valves and two Alpha Lubricators. Thereby, one HCU is operating two cylinders.

#### 2.2.14 Hydraulic Power Supply (HPS)

The HPS is installed in the front end of the engine. The HPS is electrically driven and consists of two electric motors each driving a hydraulic pump.

The pressure for the hydraulic oil is approx. 30.0 MPa. Each of the pumps has a capacity corresponding to min. 55% of the engine power. In case of malfunction of one of the pumps, it is still possible to operate the engine with 55% engine power corresponding to 85% speed.

#### 2.2.15 Camshaft and cams

The camshaft is made in one or two pieces depending on the number of cylinders, with exhaust cams shrunk onto the shaft. The exhaust cams are of a hardened roller face. They can be adjusted hydraulically.

#### 2.2.16 Chain drive

The chain drive is integrated with the thrust bearing in the aft end of the engine. The camshaft is driven from the crankshaft by chain drive. The chain drive is provided with chain tightener. The long free lengths of chain are supported by guidebars.

The starting air distributor is driven by the camshaft.





### 2.2.17 Reversing

Reversing of the engine is performed electronically and pneumatically, by changing the timing of the Fuel Injection and the starting air valves.

The exhaust gear is not reversible.

### 2.2.18 Engine manoeuvring system

The engine is provided with an electric-pneumatic manoeuvring system. The system transmits orders from the manoeuvring console to the engine.

The regulating system makes it possible to start, stop and reverse the engine and to control the engine. The speed control dial on the manoeuvring console gives a speed-setting signal to the Engine Control System.

### 2.2.19 Main Operating Panel (MOP)

In the engine control room a MOP is located, which is a Personal Computer (PC) with a touch screen as well as a trackball from where the operator can carry out engine commands, adjust the engine parameters, select the running modes, and observe the status of the control system.

### 2.2.20 Engine Side Console (ESC)

In normal operating the engine is controlled from engine control room.

Alternatively, the ESC can be activated. This redundant control is to be considered as a substitute for the previous engine side control console mounted directly onto the MC engine. The ESC is placed on the engine.

From the ESC, the basic functions are available, such as starting, engine speed control, stopping, reversing, and the most important engine data are displayed.

### 2.2.21 Governor system

The governor functions equivalent to the conventional governor system are included in the Engine Control System.

### 2.2.22 Starting air system

The starting air system comprises a main starting valve, a non-return valve, a bursting disc for the branch pipe to each cylinder, a starting air distributor, and starting valves on each cylinder. The main starting valve is connected with the main manoeuvring system, which controls the start of the engine.

The starting air distributor regulates the supply of control air to the starting valves so that they supply the engine cylinders with starting air in the correct firing order.



### 2.2.23 Scavenging air system

The air intake to the turbocharger takes place direct from the engine room through the intake silencer of the turbocharger. From the turbocharger, the air is led via the charging air pipe, air cooler and scavenging air receiver to the scavenging ports of the cylinder liners. The charging air pipe between turbocharger and air cooler is provided with a compensator and is heat insulated on the outside.

### 2.2.24 Exhaust turbocharger and air cooler

The engine is fitted with turbocharger arranged on the side of the engine.  
The turbine side is provided with cleaning device.

The engine is fitted with air cooler mono-block type so arranged for easy cleaning with chemicals at the engine standstill. The air cooler consists of tube plates of rolled brass, cooling tubes with cuprous fins and cast iron covers coated with resin.  
After the air cooler, a water mist catcher is mounted.

### 2.2.25 Auxiliary blower

The engine is provided with two electrically-driven auxiliary blowers. The suction sides of the blowers is connected to the scavenge air space after the air cooler.

Between the air cooler and the scavenge air receiver, flap valves are fitted with automatically close when the auxiliary blowers supply the air.

Both auxiliary blowers will start operating before the engine is started and will ensure sufficient scavenge air pressure to obtain a safe start.

During operation of the engine, both auxiliary blowers will start automatically each time the engine load is reduced to about 30–40%, and they will continue operating until the load again exceeds approximately 40–50%.

In cases where one of the auxiliary blowers is out of service, the other auxiliary blower will automatically compensate without any manual readjustment of the valves, thus avoiding any engine load reduction. This is achieved by the automatically working non-return valves in the suction pipe of the blowers.

### 2.2.26 Exhaust gas system

From the exhaust valves, the gas is led to the exhaust gas receiver where the fluctuating pressure from the individual cylinders is equalised, and the total volume of gas led further on to the turbochargers at a constant pressure. After the turbocharger, the gas is led to the exhaust pipe system.

Compensators are fitted between the exhaust valves and the receiver, and between the receiver and the turbocharger.

The exhaust gas receiver and exhaust pipes are provided with insulation, covered by galvanised steel plating.



### 2.2.27 Turning wheel and turning gear

The turning wheel has cylindrical teeth and is fitted to the thrust shaft. The turning wheel is driven by a pinion on the terminal shaft of the turning gear, which is mounted on the bedplate.

The turning gear is driven by an electric motor with built-in gear and brake. The turning gear is equipped with a blocking device that prevents the main engine from starting when the turning gear is engaged. Engagement and disengagement of the turning gear is effected manually by an axial movement of the pinion.

### 2.2.28 Gallery arrangement

The engine is provided with gallery brackets, stanchions, railing and platforms (exclusive of ladders). The brackets are placed at such a height that the best possible overhauling and inspection conditions are achieved. Some main pipes of the engine are suspended from the gallery brackets.

### 2.2.29 Cylinder lubricators (Alpha Lubricator System; ALS)

The cylinder lubricator units, one per engine cylinders, are mounted. The oil is led to the lubricator unit, through a pipe system from an elevated tank (Shipbuilder's supply).

The ALS is electronically controlled by the Cylinder Control Units of Engine Control System.

The setting of Alpha lubricator system can be performed by MOP.

### 2.2.30 Piping arrangements

The lubricating oil, cylinder cooling fresh water and air coolers are cooled by means of sea water. The pipes for the lubricating oil system and for the fresh water on the engine are of steel, the sea water pipes are of galvanized steel.

#### a) Forced lubrication and oil cooling:

The main forced lubrication is led to each main bearing through branches from the main lubrication pipe located along the engine. Cooling oil is led to the telescopic pipe through branches from the cooling oil main pipe located along the cooling jackets on the exhaust side of the engine, through which the oil is led to the crossheads. From there, some of the oil is branched off for lubrication of the crosshead shoes and crosshead bearings and is led through the bored connecting rod to the crank bearing.

Some of the oil is led through a pipe in the bore of the piston rod for cooling of the piston. The oil returns from here through the piston rod and let out through a duct in the crosshead.

The camshaft bearing lubricating oil and the exhaust valve driving gear oil are supplied from cooling oil system.



b) Cooling water system:

Cylinders and exhaust valves are fresh water cooled.

The fresh water is led from the main piping along the engine through branches to the each cylinder liner. The fresh water is led from the cylinder liner up through the cylinder cover and exhaust valve housing and from there to a manifold through which it is carried back to the fresh water cooler.



### **2.3 FITTING AND ACCESSORY**

The following accessories shall be supplied together with main engine.

- 1 — set of exhaust gas turbocharger
- 1 — set of air cooler
- 1 — set of flywheel
- 1 — set of turning gear
- 1 — set of thrust bearing
- 2 — sets of auxiliary blower
- 1 — set of main starting valve with non-return valve
- 1 — sets of ALPHA lubricator system
- 1 — set of grating for engine
- 1 — set of piping attached to the engine
- 1 — set of manoeuvring device
- 1 — set of pressure gauge
- 1 — set of thermometer
- 1 — set of manometer
- 1 — set of fuel oil 2nd filter
- 1 — set of oil mist detector
- 1 — set of hydraulic power supply unit (HPS)
- 1 — set of hydraulic cylinder unit (HCU)
- 2 — sets of main operating panel (MOP)
- 1 — set of local operating panel (LOP)



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### **SECTION 3   SHAFTING AND PROPELLER**

#### **3.1   GENERAL**

The entire rotating system including main engine, shafting and propeller shall be designed so that the serious torsional vibration requiring barred range shall not occur between 85% and 100% of revolution corresponding to the maximum rating of main engine.

The calculation sheets regarding the torsional vibration shall be submitted to the Owner and the Classification Society for approval.

#### **3.2   SHAFTING**

The shafting shall be one (1) line which consist of one (1) intermediate shaft and one (1) propeller shaft.

The shafting shall be of solid type and machined smooth all over except journals and coupled face which shall be finely finished.

The coupling flanges shall be integrated with the shaft and protected by sheet steel guards. The shafting shall be bolted together with straight reamer bolts.

The diameter of intermediate shaft shall be determined in accordance with the requirement of the Classification Society.

The diameter of shaft at intermediate shaft bearing shall be added 5mm to the determined shaft diameter.

The diameter of propeller shaft shall be in accordance with the requirement of the Classification Society.

The aft part of propeller shaft shall be machined with 1/20 taper and threaded at end for fitting the propeller with a steel nut.

The propeller shaft shall be withdrawn inboard by removing intermediate shaft, and the eye plate for withdrawing shall be provided.

#### **3.3   INTERMEDIATE SHAFT BEARING**

One (1) intermediate shaft bearing of removable bearing shell type shall be fitted for proper support of the intermediate shaft.

Intermediate shaft bearing shall be provided bearing metal at upper and lower part.



The bearing shall be filled with lub. oil from the pipes of branched main engine lub. oil line.

Lub. oil shall flow into the bearing clearance from the side of shaft center line through the clearance between housing bore and outside of bearing metal and lubricate the bearing.

Lub. oil shall drain off through the both end of bearing metal and flow to the returning main engine lub. oil sump tank.

### **3.4 STERN TUBE BEARING AND SEAL**

The stern tube shall accommodate one (1) stern tube bearing shell and two (2) stern tube oil sealing devices.

The stern tube sealing device at aft side shall be provided with stand-by seal ring.

The wear down measuring apparatus shall be provided to measure clearance at the aft side bushing of the stern tube.

The rope guard fabricated steel with anode shall be provided between aft end of stern frame boss and propeller boss.

The wire net guard ( propeller boss grooved type ) shall be provided.

### **3.5 PROPELLER**

There shall be provided one solid type propeller. The diameter and pitch of propeller shall be suitable for the power and speed. The propeller shall rotate clockwise, seen from aft when going ahead. The propeller shall be of key-less type and fitted on the taper end of propeller shaft and secured by a nut.

The forward end of boss shall be counterbored and fitted with a sealing gland.

The propeller surface shall be ground smooth. A propeller cap shall be bolted to the boss and its interior shall be filled with grease.

The performance of propeller shall be designed under the following conditions.

Main engine output	Normal output ( 6,425 kW )
Main engine revolution	abt. 97.6 min <sup>-1</sup> ( abt. 4% up )
Draught	Designed loaded draught
Sea condition	Calm sea

The propeller shall be swung on a mandril and statically balanced.



### 3.6 MATERIAL

#### Shafting :

Intermediate shaft	Forged steel
Propeller shaft	Forged steel
Nut for propeller shaft	Forged steel
Coupling bolt	Forged steel

#### Stern tube bearing and seal :

Stern tube bearing	Cast iron with white metal ( WJ2 )
Sealing ring	Fluoro rubber ( FPM )

#### Intermediate shaft bearing :

Upper and lower shells	Cast iron
Bearing metal	White metal ( WJ2 )

#### Propeller :

Propeller	Nickel aluminum bronze
Propeller cap	Bronze
Rope guard	Mild steel plate





## **SECTION 4 STEAM GENERATING PLANT**

### **4.1 GENERAL**

The steam generating plant shall be in accordance with the following descriptions and particulars described in Subsection 1.2 **MACHINERY PARTICULAR**.

### **4.2 AUXILIARY BOILER**

#### **4.2.1 Construction**

The boiler shall consist of the doughnut shaped steam drum and water drum which are connected by two rows of water tubes.

The flame of oil burning side shall transfer heat to water in inside water tubes by radiation. It shall become the combustion gas and be branched into two rows of water tubes and meet at the exit and be discharged from the funnel.

Contact heat transfer shall be made when water passes in water tubes and heat be transferred to water efficiently.

The exhaust gas side shall be provided with a group of a water tubes reasonably arranged circumferentially on upper and lower drums to transfer heat efficiently.

The exhaust gas inflowed through the flue shall be separated in two directions of left-hand and right-hand to effect heat exchange and discharged through the outlet funnel as low temperature exhaust gas.

Inner and outer casings shall be available. Heat insulating material shall be placed between inner and outer casings to check radiation of heat.

Insulating fire clay shall be placed in the lower part of the furnace and narrowed part of gas shorting.

#### **4.2.2 Material**

End plate	Boiler steel plate
Furnace	Boiler steel plate
Water tube	Boiler tube
Shell plate	Boiler steel plate



#### 4.2.3 Fitting and accessory

- 1 — pressure gauge root valve
- 2 — sets of water gauge  
( including water level controller )
- 1 — set of oil burning unit
- 3 — sets of soot blower ( Compressed air type )
- 2 — safety valve
- 1 — main steam stop valve
- Each 1 — main and aux. feed check valve
- Each 1 — main and aux. feed stop valve
- 1 — surface blow-off valve
- 1 — bottom blow-off valve
- 4 — water level gauge root valve
- 1 — boiler water sampling valve



## **SECTION 5 ELECTRIC GENERATING PLANT**

### **5.1 GENERAL**

There shall be provided three (3) sets of main diesel generators.

Regarding the electric generator, refer to **PART IV ELECTRIC PART**.

### **5.2 MAIN DIESEL GENERATOR ENGINE**

#### **5.2.1 General**

The main diesel generator engine shall be vertical single acting, 4-cycle direct injection, air cooled turbocharged diesel engine with air cooler.

#### **5.2.2 Construction and material**

##### **(1) Crankshaft**

The crankshaft shall be made of high grade forged steel one piece type.

##### **(2) Main bearing shell**

The main bearing shell shall be made of aluminum alloy metal lined, split in two (2) pieces type mild steel. It shall be completed thin-shell type, and provided with complete interchangeability.

##### **(3) Engine frame**

Engine frame shall be made of special cast iron, of under sling bearing structure, which is sufficiently rigid for high explosion pressure.

The engine frame shall have big inspection holes on the both side in order to be taken out the main and crank pin bearing shells, and other main moving parts.

The intake air passage shall be provided at the upper part of engine frame on the exhaust manifold side providing a double wall structure, thus substantially enclosing sound insulation.

Also passages of cooling water inlet/outlet and Lub. oil inlet shall be built into this engine frame to minimize external piping.

The main bearing cap shall be secured rigidly to the engine frame by hydraulically tightening two mounting bolts and two side bolts.



#### (4) Cylinder head

The cylinder head shall be made thick with special cast iron. It has a fuel injection nozzle on its center, and each 2 pieces of intake and exhaust valves and rocker arms are arranged around the fuel injection nozzle.

#### (5) Cylinder liner

The cylinder liner shall be made of high grade cast iron against abnormal wear, and its inside is precisely hone-finished.

The cylinder liner cooled by freshwater shall be made thick with ample rigidity so that it is sufficiently durable even under high combustion pressure and the thermal stress.

#### (6) Piston, piston pin and piston ring

The piston shall be made of ductile cast iron as mono-block type and cooled by crankcase lubricating oil through the connecting rod and piston pin inside.

1st and 2nd piston ring grooves of piston shall be surface-hardened to have resistance against wear down.

The piston pin shall be made of carbonizing-hardening chromium-molybdenum steel. A full floating method shall be adopted in fitting the piston pin.

The three piston rings and one oil ring shall be made of cast iron, and piston rings and oil rings shall be chromium plated.

#### (7) Connecting rod and crank pin bearing shell

The connecting rod shall be made of forged steel, and it is constructed so that the forging is divided into 3 parts and the large end part is horizontally divided.

The piston pin bush shall be of cylindrical steel lined with lead bronze. The crank pin bearing shell shall be of aluminum alloy metal lined completed thin shell type.

#### (8) Fuel injection pump and fuel nozzle holder

Both the pump with a tappet and the nozzle of Bosch type shall be attached to each cylinder.

The circulation type fuel injection pump shall be adopted.



#### (9) Intake and exhaust valve

Both intake and exhaust valves shall mushroom type of heat resistance steel, and provided with the valve rotators and removable seat rings respectively.

The exhaust valve shall be made of heat resistance steel.

The seat of exhaust valve shall be plated with stellite.

The exhaust valve seat shall be cooled by fresh water and the treatment of anti-corrosion shall be applied for gas passage.

### 5.2.3 Piping

#### (1) Cooling system

##### Cooler line (LT-FW)

The engine driven LT-FW pump shall run cooling water from the external freshwater cooler into the secondary L.O. cooler and air cooler.

Under low load condition, charge air inverse warming would be carried out automatically by means of cutting off cooling water from the secondary air cooler.

##### Cylinder jacket line (HT-FW)

The engine driven HT-FW pump shall be circulated cooling water, which is controlled by the attached thermostat, in the primary air cooler, cylinder jacket and cylinder heads.

#### (2) Lub. oil system

A gear pump shall be driven by the auxiliary machinery driving gear of engine.

Lub. oil sucked up from the oil sump shall be sent out into cooler and oil filter, and lubricates main bearings, crank pin metals, piston pin metal, camshaft bearings, swing arm, valve rocker arm, timing gear train and turbocharger, while some oil cools pistons and drops back to the oil sump.

For the priming of the lubrication system during engine is in rest, electric motor driven pre-priming pump of continuous priming system shall be provided.

To safeguard the oil cooler and oil piping against excessive oil pressure, a relief valve shall be attached.



#### 5.2.4 Fitting and accessory

The following accessories shall be supplied with the engine.

- 1 – turbocharger
- 1 – air cooler
- 1 – flywheel
- 1 – maneuvering gear
- 1 – governor
- 1 – exhaust gas manifold
- 1 – mechanical tachometer
- 1 – set of pressure gauge
- 1 – set of thermometer
- 1 – lub. oil filter
- 1 – lub. oil by-pass filter (centrifugal type)
- 1 – lub. oil pump ( gear )
- 1 – lub. oil cooler
- 2 – cooling fresh water pump ( centrifugal )
- 1 – turning bar
- 1 – common bed
- 1 – set of fuel oil shut-off device for emergency trip



## SECTION 6 PUMP

### 6.1 GENERAL

The particulars of pumping equipment shall be in accordance with Subsection **1.2 MACHINERY PARTICULAR.**

The continuous running pumps for propulsive use shall be provided with two (2) sets, each one of them shall be as stand-by in principle.

### 6.2 CENTRIFUGAL PUMP

Connection between pump shaft and motor shaft shall be of the pin and buffer type flexible coupling or rigid coupling according to the Maker's standard.

Pump casing except for horizontal pumps, specially constructed type pumps and small vertical pumps shall be split or removed upward only so that the rotating members may be overhauled for inspection or replacement without disturbing the pipe connections.

The pumps which self-priming is necessary shall be provided with self-priming unit.

The materials of main parts of centrifugal pumps shall be as follows:

Name	Casing	Impeller	Shaft	Shaft seal
Cool. S.W. pump	Bronze	<b>Stainless steel</b>	Stainless steel	Gland packing
Jacket cool. F.W. pump	Cast iron	Phosphor bronze	Stainless steel	<del>Mechanical seal</del> <b>Gland packing</b> <sup>△2</sup>
Fire & G.S. pump (Bilge & ballast pump)	Bronze	Phosphor bronze	Stainless steel	Gland packing
Ballast pump	Bronze	Phosphor bronze	Stainless steel	Gland packing
Ref. machine cool. S.W. pump	Bronze	<del>Stainless steel</del> <b>Phosphor bronze</b> <sup>△2</sup>	Stainless steel	Gland packing



Name	Casing	Impeller	Shaft	Shaft seal
Drinking water pump	Cast iron	Phosphor bronze	Stainless steel	Gland packing
Fresh water pump	Cast iron	Phosphor bronze	Stainless steel	Gland packing
Hot water circulating pump	Cast iron	Phosphor bronze	Stainless steel	Gland packing
Boiler feed water pump	Cast iron	<del>Phosphor bronze</del> <sup>△2</sup> SCS13	Stainless steel	<del>Gland packing</del> Mechanical seal
Main air comp. cooling F.W. pump	Cast iron	Phosphor bronze	Stainless steel	Gland packing

The fittings and accessories shall be as follows:

- 1 — set of coupling bolt, nut and rubber ring, if fitted
- 1 — coupling cover for horizontal type pump, if fitted
- 1 — drain plug
- 1 — gauge board fitted with suction and discharge pressure gauges
- Each 1 — root cock or valve for pressure gauge
- 1 — air ejector, if fitted
- 1 — common bed for horizontal type pump, if fitted

#### Main lub. oil pump

The material of main L.O. pump shall be accordance with maker standard.

The specified capacity and motor of main L.O. pump shall be designed on the following viscosity.

Name	Capacity	Motor output
Main lub. oil pump	26 cSt	260 cSt





### 6.3 ROTARY PUMP

Rotary pumps shall develop rated capacity and discharge pressure when operating with the under-said suction conditions.

Name	Suction vacuum ( MPa )	Viscosity (cSt)	Shaft seal
Fuel oil transfer pump	−0.05	26 - 1,000	Gland packing
Diesel oil transfer pump	−0.05	2 - 1,000	Mechanical seal
L.O. transfer and L.O. purifier supply pump	−0.05	26 - 1,000	Gland packing
Fuel oil booster pump	−0.05	2 - 260	Mechanical seal
M/E fuel oil circulating pump	+0.40	2 - 260	Mechanical seal
D/G fuel oil circulating pump	+0.40	2 - 260	Mechanical seal
D/G diesel oil booster pump	−0.05	2 - 260	Mechanical seal
Stern tube L.O. pump	−0.05	26 - 1,000	Gland packing
<b>D/G L. O. pur i. supply pump</b>	<b>−0.05</b>	<b>26 - 260</b>	<b>Gland packing</b>

The materials of main parts of the gear pumps shall be as follows:

Casing	Cast iron
Gear	Carbon steel
Shaft	Carbon steel

The fittings and accessories shall be as follows:

- 1 — set of coupling bolt, nut and rubber ring or coupling bush
- 1 — coupling cover for horizontal type pump
- 1 — relief valve
- 1 — gauge board fitted with suction and discharge pressure gauges
- Each 1 — root cock or valve for pressure gauge
- 1 — common bed for horizontal type pump



## 6.4 RECIPROCATING PUMP

Reciprocating type bilge pump shall be provided with conventional packing type gland seals and develop rated capacity and discharge pressure when operating with suction vacuum of  $-0.05\text{MPa}$  and viscosity of  $1\sim 1000\text{ cSt}$ .

The materials of main parts of reciprocating pump shall be as follows:

Cylinder cover	Cast iron
Cylinder liner	Brass casting
Piston	Brass
Valve	Rubber
Piston rod	Stainless steel

The fittings and accessories shall be as follows:

- 1 — safety valve
- 1 — air vent plug
- 1 — drain plug
- 2 — V belt
- Each 1 — V pulley
- 1 — safety cover
- 1 — gauge board fitted with suction and discharge pressure gauges
- 2 — gauge cock

## 6.5 MONROS PUMP

Monros pump shall be one kind of displacement type screw pump and provided with conventional packing type gland seals.

Monros type sludge pump shall develop rated capacity and discharge pressure when operating with suction vacuum of  $-0.05\text{MPa}$  and viscosity of  $1\sim 1000\text{ cSt}$ .

The materials of main parts of monros pump shall be as follows:

Stator	Rubber
Shaft, rotor and con-rod	Stainless steel
Pump stand	Cast iron



The fittings and accessories shall be as follows:

- 1 – safety valve
- 2 – V belt
- Each 1 – V pulley
- 1 – safety cover
- 1 – gauge board fitted with suction and discharge pressure gauges
- 1 – common bed

## **6.6 OTHER PUMP**

The construction, materials and design of pumps attached to the main engine, main diesel generator engines, aux. boiler, oil purifiers, air compressors, waste oil incinerator, fresh water generator and etc. shall be in accordance with Maker's standard.



## **SECTION 7 AIR COMPRESSOR AND FAN**

### **7.1 MAIN AIR COMPRESSOR**

There shall be provided two (2) sets of main air compressor for main engine and main diesel generator engine starting and for control air and general air service.

Control air and general air service shall be supplied through the air reducing valve from main air reservoir.

The main air compressor shall be of electric motor driven two stage compression, reciprocating type and shall be completed with air coolers and unloader.

The cylinders, cylinder covers and air coolers shall be cooled by fresh water.

The materials shall be as follows:

Cylinder	Cast iron
Piston	Aluminum
Connecting rod	Forged steel
Crank shaft	Forged steel
Crank case	Cast iron

The fittings and accessories shall be as follows:

- 1 — coupling with bolts and nuts
- 1 — coupling cover
- 1 — set air cooler after each stage
- 1 — pressure gauge after each stage
- 1 — relief valve after each stage
- 1 — set of drain valve
- 1 — unloader
- 1 — suction air filter
- 1 — oil level indicator or sounding rod
- 1 — oil drain plug for crank case



## **7.2 EMERGENCY AIR COMPRESSOR**

The emergency air compressor shall be of electric motor driven.

The materials of emergency air compressor shall be in accordance with Maker's standard.

## **7.3 MAIN AIR RESERVOIR**

The main air reservoir shall be made of cylindrical welded steel construction. The capacity of each air reservoir shall be sufficient to ensure six (6) starts of the main engine from rest in either direction without replenishment.

The fittings and accessories shall be as follows:

- 1 — safety valve
- 1 — charging valve
- 1 — main stop valve
- 1 — aux. stop valve
- 1 — drain valve of double shut type
- 1 — manhole
- 1 — pressure gauge

## **7.4 EMERGENCY AIR RESERVOIR**

The emergency air reservoir shall be made of cylindrical welded steel construction.

The fittings and accessories shall be as follows:

- 1 — safety valve
- 1 — charging valve
- 1 — stop valve
- 1 — pressure gauge

## **7.5 ENGINE ROOM VENTILATING FAN**

The engine room ventilating fan shall be of motor driven vertical axial flow split type and motor shall be incorporated in the fan casing.

At the reverse rotation, the capacity and head shall reduced.

The materials shall be as follows:

Casing	Steel plate
Impeller	Aluminum alloy



## SECTION 8 HEAT EXCHANGER

### 8.1 COOLER AND CONDENSER

#### 8.1.1 Shell and tube type heat exchanger

One (1) auxiliary condenser shall have a sufficient capacity to condense excess steam from the exhaust gas section of aux. boiler.

This heat exchanger shall be of horizontal shell and tube type. Tube shall be straight, and tube end of sea water inlet side shall be expanded into tube plates.

The materials shall be as follows:

Shell	Steel plate or steel pipe
Shell cover	Cast iron ( inside epoxy paint )
Tube plate	Naval brass
Tube	Aluminum brass

The fittings and accessories shall be as follows:

- 4 — thermometers ( 3 — for condenser )
- 1 — compound gauge for condenser
- 1 — peep hole for shell except small size cooler
- Necessary number — air cock and drain cock for shell and shell cover
- 1 — set of protecting anode ( Zn ) for each water chest of sea water
- 1 — set of chemical clean. flange for both tube and shell side except small size cooler

#### 8.1.2 Plate type heat exchanger

Each one (1) set of jacket cool. F.W. cooler and main L.O. cooler respectively shall have a sufficient capacity to meet max. output requirement of main engine.

Two (2) sets of D/G cool. F.W. cooler shall have a sufficient capacity to meet max. output requirement of three (3) sets of main diesel generator engine and two (2) sets of main air compressor.

The materials shall be as follows:

Frame plate	Mild steel
Plate	Titanium



The heat exchangers attached to main engine, main diesel generator engines and other machinery shall be in accordance with Maker's standard.

The design conditions for heat exchangers shall be as following table.

### HEAT EXCHANGER CALCULATION SHEET

#### SHELL AND TUBE TYPE HEAT EXCHANGER

Name	Design condition						Clean. factor (%)
	Tube side ( S.W.)			Shell side			
	Quantity (m³/h)	Temperature (°C)		Quantity (m³/h)	Temperature (°C)		
		Inlet	Outlet		Inlet	Outlet	
Aux. condenser	40	32	49.2	1,100 kg/h	100	60	85
Remarks : 1) Out diameter of tube shall be 16 mm and thickness shall be 1.0 mm. 2) As a result of particular calculation, above said value may be altered.							

#### PLATE TYPE HEAT EXCHANGER

Name	Design condition						Clean. factor (%)
	Cold side			Hot side			
	Quantity (m³/h)	Temperature (°C)		Quantity (m³/h)	Temperature (°C)		
		Inlet	Outlet		Inlet	Outlet	
Main lub. oil cooler	(S.W.) 160	32.0	36.6	220	(L.O.) 52.9	45.0	85
Jacket cooling F.W. cooler	(S.W.) 160	36.6	43.8	102	(F.W.) 90.0	79.0	85
D/G cool. F.W. cooler	(S.W.) 54	32.0	43.2	48.2	(F.W.) 50.1	38.0	85
M/E MGO cooler	(S.W.) 3.0	32.0	37.6	4.2	(MGO) 50.0	40.0	85
D/G MGO cooler	(S.W.) 1.0	32.0	38.0	1.5	(MGO) 50.0	40.0	85
Remarks :							
1) As a result of particular calculation, above said value may be altered.							



## 8.2 OIL HEATER

There shall be provided one (1) main engine fuel oil heater, two (2) purifier fuel oil heaters, one (1) purifier lub. oil heater, one (1) diesel gene. purifier lub. oil heater, one (1) diesel gene. fuel oil heater and one (1) shifter fuel oil heater.

Boiler fuel oil heater shall be in accordance with Maker's standard.

The design conditions for there heaters shall be as following table.

Name	Design condition			Heating steam press. ( MPa )
	Quantity ( Lit/h )	Temperature (°C)		
		Inlet	Outlet	
Main engine F.O. heater	4,200	105	140	0.55
Purifier F.O. heater	2,100	55	98	0.55
Purifier L.O. heater	2,100	45	90	0.55
Diesel gene. F.O. heater	1,600	105	140	0.55
Shifter F.O. heater	3,400	55	85	0.55
D/G purifier L.O. heater	600	45	90	0.55

The materials of oil heaters shall be as follows:

Shell	Steel tube
Tube	Steel tube with rod or coil tube

The fittings and accessories shall be as follows:

- 1 — drain plug
- 1 — air vent cock
- 1 — relief valve
- 2 — thermometer





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## **SECTION 9 FRESH WATER GENERATOR**

### **9.1 GENERAL**

There shall be installed one fresh water generator, utilizing the waste heat in the jacket water from the main engine.

The fresh water generator shall produce fresh water of salinity not exceeding 10 P.P.M of salt at abt. 90°C main engine jacket water temperature and 32°C cooling sea water temperature.

The distilling cycle shall be as follows:

Jacket water from the main engine cooling F.W. outlet shall be led to the evaporator. Sea water branched from condenser cooling sea water outlet shall be led to the evaporator and heated by the fresh water from the main engine cooling system.

Sea water shall be evaporated in separator shell at a comparatively low temperature due to the vacuum produced by means of the water ejector.

The vapour shall be led into the condenser through the deflector and demister and then condensed by the cooling sea water.

The brine, concentrated sea water, shall be constantly taken out from the evaporator and discharged to over board.

The ejector pump shall supply sea water to water ejector. The distillate pump shall take the fresh water produce from the condenser of the fresh water generator and transfer it to the fresh water tank.

### **9.2 FITTING AND ACCESSORY**

- 1 — ejector
- 1 — set of distillate pump
- 1 — set of ejector pump
- 1 — set of salinity alarm device
- 1 — solenoid valve
- 1 — vacuum gauge
- 1 — set of pressure gauge
- 1 — flow meter
- 1 — chemical injection unit
- Other necessary fittings

The construction and materials shall be in accordance with Maker's standard.



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## **SECTION 10 PIPING GENERAL**

### **10.1 GENERAL**

Consideration shall be given in design so that the piping shall be led as directly as practicable with a minimum of bends.

Care shall be taken to avoid as far as possible pockets in pipe lines. Where pockets do occur, they shall be fitted with bosses having valves or screwed plugs or other means for draining if necessary. The drain plugs shall not be fitted in way of cofferdams or voids. The lines which necessitate draining frequently shall be fitted with valves or traps, or both.

The radius of bends in steel pipe shall be about two times the nominal diameter except for bend elbow. But in case it is difficult to make good piping arrangement with two times, bend elbow may be used. Welding fittings may be employed in place of pipe bends.

In case that the bend elbows are used, the radius of bends shall be one or one and half times of nominal diameter.

The system shall be designed to allow for all stresses due to thermal expansions and deflections of ship's structure.

Except where otherwise noted, expansion shall be compensated by using bends.

Expansion joints in exhaust gas pipes shall be of bellows type.

The pipes shall be supported suitably against excessive vibration.

The oil piping shall be kept as far as away from hot surface as practicable. The pipe shall, as far as possible, not be arranged directly above or in front of or behind the switch board. If unavoidable, suitable protection shall be provided.

Where piping passes through water or oil tight bulkheads and decks, the connection shall be made tight by means of three spool flanges or direct welded pipes.

Connections through insulated bulkheads shall be of sufficient length to permit access to flanged connection without disturbing the insulation.

The directly welded pipes shall be employed for piping penetrated through tank walls constructed with hull, such as sounding pipes, pump suction pipes and vent pipes.

Where galvanized piping is specified, the galvanizing shall be done after the pipe is fabricated and flanges are attached thereon in shop, except for screwed ends which may be attached after galvanizing.



Where it is impracticable or welding has destroyed galvanization the surface shall be touched up with coat of zinc rich paint.

Unions joints, screw joints or bite joints may be used for connecting the small pipes, valves and cocks.

After fabrication in shop for subsequent assembly, the lubricating oil pipes of main engine forced circulation system shall be pickled before installation. After fitting out onboard, they shall be cleaned by flushing with the lubricating oil which is prepared as system oil.

Packing used for all pipe lines, in general, shall be of multipurpose type or reinforced rubber sheet type.

## **10.2 SEA CHEST**

The number of sea chest shall be kept to a minimum by combining the system.

The suction sea chest shall be of welded steel construction and fitted with sea valve of angle, globe and butterfly type.

The distance piece for overboard and sea suction connection shall be of extra heavy steel pipe or fabricated steel construction. The thickness of distance piece shall be determined according to the requirement of the Classification Society.

In general, suction sea chest shall be fitted with grid type strainer which shall be fabricated from flat steel bars and galvanized after fabrication. For small suction sea chest, perforated strainer plates of galvanized steel may be used.

Strainer grids or plates shall have a clear area not less than two times cross sectional area of the connected pipe, and shall be secured so that no part extends beyond the shell. The bolts or studs and nuts for securing strainer grid or plates shall be of stainless steel. The studs and nuts for securing sea valve shall be of stainless steel.

Steam blow valve with coupling and air vent shall be fitted to each suction sea chest.



### 10.3 VALVE AND COCK

In general, the valves and cocks of marine use which are specified in accordance with Japanese Industrial Standard ( JIS ) or equivalent standard shall be used except that the valves and cocks for control system which have special construction and shape shall be in accordance with Maker's standard.

Generally, globe and angle valve shall be used on engine room piping system, but as to fresh water and sea water lines of pipe diameter 80 mm and above, butterfly valve shall be adopted.

Pipe line	Material of valve body	Joint	Nominal
Bilge, ballast and sea water line 50 mm & above 40 mm & below	Cast iron Bronze	Steel slip on welded flange or sleeve	5K STD
Fire line 50 mm & above 40 mm & below	Cast iron Bronze	Steel slip on welded flange or sleeve	10K STD
Fresh, drinking and cooling F.W. line 50 mm & above 40 mm & below	Cast iron Bronze	Steel slip on welded flange or sleeve	5K STD
M/E F.O. circulating pump discharge line 50 mm & above 40 mm & below	Special cast iron Bronze	Steel slip on welded flange	16K STD
D/G F.O. circulating pump discharge line 50 mm & above 40 mm & below	Special cast iron Bronze	Steel slip on welded flange	16K STD
F.O. and L.O. line 50 mm & above 40 mm & below	Cast iron Bronze	Steel slip on welded flange or sleeve	5K STD
F.O. purified line 50 mm & above 40 mm & below	Special cast iron Bronze	Steel slip on welded flange or sleeve	5K STD



Pipe line	Material of valve body	Joint	Nominal
Steam ( 0.7MPa ) line 50 mm & above 40 mm & below	Cast iron Bronze	Steel slip on welded flange or sleeve (Note:4)	10K STD
Steam ( 0.4MPa ) line 50 mm & above 40 mm & below	Cast iron Bronze	Steel slip on welded flange or sleeve	5K STD
Feed water line	Bronze	Steel slip on welded flange	16K STD
Compressed air ( 2.9MPa ) line 32 mm & above 25 mm & below	Cast steel Forged steel	Steel slip on welded flange	20K STD
Compressed air ( 0.8MPa ) line	Bronze	Steel slip on welded flange or sleeve	10K STD

Note :

- 1) Valves on hull construction of 40 mm bore and below shall be of cast bronze and those of 50 mm and above shall be of cast steel.
- 2) Main suction valves fitted on outside walls of fuel oil and lub. oil tanks except double bottom tanks shall be of special cast iron except those of 40 mm bore and below of cast bronze.
- 3) Valves and pipe fittings in the piping system of group II except steam line shall be of casting with on elongation of 12% and over.
- 4) Sleeve welded joint is not to be used for steel pipes having a nominal diameter for more than 80A for steam line.
- 5) Mechanical joints shall be of NK-approved type and the construction and type shall be in accordance with Table D12.8 and Table D12.9 (12.3.3, Part D of the Rules).



## 10.4 PIPING SCHEDULE

### (1) LIST OF MATERIAL ( PIPE LIST )

Pipe line	Kind of pipe	Design		Test pressure		Remarks
		Press (MPa)	Temp. (°C)	Shop (MPa)	After inst.	
Bilge line 65 mm & above 50 mm & below	STPG370E (Sch.40) (Sch.80)	0.32	Ambi- ence	-	Work. Cond.	To be galvanized
Ballast line 65 mm & above 50 mm & below	STPG370E (Sch.40) (Sch.80)	0.30	Ambi- ence	-	Work. Cond.	To be galvanized
Fire line 65 mm & above 50 mm & below	STPG370E (Sch.40) (Sch.80)	0.75	Ambi- ence	-	Work. Cond.	To be galvanized
Cooling S.W. & S.W. service line 65 mm & above 50 mm & below	STPG370E (Sch.40) (Sch.80)	0.45	Below 55	-	Work. Cond.	To be galvanized
Cooling F.W. line 125 mm & above 100 mm & below	SGP-E SGP-B	0.45	92	-	Work. Cond.	To be pickled
F.O. sett. tank to F.O. purifier	STPG370E (Sch.40)	0.30	60	-	0.45	To be pickled & to be insulated
F.O. puri. to tank		0.30	98	0.45	0.45	
Tank to F.O.boost.P		0.30	90	0.45	0.45	
F.O. boost. pump to M/E F.O. circ.pump		0.40	140	0.60	0.60	
M/E F.O. circ. pump to main engine	KSTPG38E (Sch.40)	1.40	140	2.10	2.10	
Main engine to mix. tube	STPG370E (Sch.40)	0.40	140	0.60	0.60	
D/G F.O. circ. pump to diesel generator	KSTPG38E (Sch.40)	1.40	140	2.10	2.10	
Boiler F.O. serv. line	STPG370E (Sch.40)	0.30	98	0.45	0.45	
Boiler F.O. burning pump to burner	KSTPG38E (Sch.40)	1.80	130	2.70	2.70	
F.O. transfer line 125 mm & above 100 mm & below	SGP-E SGP-B	0.32	50	-	0.48	-
L.O. line 125 mm & above 100 mm & below	SGP-E SGP-B	0.42	55	-	Work. Cond.	To be pick. (except trans. line)
L.O. purified line 125 mm & above 100 mm & below	SGP-E SGP-B	0.35	90	0.53	Work. Cond.	To be pickled



Pipe line		Kind of pipe	Design		Test pressure		Remarks
			Press (MPa)	Temp. (°C)	Shop (MPa)	After inst.	
Steam line		SGP-B	0.80	175	1.20	Work.	To be insulated
			0.45	155	0.68	Cond.	
Boiler blow line		STPG370E (Sch.40)	1.00	175	1.50	Work. Cond.	To be insulated
Tank heating pipe (In engine room)		STPG370E (Sch.40)	0.8	175	1.20	1.2	-
Exh. steam & drain		SGP-B	Below 0.10	Below 100	-	Work. Cond.	To be insulated
Compressed air line		KSTPG38E (Sch.40)	2.99	Ambi-ence	4.49	Work. Cond.	To be galvanized for main pipe
		SGP-B	0.90	Ambi-ence	1.35		
Feed water line	Suc. line	SGP-B	Below 0.10	60	-	Work. Cond.	-
	Dis. line	STPG370E (Sch.40)	1.10	60	1.65		
Drinking water line		SUS304-A (Sch.20S)	0.55	Ambi-ence	-	Work. Cond.	-
Fresh water service line		SGP-B	0.55	Ambi-ence	-	Work. Cond.	To be galvanized
F.W. gene. distillate water line		SUS304-A (Sch.20S)	-	-	-	Work. Cond.	-
Gauge pipe line		Copper	-	-	-	Work. Cond.	-
Oily drain, deck scupper & open ended pipe		SGP-B	-	-	-	-	-
Exhaust gas pipe		SGP-E STPY-400 SS400	-	-	-	-	-

Pipe line	Bore	Kind of pipe	Remarks
Overflow pipe, sounding pipe and vent. pipe fitted to the hull constructed tank	40mm, 50mm 65mm & above	STPG370E (Sch.80) SGP	-



## (2) THICKNESS OF STEEL PIPE

Unit : mm

Nominal diameter	Outside diameter	Steel pipe		SGP-E SGP-B
		Sch.40	Sch.80	
10	17.3	2.3	3.2	2.3
15	21.7	2.8	3.7	2.8
20	27.2	2.9	3.9	2.8
25	34.0	3.4	4.5	3.2
32	42.7	3.6	4.9	3.5
40	48.6	3.7	5.1	3.5
50	60.5	3.9	5.5	3.8
65	76.3	5.2	7.0	4.2
80	89.1	5.5	7.6	4.2
100	114.3	6.0	8.6	4.5
125	139.8	6.6	9.5	4.5
150	165.2	7.1	11.0	5.0
200	216.3	8.2	12.7	5.8
250	267.4	9.3	*12.7	6.6
300	318.5	*9.5	*12.7	6.9
350	355.6	*9.5	*12.7	7.9
400	406.4	*9.5	*12.7	7.9

Unit : mm

Exhaust gas pipe			Thickness of copper pipe	
Nominal dia.	Thickness	Material	Outside dia.	Thickness
650 & above	6.0	SS 400	6	1.0
400 to 600	6.4	STPY-400	10	1.0
350 & below	-	SGP-E	12	1.2
			16	1.2

Note :

- 1) 10 mm and below pipes in nominal diameter shall be of seamless copper pipe.
- 2) STPY-400 shall be adopted for marked \* size pipe.
- 3) The material of M/E exh. gas pipe above one (1) meter under the funnel top plate shall be anti-corrosive steel.





## 10.5 STRAINER

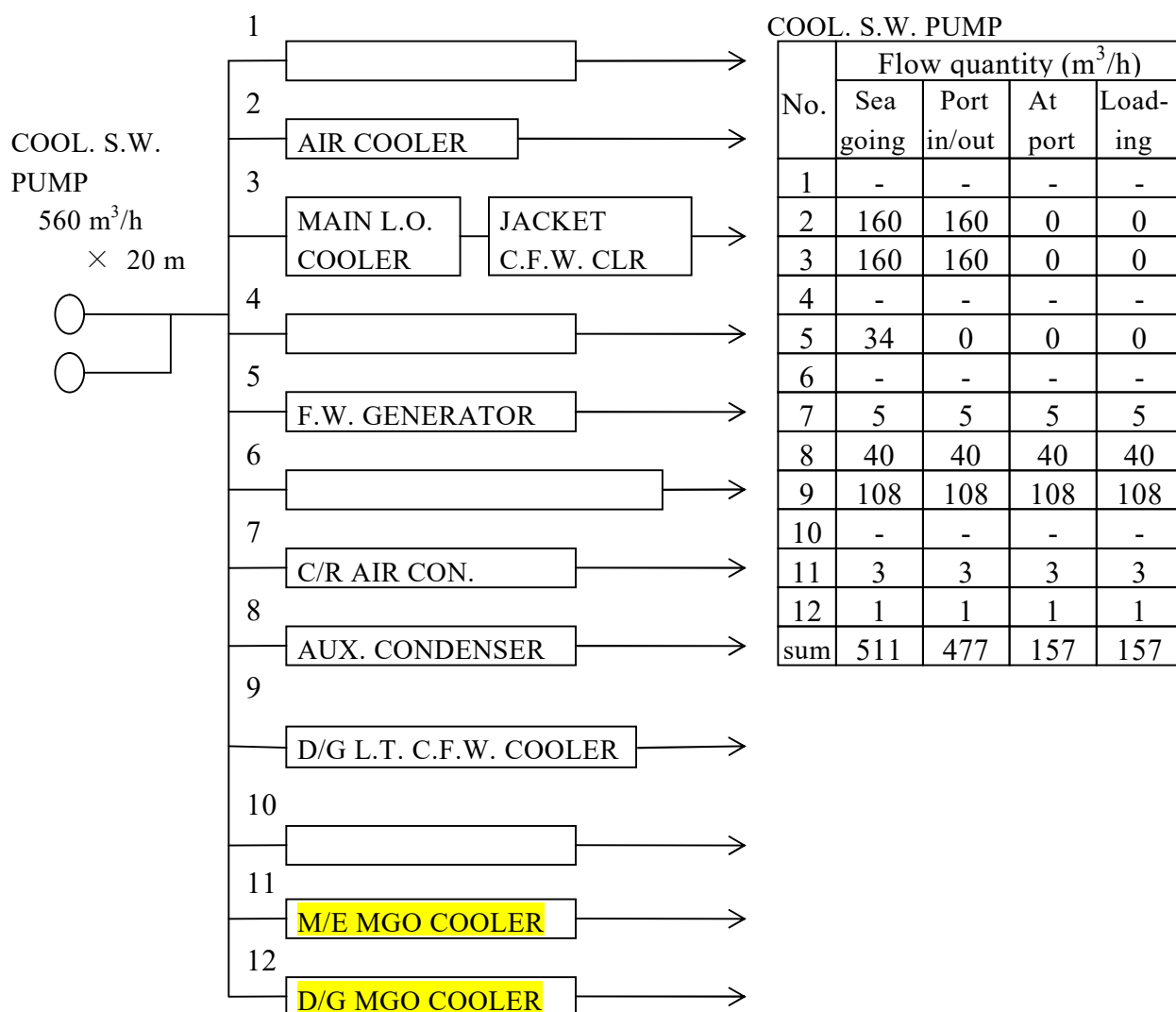
Line	Item	No. × Mesh		Remarks
		Inlet	Outlet	
Sea water line	Cool. S.W. pump	2 × 8 mm	-	Simplex type The element to be stainless, and inner surface to be of epoxy paint
	Ref. mach. cool. S.W. pump	1 × 8 mm	-	
	Main L.O. cooler	1 × abt. 4 mm		Inner strainer (Maker supply)
	D/G low temp. F.W. cooler	2 × abt. 4 mm		
Bilge & ballast line	Bilge & ballast pump	1 × 8 mm	-	Simplex type The element to be stainless, and inner surface to be of epoxy paint
	Fire & G.S. pump	1 × 8 mm	-	
	Ballast pump	2 × 4 mm	-	
	Bilge pump	1 × 32	-	Simplex type
	Sludge pump	1 × 10	-	
	Bilge separator	1 × 100	-	
Fresh water line	Drinking water tank	-	1 × 10 mm	Rose box
	Fresh water tank	-	1 × 10 mm	
Drain line	Drain trap	Each 1	-	Y type strainer
Steam line	Reducing valve & temp. cont. valve (direct type)	Each 1	-	Y type strainer



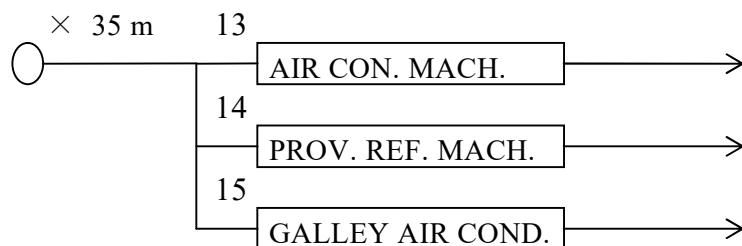
Line	Item	No. × Mesh		Remarks
		Inlet	Outlet	
Fuel oil line	F.O. transfer pump	1 × 16	-	Simplex
	D.O. transfer pump	1 × 16	-	Simplex
	F.O. purifier	1 × 60	-	Duplex ( F.O. side )
		1 × 60	-	Simplex ( D.O. side )
	F.O. booster pump	1 × 100	-	Duplex
		-	1 × E.F. 5 μ	Select type with bypass-filter (E.F.50 μ )
	Main engine F.O. circ. pump	-	1 × ABS.50 μ	Manual. back wash (Maker supply)
	Diesel generator D.O. booster pump	1 × 100	-	Duplex
	Diesel generator F.O. circ. pump	-	1 × E.F.10 μ	Manual. back wash
		-	3 × ABS.75 μ	Notch wire (Maker supply)
	Boiler F.O. pump	1 × 100	-	Simplex (Maker supply)
Lub. oil line	F.O. shifter pump	1 × 32	-	Duplex
	Waste oil incinerator	1 × 60	-	Simplex
	L.O. transfer and L.O. purifier supply pump	1 × 60	-	Duplex
	Stern tube L.O. pump	2 × 60	-	Simplex with magnet
	D/G L.O. purifier	1 × 60	-	Duplex
	Main engine L.O. pump	-	1 × ABS.40 μ	Manual back wash
	Sludge collector	1 × 150	-	(Maker supply)
	Cylinder lubricator	1	-	Y type strainer (Maker supply)
	Diesel generator L.O. pump	3	-	Simplex (Maker supply)
		-	3 × ABS.30 μ	Continuous back wash (Maker supply)



## 10.6 SEA WATER DISTRIBUTION CHART



REF. MACH.  
C.S.W. PUMP  
40 m<sup>3</sup>/h  
× 35 m



REF. MACH. C.S.W. PUMP

No.	Flow quantity (m <sup>3</sup> /h)			
	Sea going	Port in/out	At port	Load-ing
13	21	21	21	21
14	7	7	7	7
15	7	7	7	7
sum	35	35	35	35



## 10.7 PIPING SYSTEM

Schematic diagrams of piping system shall be shown as follow.

FIG. 1	BILGE LINE	M10 - 12
FIG. 2	COOLING SEA WATER LINE	M10 - 13
FIG. 3	COOLING FRESH WATER LINE	M10 - 14
FIG. 4	FRESH WATER SERVICE LINE	M10 - 15
FIG. 5	FUEL OIL TRANSFER LINE	M10 - 16
FIG. 6	FUEL OIL PURIFYING LINE	M10 - 17
FIG. 7	M/E AND BOILER FUEL OIL SERVICE LINE	M10 - 18
FIG. 8	DIESEL GENERATOR FUEL OIL SERVICE LINE	M10 - 19
FIG. 9	LUB. OIL TRANSFER & FURIFYING LINE	M10 - 20
FIG. 10	LUB. OIL SERVICE LINE	M10 - 21
FIG. 11	STERN TUBE LUB. OIL LINE	M10 - 22
FIG. 12	STEAM LINE	M10 - 23
FIG. 13	COMPRESSED AIR LINE	M10 - 24
FIG. 14	EXHAUST GAS LINE	M10 - 25



FIG. 1 BILGE LINE

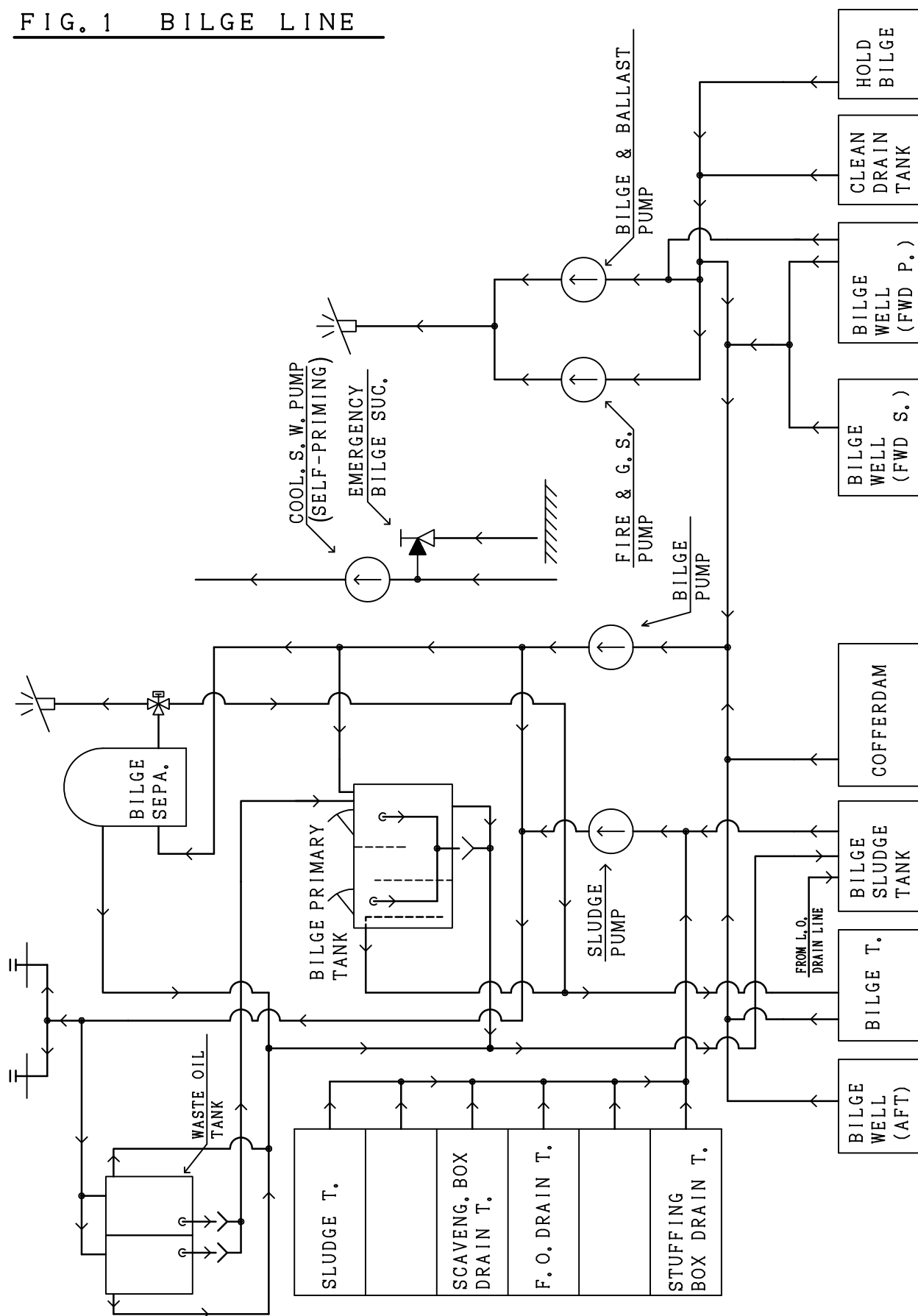




FIG. 2 COOL. S. W. LINE

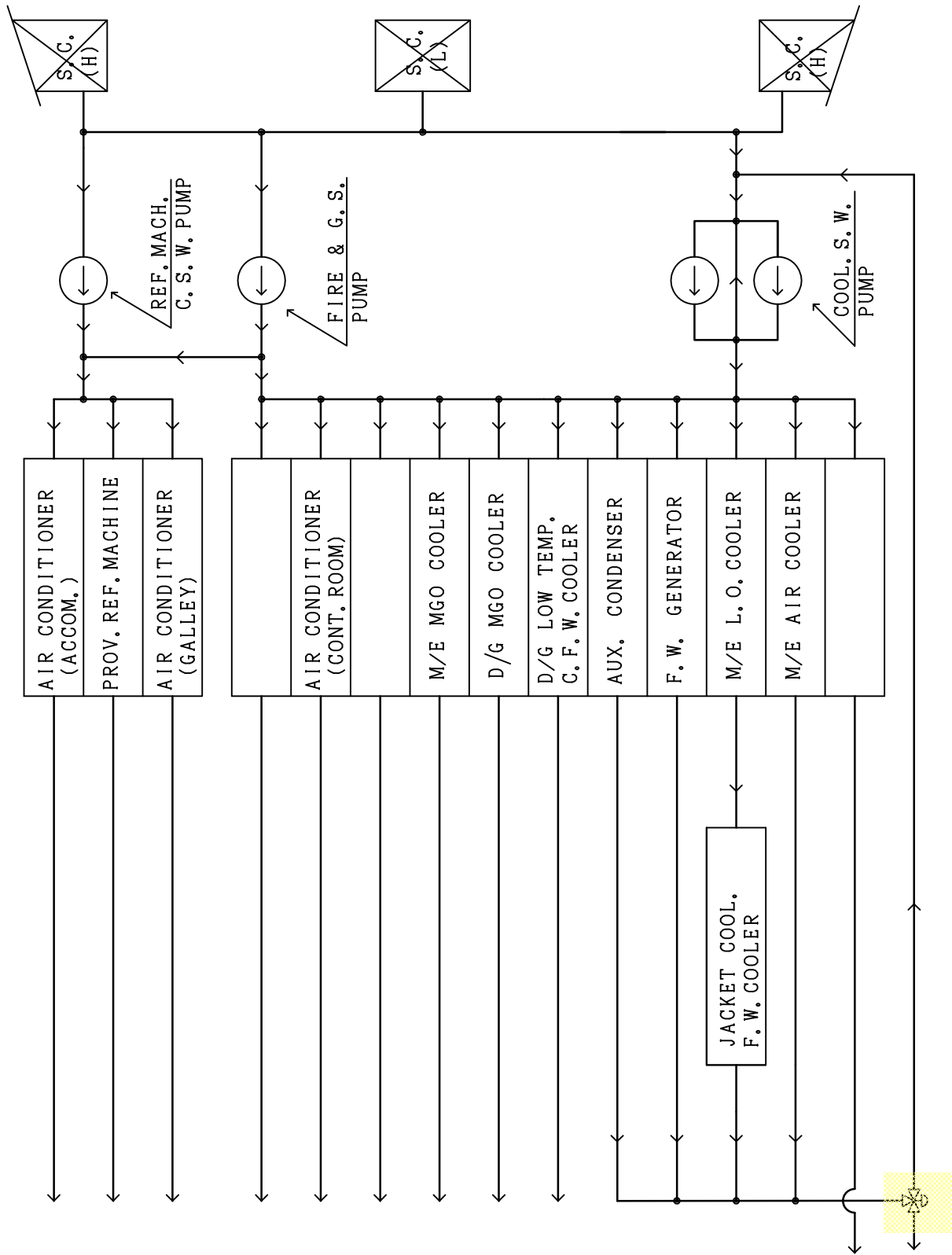




FIG. 3 COOL. F. W. LINE

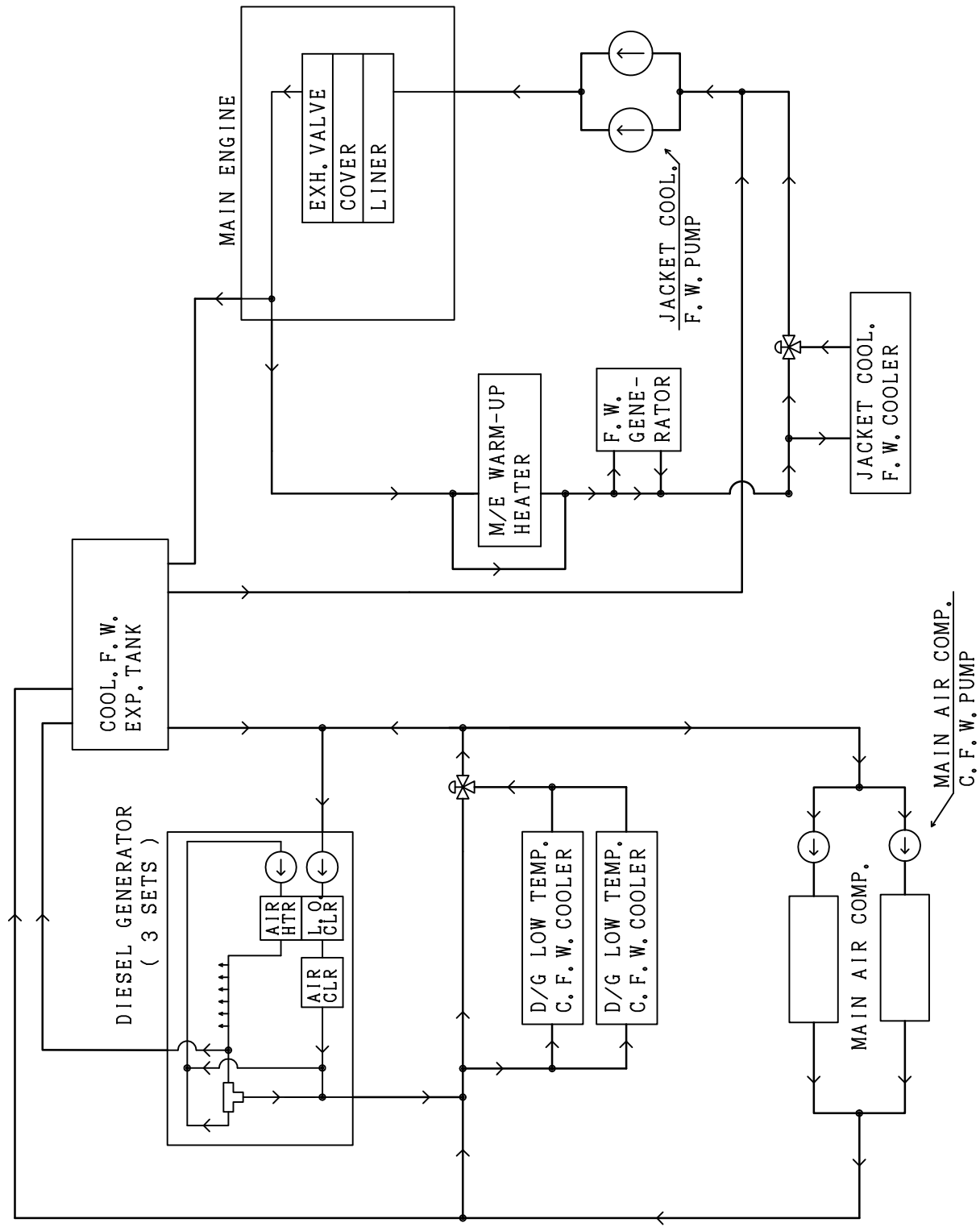




FIG. 4 FRESH W. SERVICE LINE

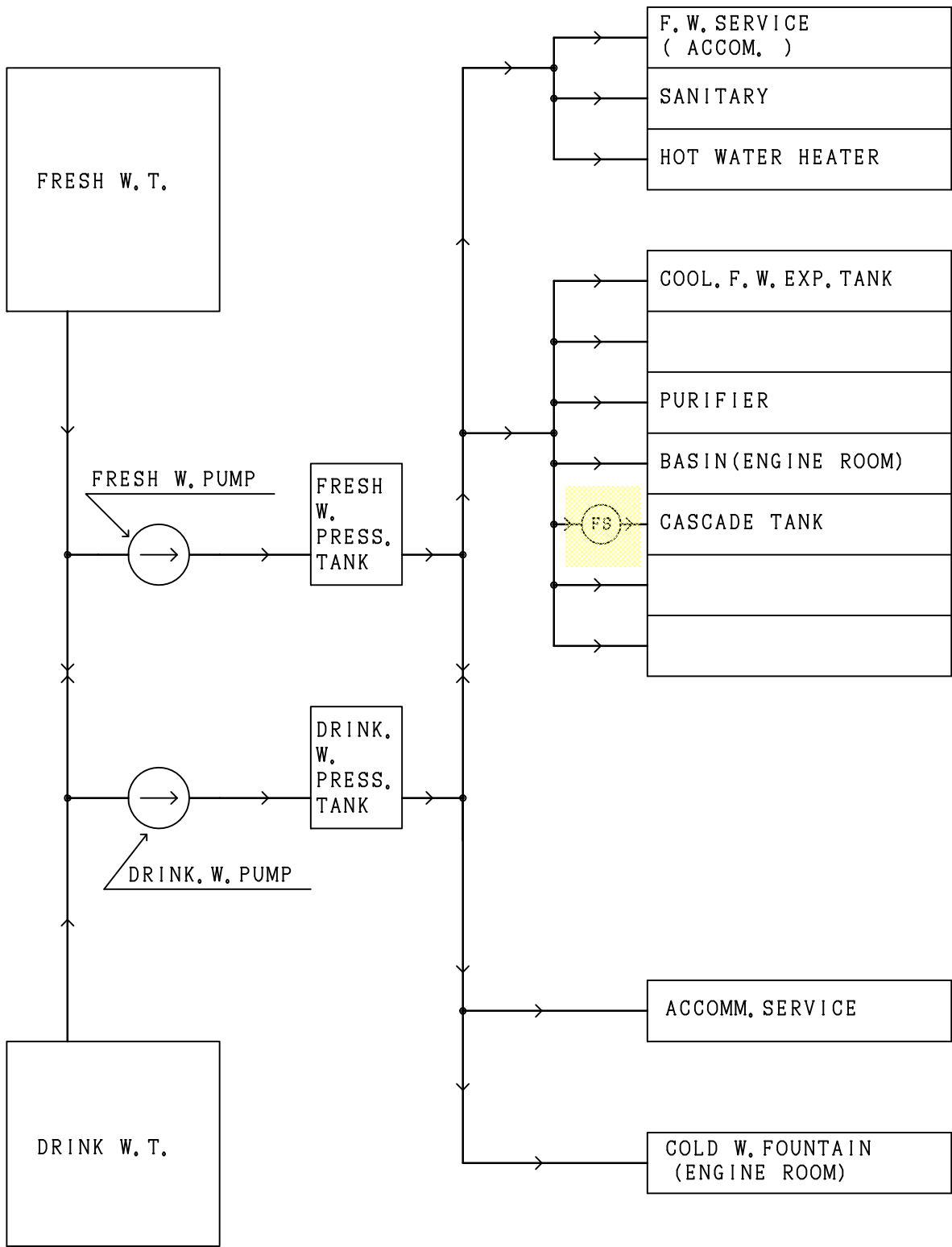




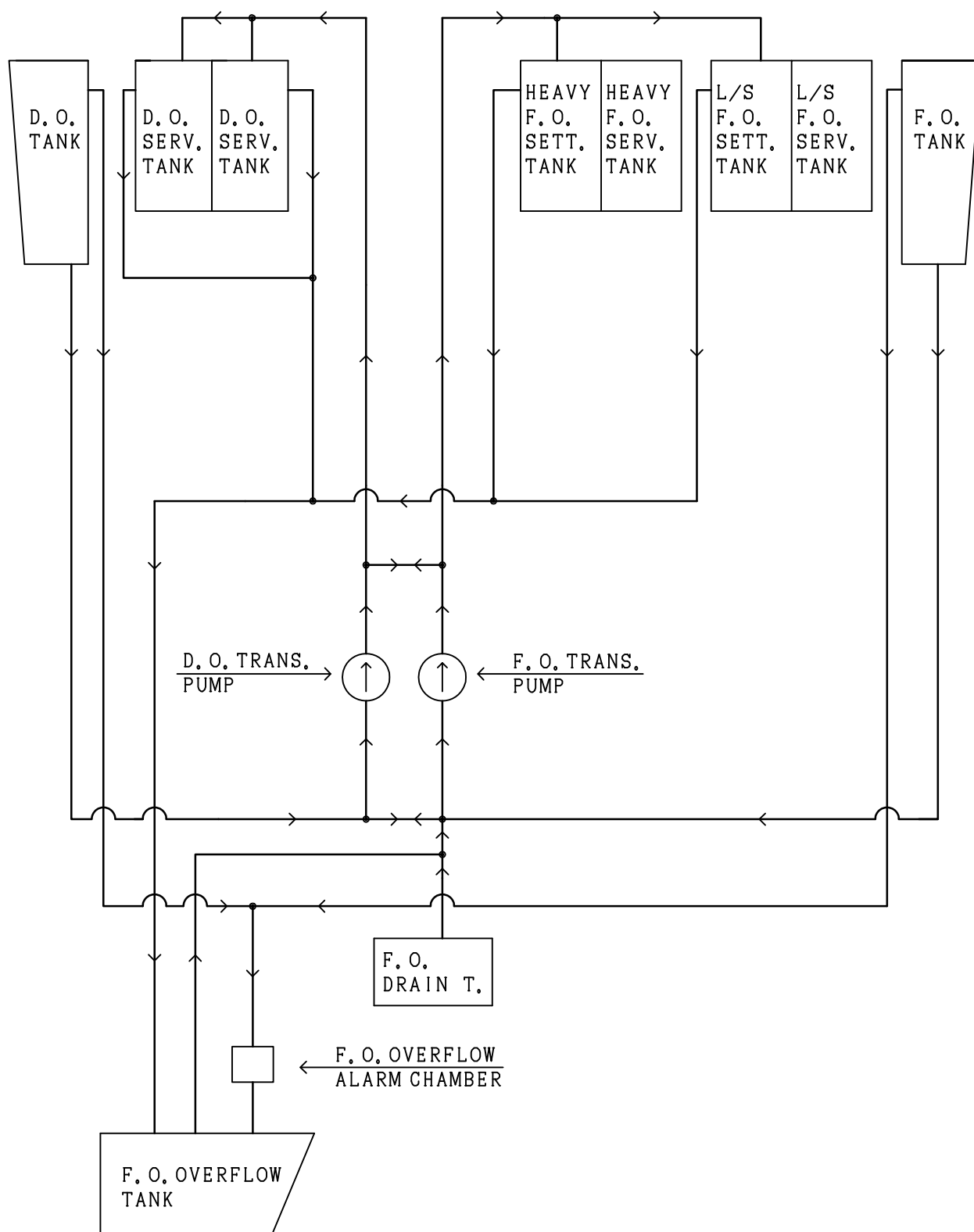
FIG. 5 F. O. TRANSFER LINE



FIG. 6 F. O. PURIFYING LINE

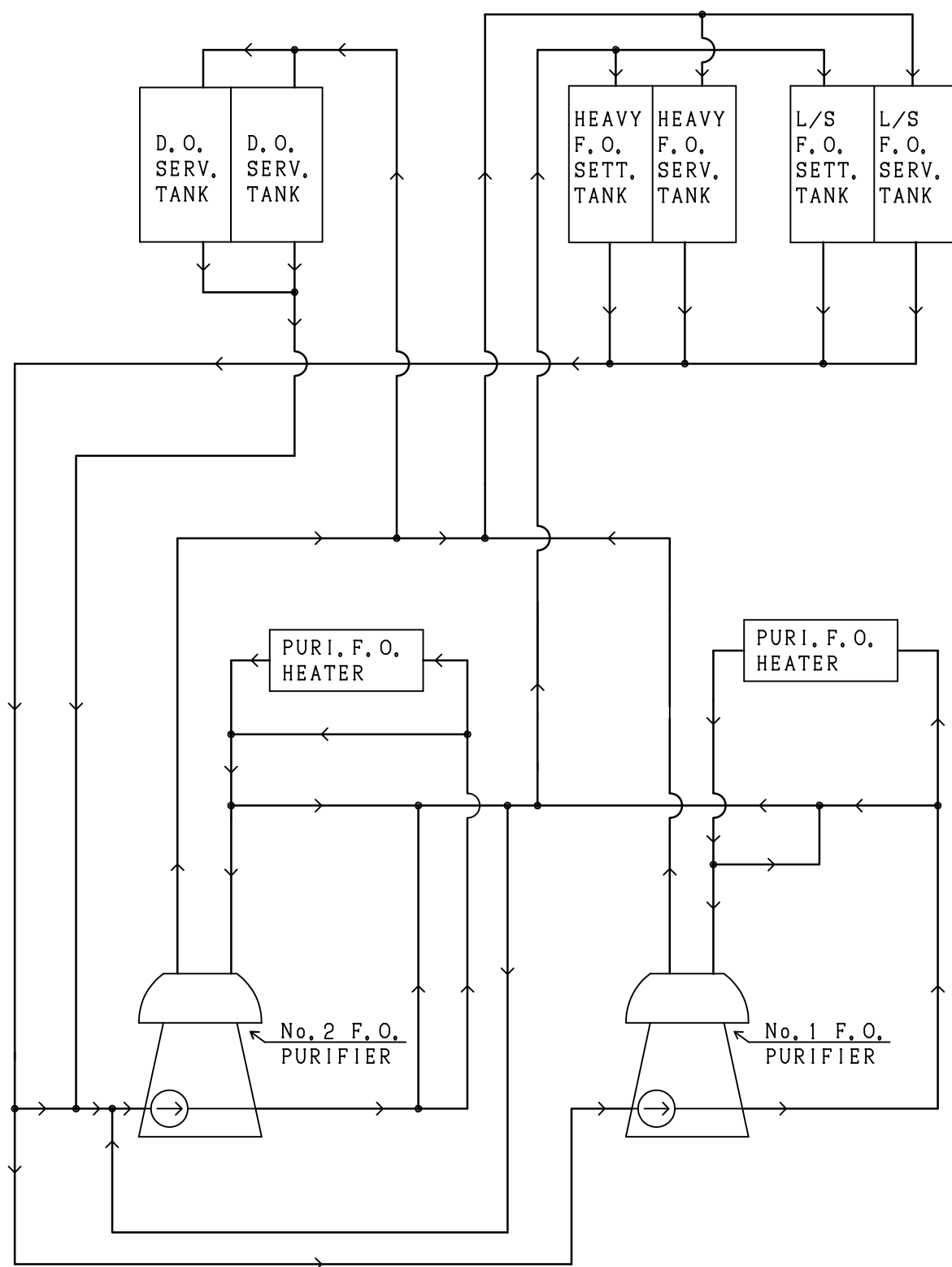




FIG. 7 M/E & BOILER F. O. SERVICE LINE

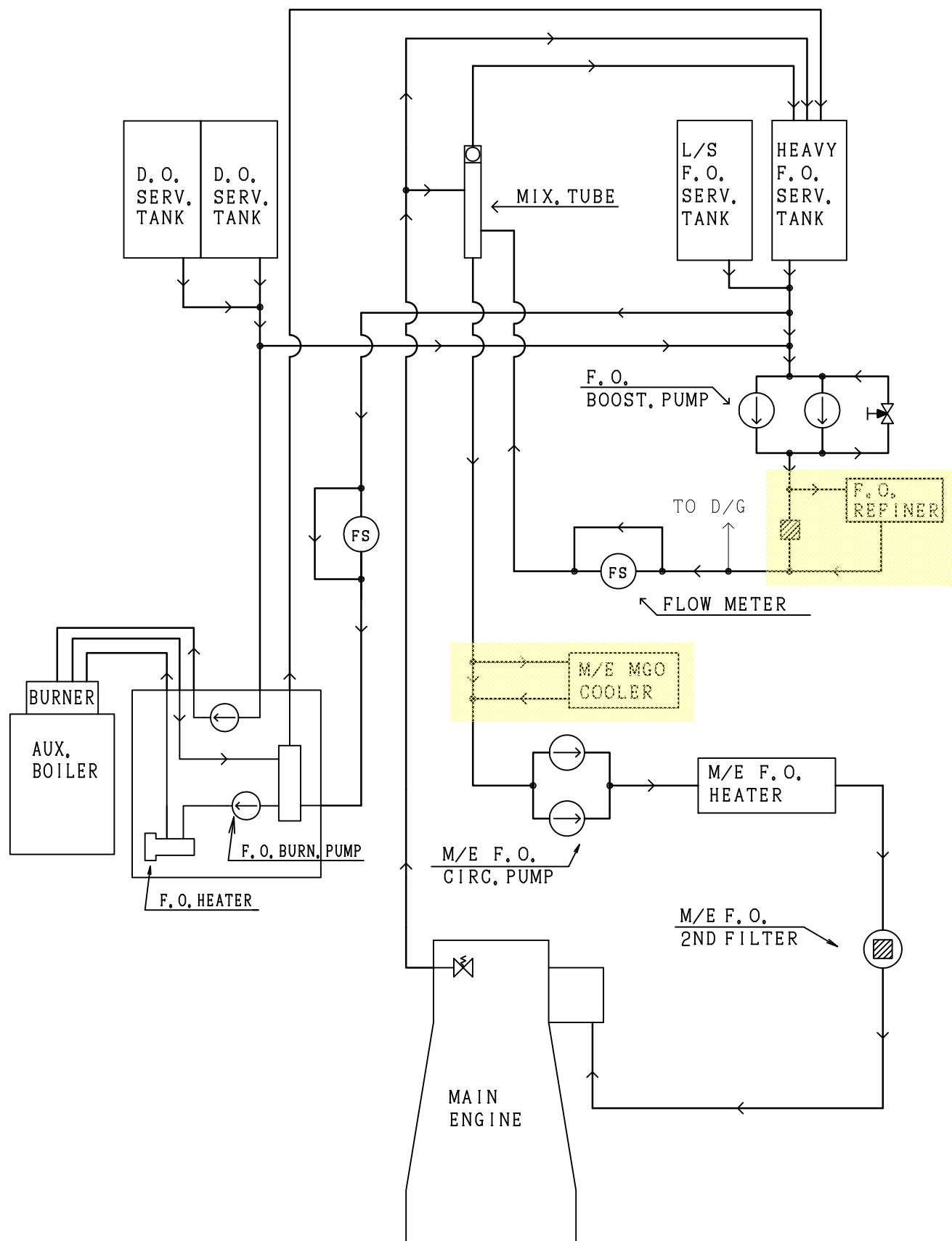
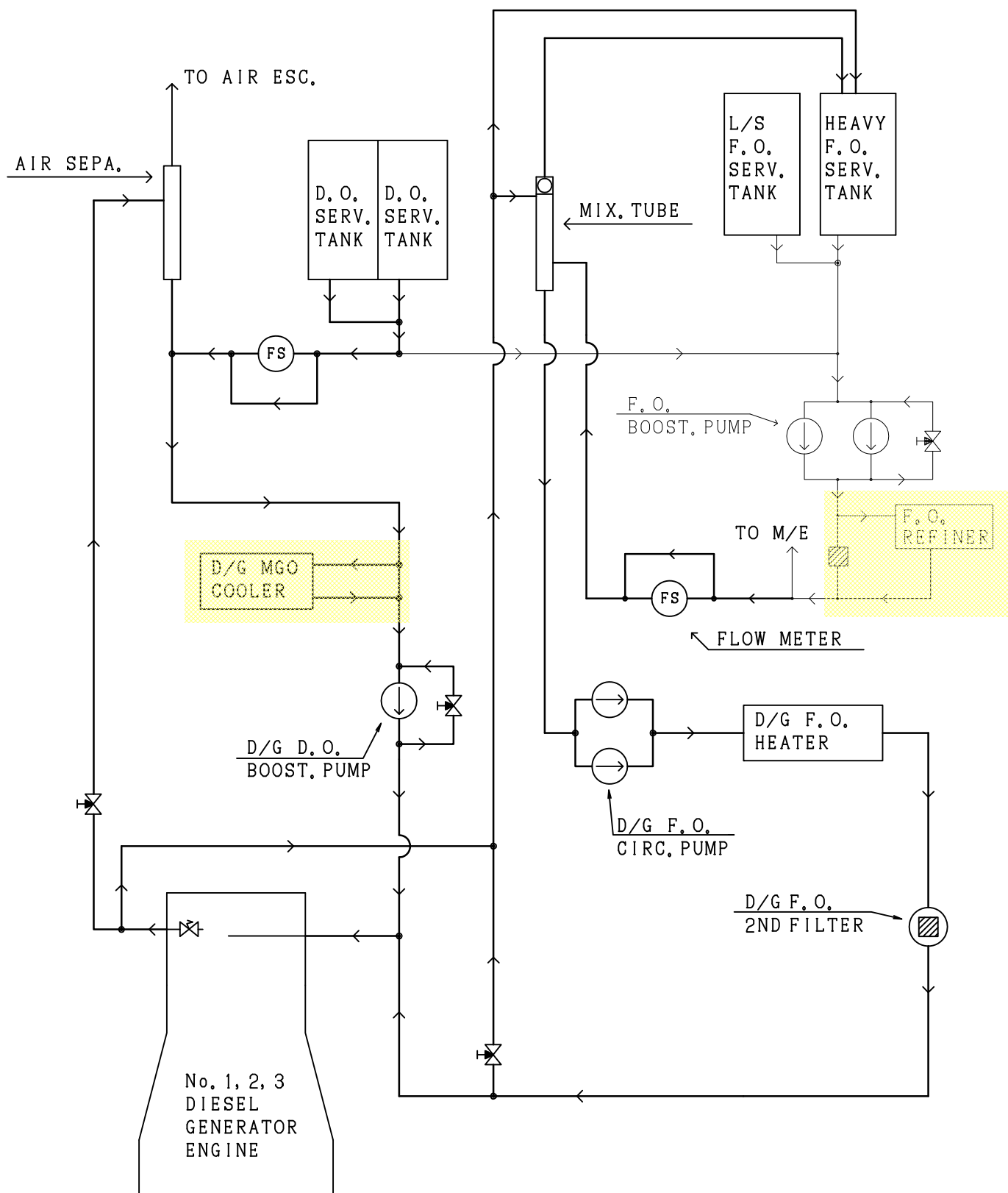




FIG. 8 D/G F. O. SERVICE LINE





△ FIG. 9 L. O. TRANS. & PURI. LINE

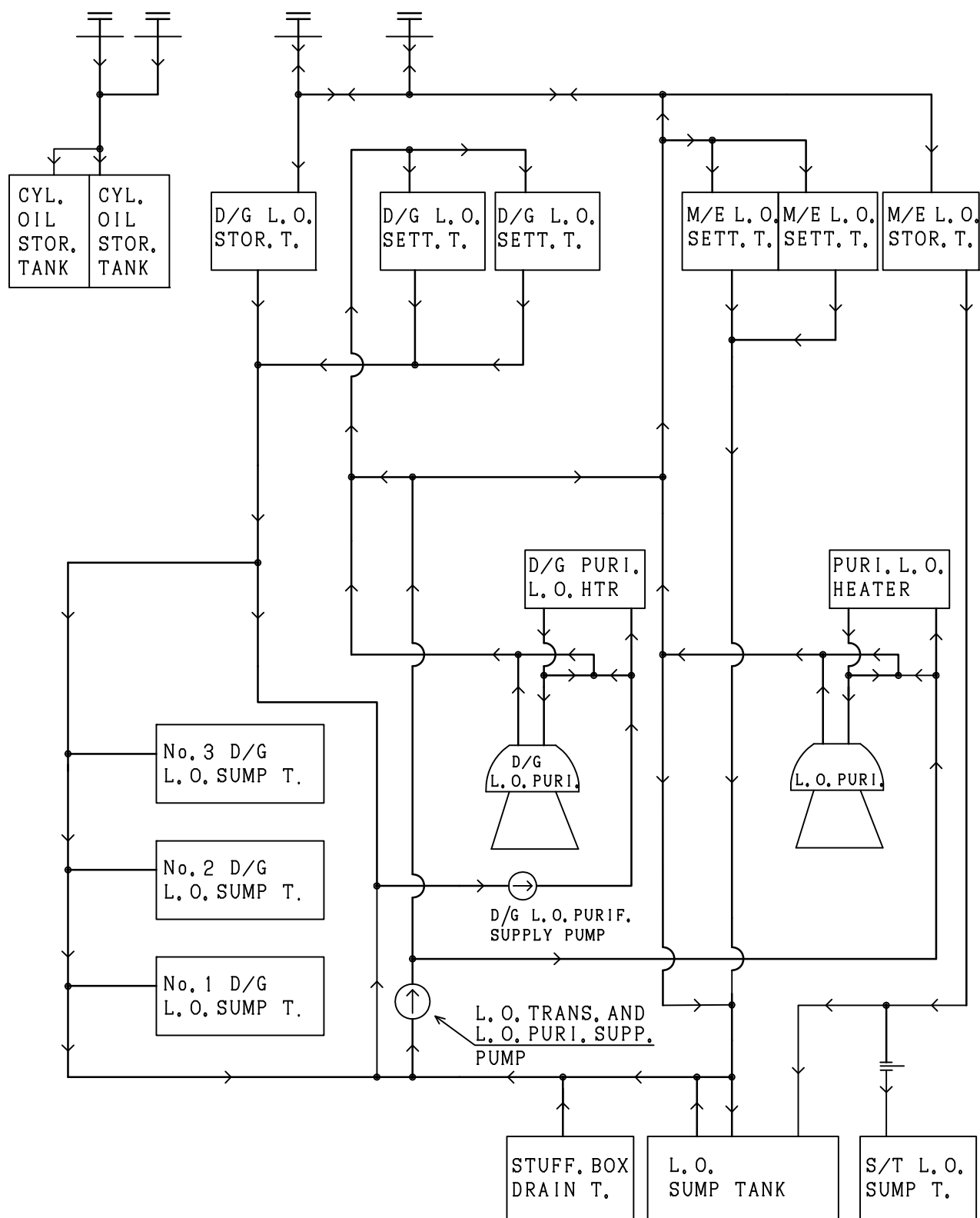




FIG. 10 L. O. SERVICE LINE

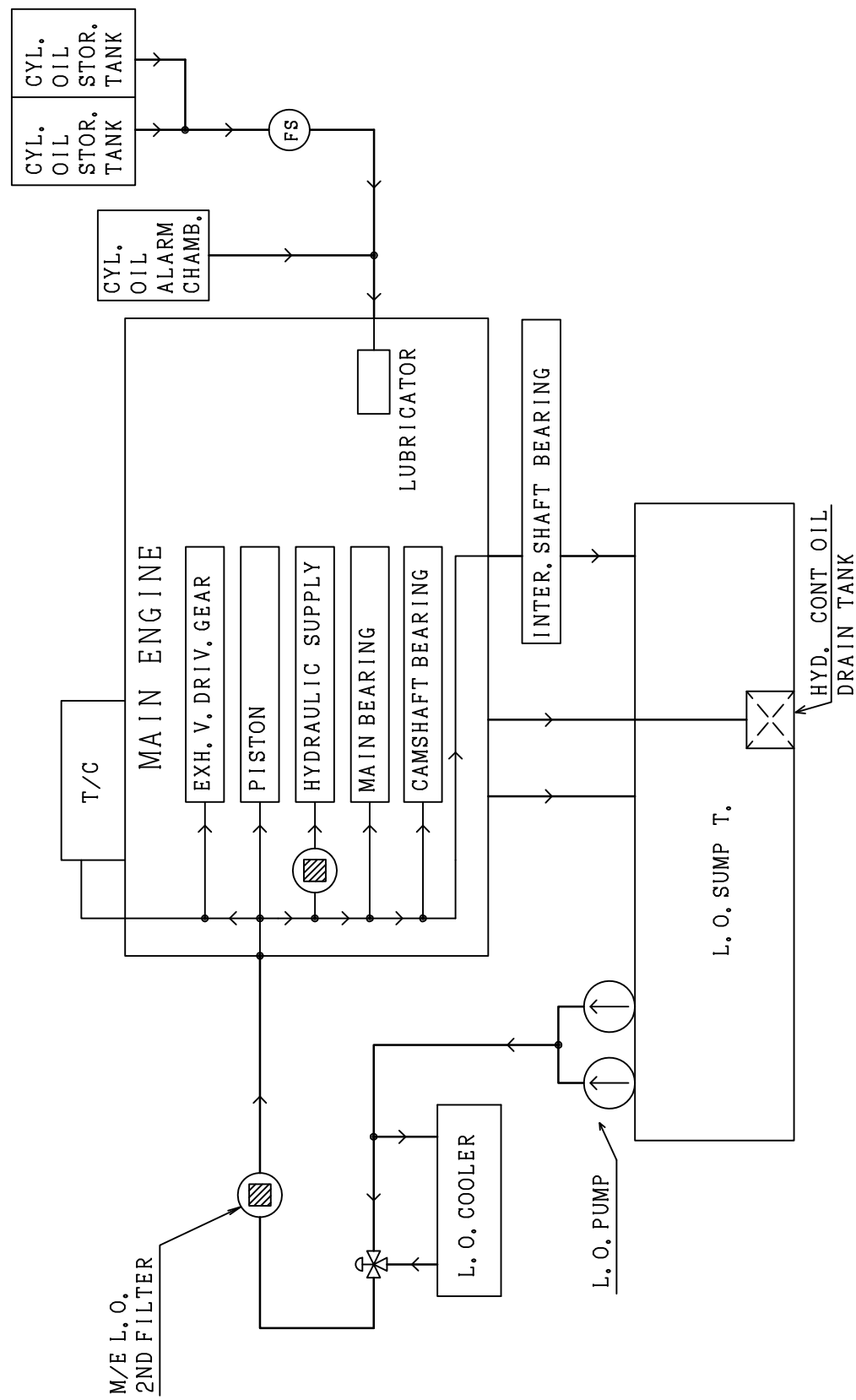




FIG. 11 STERN TUBE L. O. LINE

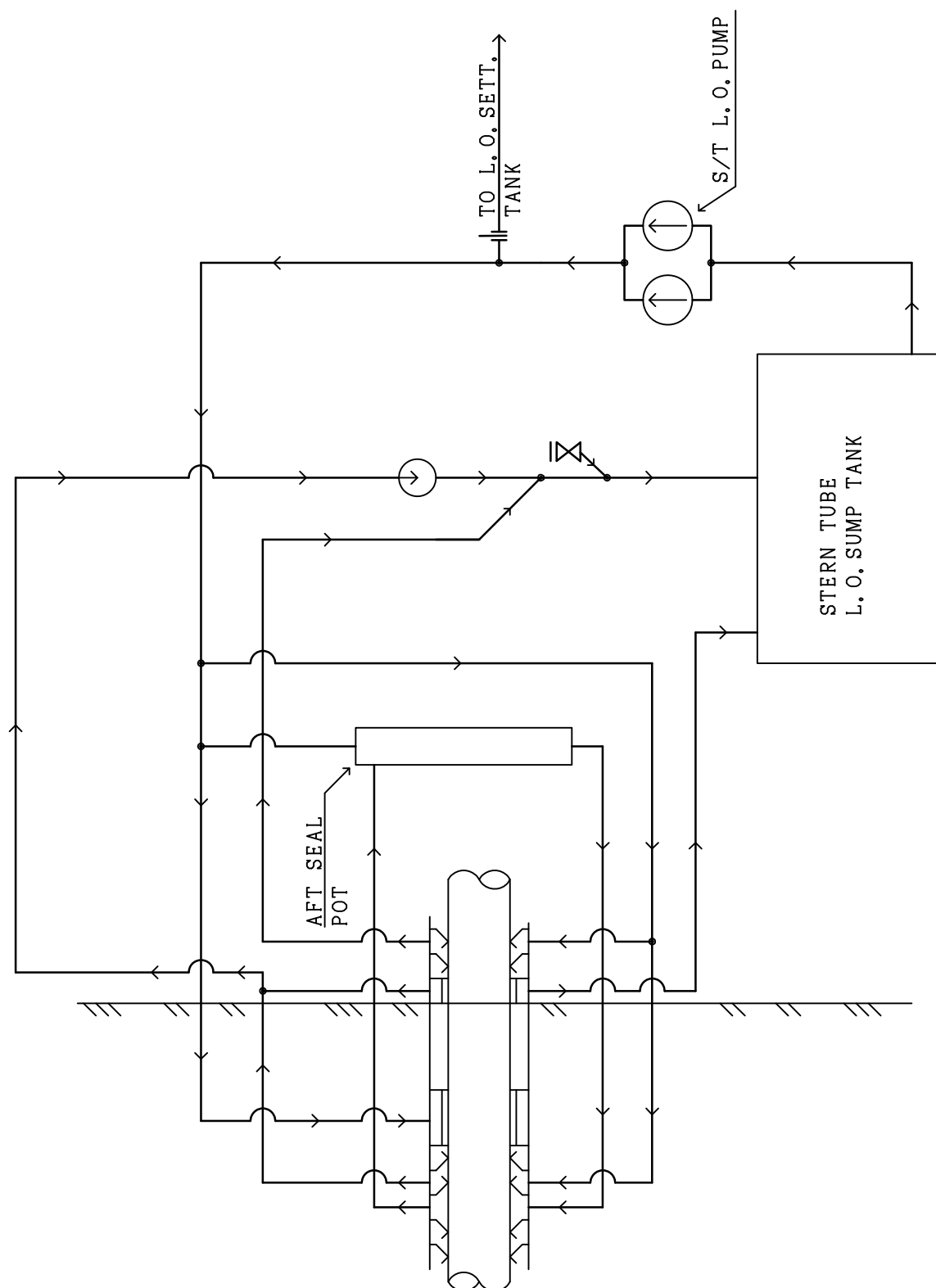




FIG. 12 STEAM LINE

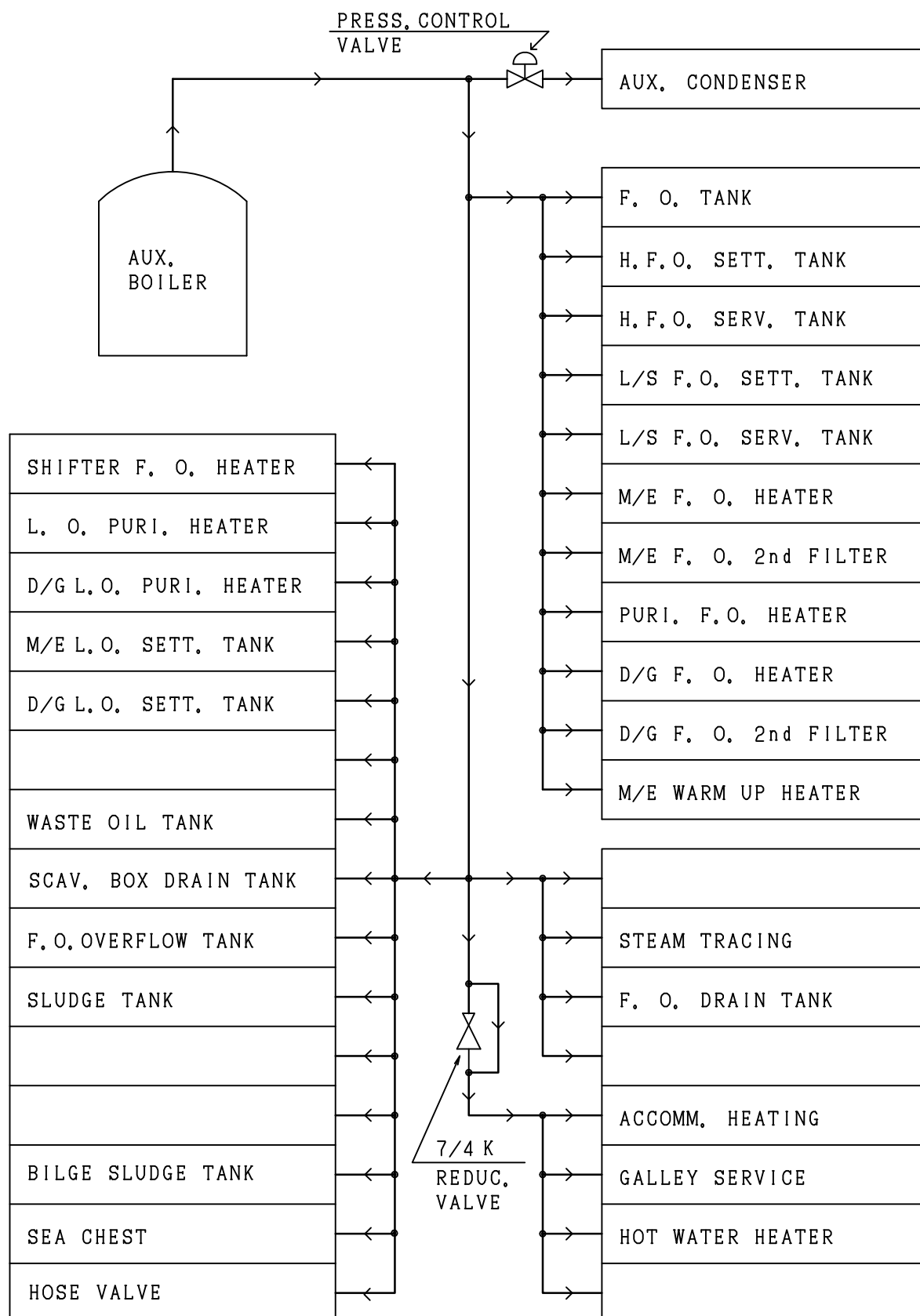






FIG. 13 COMPRESSED AIR LINE

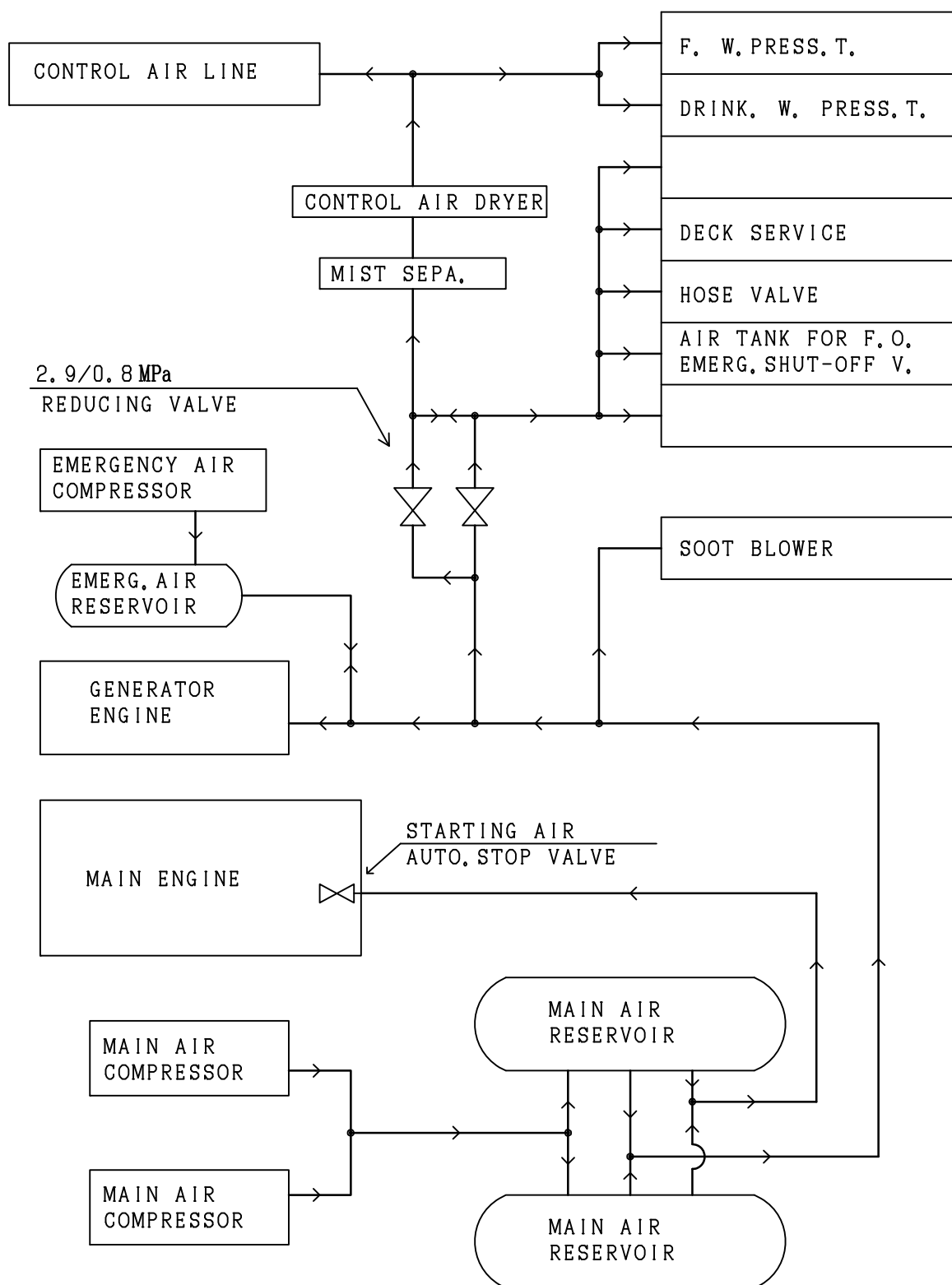
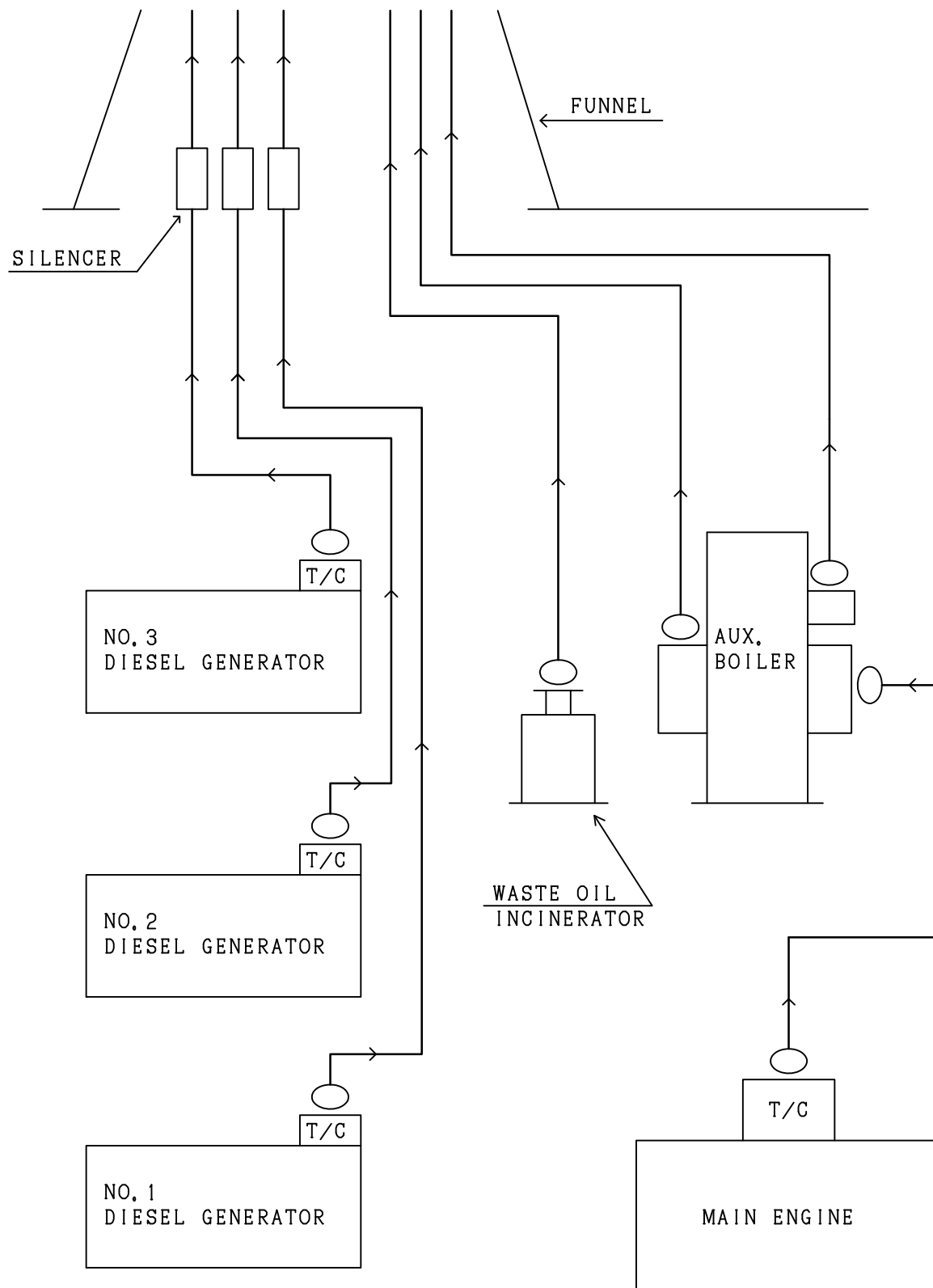


FIG. 14 EXH. GAS LINE



## SECTION 11 INSULATION AND PAINTING

### 11.1 INSULATION

#### 11.1.1 General

The external surface of the equipment and tanks which shall treat or contain the fluid having temperature above 55°C, except for the jacket cooling fresh water system, lub. oil system and boiler feed water line, shall be insulated as described below. Jacket cooling F.W. pipes in the location where people can easily touch shall be insulated.

The insulation materials such as glass wool, rock wool, etc. shall be suitably served according to the internal temperature of equipment and tanks concerned.

Where it is necessary to fit removable and replaceable insulation on flanges, valves, fittings, etc., glass wool mattress shall be used. Where glass wool mattress are used, they shall be secured with steel wires, steel bands and clips.

**A-60 insulation shall be provided for engine room fore side bulkhead.**

#### 11.1.2 Application for equipment and tank

Main engine, main diesel generator engines, incinerator and aux. boiler shall be insulated according to Maker's standard.

Pumps, coolers, condenser and oil heaters shall not be insulated, however oil heaters shall be provided with metal cover for protection.

The external surface of under said tanks which are exposed to the engine room except rear wall and bottom of the tanks shall be insulated in accordance with the following table.

Tank	Insulation		Covering
	Material	Thickness in mm	
Heavy fuel oil settling tank Heavy fuel oil service tank L/S fuel oil settling tank L/S fuel oil service tank Waste oil tank	Glass wool or rock wool	25	Galvanized steel plate (abt. 0.2mm) or aluminized glass cloth

The tanks attached to machinery or equipment, insulation of which are required, shall be insulated in accordance with Maker's standard.

Other tanks shall not be insulated.



### 11.1.3 Application for piping

The materials and thickness of insulation for piping except for exhaust gas system, jacket cooling fresh water system and lub. oil system shall be in accordance with the following table.

Temperature range of internal fluid	Nominal pipe diameter in mm			Material
	Up to 20	25 to 150	200 & above	
	Thickness of insulation in mm			
Up to 100°C	6	20	20	Glass wool, glass mat or glass wool mattress
101°C to 183°C	6	20	20	
184°C and above	6	40	40	

The exposed parts of the following pipes which is a danger to the crew shall be insulated with glass cloth irrespective of pipe diameter and internal temperature.

- Boiler blow pipe
- Drain pipe after drain valves, drain traps and safety valves of aux. boiler.

The external surface of insulation material shall be covered with glass cloth or aluminum foil for protection.

The exhaust gas pipes after turbocharger of main engine, main generator diesel engines, incinerator and uptake of aux. boiler shall be insulated up to two (2) meters height from the funnel bottom in accordance with the following table and covered with galvanized steel plate.

Name	Material	Nominal pipe diameter in mm	Thickness of insulation in mm
Main engine Diesel gene. engine Aux. Boiler Incinerator	Rock wool	All sizes	50

In all cases where pipe insulation abut on flanges and fittings the end of insulation shall be suitably terminated to permit free removable of bolts and to allow for movement of pipes at hangers.



## 11.2 PAINTING

Machinery and piping in engine room shall be painted except following parts.

1. Working surface of machinery, brass surface, and other parts which are finished bright.
2. Surface of insulation which are not covered with steel plates.
3. Internal surface of machinery, piping and tanks except otherwise mentioned.

The colour of finished coat for external surface shall be in accordance with the following table.

Name of machinery or equipment	Colour
Diesel engine Main air compressor Cooler Fresh water generator Intermediate shaft bearing	Light blue green ( Munsel notation : 7.5BG7/2 )
Turbocharger	Silver
C/R packaged air conditioner	Light blue green ( Munsel notation : 7.5BG7/2 )
Aux. boiler Incinerator	Maker's standard
Tank Pipe ( Not insulated ) Air trunk Aux. condenser Main air reservoir	White ( Munsel notation : N-9.5 )

Other machinery and equipment shall be painted in accordance with Maker's standard.

The piping system shall be discriminated with colour bands.



## **SECTION 12 MISCELLANEOUS EQUIPMENT**

### **12.1 OIL PURIFYING DEVICE**

#### **12.1.1 Fuel oil purifier**

Two (2) fuel oil purifiers shall be disc bowl type.

One (1) of these purifiers shall be able to use as diesel oil purifier.

The materials of main parts shall be as follows:

Bowl disc	Stainless steel
Bowl body	Special stainless steel
Frame	Cast iron
Vertical shaft	Special alloy steel

The fittings and accessories shall be as follows:

- 1 — oil level gauge
- 1 — multi monitor
- 1 — set of disc
- 1 — oil feed pump

As to automatic system, refer to Subsection **13.5 INSTRUMENTATION AND CONTROL IN ENGINE CONTROL ROOM.**

#### **12.1.2 Lubricating oil purifier**

One (1) lubricating oil purifier and one (1) D/G lubricating oil purifier shall be disc bowl type.

The materials of main parts shall be as follows:

Bowl disc	Stainless steel
Bowl body	Special stainless steel
Frame	Cast iron
Vertical shaft	Special alloy steel



The fittings and accessories shall be as follows:

- 1 — oil level gauge
- 1 — multi monitor
- 1 — set of disc

~~△ 5 1 — oil feed pump (D/G lubricating oil purifier only)~~

As to automatic system, refer to Subsection **13.5 INSTRUMENTATION AND CONTROL IN ENGINE CONTROL ROOM.**

## **12.2 BILGE SEPARATOR**

One (1) bilge separator shall be provided in engine room.

The materials of main parts shall be as follows:

Casing	Steel plate
--------	-------------

The fittings and accessories shall be as follows:

- 1 — solenoid valve
- 1 — relief valve
- 2 — drain plug
- 2 — test cock
- 2 — sets of pressure gauge with cock
- 1 — set of bilge alarm device
- 1 — set of automatic 3-way valve



### **12.3 ENGINEER'S WORKSHOP AND STORE ROOM**

The engineer's workshop shall be provided at suitable location in engine room and shall be provided with the machine tools as listed in the Subsection **1.2 MACHINERY PARTICULAR**, a work table combined with vice and etc. as Builder's practice. Tool cabinet shall be provided two (2) sets in the workshop.

Metal shelves shall be provided in the store room to hold small spare parts and tools.

Oxygen & acetylene bottles shall be located on outside of engine room and it's shall be led to engineer's workshop by means of fixed piping.

### **12.4 LIFTING GEAR AND TOOL**

One (1) overhead traveling crane, having as electrically hoist shall be installed over the main engine for overhauling cylinder cover, cylinder liner and piston.

Hoisting and longitudinal travelling shall be electrically performed, and transverse travelling shall be performed by hands by means of link chain pulley and reduction gear.

Plane trolleys and I beams shall be provided for overhauling diesel generator engine and purifiers respectively.

Eye plate shall be suitably fitted for overhauling pumps, heat exchangers and strainers of heavy weight.

### **12.5 TANK IN ENGINE ROOM**

Tanks as listed in the Subsection **1.2 MACHINERY PARTICULAR** shall be provided in the engine room.

All tanks shall be made of welded steel plate.

Regarding the insulation and painting of tanks, refer to **SECTION 11 INSULATION AND PAINTING**.

All tanks shall be fitted with necessary connections and fittings as following table.





Name of tank	Fitting							
	Emerg. Shut- off valve	Self closing valve	Air vent	Level gauge	Heat. coil	Heat. coil ratio (m <sup>2</sup> /m <sup>3</sup> )	Boiling connec- tion	Remarks (Thermo- meter)
Heavy fuel oil settling tank	O	O	O	F	O	0.3	o*	O
Heavy fuel oil service tank	O	O	O	F	O	0.3	o*	O
L/S fuel oil settling tank	O	O	O	F	O	0.3	o*	O
L/S fuel oil service tank	O	O	O	F	O	0.3	o*	O
Diesel oil service tank	O	O	O	F	-	-	o*	
Sludge tank	-	O	O	S	O	0.1	o*	
Fuel oil drain tank	-	-	O	S	O	0.1	o*	
Fuel oil overflow tank	-	-	O	F	O	0.03	o*	
M/E lub. oil sump tank	-	-	O	F&S	-	-	-	
M/E lub. oil storage tank	-	-	O	F	-	-	-	
M/E lub. oil settling tank	O	O	O	F	O	0.2	o*	O
D/G lub. oil storage tank	-	-	O	F	-	-	-	
D/G lub. oil settling tank	O	O	O	F	O	0.2	o*	O
S/T lub. oil sump tank	-	-	O	F	-	-	-	
S/T lub. oil seal pot	-	-	O	F	-	-	-	
Cylinder oil storage tank	O	-	O	F	-	-	-	
Cylinder oil alarm chamber	-	-	O	-	-	-	-	
Stuffing box drain tank	-	-	O	S	-	-	-	
Scavenging box drain tank	-	-	O	S	O	0.1	o*	
Cool. F.W. expansion tank	-	-	-	G	-	-	-	Open
Deaeration tank	-	-	O	-	-	-	-	
Cascade tank (Inspect. tank)	-	-	-	SG	-	-	-	Open
Fresh water pressure tank	-	-	-	G	-	-	-	
Drinking water press. tank	-	-	-	G	-	-	-	



Name of tank	Fitting							
	Emerg Shut- off valve	Self closing valve	Air vent	Level gauge	Heat. Coil	Heat. coil ratio (m <sup>2</sup> /m <sup>3</sup> )	Boiling connec- tion	Remarks (Thermo- meter)
Waste oil tank	O	-	O	S&F	O	0.5	o*	O
Bilge primary tank	-	-	-	-	-	-	-	Open
Bilge tank	-	-	O	S	-	-	o*	
Bilge sludge tank	-	-	O	S	O	0.01	o*	
Clean drain tank	-	-	O	S	-	-	-	

Note : Abbreviation

F : Float gauge

SG : Sight glass

O : To be fitted

G : Glass gauge

S : Sounding pipe

G\* : Flat type glass gauge

o\* : Seat only



## **12.6 FLOOR, LADDER AND GRATING**

The engine room floor and operation platform shall be of 4.5 mm checkered pattern steel plate, supported on suitable angle.

Removable sections shall be provided as required for proper access for handling and inspection of the equipment located under floor and manholes.

Engine room gratings shall be provided at the place where are required for proper access to the equipment.

The gratings shall have steel bars of Maker's standard pattern and which shall be suitably spaced and properly fitted in flat steel bar counterframes.

Ladders shall be fitted as required for convenient access to various grating levels.

Main ladders shall have foot grating and the vertical ladders shall have steps of round section steel bars. The inclination of main ladders shall be about 55° where applicable. The width of main ladders shall be 600 mm and that of sub-ladders shall be 500 mm. Vertical ladders shall be used only for unimportant, access to provisionally.

Handrails shall be fitted at gratings, ladders and floors where are necessary for the safety and convenience of operating personnel. Handrails shall be of steel pipe carried in steel pipe stanchions and shall be fitted with portable sections where required or overhauling machinery. Double handrails shall be fitted only at the main engine top and middle grating and above upper deck level in engine room. M/E overhauling platform arrangement shall be provided as Maker's standard.

## **12.7 VENTILATION FOR ENGINE ROOM**

Mechanical supply ventilating system shall be provided for the engine room. The fresh air for each ventilating fan shall be taken from separate ventilating air inlets and shall be distributed to the engine room through ducts.

Total supply capacity of ventilating fans shall be determined based on the amount of air consumed by the main engine running at maximum output, taking the air consumption of diesel generator engine.

As to detail of ventilating fan, refer to Subsection **7.5 ENGINE ROOM VENTILATING FAN**.



## **12.8 FIRE FIGHTING SYSTEM IN ENGINE ROOM**

The ship shall be provided with fire fighting system in accordance with the rule requirement.

There shall be provided two (2) fire pumps ( Bilge & ballast pump and Fire & G.S. pump ), fire valve and hose the suitable place in engine room.

Portable foam fire extinguisher and removal foam fire extinguisher etc. shall be provided in accordance with the rule requirement.

Details of fire fighting system, refer to **PART II HULL PART**.

Fixed water-based local fire fighting system shall be provided in accordance with the rule requirement.

The emergency stop switch shall be provided outside of engine room. Details of the emergency stop switch, refer to **PART IV ELECTRIC PART**.

The emergency shut off valve device shall be provided outside engine room for fuel oil and lub. oil tanks which are described on Subsection **12.5 TANK IN ENGINE ROOM**.

## **12.9 INCINERATOR**

There shall be installed one (1) set of waste oil incinerator for dispose of sludge and waste oil.

The construction, materials and accessories shall be in accordance with Maker's standard.

## **12.10 NAME PLATE AND CAUTION PLATE**

Name plate for machinery shall be in English and in SI unit.

Caution plate for machinery shall be in English and Japanese.

In principle, name plate written in English shall be fitted to each valve which nominal diameter 15A and above.

Tanks in engine room shall be fitted with name plate.



## **SECTION 13 AUTOMATION AND REMOTE CONTROL**

### **13.1 GENERAL**

There shall be provided an engine control room in the engine room.

The operation, control and supervision of main engine and principal auxiliary machinery shall be performed from the engine control room. On the other hand, necessary instrumentation such as minimum number of gauges shall be provided for local manual control in engine room.

As to communication equipment etc., refer to **PART IV ELECTRIC PART**.

### **13.2 MAIN ENGINE REMOTE CONTROL SYSTEM**

The main engine remote control system shall be of the electrically-pneumatically control system. The reversing, starting and speed setting of the main engine shall be controlled by telegraph receiver and fuel handle on the control console in engine control room through a ECS and proper equipment fitted on the engine.

### **13.3 ENGINE CONTROL ROOM**

The independent engine control room well-illuminated, air conditioned and of sound-proof, shall be located suitable place in the engine room, and shall serve various purpose, such as centralized controls, supervision and data collecting, and improving the circumstance for crew and the reliability on instruments.

The engine control room shall have a sufficient space to install the following.  
Space and electric socket for refrigerator shall be provided.

- |                           |       |
|---------------------------|-------|
| • Control console         | 1 set |
| • Air conditioning unit   | 1 set |
| • White board             | 1     |
| • Chair                   | 2     |
| • Drawing locker          | 1 set |
| • Main switch board       | 1 set |
| • Group starter panel     | 1 set |
| • Meeting table and bench | 1 set |
| •                         |       |



Ventilation of the engine control room shall be of semi-forced ventilating system.

A branch duct from the engine room ventilating air supply duct shall be led to the engine control room. The exhaust air from the engine control room shall be released to engine room by means of natural ventilation.

The engine control room shall have two (2) sound-proof doors with a fixed glass window, and one (1) glass window.

### 13.4 ALARM SYSTEM

Alarm of machinery located in engine room shall be able to recognize by alarming and indicating lamps in the engine control room.

On the control console, some auxiliary machines shall be controlled and there shall be provided annunciators for pressure, temperature and level.

Pressure gauges shall be of electric type or direct Bourdon type.

The running indicator and alarm shall be carried out as follows.

Alarm Condition	Running indication	Press., temp., level and other alarm	
	Lamp	Lamp	Buzzer
Normal	Light (Green)	Go out	Silence
Abnormal	Go out	Flickering (Red)	Sound
Push the buzzer stop button	Go out	Flickering (Red)	Silence
Push the flicker stop button	Go out	Light (Red)	Silence
Return to normal	Light	Go out	Silence

An alarm buzzer shall be provided on the control console.

A buzzer stop push button and flicker stop push button shall be provided for all alarms, and shall be provided on the control console.

As for details of alarming and instruments which are contained in the engine control room, refer to Subsection **13.5 INSTRUMENTATION AND CONTROL IN ENGINE CONTROL ROOM.**



### 13.5 INSTRUMENTATION AND CONTROL IN ENGINE CONTROL ROOM

Automation and instrumentation of machinery located in engine room shall be in accordance with the following table.

Abbreviation:

① .....	Item to be provided
H .....	High alarm
L .....	Low alarm
△ .....	Monitor

Divi- sion		Item	Automation	LOCAL				CENTRAL CONTROL STATION								BRIDGE					Alarm group	Remarks	
				Handling	Indicator	Indicat. Lamp	Alarm	Handling	INDICAT.			LAMP		ALARM			Handling	Indicator	Indicat. Lamp	Alarm			Recording
									Independent	Monitor	Recording												
MAIN ENGINE Maneuvering system	Start & stop																					1) Due to follows • Over speed • L.O. press. Drop • T/C L.O. press. Drop  2) C/R safety panel  3) Due to • T/C L.O. press. Drop  4) Due to • Crank case high oil mist • ME ECS Slow down  5) Local & Steer. gear room	
	Reversing																						
	Speed control																						
	Emergency trip	1) ○									2) ③												
	Manual emerg. trip		5) ○		①	①	2) ○				2) ②			①									
	Emergency trip reset		○				○																
	Emergency trip cancel						3) ○				2) ①												
	Slow down request													4) ①									
	Increase limit		○		①		2) ○				2) ①												



Divi- sion		Item	Automation	LOCAL				CENTRAL CONTROL STATION								BRIDGE					Alarm group	Remarks																										
				Handling	Indicator	Indicat. Lamp	Alarm	Handling	INDICAT.			LAMP		ALARM			Recording	Handling	Indicator	Indicat. Lamp			Alarm	Recording																								
									Independent	Monitor	Recording																																					
MAIN ENGINE ③	Maneuvering system	Control position		1) ○		2) ②		1) ○				2) ②											1) Engine side — Remote																									
																						2) “E/S”, “C/R”																										
		Engine telegraph			3) ○				○	3) ○								○	3) ○	7) ○				3)																								
		Sub — telegraph			4) ○				○	4) ○								○		4) ○				<table><tr><td>A</td><td>NAV.FULL</td></tr><tr><td>H</td><td>FULL</td></tr><tr><td>E</td><td>HALF</td></tr><tr><td>A</td><td>SLOW</td></tr><tr><td>D</td><td>D. SLOW</td></tr><tr><td colspan="2">STOP</td></tr><tr><td>A</td><td>D. SLOW</td></tr><tr><td>S</td><td>SLOW</td></tr><tr><td>T</td><td>HALF</td></tr><tr><td>E</td><td>FULL</td></tr><tr><td>R</td><td>E. FULL</td></tr><tr><td>N</td><td></td></tr></table>	A	NAV.FULL	H	FULL	E	HALF	A	SLOW	D	D. SLOW	STOP		A	D. SLOW	S	SLOW	T	HALF	E	FULL	R	E. FULL	N	
		A	NAV.FULL																																													
		H	FULL																																													
		E	HALF																																													
		A	SLOW																																													
		D	D. SLOW																																													
		STOP																																														
		A	D. SLOW																																													
		S	SLOW																																													
		T	HALF																																													
		E	FULL																																													
		R	E. FULL																																													
		N																																														
		Stand — by sound stop							○																																							
Turning gear engage					①							①																																				
Turning gear disengage		○			①							①																																				
Starting air valve			○									6) ②																																				
Main engine revolution				①					①								③						4) “F/E”, “S/B”, “R/U”																									
Main engine revolution counter									①														5) C/R safety panel																									
Turbocharger revolution									①														6) “Service”, “Blocked”																									
Fuel index									①														7) Telegraph repeater																									
Wrong way														5) ①	①																																	
Critical speed														5) ①	①																																	

Divi- sion		Item	Automation	LOCAL				CENTRAL CONTROL STATION								BRIDGE					Alarm group	Remarks	
				Handling	Indicator	Indicat. Lamp	Alarm	Handling	INDICAT.			LAMP		ALARM			Handling	Indicator	Indicat. Lamp	Alarm			Recording
									Independent	Monitor	Recording												
MAIN ENGINE △ <sub>3</sub> Maneuvering system	AC/DC power source										②			2) ②								1) C/R safety panel 2) Source failure 3) Auto. start & stop by scavenging air press. 4)"Auto.position request"	
	Safety source										1) ①			2) ①									
	Safety system abnormal													①									
	C/R relay panel source													2) ①									
	EICU source													2) ①									
	ME ECS abnormal														①								
Auxiliary blower	3) ○	○				○					②		4) ① ②										

Divi- sion		Item	Automation	LOCAL				CENTRAL CONTROL STATION								BRIDGE					Alarm group	Remarks	
				Handling	Indicator	Indicat. Lamp	Alarm	Handling	INDICAT.			LAMP		ALARM			Handling	Indicator	Indicat. Lamp	Alarm			Recording
									Independent	Monitor	Recording												
MAIN ENGINE	Pressure	Fuel oil inlet			1) ①				①						L ①								1) To be fitted with strainer outlet
		Lub. oil inlet			①				①						L ①								
		Piston cooling oil inlet			①										L ①								
		Turbocharger lub. oil inlet			①				①						L ①								
		Jacket cooling F.W. inlet			①				①						L ①								
		Air cooler sea water inlet							①														
		Exhaust valve spring air													L ①								
		Scavenging air			①				①														
		Starting air main valve inlet			①				①						L ①								
		Maneuvering air			①				①						L ①								

Divi- sion		Item	Automation	LOCAL				CENTRAL CONTROL STATION								BRIDGE					Alarm group	Remarks	
				Handling	Indicator	Indicat. Lamp	Alarm	Handling	INDICAT.			LAMP		ALARM			Handling	Indicator	Indicat. Lamp	Alarm			Recording
									Independent	Monitor	Recording												
MAIN ENGINE	Pressure																					1) U tube type	
		HPS by-pass filter difference													H ①								
		HPS filter difference													H ①								
		Turbocharger air filter difference			1) ①																		
		Air cooler in/out difference			1) ①																		

Divi- sion		Item	Automation	LOCAL				CENTRAL CONTROL STATION								BRIDGE					Alarm group	Remarks	
				Handling	Indicator	Indicat. Lamp	Alarm	Handling	INDICAT.			LAMP		ALARM			Handling	Indicator	Indicat. Lamp	Alarm			Recording
									Independent	Monitor	Recording												
MAIN ENGINE	Temperature	Fuel oil inlet	1) ○		①					△					H △							1) By the pneumatic type temp. control valve	
		Lub. oil inlet	1) ○		①					△					H △								
		Piston cooling oil each cylinder outlet			⑥																		
		Turbocharger lub. oil outlet			①					△					H △								
		Jacket cooling F.W. inlet			①					△													
		Jacket cooling F.W. each cylinder outlet			⑥																		
		Jacket cooling F.W. common outlet	1) ○							△					H △								
		Thrust pad			①					△					H △								
		Air cooler air inlet			①																		
		Air cooler air outlet			①																		
		Scavenging air			①					△													
		Air cooler sea water inlet	1) ○		①																		
		Air cooler sea water outlet			①																		

Divi- sion		Item	Automation	LOCAL				CENTRAL CONTROL STATION								BRIDGE					Alarm group	Remarks	
				Handling	Indicator	Indicat. Lamp	Alarm	Handling	INDICAT.			LAMP		ALARM			Handling	Indicator	Indicat. Lamp	Alarm			Recording
									Independent	Monitor	Recording												
MAIN ENGINE	Temperature	Exhaust gas each cylinder outlet								△					H △								
		Exhaust gas turbocharger inlet								△													
		Exhaust gas turbocharger outlet								△													
	Tank level	Lub. oil sump tank			①										L ①								
		Jacket cool. F.W. expansion tank			①										L ①								
		Cylinder oil alarm chamber													L ①								
		Fuel oil leakage tank													H ①								
		Mist catcher drain													H ①								
		Scav. box drain tank													H ①								
		Stuff. box drain tank													H ①								

Divi- sion		Item	Automation	LOCAL				CENTRAL CONTROL STATION								BRIDGE					Alarm group	Remarks	
				Handling	Indicator	Indicat. Lamp	Alarm	Handling	INDICAT.			LAMP		ALARM			Handling	Indicator	Indicat. Lamp	Alarm			Recording
									Independent	Monitor	Recording												
MAIN ENGINE	Etc.																					1) Abnormal 2)"F.O."-"D.O."	
		Crank case oil mist						⑦							H ①								
		Crank case oil mist detector												1) ①									
		A-C oil change-over		○																			
		Used oil					○					2) ②											
		Fuel oil flow meter			①																		
		Cylinder oil flow meter			①																		
		Deaeration tank													1) ①								
		M/E hydraulic pump△1	○	○			○								1) ②								
		M/E PSU AC power failure													②								
		M/E PSU UPS controller abnormal													②								
		M/E PSU 24V DC battery mode													②								

Divi- sion		Item	Automation	LOCAL				CENTRAL CONTROL STATION								BRIDGE					Alarm group	Remarks		
				Handling	Indicator	Indicat. Lamp	Alarm	Handling	INDICAT.			LAMP		ALARM			Handling	Indicator	Indicat. Lamp	Alarm			Recording	
									Independent	Monitor	Recording													Recording
SHAFTING	Temperature	Intermediate shaft bearing			①					△					H △									
		Stern tube bearing lub. oil outlet			①																			
		Stern tube bearing								△					H △									
	Tank level																							
		Stern tube lub. oil sump tank			①										L ①									
		Stern tube seal pot			①																			
	Etc.	Stern tube lub. oil non-flow													①									




Divi- sion		Item	Automation	LOCAL				CENTRAL CONTROL STATION								BRIDGE					Alarm group	Remarks		
				Handling	Indicator	Indicat. Lamp	Alarm	Handling	INDICAT.			LAMP		ALARM			Handling	Indicator	Indicat. Lamp	Alarm			Recording	
									Independent	Monitor	Recording													Recording
ELECTRIC GENERATING PLANT	Diesel engine	Start	1) ○	○				○					2) ③			3) ③								1) Due to follows • Over current • High voltage • Low voltage • Low frequency • D/G emerg. trip  2) Running lamp  3) Due to start failure  4) Auto.-Manual  5) Due to follows • F.O. handle “Run” position  6) Due to follows • Over speed • L.O. press. drop  7) ”F.O.”-“D.O.”
		Stop		○				○																
		Change-over		○				4) ○																
		Ready for start										5) ③												
		Emergency trip	6) ○													⑥								
		Used oil						○					7) ⑥											
		A-C oil change-over		○																				
		Fuel oil flow meter			①																			
		Diesel oil flow meter			①																			
		Fuel oil leakage tank														H ③								
		Speed relay abnormal														③								

Divi- sion		Item	Automation	LOCAL				CENTRAL CONTROL STATION							BRIDGE					Alarm group	Remarks			
				Handling	Indicator	Indicat. Lamp	Alarm	Handling	INDICAT.		LAMP		ALARM			Handling	Indicator	Indicat. Lamp	Alarm			Recording		
									Independent	Monitor	Recording													Recording
ELECTRIC GENERATING PLANT		D/G pressure	Lub. oil inlet			③				△	△					L △							1) By the wax type temp. control valve  2) By the pneumatic type temp. control valve	
			High temp. cooling F.W. inlet			③						△					L △							
			Low temp. cooling F.W. inlet			③						△					L △							
			Turbocharger lub. oil inlet			③											L ③							
			Starting air inlet														L ③							
			Control air inlet														L ③							
			Fuel oil inlet			③																		
		D/G temperature	Lub. oil inlet	1) ○		③						△					H △							
			High temp. cooling F.W. outlet	1) ○		③						△					H △							
			Exhaust gas each cylinder outlet			⑱																		
			Exhaust gas turbocharger inlet			⑥						△												
			Fuel oil inlet	2) ○		③						△					H △							
			Low temp. cooling F.W. inlet	2) ○		①																		

Divi- sion		Item	Automation	LOCAL				CENTRAL CONTROL STATION								BRIDGE					Alarm group	Remarks	
				Handling	Indicator	Indicat. Lamp	Alarm	Handling	INDICAT.			LAMP		ALARM			Handling	Indicator	Indicat. Lamp	Alarm			Recording
									Independent	Monitor	Recording												
ELECTRIC GENERATING PLANT	Generator	Current						③							HL ③							1) “MSB & FORE” & “ESB”  2) “Stand-by” & ”Run”	
		Bus voltage						③							HL ②								
		Bus frequency						②							HL ②								
		Electric power						③															
		MSB control source failure													①								
		MSB control system failure													①								
		MSB circ. breaker trip source abnormal													①								
		ACB non-close													③								
		ACB abnormal trip													③								
		Preferential trip													①								
		AC440V insulation													①								
		AC100V insulation													1) ②								
		Emergency generator engine abnormal										2) ②			①								

Divi- sion		Item	Automation	LOCAL				CENTRAL CONTROL STATION								BRIDGE					Alarm group	Remarks	
				Handling	Indicator	Indicat. Lamp	Alarm	Handling	INDICAT.			LAMP		ALARM			Handling	Indicator	Indicat. Lamp	Alarm			Recording
									Independent	Monitor	Recording					Recording							
AUXILIARY BOILER		Running	○	○		①							①									1) Due to follows • Miss fire & flame failure • F.D. fan stop • Drum level lowest • F.O. temp. drop • F.O. press. drop • Source failure • Exhaust gas high temp.  2) Common alarm  3) Controlled by “ON-OFF” system  4) Auto. start & stop by detect. the drum water level  5) By the thermostat	
General	Emergency trip	1) ○	○											2) ①									
Running	F.O. burning pump			○																			
	Forced draft fan	3) ○	○																				
	Feed water pump	4) ○	○			②																	
Pressure	Drum steam	3) ○			①				△	△													
	Burner F.O. inlet				①																		
Temp.	F.O. heater outlet	5) ○			①										H ①								

Divi- sion		Item	Automation	LOCAL				CENTRAL CONTROL STATION								BRIDGE					Alarm group	Remarks		
				Handling	Indicator	Indicat. Lamp	Alarm	Handling	INDICAT.			LAMP		ALARM			Handling	Indicator	Indicat. Lamp	Alarm			Recording	
									Independent	Monitor	Recording													Recording
AUXILIARY BOILER		Level	Drum	○		○		HL ②		①						HL ②								1) By the float valve  2) By the pneumatic type press. control valve
			Cascade tank	○ 1)													L ①							
		Etc.	Excess steam dumping	○ 2)	○																			
			Soot blower		○																			
			Fuel oil flow meter			①																		
			Make up water flow meter			①																		

Divi- sion		Item	Automation	LOCAL				CENTRAL CONTROL STATION							BRIDGE					Alarm group	Remarks				
				Handling	Indicator	Indicat. Lamp	Alarm	Handling	INDICAT.			LAMP		ALARM		Recording	Handling	Indicator	Indicat. Lamp			Alarm	Recording		
									Independent	Monitor	Recording														
FUEL OIL SYSTEM		Running	Fuel oil purifier		○	②							②		1) ②								1) Due to abnormal		
			Fuel oil refiner	●	●	●									5) ①								2) By the direct type temp. control valve		
			By-pass filter for refiner			●										①							3) By the pneumatic type temp. control valve		
			F.O. tank Pre-heating unit	4) ○	○											①							4) Auto. start & stop by detecting fuel oil trans. pump running		
		Temperature	Heavy fuel oil settling tank	2) ○		①										H ①								5) Due to high diff. press (Refiner or by-pass filter)	
			Heavy fuel oil service tank			①																			
			L/S fuel oil settling tank	2) ○		①										H ①									
			L/S fuel oil service tank			①																			
			F.O. tank 						⑥				○		## ⑥										
			Purifier fuel oil inlet	3) ○		②										H ②									
			Shifter fuel oil heater outlet	3) ○		①										H ①									
			Waste oil tank			②																			

Divi- sion		Item	Automation	LOCAL				CENTRAL CONTROL STATION								BRIDGE					Alarm group	Remarks	
				Handling	Indicator	Indicat. Lamp	Alarm	Handling	INDICAT.			LAMP		ALARM			Handling	Indicator	Indicat. Lamp	Alarm			Recording
									Independent	Monitor	Recording												
FUEL OIL SYSTEM	Tank level	Heavy fuel oil settling tank	1) ○		①										HL ②								1) By auto. start & stop of F.O. transfer pump  2) Over flow system  3) By auto. start & stop of D.O. transfer pump
		Heavy fuel oil service tank	2) ○		①										L ①								
		L/S fuel oil settling tank	1) ○		①										HL ②								
		L/S fuel oil service tank	2) ○		①										L ①								
		Diesel oil service tank	3) ○		②										HL ④								
		Waste oil tank			②																		
		Fuel oil drain tank													H ①								
		Fuel oil overflow tank			①										H ①								

Divi- sion		Item	Automation	LOCAL				CENTRAL CONTROL STATION								BRIDGE					Alarm group	Remarks					
				Handling	Indicator	Indicat. Lamp	Alarm	Handling	INDICAT.			LAMP		ALARM			Recording	Handling	Indicator	Indicat. Lamp			Alarm	Recording			
									Independent	Monitor	Recording																
LUB. OIL SYSTEM		Pressure	Lub. oil purifier		○		①							①		1) ①									1) Due to abnormal  2) By the pneumatic type temp. control valve		
			D/G Lub. oil purifier		○		①							①		1) ①											
		Temperature																									
			Purifier lub. oil inlet	2) ○			①																				
			D/G purifier lub. oil inlet	2) ○			①																				
		Level																									




Divi- sion		Item	Automation	LOCAL				CENTRAL CONTROL STATION								BRIDGE					Alarm group	Remarks			
				Handling	Indicator	Indicat. Lamp	Alarm	Handling	INDICAT.		LAMP		ALARM		Recording	Handling	Indicator	Indicat. Lamp	Alarm	Recording					
									Independent	Monitor	Recording														
COMPRESSED AIR SYSTEM	Running	Main air compressor	1) ○	○				2) ○					②			3) ② 5) ④								1) Auto. start & stop  2) Auto.- Manual and start - stop  3) Abnormal stop • Compress. air outlet high temp.  4) Common alarm  5) C.F.W. pump running request	
		Emergency air compressor		○																					
	Pressure	Main air reservoir				②			②							L ②									
		Emergency shut off valve operating air				①										L ①									
	Temp.	Main air compressor cooling F.W. inlet				②																			
		Main air compressor cooling F.W. outlet				②																			
	BILGE SYSTEM	Level	Bilge well												4) H ①										
Bilge tank																H ①									
Bilge sludge tank																	H ①								
Sludge tank																	H ①								
Clean drain tank																	H ①								

Divi- sion		Item	Automation	LOCAL				CENTRAL CONTROL STATION							BRIDGE					Alarm group	Remarks		
				Handling	Indicator	Indicat. Lamp	Alarm	Handling	INDICAT.			LAMP		ALARM		Recording	Handling	Indicator	Indicat. Lamp			Alarm	Recording
									Independent	Monitor	Recording												
AUXILIARY MACHINE		Running	Fresh water generator	1) ○	○	①								2) ①								1) Dump to evaporator by high salinity  2) Due to high salinity  3) Due to high oil content and separator abnormal  4) Due to abnormal  5) Due to follows • Non-voltage • Over load • Hyd. oil tank low level • Phase failure  6) By the pneumatic type temp. control valve  7) Auto. shut by thermostat  8) Auto.3 way valve  9) In accordance with 15.3.1-4 Part D	
			Bilge separator	8) ○	○	①									3) ②								
			Sewage treatment unit												4) ①								
			Ballast water treatment system												4) ①								
			Waste oil incinerator		○	①	4) ①						①	4) ①									
		Temp.	Hot water heater steam valve	7) ○																			
			Hot water heater outlet	6) ○		①																	
			Sea water (Ref. mach. C.S.W. pump outlet)							⚠													
		Etc.																					
			Steering gear		○								⚙	②	5) ⑧		○		②	9) ○			
			Air conditioner ref. machine	○	○									①									
			Provision ref. machine	○	○									②									
			Local fire fighting system												4) ①								
		Local fire fighting system start	○										①										

Divi- sion		Item	Automation	LOCAL				CENTRAL CONTROL STATION								BRIDGE					Alarm group	Remarks		
				Handling	Indicator	Indicat. Lamp	Alarm	Handling	INDICAT.			LAMP		ALARM			Recording	Handling	Indicator	Indicat. Lamp			Alarm	Recording
									Independent	Monitor	Recording													
GENERAL		Lamp & buzzer test switch						○															1) Source failure	
		Buzzer stop button						○																
		Flicker stop button						○																
		Automatic exchange telephone		○				○									○							
		Common battery telephone						○									○							
		Patrol man call						○																
		Engineer's call						○																
		Clock							①									①						
		Rudder angle							①									③						
		Console electric source (AC & DC)						○					②		1) ②									

Divi- sion		Item	Automation	LOCAL				CENTRAL CONTROL STATION								BRIDGE					Alarm group	Remarks	
				Handling	Indicator	Indicat. Lamp	Alarm	Handling	INDICAT.			LAMP		ALARM			Handling	Indicator	Indicat. Lamp	Alarm			Recording
									Independent	Monitor	Recording												
PUMP AND FAN		Main lub. oil pump		○				○					②										1) Auto. start by black-out
																						2) Auto. start and stop by detect. D/G running	
		Fuel oil booster pump		○				○					②										3) Auto. start and stop by detect. main air comp. running
		M/E fuel oil circulating pump		○				○					②										4) Auto. stop by D/G L. O. purifier abnormal
		Jacket cool. F.W. pump		○				○					②										△ <sub>5</sub>
		Cooling S.W. pump		○				○					②										
		Stern tube lub. oil pump		○				○					②										
		D/G fuel oil circulating pump		○				○					②										
		D/G diesel oil booster pump	1) ○	○				○					①										
		Main air comp. cooling F.W. pump	3) ○	○				○					②										
		D/G L. O. purifier supply pump △ <sub>5</sub>	4) ○	○																			
		D/G lub. oil priming pump	2) ○	○																			
		Engine room ventilating fan						○					③										

Divi- sion		Item	Automation	LOCAL				CENTRAL CONTROL STATION								BRIDGE					Alarm group	Remarks	
				Handling	Indicator	Indicat. Lamp	Alarm	Handling	INDICAT.			LAMP		ALARM			Handling	Indicator	Indicat. Lamp	Alarm			Recording
									Independent	Monitor	Recording												
PUMP AND FAN	Fuel oil transfer pump	1) ○	○				5) ○					①										1) Auto. start and stop by detecting the H.F.O. settling tank level  2) Auto. start and stop by detecting the D.O. service tank level  3) Auto. stop by bilge separator abnormal  4) Auto. start and stop by detecting the press. tank pressure  5) “H.F.O.”-“L/S F.O.”  6) “No.1”-“No.2”  7) Due to long running  8) Auto. stop by L.O. purifier abnormal	
	Diesel oil transfer pump	2) ○	○				6) ○					①											
	Lub.oil. transfer and lub. oil. purifier supply pump	8) ○	○				○					①											
	Bilge pump	3) ○	○				○					①			7) ①								
	Sludge pump		○				○					①											
	Fire & G.S. pump 		○				○					①				○							
	Bilge & ballast pump		○				○					①											
	Ballast pump		○				○					②											
	Ref. mach. C.S.W. pump		○				○					①											
	Fresh water pump	4) ○	○				○					①											
	Drinking water pump	4) ○	○				○					①											
	Hot water circulating pump		○																				



## SECTION 14 SPARE PARTS

### **14.1 GENERAL**

Spare parts shall be provided according to the requirement of the Classification rule and Maker's standard.

Smaller spare parts shall be stowed in suitable boxes with contents, on suitable position where convenient to the crew in engine room, but larger one shall be mounted and the stored directly on the wall of the ship.

Spare parts shall include the following at least.

Quantities shall be for one (1) ship.

Additional spare required by the Owner, if any, shall be supplied at extra cost.

### **14.2 MAIN ENGINE**

#### **(1) Cylinder cover and their fittings**

Cylinder cover complete with studs, nuts, disk spring for valves ( excluding valves )	1 cyl.
Studs and nuts for cylinder cover tightening	1/2 cyl.
Fuel valve complete	1 engine+1 cyl.
O—ring for fuel valve	1 cyl.
Exhaust valve complete	3 cyl.
Piston rings for exhaust valve ( driving side )	1 cyl.
Starting air valve complete	2 cyl.
Bursting disk for starting air valve	1 cyl.
Cylinder safety valve complete	2 cyl.
Indicator valve complete	1 cyl.

#### **(2) Main bearing**

Main bearing shell	1 journal
Studs and nuts for one main bearing	1 set

#### **(3) Cylinder liner**

Cylinder liner	1 cyl.
O—ring for cylinder liner	1 cyl.
Non—return valves for lubrication	1/2 cyl.

(4) Thrust bearing

Thrust bearing segments for ahead	1 set
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(5) Piston

Piston complete with piston rings, cooling pipe and piston rod	1 cyl.
Piston rings	1 cyl.
Piston rod stuffing box complete with sealing rings and scraping rings	1 cyl.
Telescopic pipe for piston cooling oil	1 cyl.
O—ring for stuffing box	1 cyl.

(6) Connecting rod

Crank pin bearing shell	1 cyl.
Studs and nuts for crankpin bearing	1 cyl.
Crosshead bearing shell lower part	1 cyl.
Studs and nuts for crosshead bearing	1 cyl.

(7) Fuel pump

Fuel pump barrel assembly with plunger	1 cyl.
Suction valve complete	1 cyl.
High pressure pipe, each type	1 cyl.

(8) Camshaft chain

Camshaft chain	6 links
Bearing shells with guide ring for camshaft at chain wheel	1 each

(9) Cylinder lubricator

Maker's standard spare	1 set
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(10) Hydraulic cylinder unit (HCU)

Maker's standard spare	1 set
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(11) Hydraulic system – Hydraulic power supply (HPS)

Maker's standard spare	1 set
(Accumulator diaphragm(s) of each size	2 sets)

(12) Engine control system (ECS)

Maker's standard spare 1 set

(13) Exhaust gas turbocharger

Maker's standard spare 1 set

(14) Auxiliary blower

Maker's standard spare parts 1 set

(15) Turning gear

Maker's standard spare parts 1 set

(16) Air cooler

Zinc plate 1 engine

Maker's standard spare ( except the above ) 1 set

(17) Miscellaneous

Special packing of each size for one engine not specified elsewhere 1cyl. or 1set





### 14.3 SHAFTING AND PROPELLER

Stern tube seal device

Maker's standard

### 14.4 STEAM GENERATING PLANT

(1) Aux. boiler

Safety valve spring	1
Case for water level gauge	1
Gauge glass and packing for water level gauge	2
Packing for drum manhole	1
Nozzle tip	1 set
Spare parts of fuel oil burning unit without above said	Maker's standard

Other necessary spare parts shall be in accordance with Maker's standard.



#### 14.5 DIESEL GENERATOR ENGINE ( for one ship )

Piston ring	1 cyl.
Oil ring	1 cyl.
Crank pin metal	1 cyl.
Piston pin	1 cyl.
Piston pin metal assembly	1 cyl.
Bolts for connecting rod	1 cyl.
Suction valve ( complete )	1 cyl.
Exhaust valve ( complete )	2 cyl.
High pressure pipe for fuel oil ( complete )	1 cyl.
Fuel injection pump ( complete )	1 cyl.
Fuel injection valve ( complete )	3 cyl.
Main bearing metal for each kind	1 brg.
Bolt assembly for main bearing	1 brg
Relief valve and spring for lub. oil	1 set
Special packing for each kind	1/4 eng.
O ring of each kind	1/4 eng.
Main bearing for turbocharger	1 eng.
Packing for rotor shaft of turbocharger	1 eng.

Other necessary spare parts shall be in accordance with Maker's standard.



## 14.6 PUMP

(1) Centrifugal pump ( for each size of pump )

For Cooling S.W. pump (2 sets) and Jacket cooling F.W. pump (2 sets)

Impeller shaft	1 set
Ball bearing ( if fitted )	1 set
Casing ring	1 set
Gland packing or mechanical seal	1 set
Coupling bolt and nut ( if fitted )	1 set

For Fire & G.S. pump and Bilge & ballast pump

Ball bearing ( if fitted )	1 set
Casing ring	1 set
Gland packing	1 set
Coupling bolt and nut ( if fitted )	1 set

For Fresh water pump & Drinking water pump (2 sets), Ref. machine C.S.W. pump (1 set), Boiler feed water pump (2 sets), Ballast pump (2 sets), Hot water circ. pump (1 set) and Main air comp. cooling F.W. pump (2 sets)

Ball bearing ( if fitted )	1 set
Casing ring	1 set
Gland packing or mechanical seal	1 set
Coupling bolt and nut ( if fitted )	1 set

For main L.O. pump (2 sets)

Ball bearing ( if fitted )	1 set
Casing ring	1 set
Oil seal	1 set
Coupling bolt and nut	1 set



(2) Gear pump ( for each size of pump )

For F.O. trans. pump (1 set), D.O. trans. pump (1 sets), L.O. trans. and L.O. puri. supply pump (1 set), F.O. boost. pump (2 sets), M/E F.O. circ. pump (2 sets), S/T L.O. pump (2 sets), D/G F.O. circ. pump (2 sets) and D/G D.O. boost. pump (1 set)



**and D/G L.O. puri. supply pump (1 set)**

Bearing metal	1 set
Gland packing or mechanical seal	1 set
Safety valve spring	1
Coupling bolt and nut or coupling bush	1 set

(3) Reciprocating pump

For Bilge pump (1 set)

Piston ring	2
Valve and valve seat	4 sets
Gland packing	1 set
Safety valve spring	1
V belt	2

(4) Monros pump

For Sludge pump (1 set)

Ball bearing	1
Safety valve spring	1
Gland packing	1 set
O ring	1
V belt	2



#### 14.7 MAIN AIR COMPRESSOR

1st stage valve complete	1 set
2nd stage valve complete	1 set
Piston ring	1 set
Connecting rod bearing	1 set
Piston pin bush	1 set
Special packing	each 1
Other Maker's standard spare	1 set

#### 14.8 HEAT EXCHANGER

(1) Cooler and condenser (shell & tube type)

Protecting anode	Total number
Packing	1 set

(2) Oil heater

Relief valve spring	each 1
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#### 14.9 OTHER MACHINERY

Spare parts for machinery except above shall be in accordance with Maker's standard.



## SECTION 15 TOOLS AND OUTFITS

### **15.1 GENERAL**

Tools and outfits shall be provided as necessary for proper maintenance and overhauling of equipment according to Maker's standard.

Smaller tools shall be stowed in suitable boxes with contents on suitable position where convenient to the crew in engine room, but larger ones shall be mounted and stored directly on the wall of the ship.

Tools and outfits shall include the following at least.

Quantities shall be for one (1) ship.

### **15.2 MAIN ENGINE**

Hydraulic tightening tools with pump	1 set
for cylinder cover stud	
for exhaust valve stud	
for stay bolt	
for main bearing stud	
for crosshead bearing stud	
for crankpin bearing stud	
Grinding machine for exhaust valve spindle and seat	1 set
Fuel valve injection testing device	1 set
Indicator	1 set
Deflection gauge	1 set
Gauge for measuring and adjusting for the engine	1 set
Maker's standard tool for the accessories such as turbocharger,	
air cooler, governor and aux. blower	1 set
Air driven pump for M/E air cooler cleaning	1 set
Other necessary tools for overhaul and reassembling of the engine	1 set



### 15.3 SHAFTING AND PROPELLER

Spanner for shaft coupling bolt each 1

### 15.4 AUXILIARY BOILER

Tube stopper	12
Standard pressure gauge	1
Water tester	1 set

Other necessary special tools shall be in accordance with Maker's standard.

### 15.5 DIESEL GENERATOR ENGINE

Special tool for overhauling and reassembling	1 set
Lapping tool for suction and exhaust valves	1 set
Fuel valve testing device	1 set
Cylinder bore gauge	1 set
Deflection gauge	1 set
Indicator	1 set

Other necessary special tools shall be in accordance with Maker's standard.

### 15.6 HEAT EXCHANGER

For shell & tube type heat exchanger:

Tube expander	each kind 1
Tube cleaning tool	1 set
Brass plug	10

### 15.7 OTHER MACHINERY

Other necessary special tools for dismantling and assembling shall be in accordance with Maker's standard.



## 15.8 GENERAL TOOLS AND OUTFITS

<u>Item</u>	<u>No. of set</u>	<u>Remarks</u>
Thermometer ( alcohol )	2	100°C
Thermometer ( mercury )	1	500°C
Parallel bench vice	1	150 mm
Hand lantern	3	
Shackle	Each 2 ( total 8 )	1, 2, 3, 5 T
Eye bolt	Each 2 (total 8)	M10, M12, M16, M20
Hexagon head bolt & nut	Each 10 ( total 40 )	M10, M12, M16, M20
Plain washer	Each 10 ( total 40 )	M10, M12, M16, M20
Split pin	Each 10 ( total 30 )	2 × 12 mm, 3.2 × 18 mm, 4 × 25 mm
Tap & dies	Each 1      Tap	M6, M8, M10, M12, M16, M20, M24
	Each 1      Dies	M6, M8, M10, M12, M16, M20, M24
Steel tape measure	1	30 m
Scaffolding plate ( wood )	2	4000 mm × 300 mm × 50 mm
Steel plate	Each 2 ( total 4 )	1.6 mm × 914 mm × 1829 mm 3.2 mm × 914 mm × 1829 mm
Steel bar	Each 2 ( total 8 )	φ 9 mm, φ 13 mm, φ 16 mm, φ 19 mm Length : 2000 mm
Surface plate	1	500 mm × 500 mm
Copper plate or brass plate	1	0.3 mm × 365 mm × 1200 mm
Listening rod	2	
Valve handle spanner	8	
White board and eraser	4	450 mm × 600 mm
Hand hammer	Each 1 ( total 2 )	0.91 kg, 0.45 kg
Steel wire	1	φ 1 mm ( 1 kg )

The following machine tools are listed in the Subsection **1.2 MACHINERY PARTICULAR.**

Lathe	1	Center distance 600 mm
Drilling machine	1	φ 21 mm
Grinding machine	1	φ 255 × 25t
Electric welder	2	300Amp
Chain block	1 / 2 / 3	3 ton / 1 ton / 0.5ton
Gas cutting machine	1	Oxygen B. × 2, Acetylene B. × 1 Flame arrestor for Acetylene B. × 1 Flame arrestor for Oxygen B. × 1 Hose : Each 25m × 3