



III MACHINERY PART



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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 | | NK, NS* and MNS*(M0) | | | | | | |
| Kind of Ship | | BULK CARRIER | | | | | | |
| Hull | | | | | | | | |
| Dimension | m | Lpp | B | D | d (Ext.) | | | |
| Tonnage | Ton | abt. G.T. | | abt. D.W. | | | | |
| Speed | knot | Sea Trial | | abt. Service | | | | |
| Main Engine | | | | | | | | |
| Type & No. of Set | | MITSUI-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 ⁻¹ | 7,560 × 99.0 | | | Turbocharger TCA55 × 1 set | | |
| | Normal Rating | kW × min ⁻¹ | 6,425 × 93.8 (85 %) | | | | | |
| Brake Mean Effective Press. at Max. Rating | | MPa | * | | | | | |
| Mean Piston Speed at Max. Rating | | m/s | 7.31 | | | | | |
| Cylinder No. & Size | | mm | 6 × φ 500 × 2,214 | | | | | |
| Turning Motor | | kW × min ⁻¹ | 2.2 × 1,200 | | | | | |
| | | | | | | | | |
| Shafting | | | | | | | | |
| Thrust Shaft | | No. × mm | Attached to Main Engine | | | | | |
| Intermediate Shaft | | No. × mm | 1 × φ * × * | | | | | |
| Propeller Shaft | | No. × mm | 1 × φ * × * | | | | | |
| | | | | | | | | |
| Propeller | | | | | | | | |
| Type & No. of Set | | * Bladed Solid Type (Ni- Al- Br) × 1 set | | | | | | |
| Diameter × Pitch | | mm | φ * × * | | | | | |
| Exp. Area Ratio × Boss Ratio | | — | * × * | | | | | |
| Skew Angle | | deg. | * | | | | | |
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| Auxiliary Boiler | | | | | |
|------------------------------|--|----------------|---|---------------------------------------|--|
| Type & No. of Set | | | Composite system vertical type boiler × 1 set | | |
| Steam Pressure & Temperature | | — × °C | (Design) 0.8 MPa × (Work.) 0.55 MPa × | Saturated Saturated | |
| Heating Surface | | m ² | (Oil burning side) * × | (Exh. gas side) * | |
| Evaporation | | kg/h | (Oil burning side) 1,100 × | (Exh. gas side) 680 (M/E 85 % Load) | |
| Feed Water Temp. | | °C | abt. 60 | | |
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| Service | No.of Set | Type | Capacity (m ³ /h × MPa) | Motor (kW × min ⁻¹) | |
|--|-----------|-----------------|---------------------------------------|------------------------------------|---------------------|
| Cooling Sea Water Pump | 2 | MD. V. Cent. | (T.H.) 580 × 20 m | 55 × 1800 | Self Priming (No.1) |
| | | | | | |
| Jacket Cooling Fresh Water Pump | 2 | MD. V. Cent. | (T.H.) 102 × 40 m | 22 × 1800 | |
| Main Air Comp. Cooling F.W. Pump | 2 | MD. H. Cent | (T.H.) 3.2 × 25m | 1.5 × 3600 | |
| Main Lubricating Oil Pump | 2 | MD.V. Cent. | (D.P.) 220 × 0.42 | 60 × 1800 | |
| | | | | | |
| Fuel Oil Booster Pump | 2 | MD. H. Gear | (D.P.) 2.9 × 0.4 | 1.5 × 1200 | |
| Main Engine Fuel Oil Circulating Pump | 2 | MD. H. Gear | (D.P.) 4.2 × 1.0 | 3.7 × 1200 | |
| Fuel Oil Transfer Pump | 1 | MD. H. Gear | (D.P.) 15 × 0.3 | 5.5 × 1200 | |
| Diesel Oil Transfer Pump | 1 | MD. H. Gear | (D.P.) 4 × 0.3 | 2.2 × 1200 | |
| Lubricating Oil Transfer and L.O. Purifier Supply Pump | 1 | MD. H. Gear | (D.P.) 4 × 0.3 | 1.5 × 1200 | |
| | | | | | |
| Diesel Gene. Fuel Oil Circulating Pump | 2 | MD. H. Gear | (D.P.) 1.6 × 0.9 | 1.5 × 1200 | |
| Diesel Gene. Diesel Oil Booster Pump | 1 | MD. H. Gear | (D.P.) 1.5 × 0.75 | 3.7 × 1200 | |
| Stern Tube Lubricating Oil Pump | 2 | MD. H. Gear | (D.P.) 0.5 × 0.2 | 0.4 × 1200 | |
| Diesel Gene. Lub. Oil Priming Pump | 3 | MD. H. Gear | (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 | |
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| Bilge & Ballast Pump | 1 | MD. V. Cent. | (T.H.) 220/90 × 20/70 m | 50 × 3600 | Self Priming |
| Fire & G.S. Pump | 1 | MD. V. Cent. | (T.H.) 220/90 × 20/70 m | 50 × 3600 | Self Priming |
| Ballast Pump | 2 | MD. V. Cent. | (T.H.) 900 × 26 m | 90 × 1800 | |
| Bilge Pump | 1 | MD. H. Recipro. | (T.H.) 2 × 30 m | 0.75 × 1200 | |
| Sludge Pump | 1 | MD. H. Monros | (T.H.) 2.5 × 41 m | 1.5 × 1200 | |
| | | | | | |
| Ref. Mach. Cooling Sea Water Pump | 1 | MD. H. Cent. | (T.H.) 40 × 35 m | 7.5 × 3600 | |

| Service | No.of Set | Type | Capacity (m ³ /h × MPa) | Motor (kW × min ⁻¹) | |
|---------------------------------------|-----------|-------------------------------|---------------------------------------|------------------------------------|-------------------------|
| Drinking Water Pump | 1 | MD. V. Cent. | (T.H.) 5 × 50 m | 3.7 × 3600 | |
| Fresh Water Pump | 1 | MD. V. Cent. | (T.H.) 5 × 50 m | 3.7 × 3600 | |
| Hot Water Circulating Pump | 1 | MD. H. Cent. | (T.H.) 2 × 10 m | 0.4 × 3600 | |
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| Boiler Fuel Oil Booster Pump | 1 | MD. H. Gear | (D.P.) 0.5 × 0.20 | 0.4 × 1200 | |
| Boiler HFO/MGO 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 ³ /min × 2.94 kPa | 2.2 × 3600 | ※ |
| Boiler Feed Water Pump | 2 | MD. H. Cent. | (T.H.) 4 × 100 m | 7.5 × 3600 | |
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| Fuel Oil Purifier | 2 | MD. V. Centrifuge | 2,100 ℓ/h (380 cSt at 50°C) | 5.5 × 1800 | SJ25H |
| Lubricating Oil Purifier | 1 | MD. V. Centrifuge | 2,400 ℓ/h | 5.5 × 1800 | SJ25H |
| D/G Lubricating Oil Purifier | 1 | MD. V. Centrifuge | 1,300 ℓ/h | 3.7 × 1800 | SJ15H |
| D/G Lubricating oil by-pass filter | 3 | | * | | ※ |
| | | | | | |
| Engine Room Ventilating Fan | 2 | MD. V. Axial | 650 m ³ /min × 0.29 kPa | 7.5 × 1200 | Reversible |
| Engine Room Ventilating Fan | 1 | MD. V. Axial | 650 m ³ /min × 0.29 kPa | 7.5 × 1200 | |
| | | | | | |
| Auxiliary Blower \triangle | 2 | MD. Turbo | | 45 × 3600 | Attach to M/E |
| Motor for M/E hydraulic system | 2 | MD. | | 51 × 1800 | Attach to M/E |
| | | | | | |
| Bilge Separator | 1 | with Content meter | 2 m ³ /h | | |
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| Shaft Grounding Equipment | 1 | | | | with mV-Meter |
| Ballast Water Treatment System | 1 | Filter& Chemical Injection | | | Owner supply KURARAY |

| Service | No. of Set | Type | Capacity (m ³ /h × MPa) | Motor (kW × min ⁻¹) | |
|---|-------------|-----------------------|--|---|-----------------------------|
| Overhead Travelling Crane  | 1 | MD. | 3 ton $\frac{2.2 \times 900}{0.2 \times 1800}$ | 5.0 × 1800 0.4 × 1800 — | Traverse to be hand operate |
| Lathe | 1 | MD. | Center distance 600 mm | 2.2 × 1800 | |
| Drilling Machine | 1 | MD. | φ 21 | 0.4 × 1800 | |
| Grinding Machine | 1 | MD. 2 — Wheels | φ 255 × 25t | 0.75 × 1800 | AC440V 3 φ 60Hz |
| 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 | Packaged Type (R404a) | 11.3 kW | 2.2 × 3600 | with E. heater |
| | | | | | |
| Water-based Local Fire Fighting System | 1 | Low Press. Type | | | |
| Sewage Treatment Unit | 1 | | | | |
| Ballast Eductor | 1 | | 100 m ³ /h | | |
| Bilge Eductor | 1 | | 50 m ³ /h | | |
| F.O. Tank Pre-heating Unit | 1 | | | | |
| F.O. Shifter Pump | 1 | MD. H. Gear | (D.P.) 7.2 × 0.49 | 3.7 × 1800 | ※ 100%Capa. |
| | | | | | |
| Fresh Water Generator | 1 | | 25 T/D | | WM-25DK |
| Distillate Pump | 1 | MD. H. Cent. | (T.H.) 1.05 × 30 m | 0.75 × 3600 | ※ |
| Ejector Pump | 1 | MD. H. Cent. | (T.H.) 26 × 48 m | 7.5 × 3600 | ※ |
| | | | | | |
| Waste Oil Incinerator | 1 | | 349 kW | | BGW-30N-A |
| Waste Oil Pump | 1 | MD.H.Trochoid | 160 ℓ/h × 0.2 MPa | 0.1kW | ※ |
| Exhaust & Cooling Fan | 1 | MD. | 95 m ³ /min × 2.65 kPa | 7.5 × 3600 | ※ |
| Burning Fan | 1 | MD. | 11.4 m ³ /min × 1.18 kPa | 1.5 × 3600 | ※ |

| Service | No.of Set | Type | Capacity (m ²) | Motor (kW × min ⁻¹) | |
|-----------------------------------|-----------|------------------|---------------------------------|---------------------------------|----------------------------|
| Jacket Cooling Fresh Water Cooler | 1 | Plate | * | | |
| Main Lubricating Oil Cooler | 1 | Plate | * | | |
| Diesel Gene. Cooling F.W. Cooler | 2 | Plate | * | | |
| | | | | | |
| | | | | | |
| F.O. 2nd Filter | 1 | Auto back wash | E.F.10μ | | JET FILTER |
| M/E F.O. 3rd Filter | 1 | Manual back wash | E.F.20μ 4.2m ³ /h | | CONHIRA |
| D/G F.O. 3rd Filter | 1 | Manual back wash | E.F.20μ 1.6m ³ /h | | CONHIRA |
| | | | | | |
| Auxiliary Condenser | 1 | H. Shell & Tube | 12 | | |
| | | | | | |
| Shifter Fuel Oil Heater | 1 | Steam Heat | | | STM 0.55MPa 55 → 85°C |
| Purifier Lub. Oil Heater | 1 | Steam Heat | | | STM 0.55MPa 45 → 90°C |
| D/G Purifier Lub. Oil Heater | 1 | Steam Heat | | | STM 0.55MPa 45 → 90°C |
| Purifier Fuel Oil Heater | 2 | Steam Heat | | | STM 0.55MPa 55 → 98°C |
| Main Engine Fuel Oil Heater | 1 | Steam Heat | | | STM 0.55MPa 105 → 140°C |
| Boiler Fuel Oil Heater | 1 | Electric Heat | | 6 kW | ※ |
| Diesel Gene. Fuel Oil Heater | 1 | Steam Heat | | | STM 0.55MPa 105 → 140°C |
| Calorifier Unit | 1 | Steam Heat | | | STM 0.3MPa 10 → 70°C |
| Main Engine Warm-up Heater | 1 | Steam Heat | 2 | | STM 0.55MPa |
| | | | | | |
| | | | | | |
| | | | | | |
| Main Air Reservoir | 2 | Cylindrical | 5.0 m ³ × 2.9 MPa | | |
| Emergency Air Reservoir | 1 | Cylindrical | 150 ℓ × 2.9 MPa | | ※ |
| Control Air Dryer | 1 | Membrane | 50 Nm ³ /h | | |
| | | | | | |

| Service | No.of Set | Type | Capacity (m ³) | Heat. Ratio (m ² /m ³) | |
|-------------------------------------|-----------|------|----------------------------|---|------------------|
| Heavy Fuel Oil Settling Tank | 1 | | 16 | 0.3 | Integrated |
| Heavy Fuel Oil Service Tank | 1 | | 16 | 0.3 | Integrated |
| | | | | | |
| Low Sulphur Fuel Oil Service Tank | 1 | | 8 | 0.3 | Integrated |
| Diesel Oil Service Tank | 2 | | 8 | | Integrated |
| | | | | | |
| Sludge Tank | 1 | | 1.5 | 0.1 | |
| Fuel Oil Filter Drain Tank | 1 | | 1.5 | 0.2 | |
| Fuel Oil Overflow Tank | 1 | | abt * | 0.03 | In Double Bottom |
| | | | | | |
| Bilge Separate Tank | 1 | | 2 | | |
| Waste Oil Tank | 1 | | 2 | 0.5 | |
| | | | | | |
| Main Engine Lub. Oil Storage Tank | 1 | | abt. 16 | | Integrated |
| Main Engine Lub. Oil Settling Tank | 2 | | abt.8 | 0.2 | Integrated |
| Main Engine Lub. Oil Sump Tank | 1 | | abt. 16 | | In Double Bottom |
| | | | | | |
| Diesel Gene. Lub. Oil Storage Tank | 1 | | 5 | | |
| Diesel Gene. Lub. Oil Settling Tank | 1 | | 5 | 0.2 | |
| Diesel Gene. Lub. Oil Sump Tank | Each 1 | | * | | In Common Bed |
| Diesel Gene. Lub. Oil Overflow Tank | 1 | | 1.2 | | |
| | | | | | |
| | | | | | |
| Cylinder Oil Alarm Chamber | 1 | | 0.02 | | |
| Cylinder Oil Storage Tank | 2 | | Total 40 | | Integrated |
| | | | | | |
| | | | | | |

| Service | No.of Set | Type | Capacity (m ³) | Heat. Ratio (m ² /m ³) | |
|----------------------------------|-----------|-------------|----------------------------|---|-----------------------|
| | | | | | |
| | | | | | |
| | | | | | |
| Stern Tube Lub. Oil Sump Tank | 1 | | abt. 1 | | In Double Bottom |
| | | | | | |
| | | | | | |
| Stuffing Box Drain Tank | 1 | | 0.9 | | |
| | | | | | |
| | | | | | |
| | | | | | |
| Deaeration Tank | 1 | | abt. * | | |
| Jacket Cool. F.W. Expansion Tank | 1 | | 1.5 | | |
| | | | | | |
| | | | | | |
| Fresh Water Pressure Tank | 1 | Cylindrical | 1 | | |
| Drinking water Pressure Tank | 1 | Cylindrical | 1 | | |
| | | | | | |
| Cascade Tank | 1 | | 1 | | With Inspect. Section |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| Bilge Tank | 1 | | abt. * | | In Double Bottom |
| Bilge Sludge Tank | 1 | | abt. * | 0.01 | In Double Bottom |
| Clean Drain Tank | 1 | | abt. * | | In Double Bottom |
| | | | | | |
| | | | | | |



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.



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 160.8 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) and applying part load optimize turning with exhaust gas by-pass (PLO with EGB). 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 |



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 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)



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.

Special requirement for Postponement Survey of propeller shaft kind 1C (Survey intervals 10 years) shall be adopted.

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 and distance piece.

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 ⁻¹ (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 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 device attached to the pump.

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

| Name | Casing | Impeller | Shaft | Shaft seal |
|--|-----------|-----------------|-----------------|---------------|
| Cool. S.W. pump | Bronze | Phosphor bronze | Stainless steel | Gland packing |
| Jacket cool. F.W. pump | Cast iron | Phosphor bronze | Stainless steel | Gland packing |
| 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 | Stainless steel | Stainless steel | Gland packing |



| Name | Casing | Impeller | Shaft | Shaft seal |
|---------------------------------|-----------|--|-----------------|---------------|
| Drinking water pump | Cast iron | Synthetic resin [△] Phosphor bronze | Stainless steel | Gland packing |
| Fresh water pump | Cast iron | Synthetic resin [△] Phosphor bronze | Stainless steel | Gland packing |
| Hot water circulating pump | Cast iron | Synthetic resin [△] Phosphor bronze | Stainless steel | Gland packing |
| Boiler feed water pump | Cast iron | Phosphor bronze | Stainless steel | Gland packing |
| Main air compressor C.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 — self-priming device, if fitted
- 1 — common bed for horizontal type pump, if fitted

Pump handling lub. oil

The construction of main lub. oil pump shall be in accordance with Maker's standard.

The specified capacity and motor output of main lub. oil pump shall be designed based on the following viscosity.

| Name | Capacity (cSt) | Motor output (cSt) |
|--------------------|----------------|--------------------|
| Main lub. oil pump | 26 | 260 |



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 |
| D/G L.O. puri. supply pump | -0.05 | 26 - 260 | Gland packing |
| Boiler F.O. booster pump | -0.05 | 2 - 260 | Mechanical seal |

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 — air vent plug
- 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 -0.05MPa .

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 -0.05MPa .

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 (m ³ /h) | Temperature (°C) | | Quantity (m ³ /h) | Temperature (°C) | | |
| | | Inlet | Outlet | | Inlet | Outlet | |
| | | | | | | | |
| Aux. condenser | 50 | 32 | 49.5 | 1,400 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 (%) |
|---|---------------------------------|------------------|--------|---------------------------------|------------------|--------|-------------------------|
| | Cooling S.W. side | | | L.O. or F.W. side | | | |
| | Quantity (m ³ /h) | Temperature (°C) | | Quantity (m ³ /h) | Temperature (°C) | | |
| | | Inlet | Outlet | | Inlet | Outlet | |
| Main lub. oil cooler | 160 | 32.0 | 36.3 | 220 | 52.5 | 45.0 | 85 |
| Jacket cooling F.W. cooler | 160 | 36.3 | 43.6 | 102 | 90.0 | 79.0 | 85 |
| | | | | | | | |
| D/G cool. F.W. cooler | 54 | 32.0 | 42.0 | 48.2 | 48.8 | 38.0 | 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. fuel oil heater , one (1) shifter fuel oil heater and one (1) diesel gene. purifier lub. 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



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.



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) (In waste oil tank) | | STPG370E (Sch.40) (Sch.80) | 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

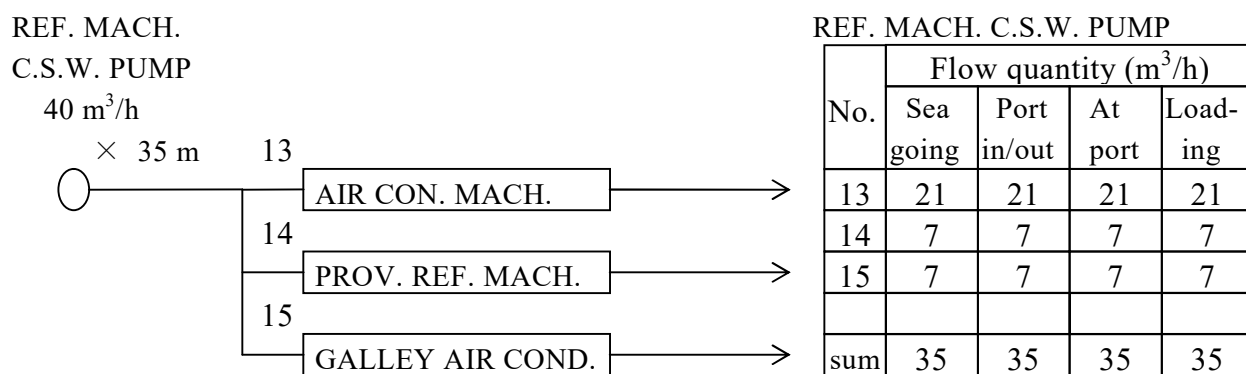
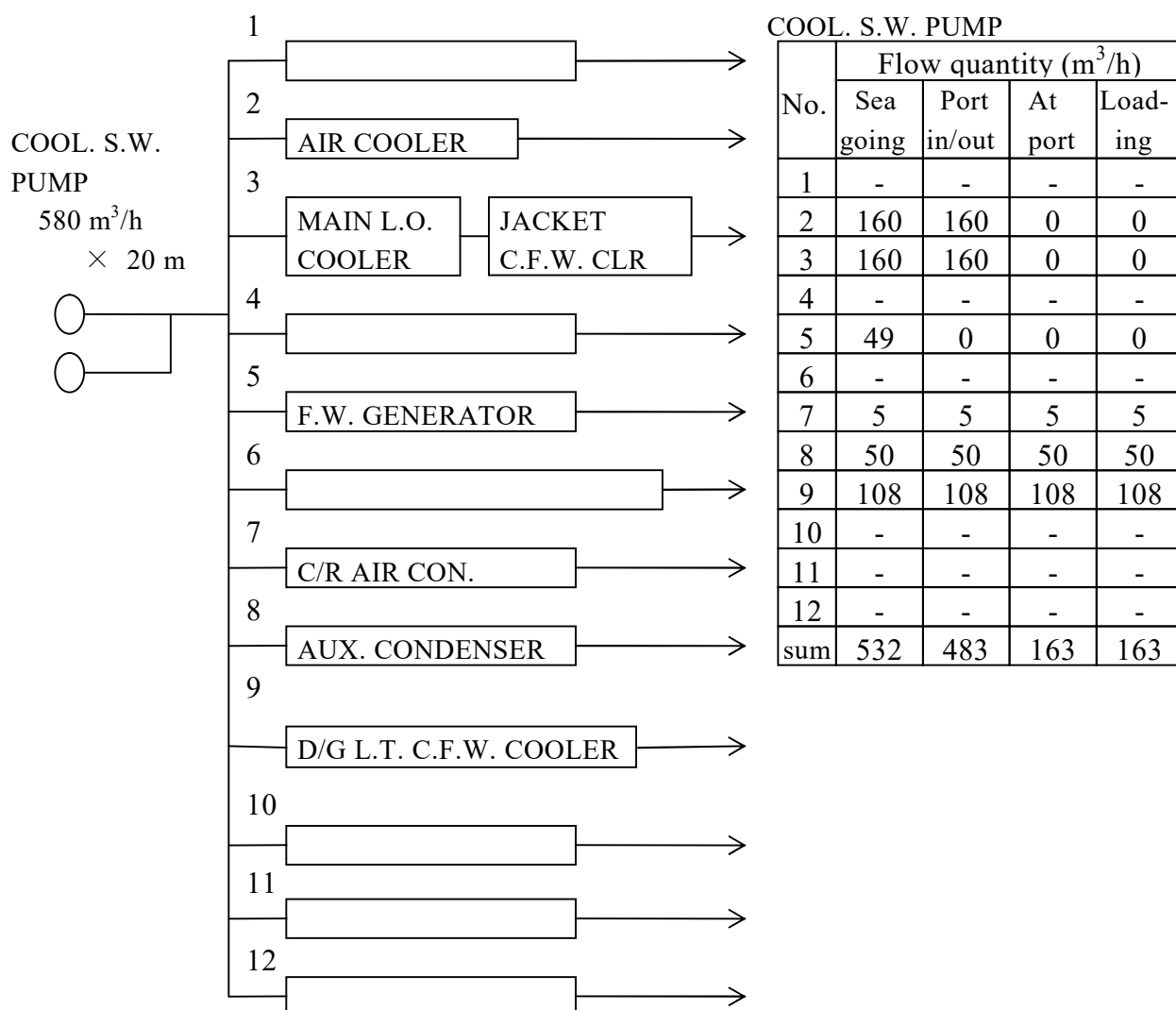
| Line | Item | No. × Mesh | | Remarks |
|----------------------|--|---------------|-----------|---|
| | | Inlet | Outlet | |
| Sea water line | Cool. S.W. pump | 2 × 8 mm | - | Simplex type The element to be stainless, and inner surface to be of epoxy paint |
| | Ref. mach. cool. S.W. pump | 1 × 8 mm | - | |
| | | | | |
| | 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 × 8 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 |
| | | - | 1 × 200 | Simplex |
| | F.O. purifier | 1 × 60 | - | Duplex (F.O. side) |
| | | | | |
| | F.O. booster pump | 1 × 100 | - | Duplex |
| | | - | 1 × E.F.10 μ | Jet filter Auto back wash |
| | Main engine F.O. circ. pump | - | 1 × E.F.20 μ | Duplex Manual back wash (Maker supply) |
| | Diesel generator D.O. booster pump | 1 × 100 | - | Duplex |
| | Diesel generator F.O. circ. pump | - | 1 × E.F.20 μ | Duplex Manual back wash |
| | | | 3 × ABS.75 μ | Notch wire (Maker supply) |
| | Boiler F.O. pump | 1 × 100 | - | Simplex (Maker supply) |
| | Waste oil incinerator | 1 × 60 | - | Simplex |
| Lub. oil line | F.O. shifter pump | 1 × 32 | - | Duplex |
| | Boiler F.O. booster pump | 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 |
| | (For T/C) | 1 × ABS.35 μ | - | Continuous back wash (Maker supply) |
| | Sludge collector | 1 × 150 | - 1 × 5 μ | (Maker supply) (Yard supply) |
| | Cylinder lubricator | 1 | - | Y type strainer (Maker supply) |
| | Diesel generator L.O. pump | 3 | - | (Maker supply) |
| | | - | 3 × ABS.30 μ | Continuous. back wash (Maker supply) |
| | Scavenging box drain | 1 × 32 | - | Simplex |



10.6 SEA WATER DISTRIBUTION CHART





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

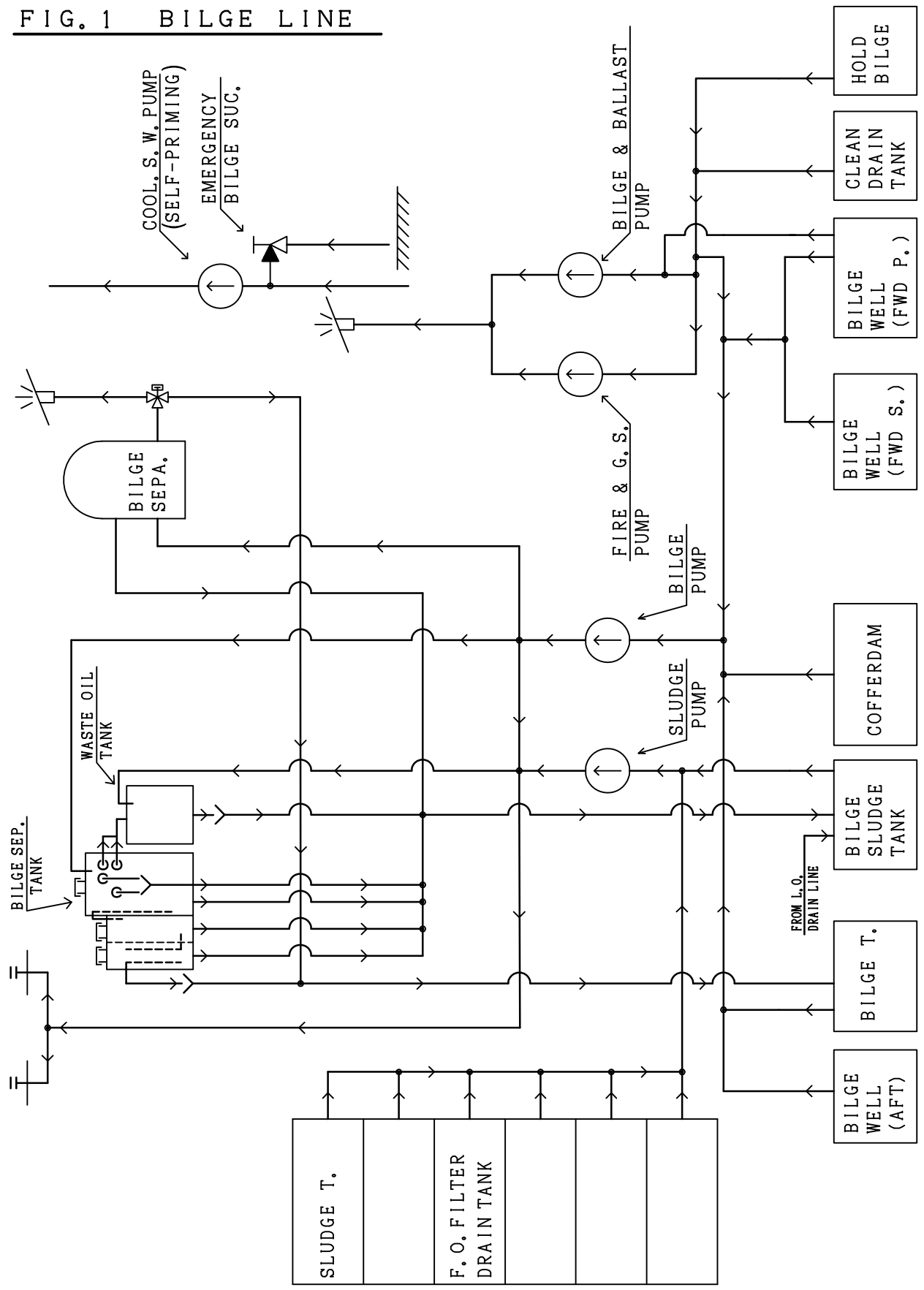




FIG. 2 COOL. S. W. LINE

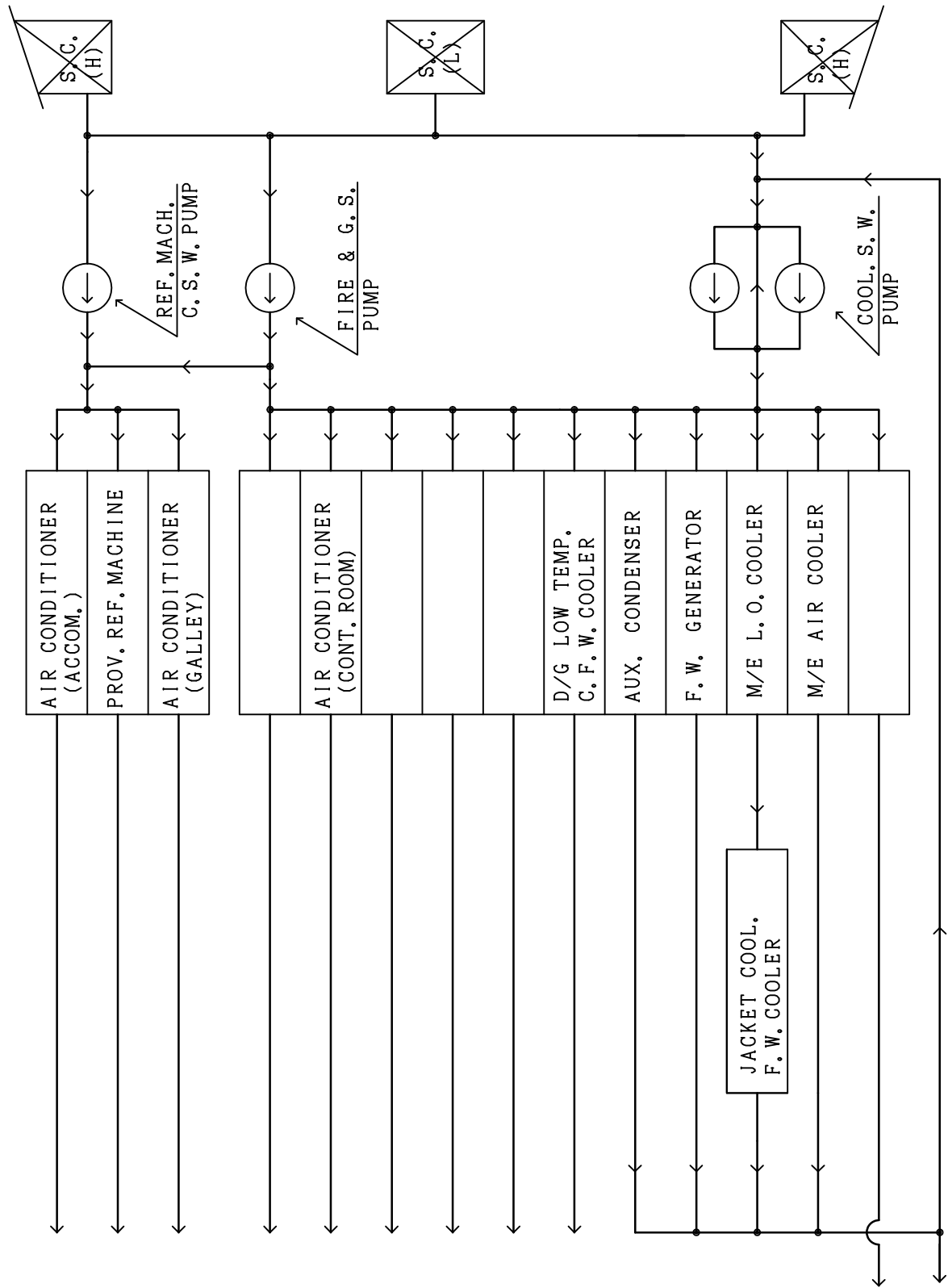




FIG. 3 COOL. F. W. LINE

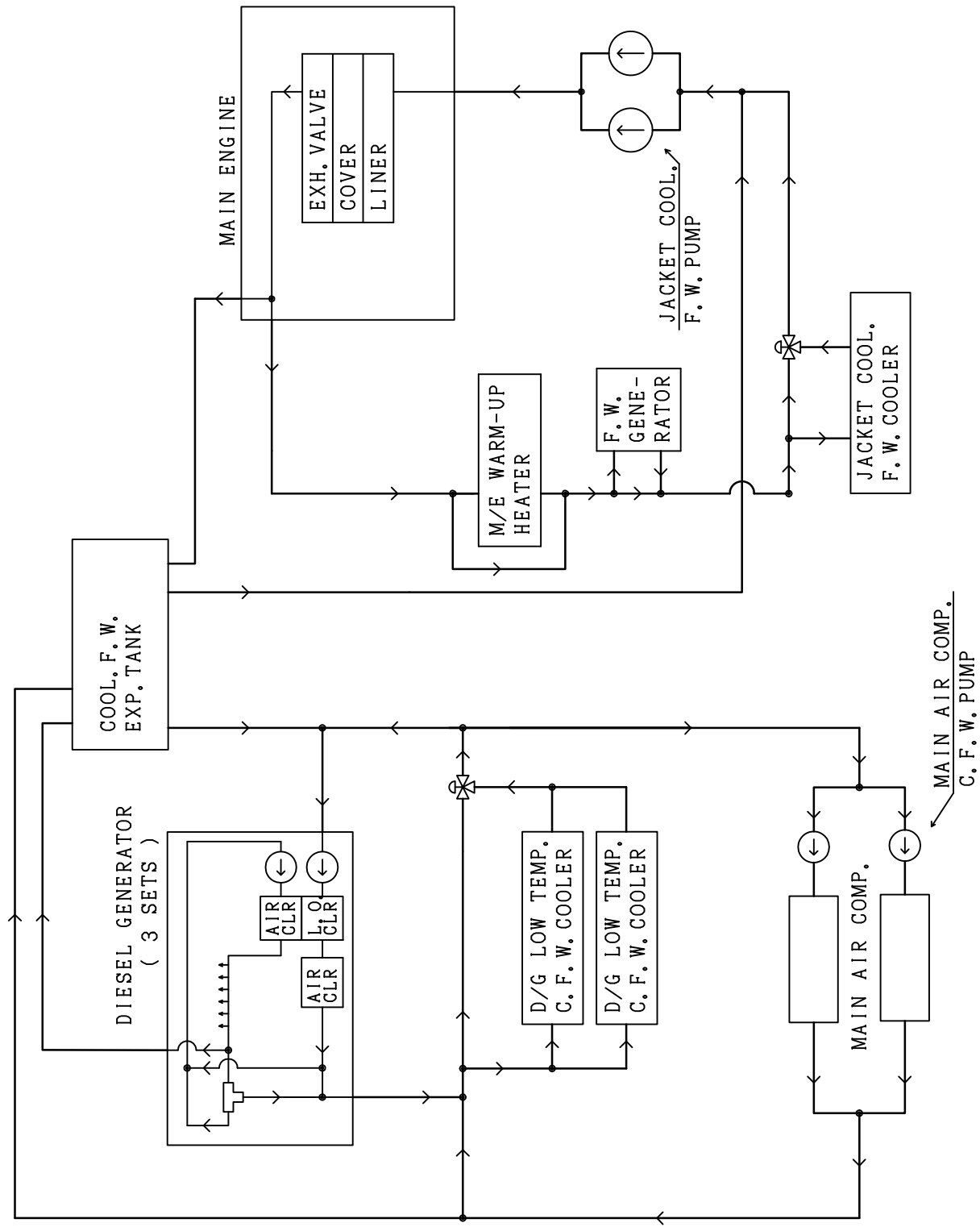


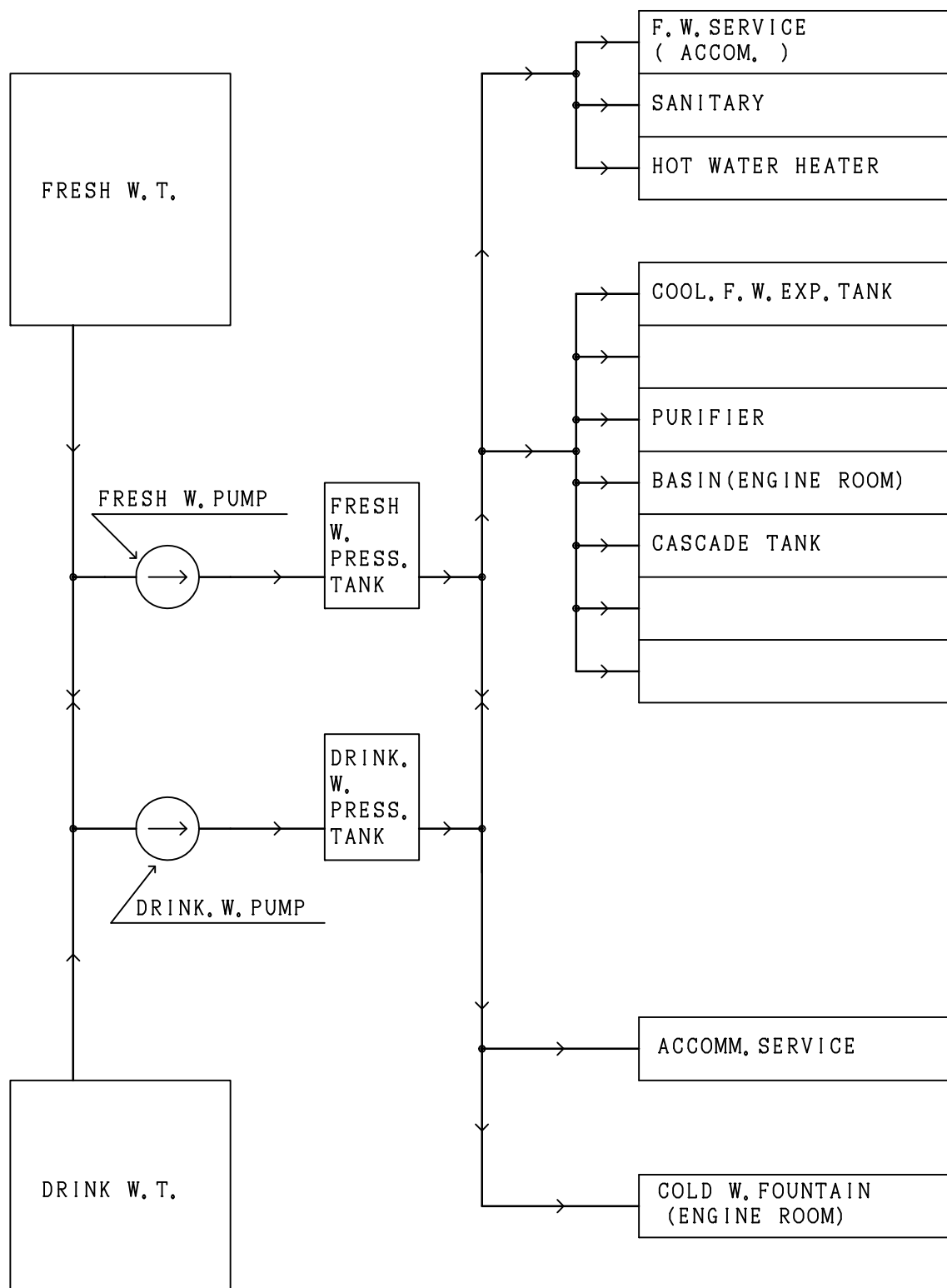
FIG. 4 FRESH W. SERVICE LINE



FIG. 5 F. O. TRANSFER LINE

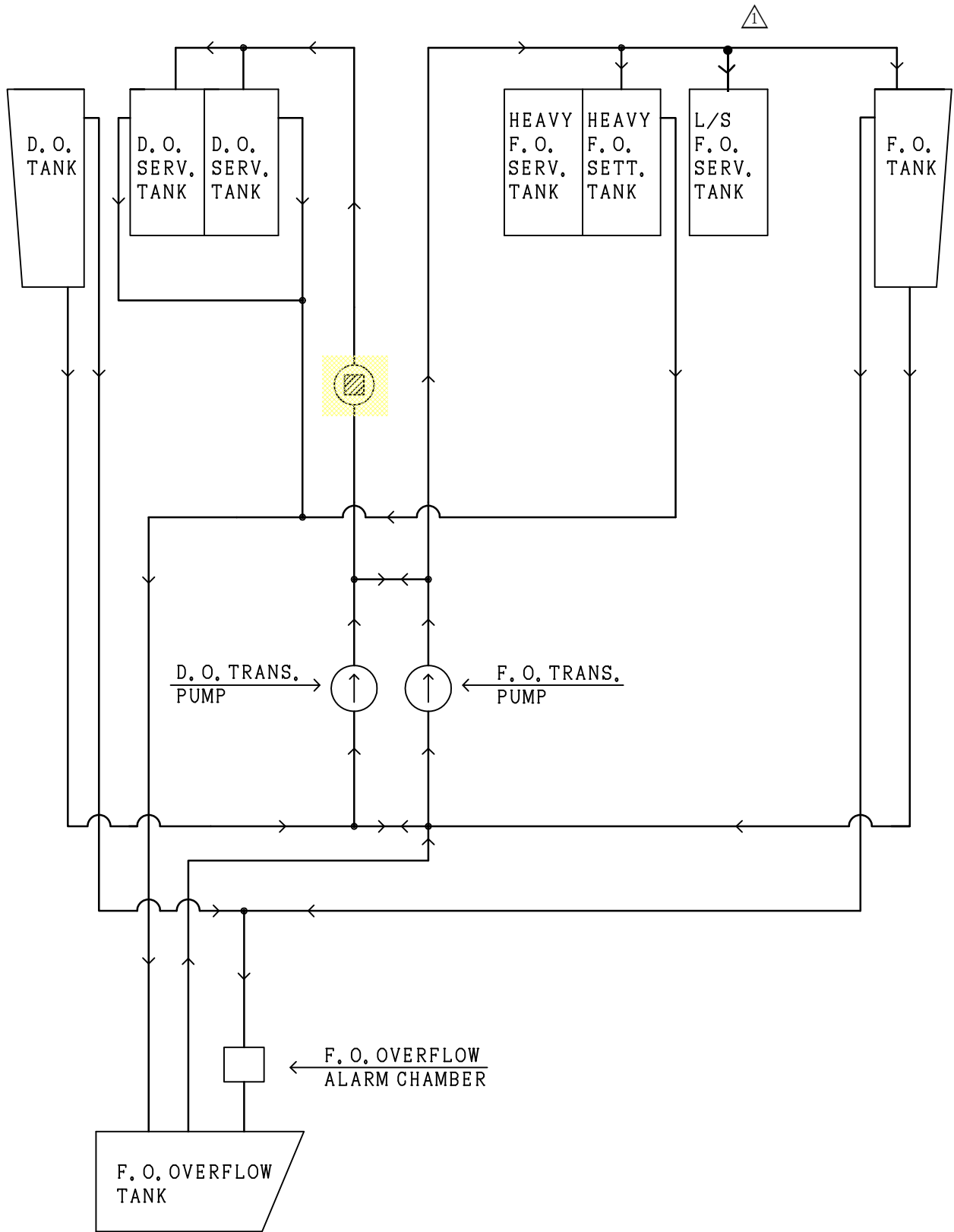




FIG. 6 F. O. PURIFYING LINE

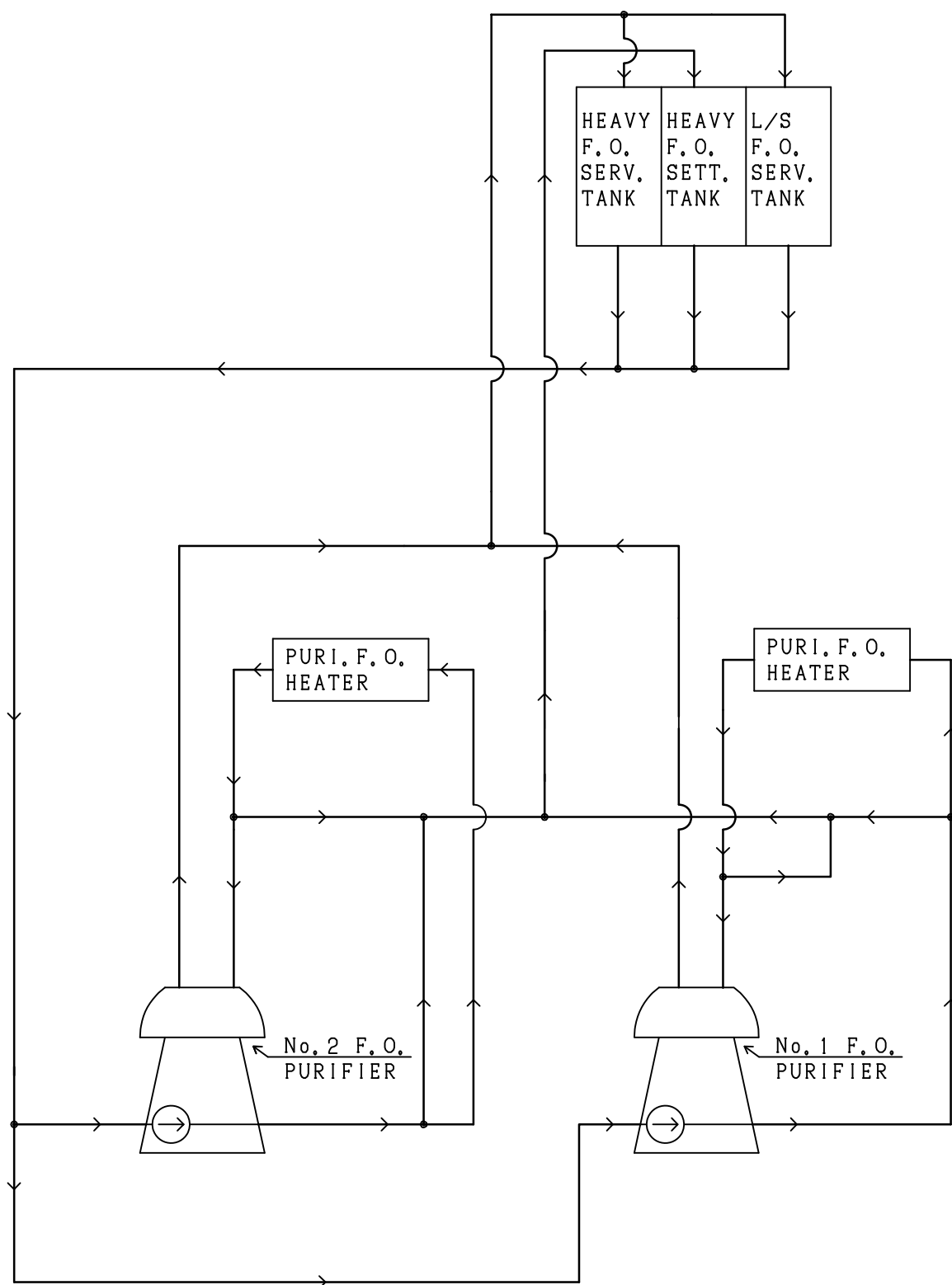




FIG. 7 M/E & BOILER F. O. SERVICE LINE

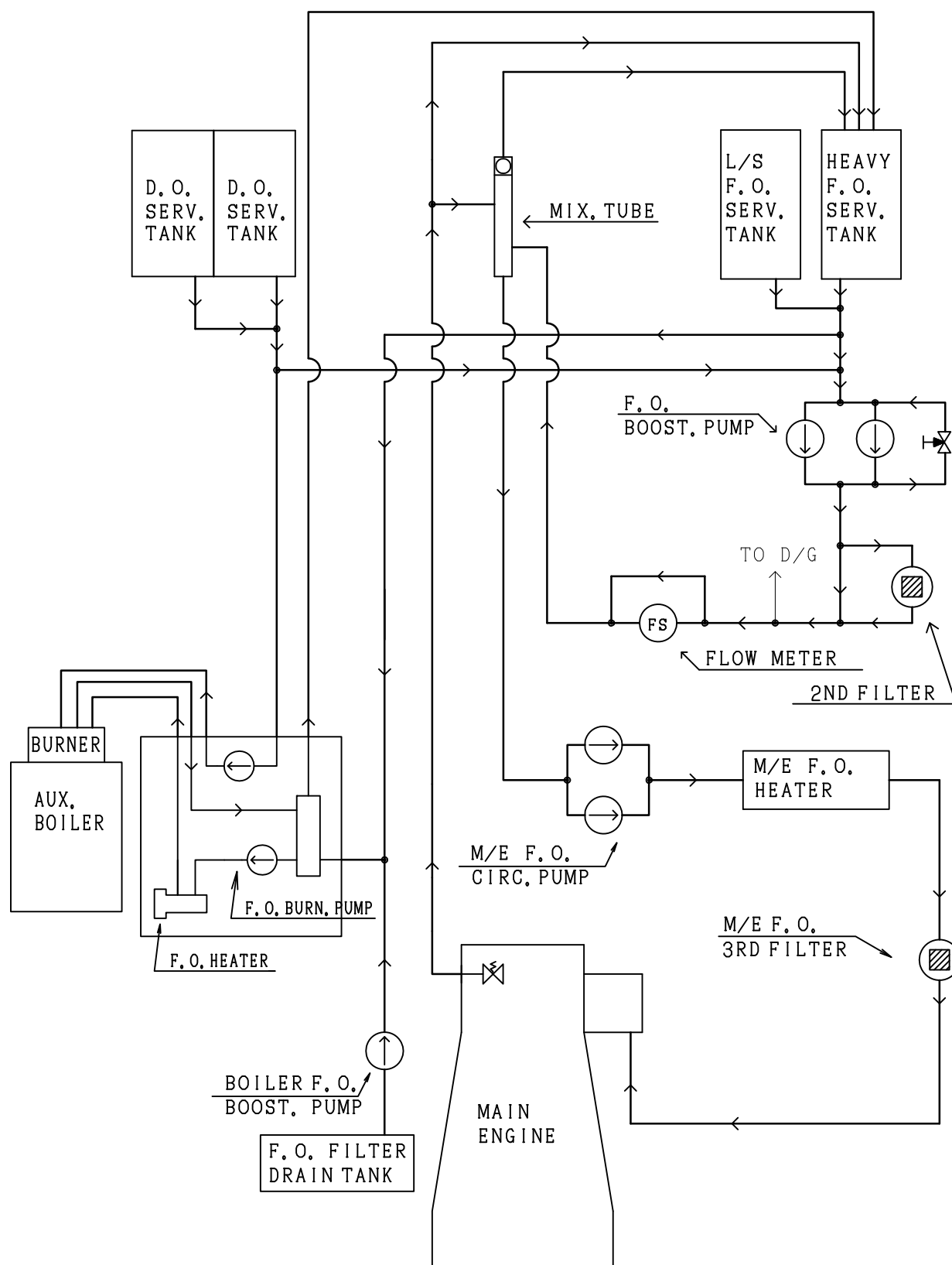




FIG. 8 D/G F. O. SERVICE LINE

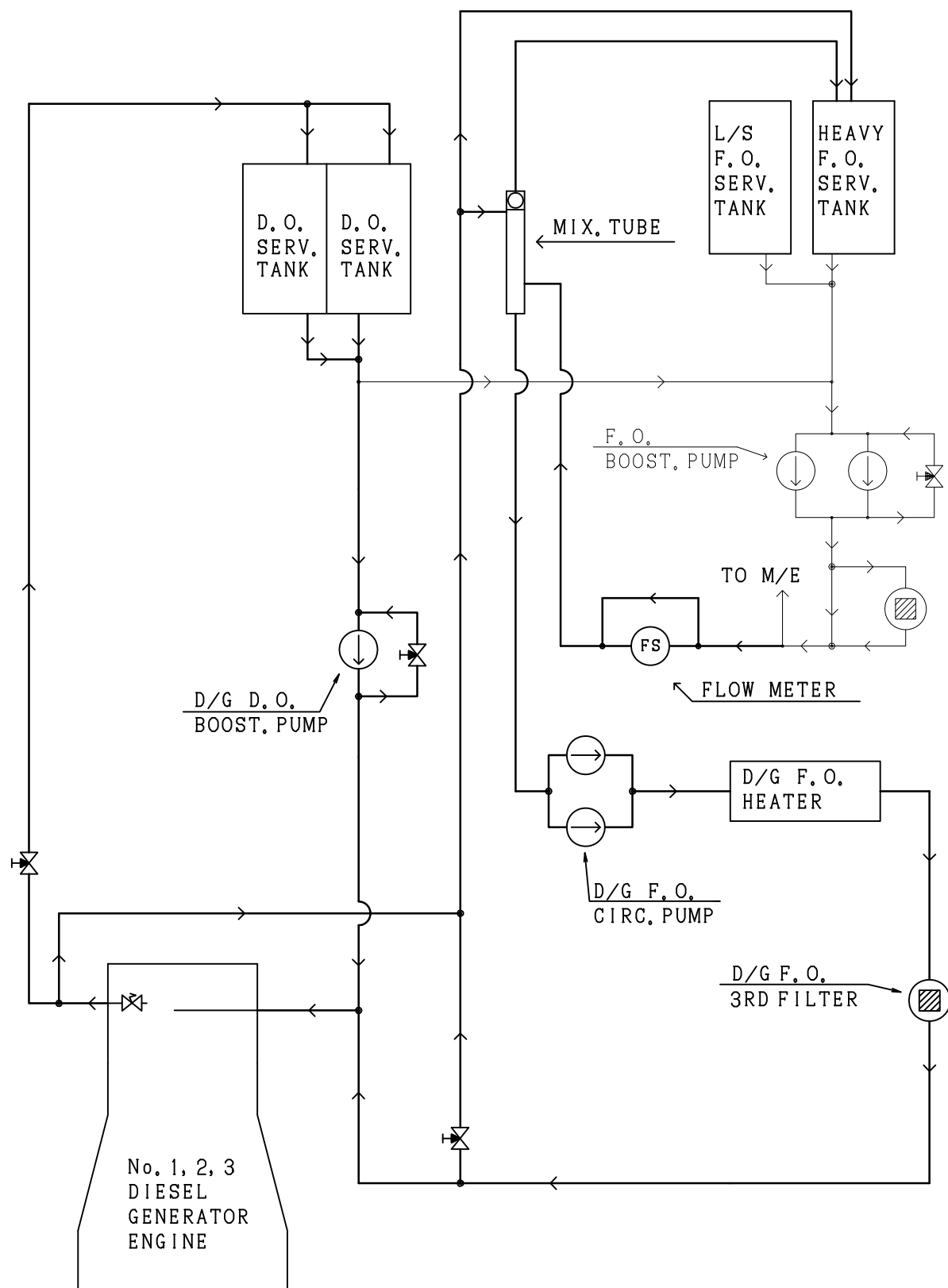




FIG. 9 L. O. TRANS. & PURI. LINE

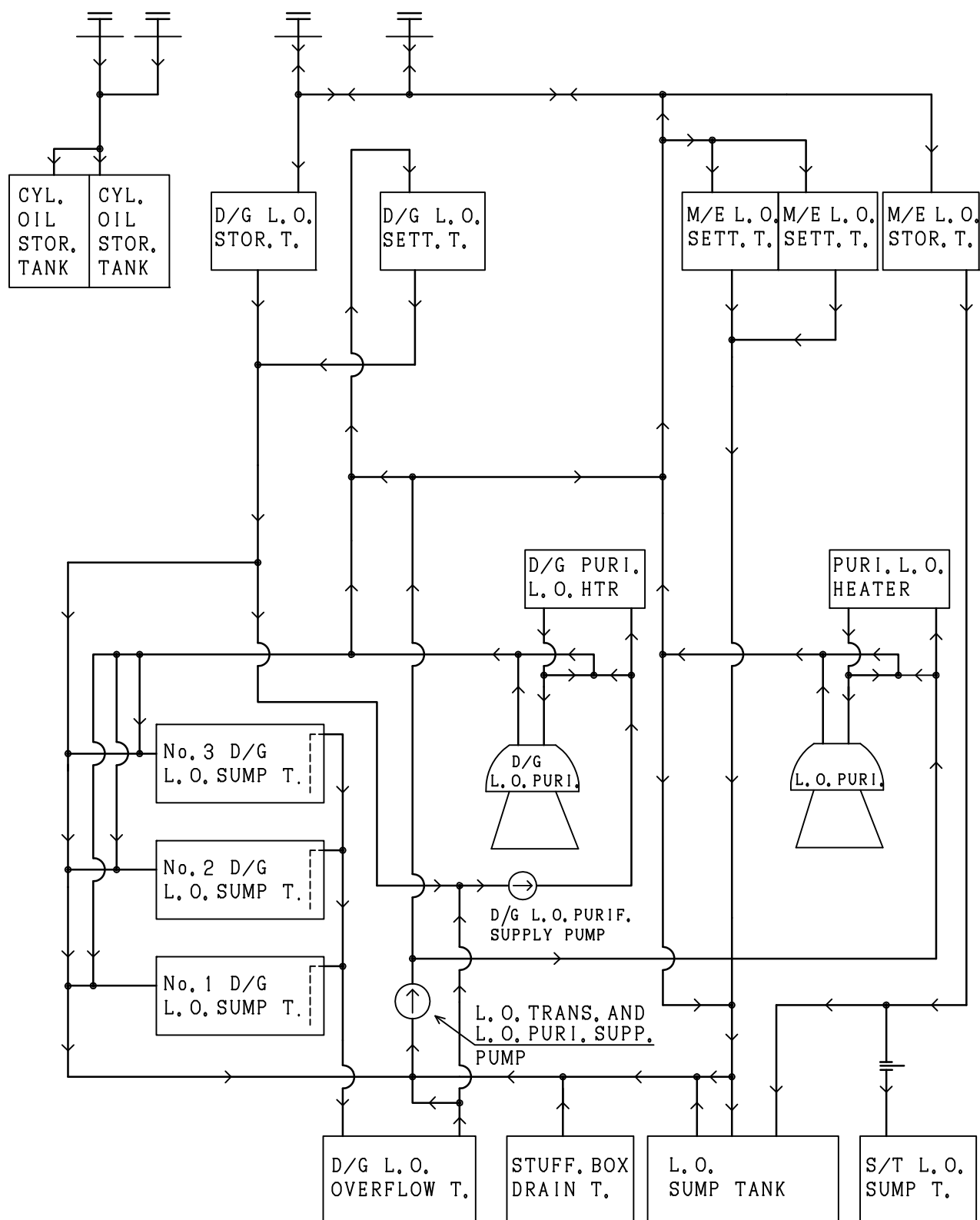




FIG. 10 L. O. SERVICE LINE

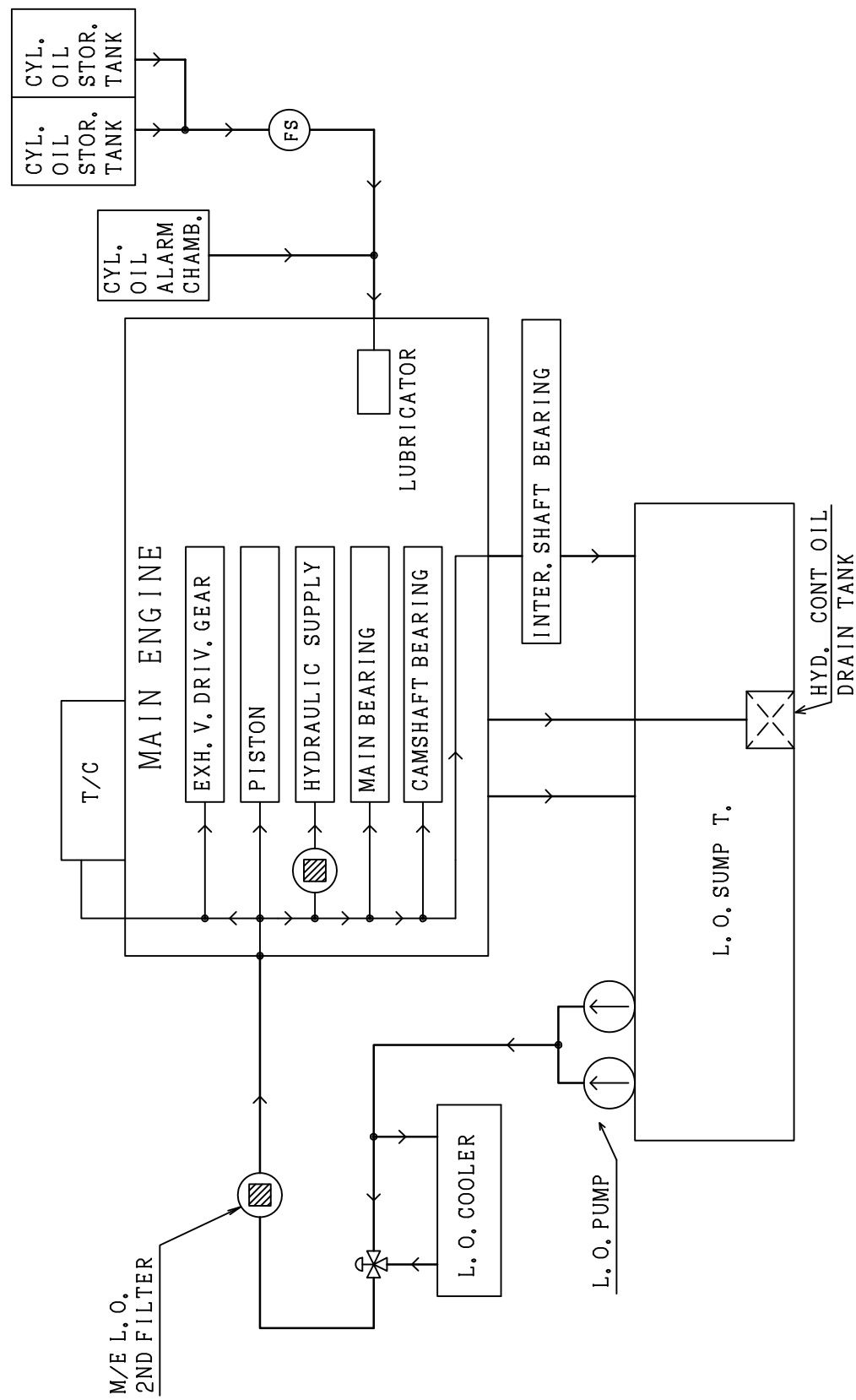




FIG. 11 STERN TUBE L. O. LINE

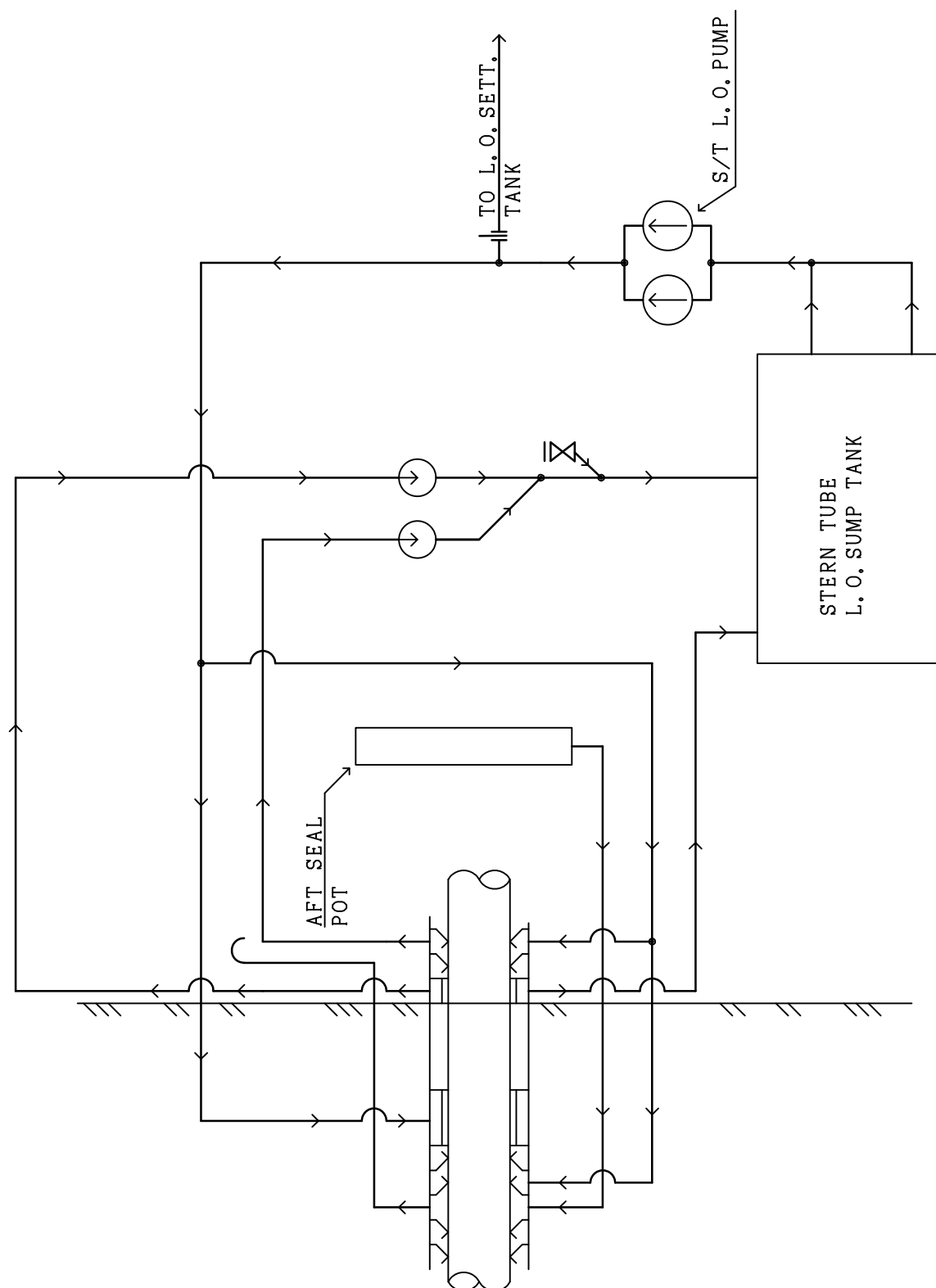




FIG. 12 STEAM LINE

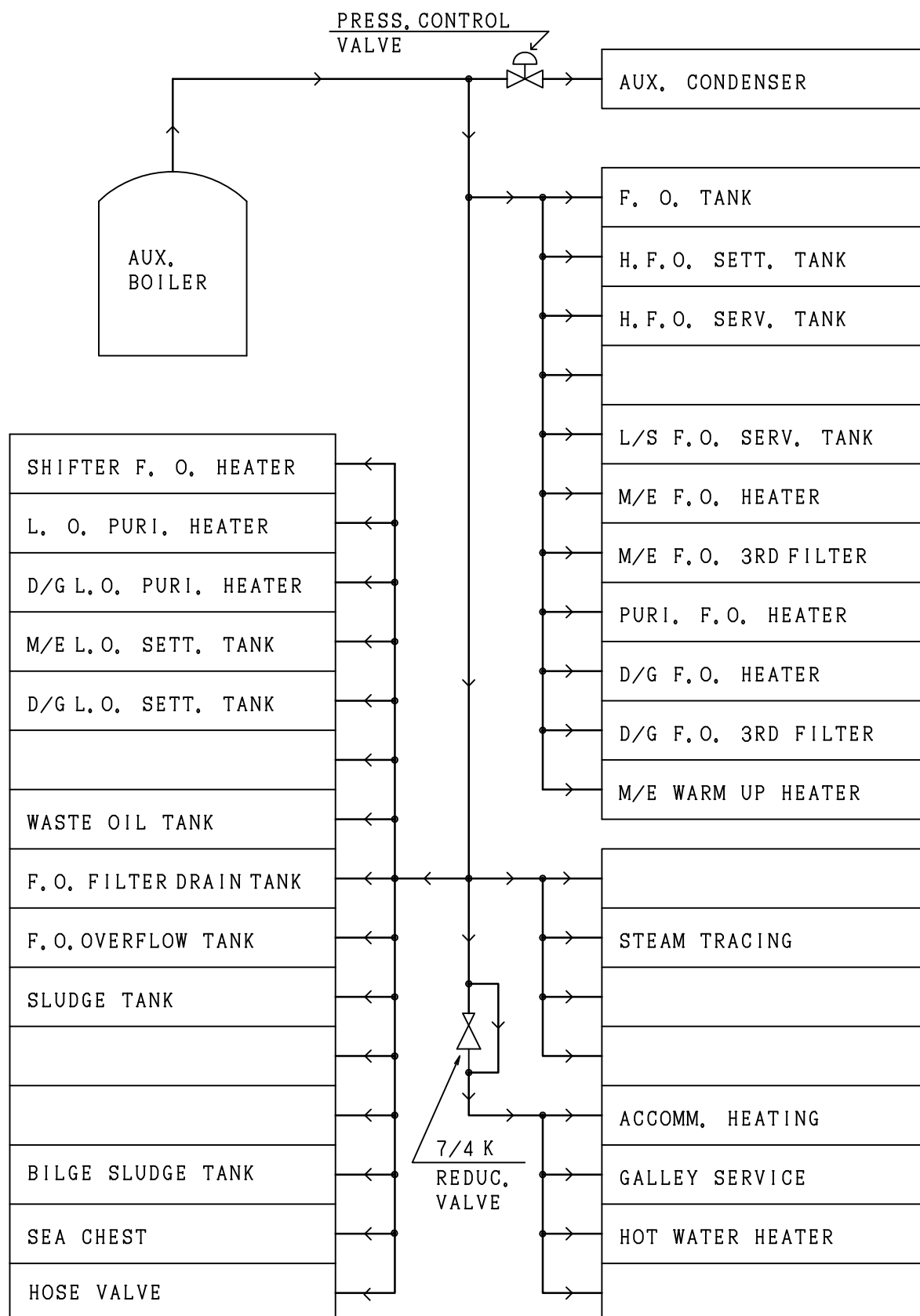




FIG. 13 COMPRESSED AIR LINE

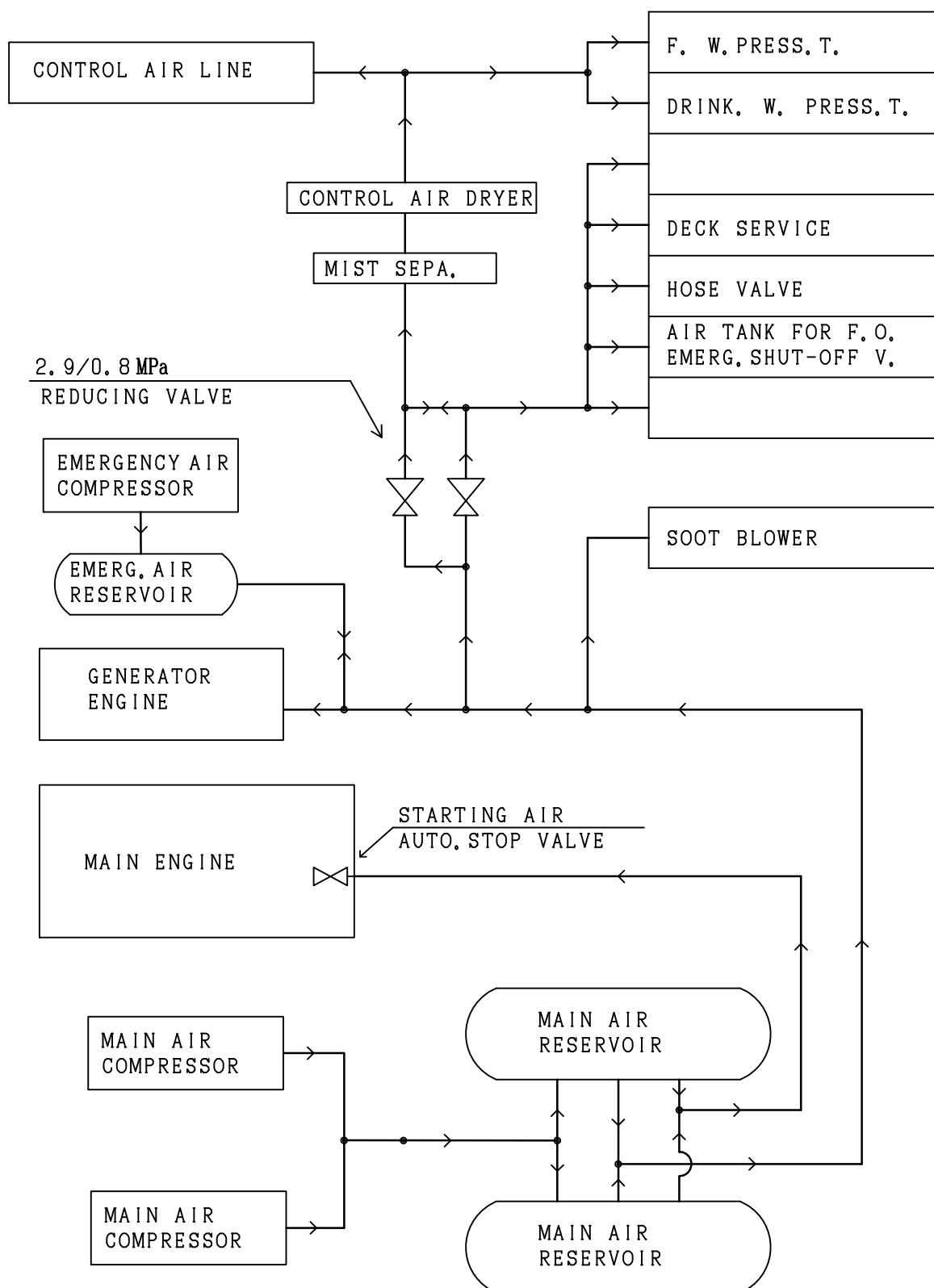
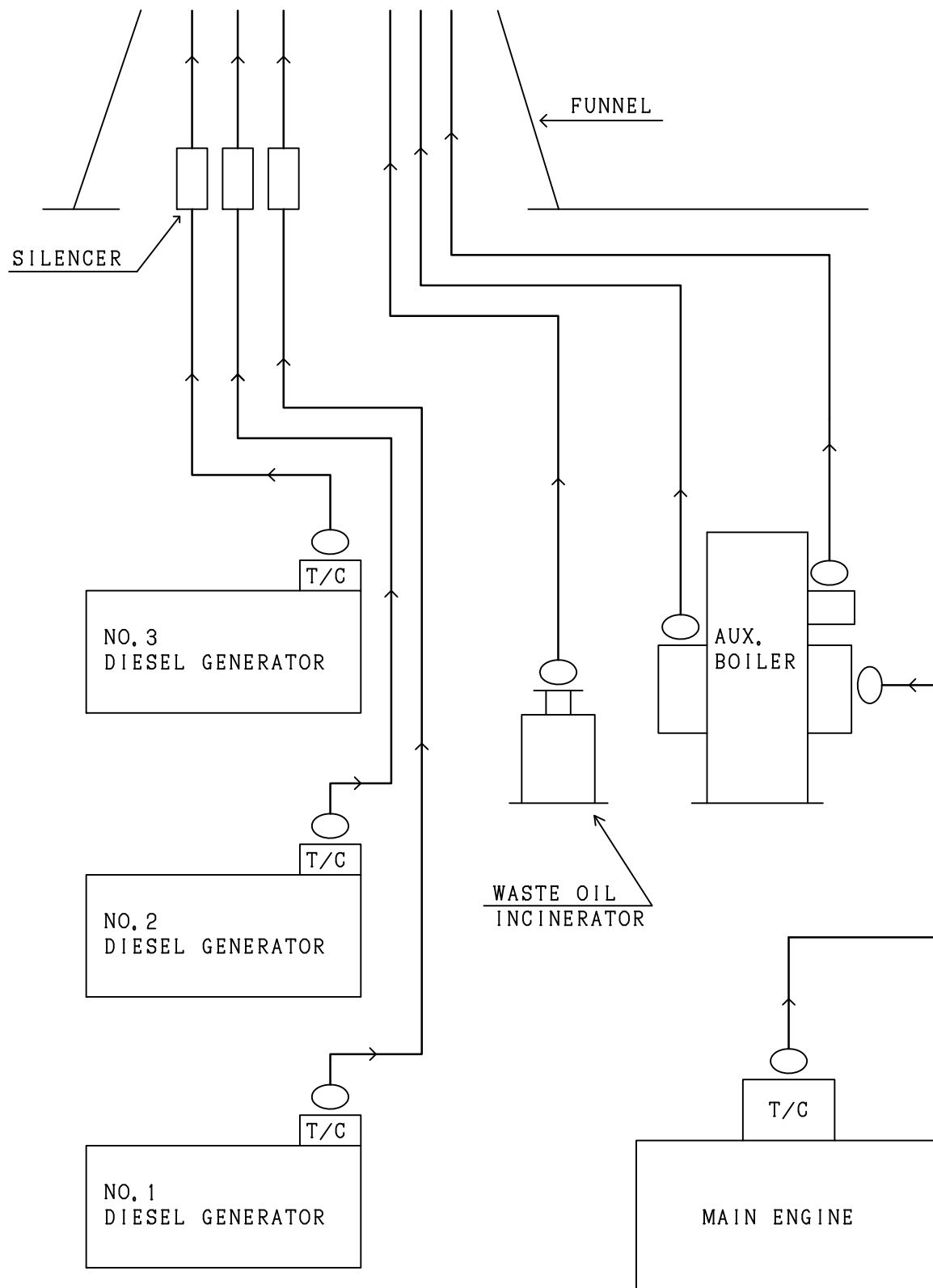


FIG. 14 EXH. GAS LINE



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 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 Aux. condenser Main air reservoir 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 | 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.

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

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 ² /m ³) | 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 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 filter drain tank | - | O | O | S | O | 0.2 | 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 |
| D/G lub. oil overflow tank | - | - | O | F | - | - | - | |
| S/T lub. oil sump tank | - | - | O | F | - | - | - | |
| S/T lub. oil seal pot | - | - | O | Y | - | - | - | Open |
| | | | | | | | | |
| Cylinder oil storage tank | O | - | O | F | - | - | - | |
| Cylinder oil alarm chamber | - | - | O | - | - | - | - | |
| | | | | | | | | |
| Stuffing box drain tank | - | - | O | S | - | - | - | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| 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 | | | | | | | Remarks (Thermo-meter) |
|---------------------|--------------------------------|--------------------------|-------------|----------------|---------------|---|----------------------------|---------------------------|
| | Emerg Shut- off valve | Self closing valve | Air vent | Level gauge | Heat. Coil | Heat. coil ratio (m ² /m ³) | Boiling connec- tion | |
| | | | | | | | | |
| Bilge separate tank | - | - | - | - | - | - | - | Open |
| Waste oil tank | O | - | O | F | O | 0.5 | - | |
| | | | | | | | | |
| | | | | | | | | |
| 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 **PARTIV 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

The control and monitoring system specified in this specification shall be designed to comply with the requirement of the Rule applicable, so as to operate the ship with unattended machinery space for period of proper hours under all sailing condition including maneuvering.

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

The main engine shall be remotely controlled from either bridge or engine control room.

The control and monitoring equipment for propulsion plant and associated ship service system shall be assembled and installed in the engine control room in order to obtain same effect on the handling which could be done at normal control and local monitoring.

Emergency running shall be also be able to do at local by means of control device of necessary minimum number.

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 provided performance of reversing, starting, stopping and speed setting of the main engine, electrically-pneumatically with a micro-computer from the bridge by operating a single telegraph transmitter, and electrically-pneumatically with a micro computer from the engine control room by operating the telegraph receiver and maneuvering dial for reversing, speed setting and starting.

When the main engine control is carried out from the engine control room or local, the telegraph handle on bridge control console shall be used as conventional type engine telegraph.

The local control system shall be provided on the main engine for the case of emergency in failure of the remote control system or the governor.



13.3 ENGINE CONTROL ROOM

The independent engine control room well-illuminated, air conditioned and of sound-proof, shall be located suitable place in engine room, and shall serve various purposes, 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.

| | |
|--------------------------------|-------|
| • 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 |
| • Refrigerator (abt.130 liter) | 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 indicating lamps or display in engine control room.

As for details of the alarming and other instruments, refer to Subsection **13.5 INSTRUMENTATION AND CONTROL IN ENGINE CONTROL ROOM.**

When the abnormal condition happen in engine room during “Unattended machinery spaces” running, indicating of group shall be done with alarm at following places.



1) Alarm indicating place

- Bridge
- Ship's office
- Officer's mess room
- Saloon
- Chief engineer's room
- 1st engineer's room
- 2nd engineer's room
- 3rd engineer's room

Alarm for 1st, 2nd and 3rd engineer's room shall be selected only for the duty engineer's room by select switch, provided in engine control room.

Extension alarm panel shall be of identification of group "A", "B", "C", "D" and "E".

2) Group of indicating

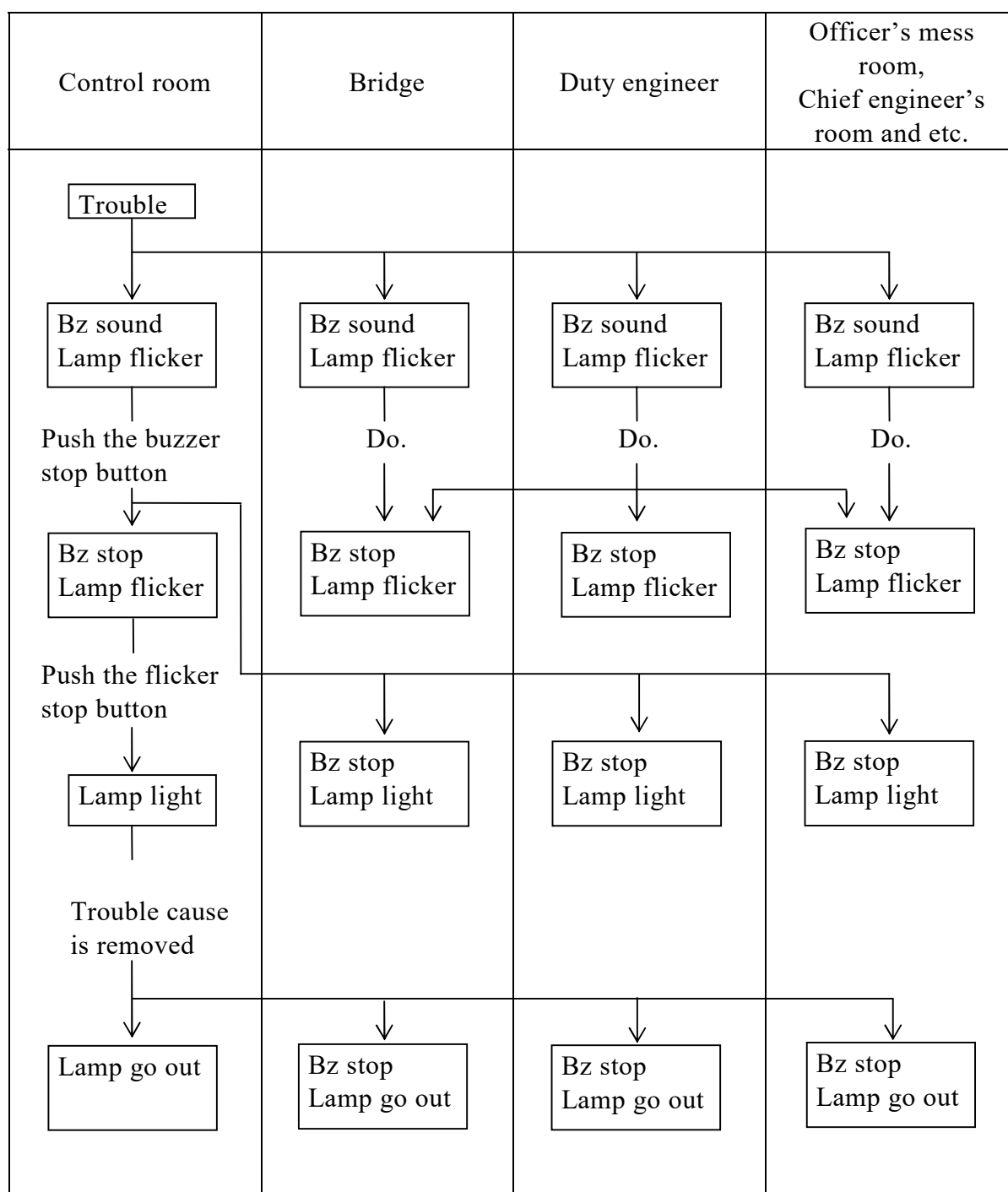
- "A" group : Main engine emergency shut down
- "B" group : Main engine slow down
- "C" group : Main engine and propulsion auxiliaries trouble
except "A" and "B" group
- "D" group : Electric and steam generating plants trouble
- "E" group : Other trouble

The smoke type or temperature type fire detector shall be fitted in the engine room, and sectionalized into proper groups to cover specified zone of engine room which shall be identified in the fire alarm panel provided in bridge.

The audible fire alarm shall be provided to engine room, engine control room, bridge and each storey passage of accommodation quarter.



3) Operation of extension alarm





4) Operation of alarm lamp and buzzer in engine control room

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

13.5 INSTRUMENTATION AND CONTROL IN ENGINE CONTROL ROOM

Abbreviation:

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

Note:

(1) Details of Display shall be as follows:

- Size of display : 15 inches (Color)
- Number of set : 2 sets
- Operating panel : 2 sets
- Log printer (log & alarm) : 1 set

Indicating pattern shall be in accordance with Maker's standard.

| 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 | Display | Recording | Independent | Display | Independent | Display | Recording | | | | | | | | |
| MAIN ENGINE | Maneuvering system | Start & stop | | <input type="radio"/> | | | | <input type="radio"/> | | | | | | | | | 1) <input type="radio"/> | | | | | | 1) Common control lever with engine telegraph 2) Due to follows • Over speed • L.O. press. Drop • T/C L.O. press. Drop • Manual emergency trip 3) On LCD display 4) Due to follows • Crank case high oil mist • Scavenging box fire • Piston cool. oil non-flow • L.O. low press. • Jacket C.F.W. low press • Jacket C.F.W. out. H.T. • Piston cool.oil out. H.T. • Exh.gas cyl. out. H.T. • Thrust pad high temp. • S/T bearing high temp. • Slow down from EICU (Inc.cyl.lub.oil non-flow) 5) ”Pre-warning” & “Slow down” 6) In case of E/S maneu. | |
| | | Reversing | | <input type="radio"/> | | | | <input type="radio"/> | | | | | | | | | 1) <input type="radio"/> | | | | | | | |
| | | Speed control | | <input type="radio"/> | | | | <input type="radio"/> | | | | | | | | | 1) <input type="radio"/> | | | | | | | |
| | | Load limitation | <input type="radio"/> | | | | | <input type="radio"/> | | | | 3) ① | | | | | <input type="radio"/> | | ① | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Upper speed limit | | | | | | | | | | 3) ① | | | | | | | ① | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Emergency trip | 2) <input type="radio"/> | | | | | | | | | 3) ④ | | | | | | | | | | | | A |
| | | Manual emerg. trip | | <input type="radio"/> | | ① | ① | <input type="radio"/> | | | | 3) ① | | | ① | ① | <input type="radio"/> | | ① | ① | | | | |
| | | Emergency trip reset | | <input type="radio"/> | | | | <input type="radio"/> | | | | | | | | | <input type="radio"/> | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Auto. slow down | 4) <input type="radio"/> | | | | | | | | | 3) ①① | | | | ① | ① | | | | 5) ② | | | B |
| | | Auto. slow down reset | | | | | | <input type="radio"/> | | | | | | | | | <input type="radio"/> | | | | | | | |
| | | Auto. slow down cancel | | | | | | <input type="radio"/> | | | | 3) ① | | | | | <input type="radio"/> | | ① | | | | | |
| | | Slow down request | | | | | | | | | | | | | 6) ① | ① | | | | ① | | B | | |
| Increase limit | | <input type="radio"/> | | | | <input type="radio"/> | | | | 3) ① | | | | | <input type="radio"/> | | | | | | | | | |

| 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 | Display | Recording | Independent | Display | Independent | Display | Recording | | | | | | | | | | | |
| MAIN ENGINE | Maneuvering system | Control position | | 1) ○ | | 1) ② | | 2) ○ | | | | 3) ③ | | | | | 4) ○ | | 3) ③ | | | | | | 1) Engine side – Remote | | |
| | | | | | | | | | | | | | | | | | | | | | | | | 2) C/R – W/H | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | 3) "E/S", "C/R", "W/H" | | | |
| | | Imperfect Bridge control condition | | | | | | | | | | | | | | ① | ① | | | | ① | | C | 4) Confirmation | | | |
| | | Engine telegraph | | ○ | 5) ○ | | | ○ | 5) ○ | | | | | | | | | ① | ① | | | | ① | | C | 5) | |
| | | Sub – telegraph | | | | | | ○ | | | | | 6) ③ | | | | | ○ | | 5) ○ | 8) ○ | | 7) ○ | | | | |
| | | Handle matching | | | | | | | | | | | 9) ① | | | | | | | 6) ③ | | 7) ○ | | | | | |
| | | | | | | | | | | | | | | | | | | | | | ① | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Turning gear “Engage – Disengage” | | ○ | | ① | | | | | | | | | | | | | | | | | | | | | |
| | | Starting air valve | | ○ | | | | | | | | | | | | | | | | | | | | | | | |
| | | ME cont system | | | | | | | | | | | | | | | | | | | | | | | C | 6) "F/E", "S/B", "R/U" | |
| | | Main engine revolution | | | ① | | | | | △ | △ | ① | | | | | | | | | | | | | | | 7) Recording the order and time |
| | | Main engine revolution counter | | | | | | | | ① | | | | | | | | | | | ④ | | | | | | 8) Telegraph repeater |
| | | Turbocharger revolution | | | | | | | | △ | | | | | | | | | | | | | | | | | 9) On the LCD display |
| | | Fuel index | | | | | | | | △ | | | | | | | | | | | | | | | | | |

| | |
|------|----------|
| 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 | |

| 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 | Display | Recording | Independent | Display | Independent | Display | Recording | | | | | | | | |
| MAIN ENGINE | Maneuvering system | Starting failure | | | | | | | | | | | | | ① | ① | | | | ① | | C | 1) Critical speed continuous running 2) On the LCD display 3) Source failure 4) Auto. start & stop by scavenging air press. 5) “M0” 6) “MAN-1/E-2/E-3/E” 7) “1/E”, ”2/E”, ”3/E” 8) “System failure” 9) “Auto. position request” ① | |
| | | Wrong way | | | | | | | | | | | 2) ① | ① | ① | | | | | | C | | | |
| | | Critical speed | ○ | | | | | | | | | | 2) ① | 1) ① | ① | | | | 1) ① | | C | | | |
| | | AC/DC power source | | | | | | | | | | | 3) ② | ② | ② | | | | | | C | | | |
| | | RCS power source | | | | | | | | | 2) ① | | 3) ① | ① | ① | | | | 8) ① | | C | | | |
| | | RCS failure | | | | | | | | | | | ① | ① | ① | | | | | | C | | | |
| | | EPS power source | | | | | | | | 2) ① | | 3) ① | ① | ① | | | | | | C | | | | |
| | | EPS failure | | | | | | | | | | | ① | ① | ① | | | | | C | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | 8) “System failure” |
| | | | | | | | | | | | | | | | | | | | | | | | | 9) “Auto. position request” |
| | | ETS power source | | | | | | | | | 2) ① | | 3) ① | ① | ① | | | | | | | C | | |
| | | ETS failure | | | | | | | | | | | | ① | ① | ① | | | | ① | | C | | |
| | | LOP power failure | | | | | | | | | | | | ① | ① | ① | | | | | | C | | |
| | | Auxiliary blower | 4) ○ | ○ | | | | ○ | | | | ② | | 3) ① | ① | ① | | | | | | C | | |
| | | Unattended machinery space | | | | | | 6) ○ | | | | 5) ① | | | | | | | 5) ① | | | | | |
| | | Duty engineer | | | | | | ○ | | | | 7) ③ | | | | | | | 7) 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 | Display | Recording | Independent | Display | Independent | Display | Recording | | | | | | | | |
| MAIN ENGINE | Pressure | Fuel oil inlet | | | 1) ① | | | | △ | △ | ① | | | | L △ | ① | | | | | | C | 1) To be fitted with strainer outlet 2) System failure | |
| | | Lub. oil inlet | | | ① | | | | △ | △ | ① | | | | L △ | ① | | | | | | B | | |
| | | Piston cooling oil inlet | | | ① | | | | | | | | | | L ① | ① | | | | | | C | | |
| | | Turbocharger lub. oil inlet | | | ① | | | | | △ | ① | | | | L △ | ① | | | | | | C | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Jacket cooling F.W. inlet | | | ① | | | | | △ | ① | | | | L △ | ① | | | | | | B | | |
| | | Air cooler sea water inlet | | | | | | | | △ | ① | | | | L △ | ① | | | | | | C | | |
| | | Exhaust valve spring air | | | | | | | | | | | | | L ① | ① | | | | | | C | | |
| | | Scavenging air | | | ① | | | | △ | △ | ① | | | | | | | | | | | | | |
| | | Starting air main valve inlet | | | ① | | | | △ | △ | ① | | | | L △ | ① | | | | L ① | | | | C |
| | | Maneuvering air | | | ① | | | | | △ | ① | | | | L △ | ① | | | | 2) ○ | | | | C |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
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| 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 | Display | Recording | Independent | Display | Independent | Display | Recording | | | | | | | | |
| MAIN ENGINE | Pressure | Fuel oil 3rd filter difference ⚠ | ⚠ | | ○ | | | | | | | | | | H ① | ① | | | | | | C | 1) U tube type | |
| | | Lub. oil 2nd filter difference | | | ○ | | | | | | | | | | H ① | ① | | | | | | C | | |
| | | T/C Lub. oil 2nd filter difference | | | ○ | | | | | | | | | | H ① | ① | | | | | | C | | |
| | | Turbocharger air filter difference | | | 1) ① | | | | | | | | | | | | | | | | | | | |
| | | Air cooler in/out difference | | | 1) ① | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
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| | | | | | | | | | | | | | | | | | | | | | | | | |
| | | HPS filter difference | | | | | | | | | | | | | | H ① | ① | | | | | | | C |
| | | HPS by-pass filter difference ⚠ | | | | | | | | | | | | | | H ① | ① | | | | | | | C |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
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| 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 | Display | Recording | Independent | Display | Independent | Display | Recording | | | | | | | |
| MAIN ENGINE | Temperature | Fuel oil inlet | 1) ○ | | ① | | | | | △ | ① | | | | HL △ | ② | | | | | | C | 1) By the pneumatic type temp. control valve |
| | | Lub. oil inlet | 1) ○ | | ① | | | | | △ | ① | | | | H △ | ① | | | | | | C | |
| | | Piston cooling oil each cylinder outlet | | | ⑥ | | | | | △ | ⑥ | | | | H △ | ⑥ | | | | | | B | |
| | | Turbocharger lub. oil outlet | | | ① | | | | | △ | ① | | | | H △ | ① | | | | | | C | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| | | Jacket cooling F.W. inlet | | | ① | | | | | △ | ① | | | | | | | | | | | | |
| | | Jacket cooling F.W. each cylinder outlet | 1) ○ | | | | | | | △ | ⑥ | | | | H △ | ⑥ | | | | | | C | |
| | | Jacket cooling F.W. each cylinder outlet(SD) | | | | | | | | △ | ⑥ | | | | H △ | ⑥ | | | | | | B | |
| | | Thrust pad | | | ① | | | | | △ | ① | | | | H △ | ① | | | | | | B | |
| | | Air cooler air inlet | | | ① | | | | | | | | | | | | | | | | | | |
| | | Air cooler air outlet | | | ① | | | | | | | | | | | | | | | | | | |
| | | Scavenging air | | | ① | | | | | △ | ① | | | | | | | | | | | | |
| | | Air cooler sea water inlet | | | 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 | Display | Recording | Independent | Display | Independent | Display | Recording | | | | | | | | | |
| MAIN ENGINE | Temperature | Exhaust gas each cylinder outlet | | | | | | | | △ | ⑥ | | | | H △ | ⑥ | | | | | | | B | | |
| | | Exhaust gas each cylinder outlet deviation | | | | | | | | △ | | | | | H △ | ⑥ | | | | | | | C | | |
| | | Exhaust gas turbocharger inlet | | | | | | | | △ | ① | | | | H △ | ① | | | | | | | C | | |
| | | Exhaust gas turbocharger outlet | | | | | | | | △ | ① | | | | H △ | ① | | | | | | | C | | |
| | | Scavenging box fire | | | | | | | | △ | ⑥ | | | | H △ | ⑥ | | | | | | | B | | |
| | | Fuel oil flow meter | | | ○ | | | | | | | | | | | | | | | | | | | | |
| | | Cylinder oil flow meter | | | ○ | | | | | | | | | | | | | | | | | | | | |
| | Tank level | Lub. oil sump tank | | | ① | | | | | | | | | | L ① | ① | | | | | | | | | C |
| | | Jacket cool. F.W. expansion tank | | | ① | | | | | | | | | | L ① | ① | | | | | | | | | C |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Cylinder oil alarm chamber | | | | | | | | | | | | | L ① | ① | | | | | | | | | C |
| | | Fuel oil leakage tank | | | | | | | | | | | | | H ① | ① | | | | | | | | | C |
| | | Mist catcher drain | | | | | | | | | | | | | H ① | ① | | | | | | | | | C |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | HCU | | | | | | | | | | | | | H ① | ① | | | | | | | | | C |
| | | | | | | | | | | | | | | | | | | | | | | | | | |

| 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 | Display | Recording | Independent | Display | Independent | Display | Recording | | | | | | | | | |
| MAIN ENGINE | Etc. | | | | | | | | | | | | | | | | | | | | | 1) Abnormal 2)Slow down request ⚠ | | | |
| | | Piston cooling oil non-flow | | | | | | | | | | | | | ⑥ | ⑥ | | | | | | | B | | |
| | | Crank case oil mist | | | | | | ⑦ | | | | | | | H ① | ① | | | | | | | B | | |
| | | Oil mist detector | | | | | | | | | | | | | 1) ① | ① | | | | | | | C | | |
| | | A-C oil change-over | | ○ | | | | | | | | | | | | | | | | | | | | | |
| | | M/E Axial vibration ⚠ | | | ⚠ | | | | | ⚠ | ① | | | | 2)H ⚠ | ① | | | | | | | | B | |
| | | M/E Axial vibration abnormal ⚠ | | | | | | | | | | | | | ① | ① | | | | | | | | C | |
| | | Fuel oil flow meter | | | ① | | | | | | | | | | | | | | | | | | | | |
| | | Cylinder oil flow meter | | | ① | | | | | | | | | | | | | | | | | | | | |
| | | M/E hydrauric pump ⚠ | ○ | ○ | | | ○ | | | | | | ② | | | ② | ② | | | | | | | | C |
| | | Deaeration tank | | | | | | | | | | | | | | 1) ① | ① | | | | | | | | C |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | M/E PSU AC power failure | | | | | | | | | | | | | | ② | ② | | | | | | | | C |
| | | M/E PSU UPS controller abnormal | | | | | | | | | | | | | | ② | ② | | | | | | | | C |
| | | M/E PSU 24V DC battery mode | | | | | | | | | | | | | | ② | ② | | | | | | | | C |

| 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 | Display | Recording | Independent | Display | Independent | Display | Recording | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| SHAFTING | Temperature | Intermediate shaft bearing | | | ① | | | | | | △ | ① | | | | H △ | ① | | | | | | C | |
| | | Stern tube bearing lub. oil outlet | | | ① | | | | | | | | | | | | | | | | | | | |
| | | Stern tube bearing | | | | | | | | | △ | ② | | | | H △ | ② | | | | | | B | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| | Tank level | | | | | | | | | | | | | | | | | | | | | | | |
| | | Stern tube lub. oil sump tank | | | ① | | | | | | | | | | | L ① | ① | | | | | | C | |
| | | Stern tube seal pot | | | | | | | | | | | | | | HL ② | ② | | | | | | C | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| | Etc. | Stern tube lub. oil non-flow | | | | | | | | | | | | | | ① | ① | | | | | | C | |
| | | Stern tube fwd seal lub. oil non-flow | | | | | | | | | | | | | | ① | ① | | | | | | C | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Spare seal ring “use” | | | | | | ○ | | | | 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 | Display | Recording | Independent | Display | Independent | Display | Recording | | | | | | | | | |
| ELECTRIC GENERATING PLANT | Diesel engine | Start | 1) ○ | ○ | | | | ○ | | | | | 2) ③ | | | | 3) ③ | ③ | | | | | D | 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 • F.W. high temp. | |
| | | Stop | | ○ | | | | ○ | | | | | | | | | | | | | | | | | |
| | | Change-over | | ○ | | | | 4) ○ | | | | | | | | | | | | | | | | | |
| | | Ready for start | | | | | | | | | | 5) ③ | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Emergency trip | 6) ○ | | | | | | | | | | | | | | ⑨ | ⑨ | | | | | D | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Fuel oil flow meter | | | | ① | | | | | | | | | | | | | | | | | | | |
| | | Fuel oil leakage tank | | | | | | | | | | | | | | | | H ③ | ③ | | | | | | D |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Speed relay abnormal | | | | | | | | | | | | | | | | ③ | ③ | | | | | | D |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |

| 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 | Display | Recording | Independent | Display | Independent | Display | Recording | | | | | | | | | |
| ELECTRIC GENERATING PLANT | | D/G pressure | Lub. oil inlet | | | ③ | | | | | | △ ₃ | ③ | | | | L △ ₃ | ③ | | | | | D | 1) By the wax type temp. control valve 2) By the pneumatic type temp. control valve | |
| | | | High temp. cooling F.W. inlet | | | ③ | | | | | | △ ₃ | ③ | | | | L △ ₃ | ③ | | | | | D | | |
| | | | Low temp. cooling F.W. inlet | | | ③ | | | | | | △ ₃ | ③ | | | | L △ ₃ | ③ | | | | | D | | |
| | | | Turbocharger lub. oil inlet | | | ③ | | | | | | | | | | L △ ₃ | ③ | | | | | | D | | |
| | | | Starting air inlet | | | | | | | | | | | | | L ③ | ③ | | | | | | | | D |
| | | | Control air inlet | | | | | | | | | | | | | L ③ | ③ | | | | | | | | D |
| | | | Fuel oil inlet | | | ③ | | | | | | | | | | | | | | | | | | | |
| | | | Fuel oil 3rd filter difference | | | | | | | | | | | | | | H ① | ① | | | | | | | D |
| | | | Lub. oil 2nd filter difference | ○ | | | | | | | | | | | | | H ③ | ③ | | | | | | | |
| | | D/G temperature | Lub. oil inlet | 1) ○ | | ③ | | | | | | | △ ₃ | ③ | | | | H △ ₃ | ③ | | | | | | D |
| | | | High temp. cooling F.W. outlet | 1) ○ | | ③ | | | | | | | △ ₃ | ③ | | | | H △ ₃ | ③ | | | | | | D |
| | | | Exhaust gas each cylinder outlet | | | ⑱ | | | | | | | | | | | | | | | | | | | |
| | | | Exhaust gas turbocharger inlet | | | ⑥ | | | | | | | △ ₆ | ⑥ | | | | H △ ₆ | ⑥ | | | | | | D |
| | | | Fuel oil inlet | 2) ○ | | ③ | | | | | | | △ ₃ | ③ | | | | HL △ ₆ | ⑥ | | | | | | D |
| | | | Low temp. cooling F.W. inlet | 2) ○ | | ① | | | | | | | △ ₁ | ① | | | | HL △ ₂ | ② | | | | | | D |
| | | | Boost air inlet | | | 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 | Display | Recording | Independent | Display | Independent | Display | Recording | | | | | | | |
| ELECTRIC GENERATING PLANT Generator | | Current | | | | | | ③ | | | | | | H ③ | ③ | | | | | | D | 1) “Stand-by” & “Run” 2) “MSB & FORE” & ”ESB” | |
| | | Voltage | | | | | | ③ | | | | | | HL ② | ② | | | | | | D | | |
| | | Frequency | | | | | | ② | | | | | | HL ② | ② | | | | | | D | | |
| | | Electric power | | | | | | ③ | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| | | MSB control source failure | | | | | | | | | | | | | ① | ① | | | | | D | | |
| | | MSB circ. breaker trip source failure | | | | | | | | | | | | | ① | ① | | | | | D | | |
| | | MSB control system failure | | | | | | | | | | | | | ① | ① | | | | | D | | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| | | ACB non-close | | | | | | | | | | | | | ③ | ③ | | | | | D | | |
| | | ACB abnormal | | | | | | | | | | | | | ③ | ③ | | | | | D | | |
| | | Preferential trip | | | | | | | | | | | | | ① | ① | | | | | D | | |
| | | AC440V insulation | | | | | | | | | | | | | L ① | ① | | | | | E | | |
| | | AC100V insulation | | | | | | | | | | | | 2) L ② | ② | ② | | | | | E | | |
| | | Emergency generator engine abnormal | | | | | | | | | | 1) ② | | | | ① | ① | | | | D | | |
| | | | | | | | | | | | | | | | | | | | | | | | |

| 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 | Display | Recording | Independent | Display | Independent | Display | Recording | | | | | | | | | | |
| AUXILIARY BOILER | | General | 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 • Exh. 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 | | |
| | | | Emergency trip | 1) ○ | ○ | | | | | | | | | | 2) ① | ① | | | | | | | D | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Running | F.O. burning pump | | ○ | | | | | | | | | | | | | | | | | | | | | |
| | | | Forced draft fan | 3) ○ | ○ | | | | | | | | | | | ① | ① | | | | | | | | D | |
| | | | Feed water pump | 4) ○ | ○ | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Pressure | Drum steam | 3) ○ | | ① | | | | △ | △ | ① | | | | L △ | ① | | | | | | | | | D |
| | | | Burner F.O. inlet | | | ① | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Temp. | F.O. heater outlet | 5) ○ | | ① | | | | | | | | | | | HL ② | ② | | | | | | | | D |
| | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | |

| 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 | Display | Recording | Independent | Display | Independent | Display | Recording | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| AUXILIARY BOILER | | Level | Drum | ○ | | ○ | | HL ② | | | | | | | | HL ② | ② | | | | | | D | 1) By the float valve 2) By the pneumatic type press. control valve | |
| | | | Cascade tank | ○ 1) | | | | | | | | | | | | | L ① | ① | | | | | | | D |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Etc. | Excess steam dumping | ○ 2) | ○ | | | | | | | | | | | | | | | | | | | | |
| | | | Soot blower | | ○ | | | | | | | | | | | | | | | | | | | | |
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| 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 | Display | Recording | Independent | Display | Independent | Display | Recording | | | | | | | | |
| FUEL OIL SYSTEM | | Running | Fuel oil purifier | 1) ○ | ○ | ② | | | | | | | ② | | 2) ② | ② | | | | | | E | 1) Auto. sludge discharge system (No.1 F.O. puri.) 2) Due to follows • Oil leakage 3) By the direct type temp. control valve 4) By the pneumatic type temp. control valve 5) Auto. start & stop by detecting fuel oil trans. pump running | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | Fuel oil shifter | 5) ○ | ○ | ② | | | | | | | | | | ① | ① | | | | | | | E |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | Fuel oil 2nd filter (Jet filter) difference [⚠] | | | | | | | | | | | | H ① | ① | | | | | | E | | |
| | | Temperature | Heavy fuel oil settling tank | 3) ○ | | ① | | | | | | | | | | H ① | ① | | | | | | | E |
| | | | Heavy fuel oil service tank | | | ① | | | | | | | | | | H ① | ① | | | | | | | E |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | L/S fuel oil service tank | | | ① | | | | | | | | | | H ① | ① | | | | | | | E |
| | | | F.O. tank [⚠] | | | | | | ⑥ | | | | | | ⑥ | H ① | ① | | | | | | | E |
| | | | Purifier fuel oil inlet | 4) ○ | | ② | | | | | | | | | | H ② | ② | | | | | | | E |
| | | | Shifter fuel oil heater outlet | 4) ○ | | ① | | | | | | | | | | H ① | ① | | | | | | | E |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | Waste oil tank | | | ① | | | | | | | | | | | H ① | ① | | | | | | E |
| | | | | | | | | | | | | | | | | | | | | | | | | |

| 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 | Display | Recording | Independent | Display | Independent | Display | Recording | | | | | | | | |
| FUEL OIL SYSTEM | | Tank level | Heavy fuel oil settling tank | 1) ○ | | ① | | | | | | | | | HL ② | ② | | | | | | E | 1) By auto. start & stop of F.O. transfer pump 2) Over flow system 3) By auto. stop of D.O. transfer pump 4) Overflow alarm | |
| | | | Heavy fuel oil service tank | 2) ○ | | ① | | | | | | | | | L ① | ① | | | | | | E | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | L/S fuel oil service tank | 2) ○ | | ① | | | | | | | | | L ① | ① | | | | | | E | | |
| | | | Diesel oil service tank | 3) ○ | | ② | | | | | | | | | HL ④ | ④ | | | | | | E | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
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| | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | Sludge tank | | | | | | | | | | | | | H ① | ① | | | | | | | E |
| | | | Fuel oil filter drain tank | | | | | | | | | | | | | H ① | ① | | | | | | | E |
| | | | Fuel oil overflow tank | | | | | | | | | | | | | H ① | ① | | | | | | | E |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Etc. | Fuel oil overflow line | | | | | | | | | | | | | 4) ① | ① | | | | | | | E |
| | | | | | | | | | | | | | | | | | | | | | | | | |
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| 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 | Display | Recording | Independent | Display | Independent | Display | Recording | | | | | | | | | |
| LUB. OIL SYSTEM | | Running | Lub. oil purifier | | ○ | | ① | | | | | | | | ① | | 2) ① | ① | | | | | | E | 1) By the pneumatic type temp. control valve 2) Due to follows • Oil leakage |
| | | | D/G Lub. oil purifier | | ○ | | | ① | | | | | | | ① | | 2) ① | ① | | | | | | E | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Temperature | Purifier lub. oil inlet | 1) ○ | | | ① | | | | | | | | | | | H ① | ① | | | | | | E |
| | | | D/G Purifier lub. oil inlet | 1) ○ | | | ① | | | | | | | | | | | H ① | ① | | | | | | E |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Level | D/G lub. oil overflow tank | | | | ① | | | | | | | | | | | L ① | ① | | | | | | E |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
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| 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 | Display | Recording | Independent | Display | Independent | Display | Recording | | | | | | | | |
| COMPRESSED AIR SYSTEM | Running | Main air compressor \triangle | 1) ○ | ○ | | | | 2) ○ | | | | | ② | ② | | 3) ② | ② | ② | | | | | E | 1) Auto. start & stop 2) Auto.- Manual and start - stop 3) Abnormal stop • Compress. air outlet high temp. 4) C.F.W. pump running request \triangle |
| | | Emergency air compressor | | ○ | | | | | | | | | | | | 4) ① | ① | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| | Pressure | Main air reservoir | | | ② | | | | | | \triangle | ② | | | | L \triangle | ② | ② | | | | | E | |
| | | Control air | | | ① | | | | | | | | | | | L ① | ① | ① | | | | | E | |
| | | Emergency shut off valve operating air | | | ① | | | | | | | | | | | L ① | ① | ① | | | | | E | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| | Temp. | Main air compressor cooling F.W. inlet | | | ② | | | | | | | | | | | | | | | | | | | |
| | | Main air compressor cooling F.W. outlet | | | ② | | | | | | | | | | | | | | | | | | | |
| BILGE SYSTEM | Level | Bilge well | | | | | | | | | | | | | H ③ | ③ | | | H ① | | | E | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
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| 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 | Display | Recording | Independent | Display | Independent | Display | Recording | | | | | | | | |
| AUXILIARY MACHINE | | General | Fresh water generator | 1) ○ | ○ | ① | | | | | | | | | 2) ① | ① | | | | | | E | 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 | |
| | | | Bilge separator | 8) ○ | ○ | ① | | | | | | | | | | 3) ② | ② | | | | | | | E |
| | | | Sewage treatment unit | | | | | | | | | | | | | 4) ① | ① | | | | | | | E |
| | | | Ballast water treatment system | | | | | | | | | | | | | 4) ① | ① | | | | | | | E |
| | | | Waste oil incinerator | | ○ | ① | 4) ① | | | | | | ① | | 4) ① | ① | | | | | | | | E |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Temp. | Hot water heater steam valve | 7) ○ | | | | | | | | | | | | | | | | | | | | |
| | | | Hot water heater outlet | 6) ○ | | ① | | | | | | | | | | | | | | | | | | |
| | | | Sea water (Ref. mach. C.S.W. pump outlet) | | | | | | | | △ | ① | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Etc. | Steering gear | | ○ | | | | | | | | ② | ② | | 5) ⑧ | ⑧ | ○ | | ② | ○ | | | E |
| | | | Air conditioner ref. machine | ○ | ○ | | | | | | | | | ① | | 4) ① | ① | | | | | | | E |
| | | | Provision ref. machine | ○ | ○ | | | | | | | | | ② | | 4) ② | ② | | | | | | | E |
| | | | Local fire fighting system | | | | | | | | | | | | | 4) ① | ① | | | | | | | E |
| | | | Local fire fighting system start | ○ | | | | | | | | | | | | | ① | ① | | | | | | E |

| 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 | Display | Recording | Independent | Display | Independent | Display | | | | | | Recording | | | | |
| GENERAL | | Lamp & buzzer test switch | | | | | | ○ | | | | | | | | | ○ | | | | | | 1) Source failure | | |
| | | Buzzer stop button | | | | | | ○ | | | | | | | | | ○ | | | | | | | | |
| | | Flicker stop button | | | | | | ○ | | | | | | | | | | | | | | | | | |
| | | Function test 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 | ② | | 1) ② | ② | | | | | | | | E | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
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| 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 | Display | Recording | Independent | Display | Independent | Display | Recording | | | | | | | | |
| PUMP AND FAN | | Main lub. oil pump | 1) ○ | ○ | | | | ○ | | | | | ② | ② | | 3) ② | ② | | | | | | C | 1) Auto. change by detect. the non-voltage and pressure 2) Auto. change by detect. the non-voltage 3) Abnormal stop 4) Auto. start and stop detect. by D/G running 5) Auto. start by restart of D/G via black-out 6) Auto. change by detect. the non-voltage and non-flow 7) Auto. stop by starting fixed water- based local fire fighting system 8) Auto. stop by D/G L.O. purifier abnormal flow |
| | | M/E hydraulic pump [△] | | | | | | | | | | | | | | 4) ② | ② | | | | | | C | |
| | | Fuel oil booster pump | 2) ○ | ○ | | | | ○ | | | | | ② | ② | | 3) ② | ② | | | | | | C | |
| | | M/E fuel oil circulating pump | 2) ○ | ○ | | | | ○ | | | | | ② | ② | | 3) ② | ② | | | | | | C | |
| | | Jacket cool. F.W. pump | 2) ○ | ○ | | | | ○ | | | | | ② | ② | | 3) ② | ② | | | | | | C | |
| | | Cooling S.W. pump | 2) ○ | ○ | | | | ○ | | | | | ② | ② | | 3) ② | ② | | | | | | C | |
| | | Stern tube lub. oil pump | 6) ○ | ○ | | | | ○ | | | | | ② | ② | | 3) ② | ② | | | | | | C | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| | | D/G fuel oil circulating pump | 2) ○ | ○ | | | | ○ | | | | | ② | ② | | 3) ② | ② | | | | | | D | |
| | | D/G diesel oil booster pump | 5) ○ | ○ | | | | ○ | | | | | ① | ① | | 3) ① | ① | | | | | | D | |
| | | Boiler F.O. booster pump | | ○ | | | | ○ | | | | | ① | ① | | 3) ① | ① | | | | | | D | |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| | | D/G L.O. purifier supply pump | 8) ○ | ○ | | | | | | | | | | | | | | | | | | | | |
| | | D/G lub. oil priming pump | 4) ○ | ○ | | ③ | | | | | | | | | | 3) ③ | ③ | | | | | | D | |
| | | Engine room ventilating fan | 7) ○ | | | | | ○ | | | | | ③ | ③ | | 3) ③ | ③ | | | | | | C | |
| | | | | | | | | | | | | | | | | | | | | | | | | |

| 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 | Display | Recording | Independent | Display | Independent | Display | Recording | | | | | | | |
| PUMP AND FAN | Fuel oil transfer pump | 1) ○ | ○ | | | | | ○ | | | | | ① | | | | | | | | | | 1) Auto. start and stop by detecting the H.F.O. settling tank level 2) Auto. stop by detecting the D.O. service tank level 3) Auto. stop by bilge separator abnormal 4) Auto. change by detect. the non-voltage 5) Abnormal stop 6) Auto. start and stop by detecting the press. tank pressure 7) Due to long running 8) “No.1”-“No.2” 9) Auto. Start and stop by detect. Main air comp. running 10) Auto. stop by L.O. purifier abnormal flow |
| | Diesel oil transfer pump | 2) ○ | ○ | | | | | 8) ○ | | | | | ① | | | | | | | | | | |
| | Lub.oil transfer and lub. oil purifier supply pump | 10) ○ | ○ | | | | | ○ | | | | | ① | | | | | | | | | | |
| | Bilge pump | 3) ○ | ○ | | | | | ○ | | | | | ① | | | 7) ① | ① | | | | | E | |
| | Sludge pump | | ○ | | | | | ○ | | | | | ① | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| | Boiler feed water pump | 4) ○ | ○ | | | ② | | | | | | | ② | | | 5) ② | ② | | | | | D | |
| | Fire & G.S. pump | | ○ | | | | | ○ | | | | | ① | | | | | ○ | | | | | |
| | Bilge & ballast pump | | ○ | | | | | ○ | | | | | ① | | | | | | | | | | |
| | Ballast pump | | ○ | | | | | ○ | | | | | ② | | | | | | | | | | |
| | Ref. mach. C.S.W. pump | | ○ | | | | | ○ | | | | | ① | | | 5) ① | ① | | | | | E | |
| | Main air compressor C.F.W. pump | 9) ○ | ○ | | | | | | | | | | ② | ② | | 5) ② | ② | | | | | E | |
| | Fresh water pump | 6) ○ | ○ | | | | | ○ | | | | | ① | | | | | | | | | | |
| | Drinking water pump | 6) ○ | ○ | | | | | ○ | | | | | 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. |
| 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 |
|-----------------------------------|-------|

(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 |
|------------------------|-------|

(10) Hydraulic cylinder unit (HCU)

| | |
|------------------------|-------|
| Maker's standard spare | 1 set |
|------------------------|-------|

(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) and Hot water circ. pump (1 set) and Main air comp. C.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), D/G L.O. puri. supply pump (1 set), D/G D.O. boost. pump (1 set) and Boiler F.O. booster 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 |
|---------------------|--------|

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 |
| 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 (owner supply) | 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) |
| Tool cabinet (in the workshop) | 2 | |

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 |