PETRONET

Machinery Operating Manual

LNGC DISHA (H2210)

Machinery Symbol and Colour Scheme

STANDARD SYMBOL VALVE, COCK, STRAINER, PIPE FITTING & INSTRUMENT			
SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
	B'FLY LUG TYPE		QUICK CLOSING WIRE (STR/ANG)
	B'FLY WAFER TYPE		REM. HYD. B'FLY LUG
	B'FLY FLANGE TYPE		REM. HD. B'FLY WAFER
	BALL FULL BORE SOLID		REM. HYD. B'FLY FLANGE
	BALL 3-WAY (T - TYPE/L - TYPE)		SELF CLOSING SPRING (STR./ANG)
	COCK 2-WAY		SAFETY (STR./ANG)
	COCK 3-WAY (T - TYPE/L - TYPE)		STORM VERT. SWING CHECK STR.
	FLOW CONT. BALL FLOAT		STORM VERT. SWING CHECK STR.
	FLOW CONT. BALL FLOAT CHECK		TEMP. CONROL 2-WAY WAX
	FLOW CONT. 2-WAY DISC/DIAPHRAGM		TEMP. CONTROL 2-WAY PNEU.
	GLOBE (STR./ANG)		TEMP. CONTROL 3-WAY WAX
	GLOBE SDNR (STR./ANG)		TEMP. CONTROL 3-WAY ROTARY PISTON
	SOLENOID 2-WAY (STR.)		TEMP. CONTROL 2-WAY ROTARY PISTON
	GATE NON-RISING		TEMP. CONTROL 3-WAY ROTARY PISTON WITH HANDLE
	HOSE GLOBE (STR./ANG)		REM. HYD. B' FLY WAFER PISTON WITH HANDLE
	GLOBE SDNR WITH HOSE CONNECTOR (STR/ANG)		WATER SEAL GLOBE (STR)
	MAGNETIC 2-WAY (STR./ANG)		WATER SEAL GATE
	MAGNETIC 3-WAY		WATER SEAL REM. ELEC. B' FLY WATER WITH HANDLE
	NON-RETURN FLAP		BELL MOUTH
	NON-RETURN SWING		BLANK FLANGE
	NON-RETURN LIFT (STR./ANG)		BOSS AND PLUG
	NON-RETURN BALL WITHOUT SPRING		DRESSER COUPLING
	NEEDLE STR.		SLEEVE COUPLING
	LOCK (OPEN/CLOSE)		BELLOWS COUPLING
	NEEDLE 3-WAY TEST		NOZZLE
	PRESS. CONT. PRIMARY PNEU.		FLEXIBLE HOSE
	PRESS. CONT. REDUCING PNEU.		HOPPER
	PRESS. CONT. REGULAT'G		OVERBOARD
	QUICK CLOSING PNEU. (STR/ANG)		REDUCER
	QUICK CLOSING HYD. (STR/ANG)		BRANCH

STANDARD SYMBOL VALVE, COCK, STRAINER, PIPE FITTING & INSTRUMENT			
SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
	SEPARATOR		FLOW METER
	SPECTACLE FLANGE (NORMAL OPENED/CLOSED)		HORN
	ORIFICE PLATE		EJECTOR
	SPOOL PIECE		AUTO FILTER
	AIR VENT GOOSE NECK PIPE		PORTABLE TANK
	AIR VENT GOOSE NECK (FLOAT/SCR.)		HULL TANK
	AIR VENT (FLOAT/FLOAT SCR.)		CENTRIFUGAL PUMP
	SOUNDING CAP SELF CLOS'G WEIGHT WITH SELF CLOS'G COCK		GEAR PUMP
	SOUNDING CAP NORMAL		HAND PUMP
	SOUNDING CAP DK PIECE		SCREW PUMP
	SOUNDING CAP SELF CLOS'G WEIGHT PEDAL WITH SELF CLOS'G COCK		MONO PUMP
	FILLING CAP		PISTON PUMP
	MUD BOX (ANG./STR.)		VISC. CONTROLLER
	ROSE BOX		F.W FOUNTAIN
	LEVEL GAUGE WITH VALVE (FLAT/CYLINDRICAL TYPE)		WASH BASIN
			SHELL/TUBE TYPE HEAT EXCH.
	LEVEL GAUGE (DIAL FLOAT/FLOAT) TYPE		COOLER PLATE TYPE
			MAKER SUPPLY
	LEVEL GAUGE WITH VALVE (DIAL TYPE)		STEAM TRACING AND INSULATION
			INSULATION
	SIGHT GLASS		HYD. OIL PIPE
	STRAINER Y-TYPE		CONTROL AIR PIPE
	STRAINER SIMPLEX		CAPILLARY TUBE
	STRAINER DUPLEX		ELECTRIC CABLE
	STEAM TRAP FLOAT TYPE		DECK
	STEAM TRAP DISC TYPE WITH V/V		VISCOSITY SENSOR
	FILTER REGULATOR		LOCAL INSTRUMENT
	STEAM TRAP BIMETAL TYPE		REMOTE CONTROL INSTRUMENT
	SEAL POT TANK SIPHON		AUX. SWITCH
	LOOP SEAL PIPE SIPHON		

Symbol Colour

CARGO LINE	RGB (0, 0, 255)
STRIP LINE	RGB (0, 255, 255)
VAPOUR LINE	RGB (226, 0, 255)
GAS LINE	RGB (253, 253, 0)
STEAM LINE	RGB (255, 0, 0)
N2 LINE	RGB (255, 89, 0)
IG LINE	RGB (74, 74, 74)
LO LINE	RGB (255, 218, 0)
FO LINE	RGB (0, 0, 0)
GLY. W. LINE	RGB (0, 255, 175)
SEA W. LINE	RGB (0, 255, 0)
F.W LINE	RGB (0, 0, 255)
HYD. OIL LINE	RGB (255, 0, 168)
DO LINE	RGB (255, 135,0)
COND. LINE	RGB (0, 0, 255)
AIR LINE	RGB (128, 159, 255)
BILGE LINE	RGB (0, 255, 0)

Electrical Symbol List

	STARTER (DIRECT ON LINE)		TRANSFORMER		OVERCURRENT RELAY	BL	BELL	
GSP	LOCAL GROUP STARTER PANEL	LD	LIQUID SENSOR	I O	I/O CABINET (ALARM MONITORING SYSTEM)		110 CENTRAL METER	
C P	CONTROL PANEL	I P	CURRENT TO PRESS CONVERTER	SIG R B	WHISTLE RELAY BOX		RECTIFIER EQUIPMENT	
PD	440V DIST. BOARD	P I	PRESS TO CURRENT CONVERTER	GJB/XX	GROUP JUNCTION BOX XX (XX=LOCATION)		MAKING CONTACT	AUXILIARY RELAY CONTRACT
LD	220V POWER DIST. BOARD	RMP	RPM PICK-UP		RESISTOR		BREAKING	
LD L	LIGHTING DIST. BOARD		GAUGE		VARIABLE RESISTOR		MAKING CONTACT	WITH TIME LIMIT IN CLOSING
M	AIR CIRCUIT BREAKER	IS	INTRINSICALLY SAFETY CIRCUIT		DIMMER		BREAKING	
	MCCB 1 PHASE		POWER SUPPLY UNIT		DIODE		MAKING CONTACT	WITH TIME LIMIT IN OPENING
	MCCB 3 PHASE	ZBK	ZENER BARRIER BOX		CAPACITOR		BREAKING	
	BATTERY CHARGER	LM	LIMIT SWITCH	10A	FUSE		MAKING CONTACT	FLICKER RELAY
	BATTERY		SOLENOID VALVE		FUSE		BREAKING	
	SPACE HEATER (ELEMENT TYPE)	VR	VOLTAGE REFERENCE SELECTOR		DISCONNECTION SWITCH		PUSHBUTTON SWITCH (ALTERNATIVE)	
DG	DIESEL GENERATOR		RECEPTACLE		SNAP SWITCH		PUSHBUTTON SWITCH (ALTERNATIVE)	
EG	EMERGENCY GENERATOR	J	NWT JOINT BOX		CHANGEOVER SWITCH (CAM SWITCH)		PUSHBUTTON (START/STOP)	
M	AC INDUCTION MOTOR	J J	WT JOINT BOX 2 GLANDS (4 GLANDS)		INDICATOR LAMP WITH TRANSFORMER		PUSHBUTTON (START/STOP/RUNNING)	
GM	GOVERNOR MOTOR	HS	HUMIDISTAT	RL	INDICATOR LAMP		EMERGENCY STOP PUSHBUTTON BOX	
	EARTH	WT	WATER TRANSDUCER	D-D	RELAY COIL	Trip	AUTOMATIC TRIP	
	SHIELD WIRE	AMS	ALARM MONITORING SYSTEM	BZ	BUZZER			

CP	COMPOUND GAUGE
DPI	DIFFERENTIAL PRESSURE INDICATOR
DPS	DIFFERENTIAL PRESSURE SWITCH
DPT	DIFFERENTIAL PRESSURE TRANSMITTER
FD	FLOW DETECTOR
FS	FLOW SWITCH
FT	FLOW TRANSMITTER
IL	INDICATION LAMP
LAH	LEVEL ALARM HIGH
LAHH	LEVEL ALARM HIGH HIGH
LAL	LEVEL ALARM LOW
LI	LEVEL INDICATOR
LIC	LEVEL INDICATING CONTROLLER
LS	LEVEL SWITCH
LT	LEVEL TRANSMITTER
PAH	PRESSURE ALARM HIGH
PAL	PRESSURE ALARM LOW
PI	PRESSURE INDICATOR
PIC	PRESSURE INDICATING CONTROLLER
PIAH	PRESSURE INDICATOR ALARM HIGH
PIAL	PRESSURE INDICATOR ALARM LOW
PIAHL	PRESSURE INDICATOR ALARM HIGH LOW
PS	PRESSURE SWITCH
PT	PRESSURE TRANSMITTER
SAH	SALINITY ALARM HIGH
SD	SALINITY DETECTOR
SI	SALINITY INDICATOR
SV	SOLENOID VALVE
TAH	TEMPERATURE ALARM HIGH
TAL	TEMPERATURE ALARM LOW
TI	TEMPERATURE INDICATOR
TIC	TEMPERATURE INDICATING CONTROLLER
TIAH	TEMPERATURE INDICATOR ALARM HIGH
TIAL	TEMPERATURE INDICATOR ALARM LOW
TIAHL	TEMPERATURE INDICATOR ALARM HIGH LOW
TS	TEMPERATURE SWITCH
TT	TEMPERATURE TRANSMITTER
VAH	VISCOSITY ALARM HIGH
VAL	VISCOSITY ALARM LOW
VCA	VACUUM ALARM
VCI	VACUUM INDICATOR
VCT	VACUUM TRANSMITTER
XS	AUXILIARY UNSPECIFIED SWITCH
ZI	POSITION INDICATOR
ZS	LIMIT SWITCH
XXX	LOCALLY MOUNTED INSTRUMENT
XXX XXXX	REMOTELY MOUNTED INSTRUMENT

Part 1 : Ship Particulars

Part 1
Ship Particulars

Part 1 : Ship Particulars

1.1 Principal Particulars

1.1.1 Principal Particulars of the Ship

Shipbuilder	Daewoo Shipbuilding and Marine Engineering Co., Ltd. Okpo Shipyard Republic of Korea
Yard Number	2210
Ship Name	DISHA
Year Built	2002
Delivered	2004
Nationality	Malta
Port of Registration	Valletta
Call Sign	**************
Inmarsat-C I.D.	**************
Type of Cargo	LNG
Type of Ship	Segregated Ballast LNG Carrier
Stem	Bulbous Bow and Raked Stem
Stern	Transom
Navigation	Foreign Going
Classification	Bureau Veritas and IRS I + HULL + MACH, Liquefied Gas Carrier/LNG, Ship type 2G (-163 °C 500 kg/m^3 0.25 bar), Unrestricted navigation, +VeriSTAR-HULL, + AUT-UMS, + SYS-NEQ-1, + MON-Shaft, , In-watersurvey
Length Overall	277.0 m
Length Between Perpendiculars	266.0 m
Breadth Moulded	43.4 m
Depth Moulded	26.0 m
Design Draught	11.4 m
Scantling Draught	12.5 m
Cargo Tank Capacity	138,097 m^3
Gross tonnage	94058 Tons
Net tonnage	28217 Tons
Freeboard	8773 mm from deck (Sunken deck)
Displacement	100149 Tons at the design draft of 11.4 m
Deadweight	70151 Tons at the design draft of 11.4 m
Design speed	19.6 knots with 90% MCR, with 21% sea margin / 20.5 knots with 90% MCR, with out sea margin
Ballast Draft	9.7 m
Cargo Tank Safety Valve	25 kPag
Insulation Safety Valve	1 kPag
Fuel Oil Consumption per day	166.8 Tons per day.
Guaranteed boil-off rate	0.15% / day

Main Turbine

Maker	Kawasaki
No. of Set	1
Type	UA-306
Output	MCR 36,000 PS (88 rpm) NCR 32,400 PS (85 rpm)
Steam Pressure	5.88 MPag (60 kgf/cm^{2}g)
Steam Temperature	510ºC

Main Boiler

Maker	Mitsubishi Heavy Industries Ltd.
No. of Set	2
Model	MB-4B-NS
Max. Evaporation	63,000 kg/h
Nor. Evaporation	54,000 kg/h
Max. Steam Condition	6.81 MPag /284.9ºC
Nor. Steam Condition	6.61 MPag /283ºC

Turbo generator

Make	Mitsubishi Heavy Ind.
Type	Horizontal Multi-stage Impulse condensing turbine AT42CT-B
No. of Set	2
Capacity	3450 kW

Diesel generator

Maker	STX Corporation
Type	4 stroke Trunk Piston 8L 32/40
No. of Set	1
Capacity	3664 kW(Eng.) 3459 kW(Gen.)

EM'CY generator

Maker	STX Corporation
Type	4 stroke Water cooled KTA38DMGE
No. of Set	1
Capacity	850 kW

Steering gear [IMO-100]

Maker	YooWon Industries Ltd
Type	YSFTX2-380-2(45°)
No. of Set	2
Torque	3.334 kN-m, 340 t-m
Hyd. Pump capacity	386 l/min.
Elect. Motor kW & rpm	90 kW & 1200 rpm

Ballast stripping eductor

Type	FCD450/SUS316 Nozzle Sea Water Driven Eductor
No. of Set	1
Capacity	300 m^3/hour

Ballast pump

Type	Vertical Centrifugal
No. of Set	3
Capacity	3000 m^3/hour x 300 MTH.

Windlass

Maker	Rolls-Royce
Type	BFMC41.102 Electro-Hydraulic
No. of Set	2
Capacity	49.4 Tons

Mooring winch

Maker	Rolls-Royce
Type	WMC41030
No. of Set	7
Capacity	30 Tons

Hose handling crane

Maker	HYDRALIFT
Type	MCV1800-10-24Ex Electro-Hydraulic
No. of Set	2
Capacity	10 Tons

Provision handling crane

Maker	HYDRALIFT
Type	MCV1800-15-16 ELECTRO-HYDRAULIC
No. of Set	2
Capacity	15 Tons

Anchor

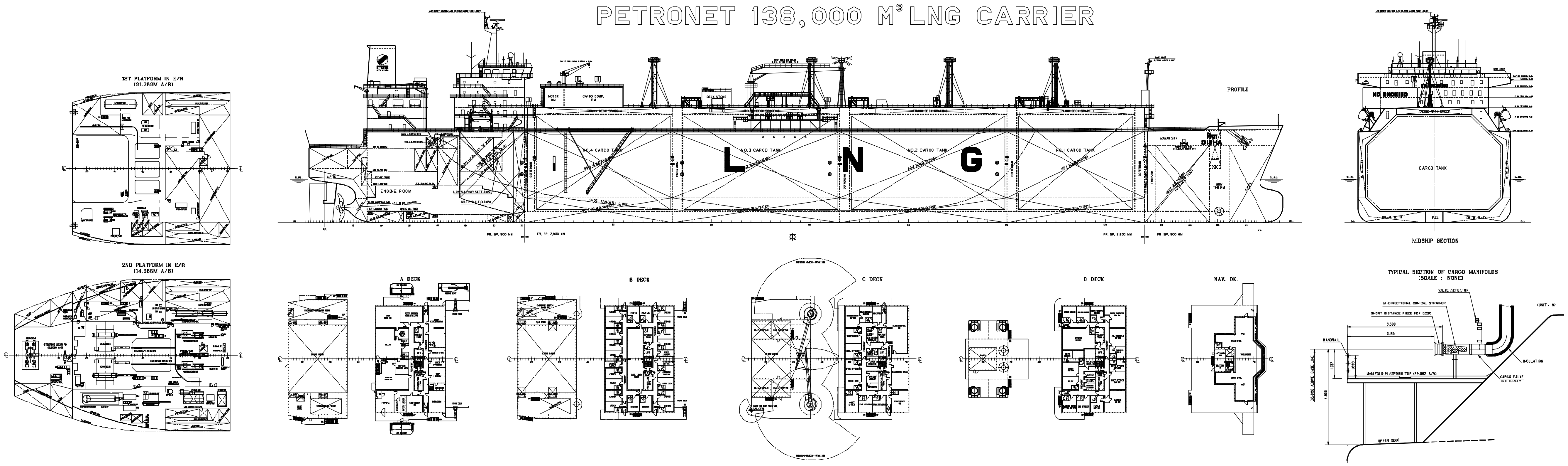
Maker	Kum Hwa Cast Steel
Type	HHP
No. of Set	3
Weight	13,350 kg

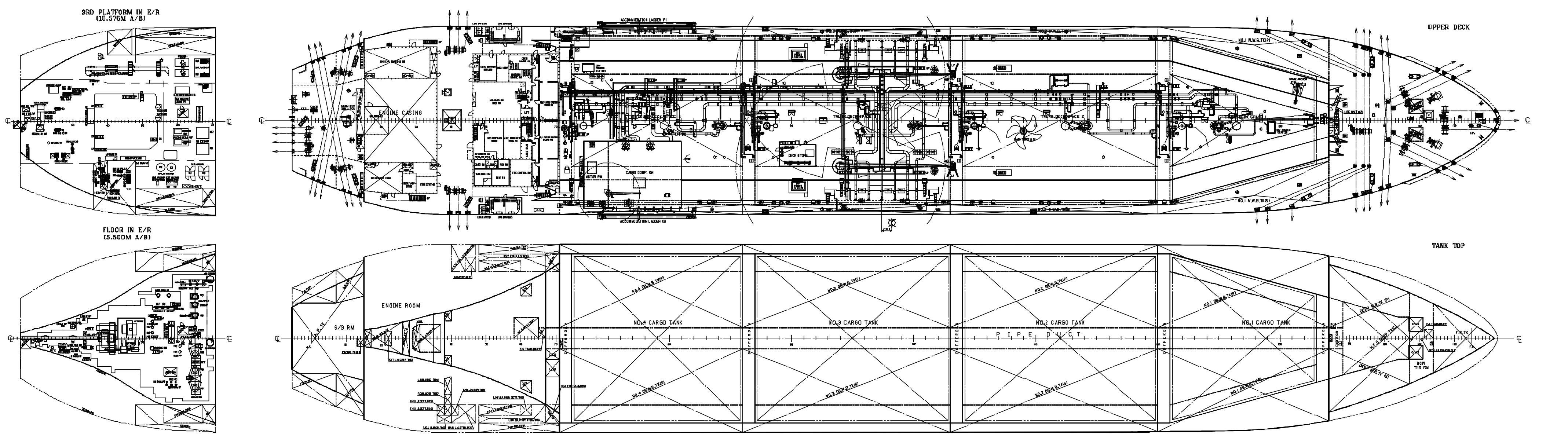
Anchor chain cable

Maker	Dai Han Anchor Chain
Type	Flash butt welded extra high Strength steel (Grade Q3A)
No. of Set	1
Dimension	102 mm Dia x 742.5 m

Air capstan	
Maker	Yong Nam Marine Mach.
Type	Pneumatic type
No. of Set	4
Capacity	0.5 Tons X 25 m/min.
Rope reel winch	
Type	Manual type
No. of Set	2
Stowage capacity	38 mm Dia. X 90 m
Accommodation ladder	
Maker	Sam Gong Co., Ltd
Type	Vertical self stowing type
No. of Set	2
Hawsers	
Type	6 X 36 IWRC Galv'd
No of Set	22
Size	42 mm Dia. X 275 m

1.2 G/A Plan





PRINCIPAL PARTICULARS

Length Over All		277.00 M
Length Between Perp.		266.00 M
Breadth	(mld)	43.40 M
Depth	(mld)	26.00 M
Draft Design	(ext)	11.42 M
Scant.	(ext)	12.52 M

SERVICE SPEED 19.6 Knots at 90% MCR WITH 21% S.M.

MAIN ENGINE TYPE : MARINE STEAM TURBINE
MCR : 36,000 PS x 88.0 RPM
NCR : 32,400 PS x 85.0 RPM

CLASSIFICATION

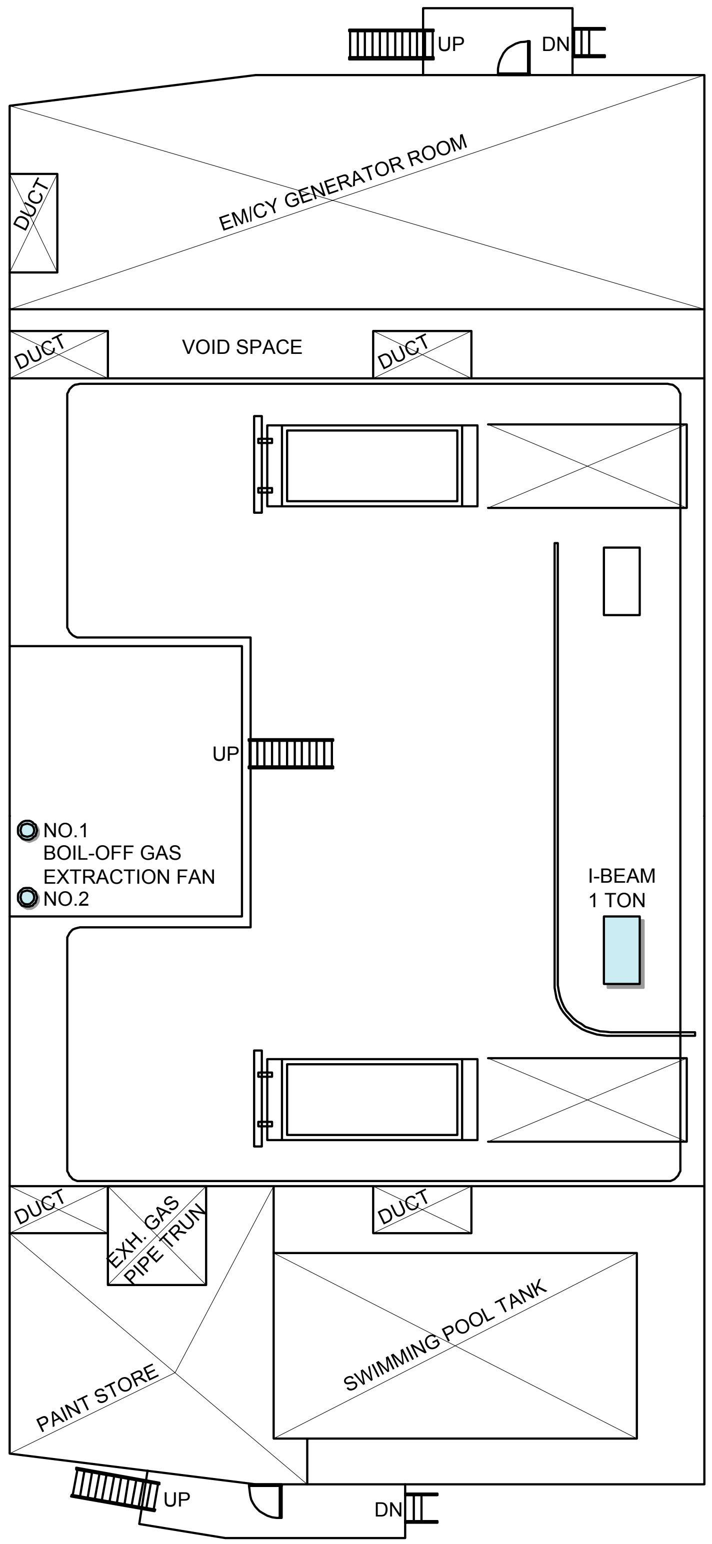
BUREAU VERITAS :

I +HULL +MACH. Liquefied gas carrier/LNG. Ship type 2G (-163 °C, 500kg/m³, 0.25 bar), unrestricted navigation, +VeriSTAR-HULL, +AUT-UMS, +SYS-NEQ-1, +MON-SHAFT, INWATERSURVEY.

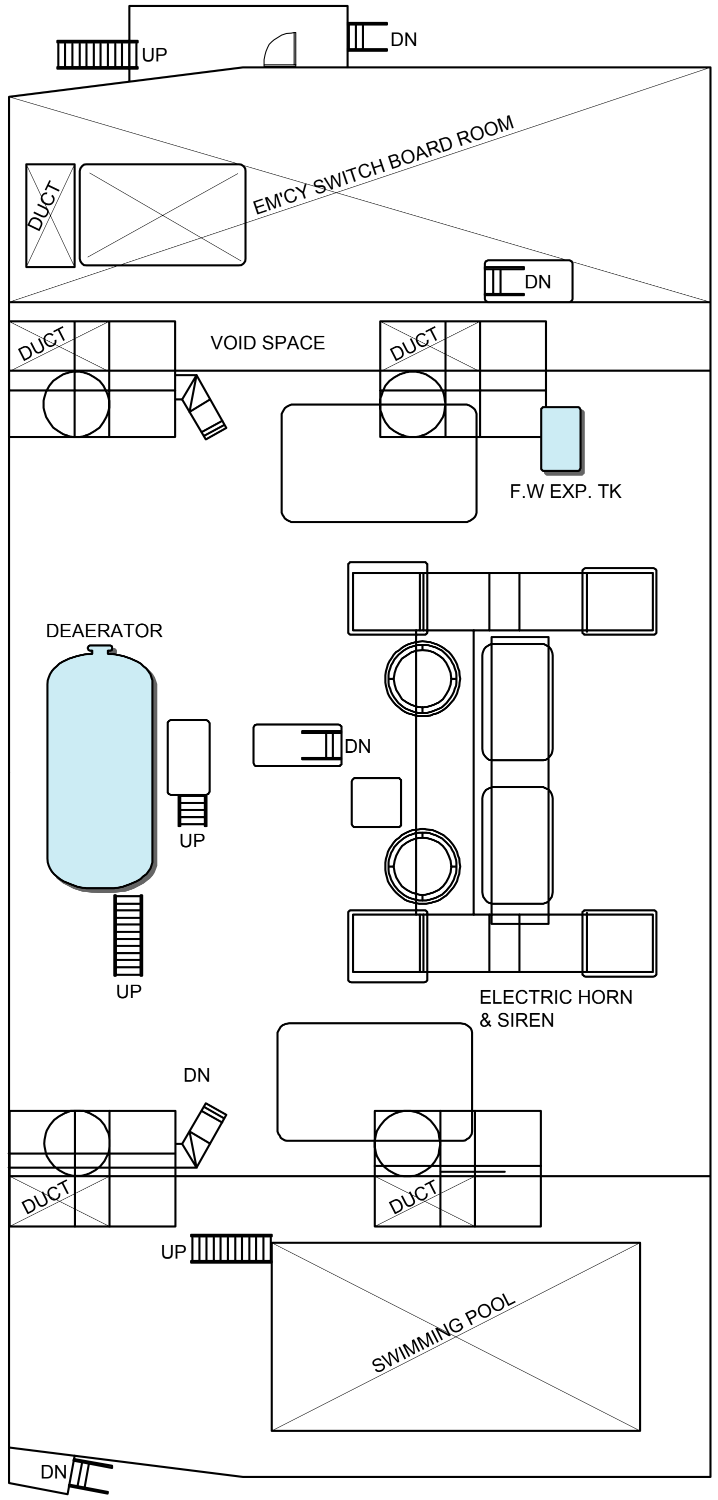
COMPLEMENT : 41 PERSONS + 6 SUEZ CREW

1.3 Engine Room Arrangement

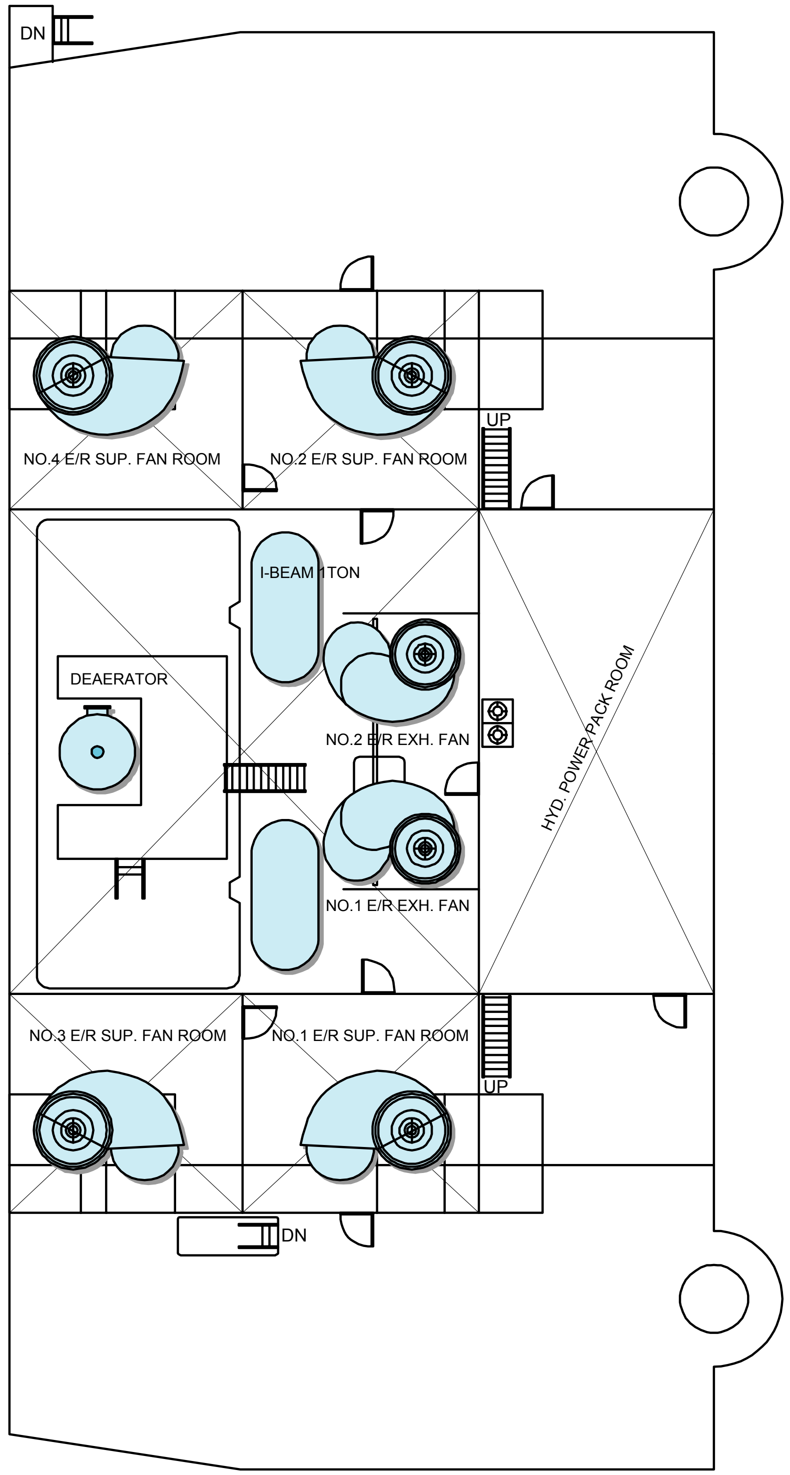
Casing A Deck



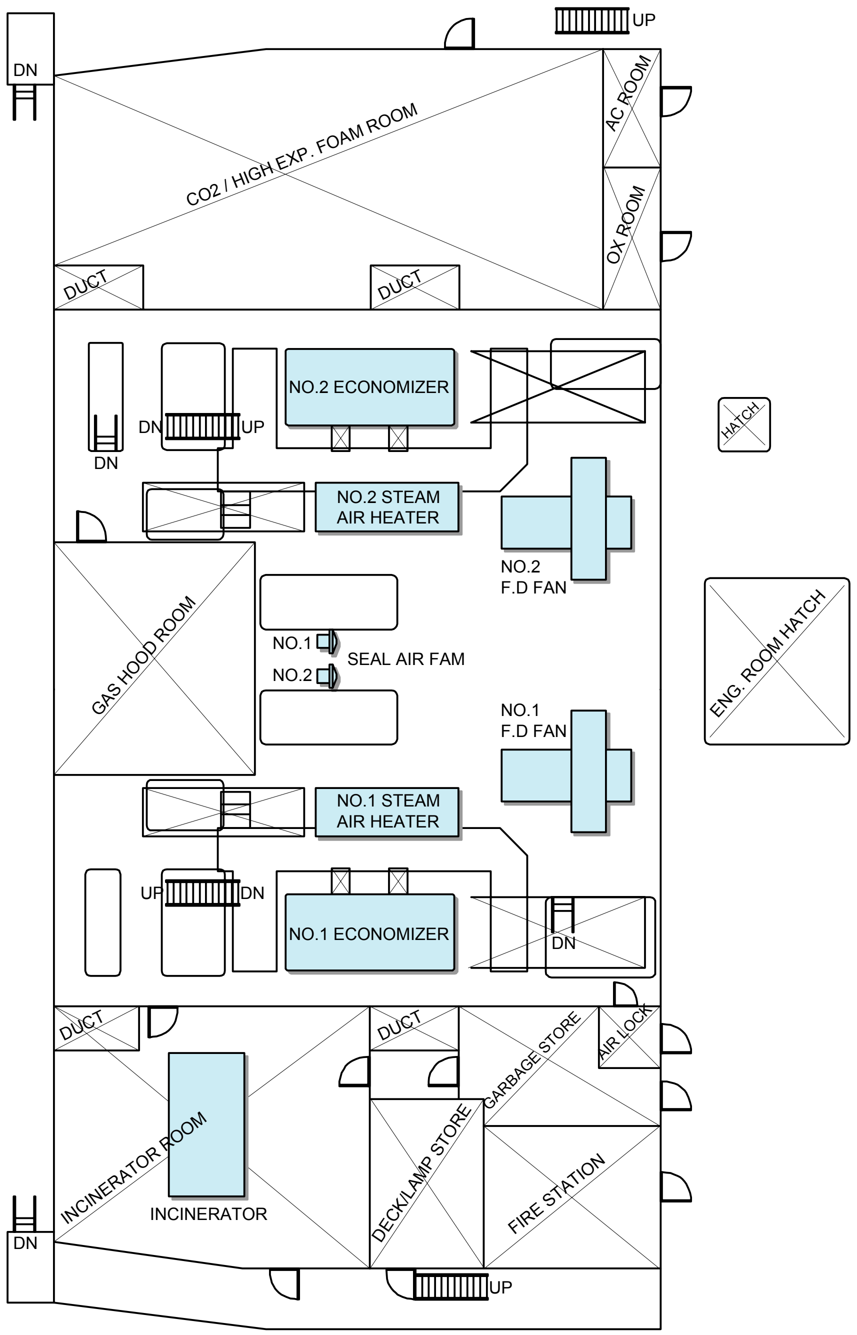
Casing B Deck



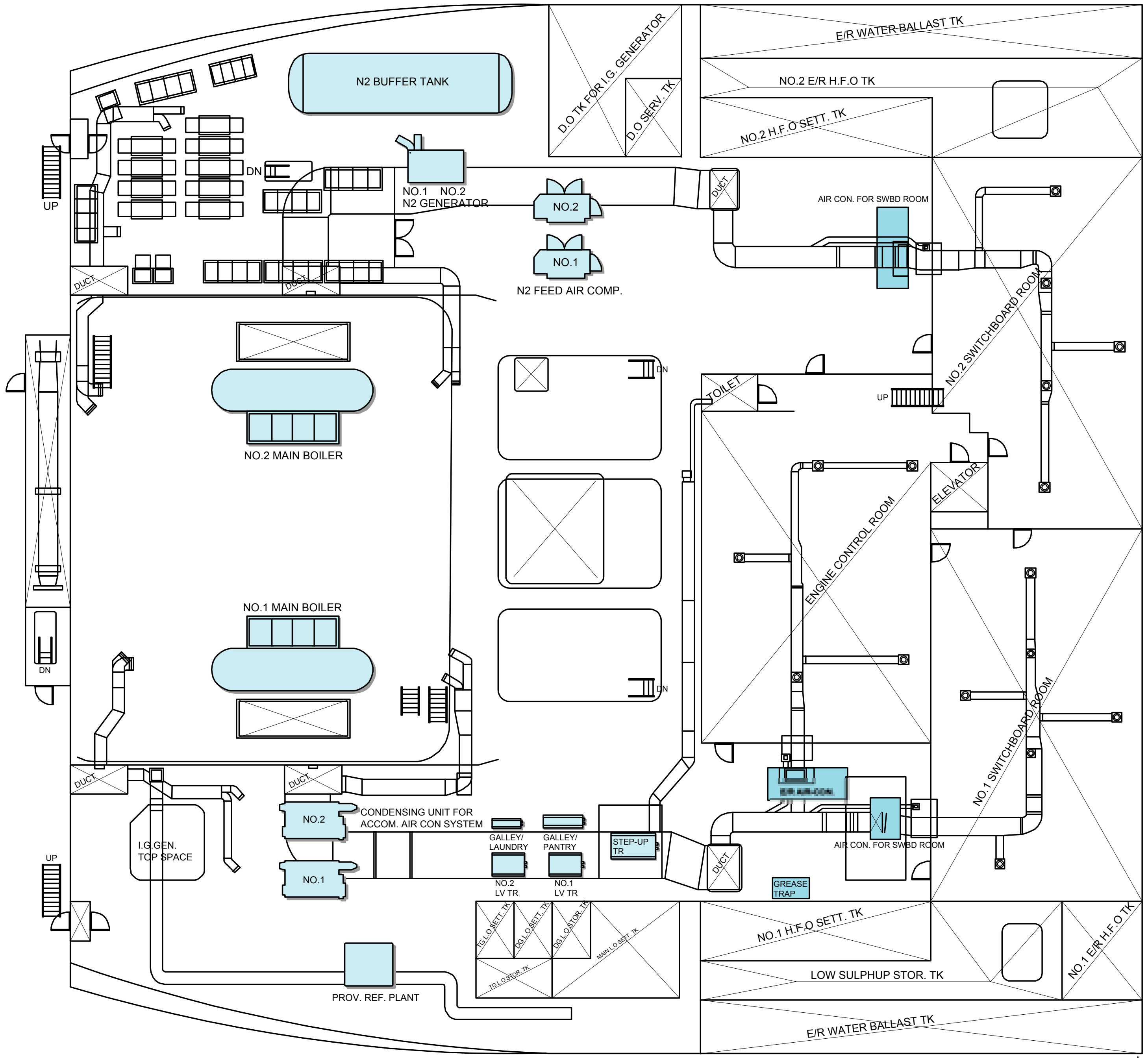
Casing C Deck



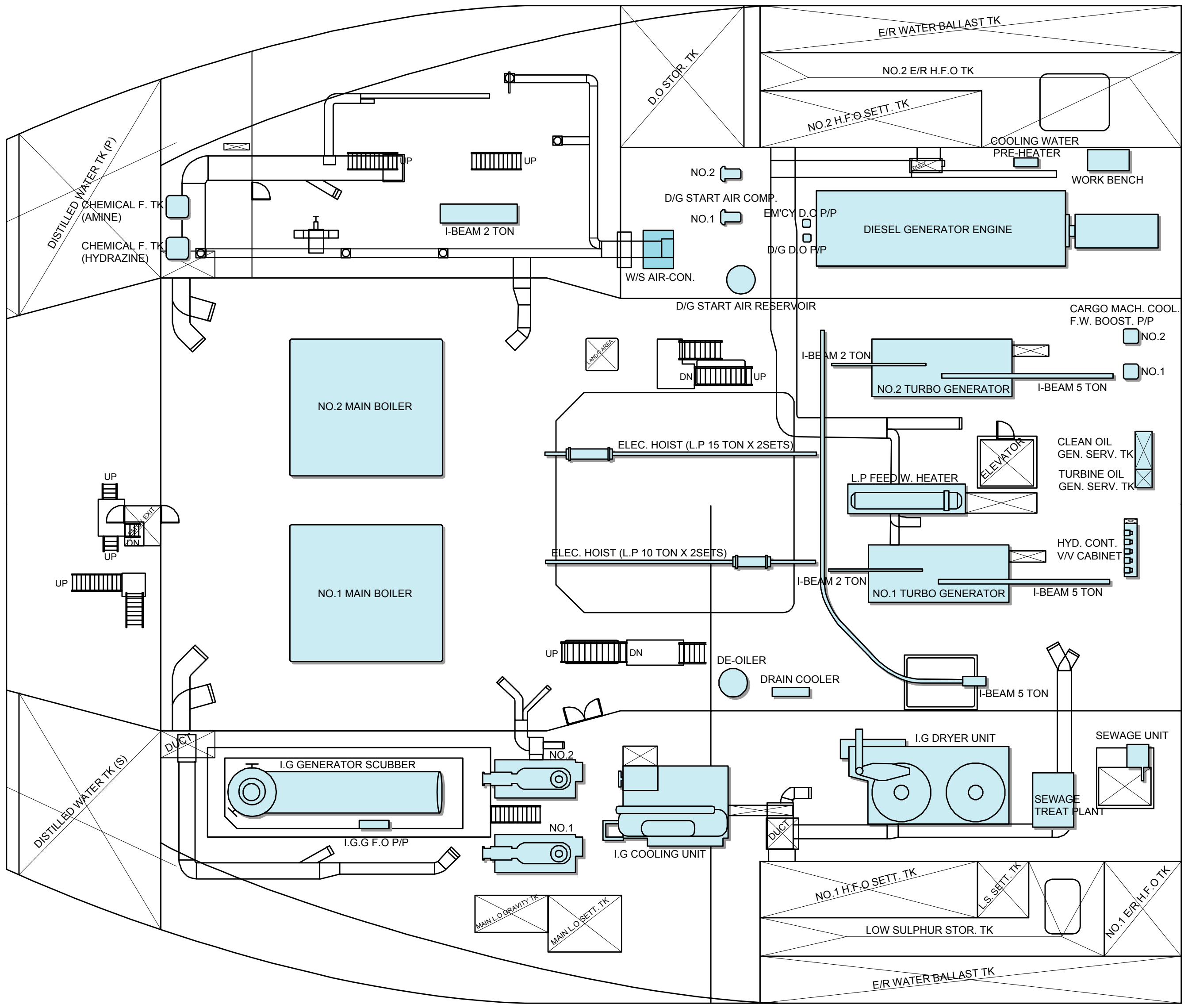
Casing Upper Deck



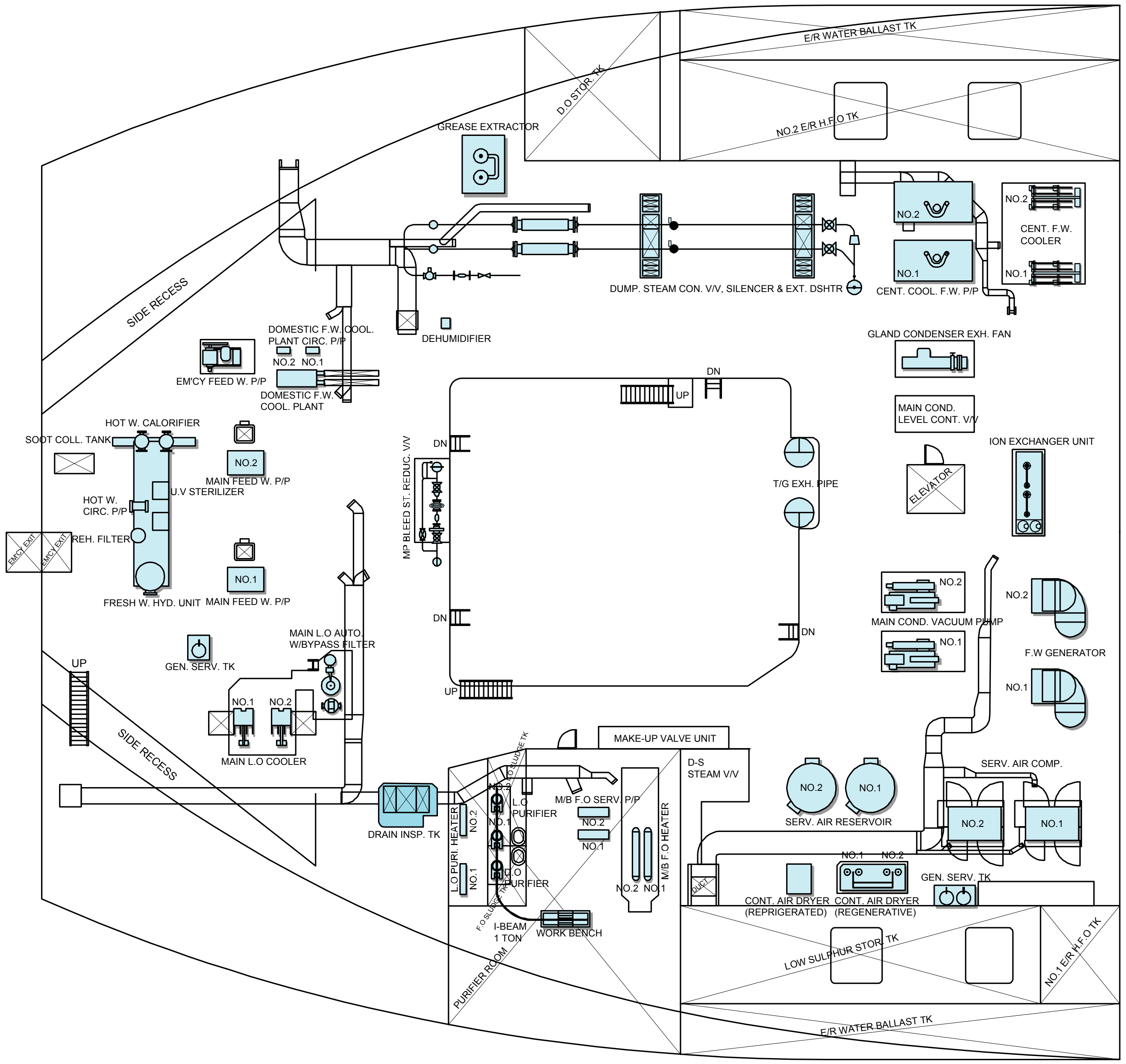
E/R 1st Platform



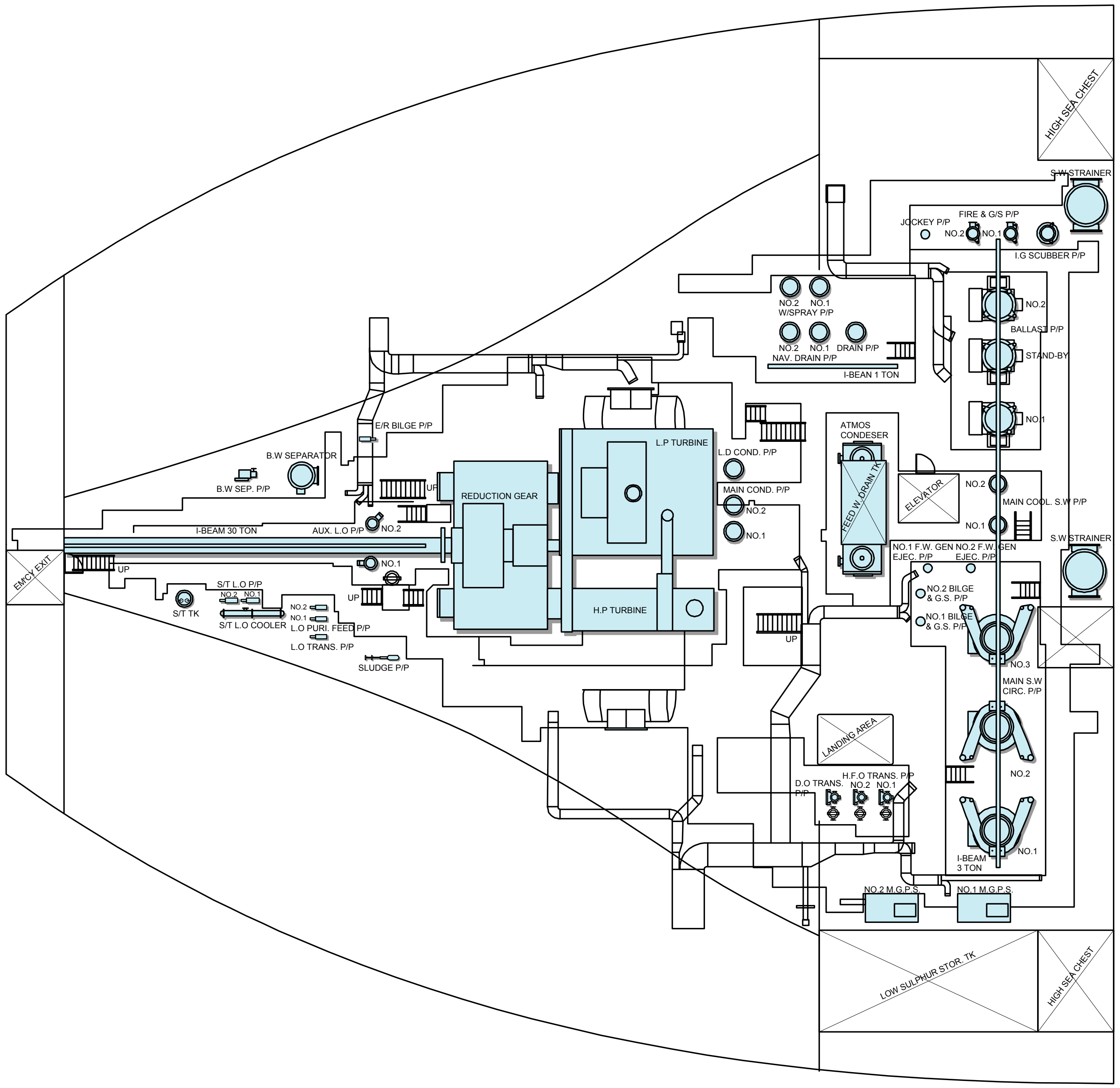
E/R 2nd Platform



E/R 3rd Platform



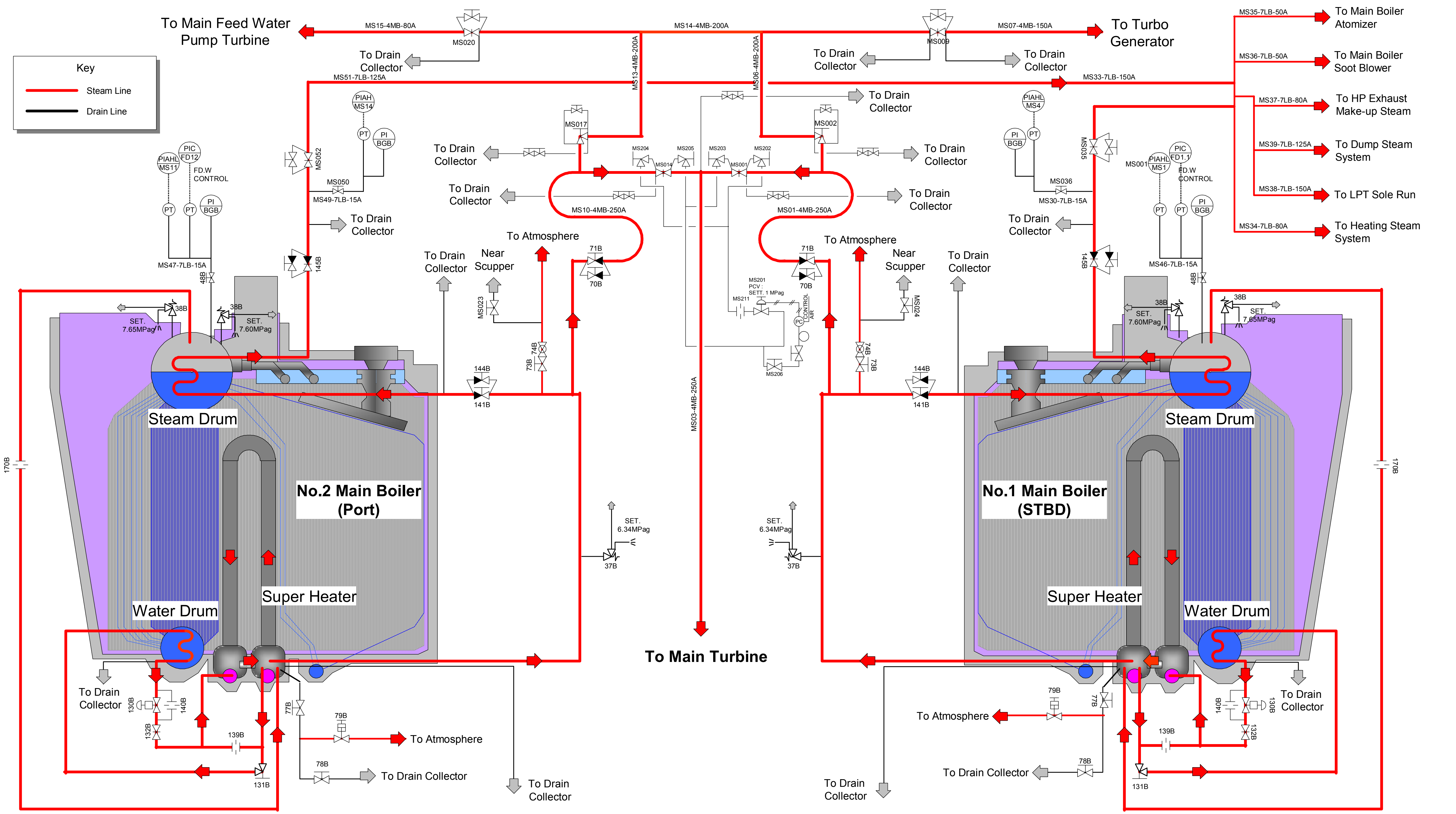
E/R Floor Deck



Part 2 : Ship System

Part 2
Ship System

Illustration 2.1.1i Superheated Steam



Part 2 : Ship System

2.1 Steam Systems

2.1.1 Superheated Steam System

Boiler Details

Maker :	Mitsubishi Heavy Industries Ltd.
No. of Sets :	2
Model :	MB-4B-NS
Maximum Evaporation :	63,000 kg/h
Normal Evaporation :	54,600 kg/h
Steam Condition :	6.03MPag superheated steam at 515°C

Safety Valve Settings

Drum High Set :	7.65 MPag
Drum Low Set :	7.60 MPag
Superheater :	6.34 MPag

All the steam requirements for the vessel are generated within the two main boilers. Steam from the steam drum is led to the primary superheater section through an orifice where the drop in pressure is measured and converted to a signal for steam flow. The steam, then, flows through the primary section of the superheater and on to the secondary superheater section.

Taking steam from the primary superheater and leading it through the temperature control desuperheater, which is located in the water drum that regulates the outlet temperature of the steam. The control valve, then, regulates the outlet from the desuperheater to the secondary superheater, depending on the outlet temperature on the steam leaving the boiler. To ensure that there is always a steam flow through the secondary superheater, a line fitted with an orifice bypasses the temperature control desuperheater and the control valve. The temperature control valve also has a bypass orifice.

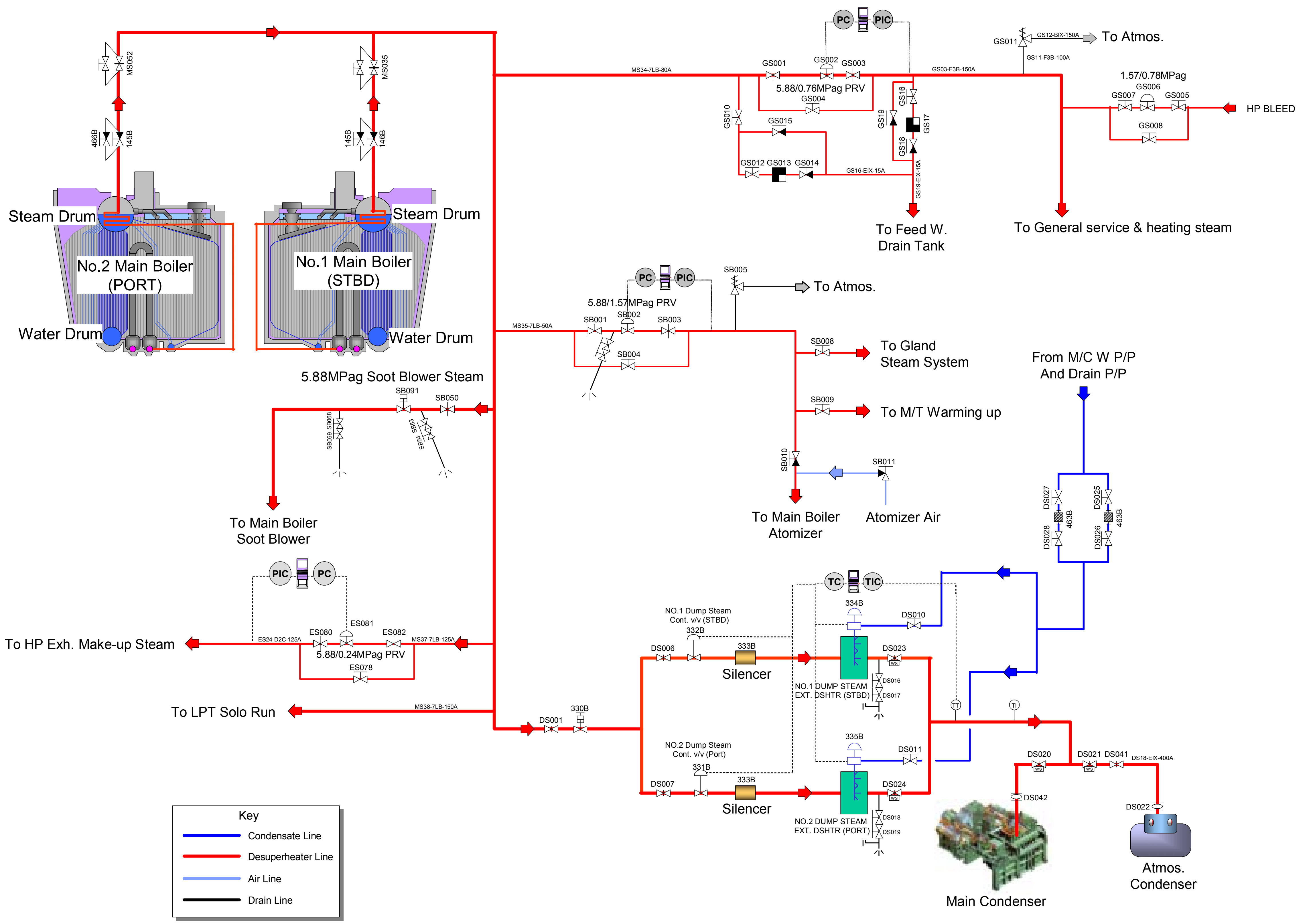
The main turbine main stop valves MS001 and MS014 interconnect both boilers. A common line supplies the main turbine. Each boiler has an auxiliary machinery stop valve, which supplies a manifold line, and in turn supplies the three main boiler feed water pumps and both turbo generators. The circuit is designed to supply the auxiliary machinery from either side of the manifold, giving greater flexibility for maintenance. Warming through bypass valves are provided at all the principal stop valves.

Steam from the superheater outlet is led to the internal desuperheater which is distributed to the various steam service.

Control and Alarm Settings

BLR STM DRUM H/L PRESS.	7.50 / 5.10	MPag
BLR SHTR STM H/H-H	525 / 530	°C
BLR SHTR PRESS. H/L	6.25 / 5.3	MPag
BLR DSHTR STM PRESS. H	6.25	MPag
BLR DSHTR TEMP H	400	°C

Illustration 2.1.2i Desuperheated Steam



2.1.2 Desuperheated Steam Systems

Desuperheated Steam System

Superheated steam from each boiler's outlet is led to an internal desuperheater that is fitted in each boiler's steam drum.

These desuperheaters discharge to a common line and supply the following services to the :

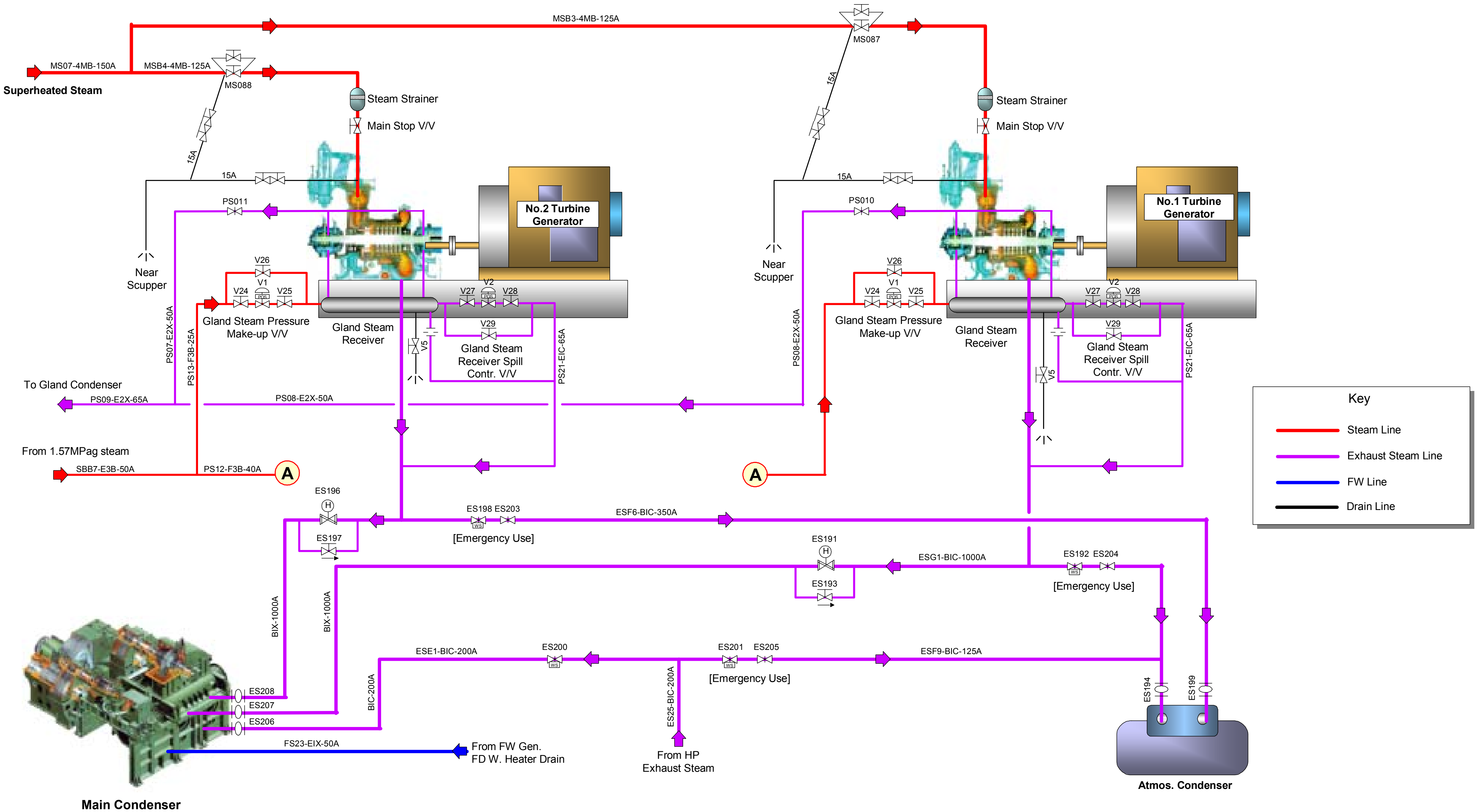
LP turbine solo running operation
Main dump external desuperheaters
Main boilers soot blowers
General service and heating steam
5.88/1.57 MPag reducing valve (SB002) which supplies:
Main turbine warming up steam
Boiler atomizing steam
Turbines gland packing steam

The 5.88/0.24 MPag reducing valve (ES081) supplies the HP exhaust make-up steam to heat up the deaerator, steam air heaters, fresh water generators, along with the IP bleed steam.

Control and Alarm Settings

BLR STM DRUM H/L PRESS.	7.50 / 5.10	MPag
BLR SHTR STM H/H-H	525 / 530	°C
BLR SHTR PRESS. H/L	6.25 / 5.3	MPag
BLR DSHTR STM PRESS. H	6.25	MPag
BLR DSHTR TEMP H	400	°C

Illustration 2.1.3i Generator Steam System



2.1.3 Steam Dump and Turbine Generator Exhaust System

Steam Dump Desuperheaters

The main boilers burn excess boil-off gas produced from the cargo. If the boil-off gas produced exceeds the requirements for normal steam production, then steam production is increased. The excess steam produced is dumped to the main condenser or the atmospheric condenser via the main dump external desuperheaters. The spray water for the desuperheater sprays is supplied from the discharge of the main condensate and the drain pump. Desuperheaters can discharge to the atmospheric condenser whenever the main condenser is unavailable. The temperature at the outlet from the desuperheater is measured and a corresponding signal is transmitted to the spray control valve, which alters the water supply accordingly.

High Boiler Pressure

The main dump external desuperheaters are controlled from the ACC. The control valve to the desuperheater will open when the boiler pressure exceeds its normal set point. It provides stability during periods of fluctuation where the burners are reduced to minimum flow, such as during manoeuvring, crash astern/ahead and emergency stops of the main turbine. The dump will control any excess steam pressure generated during these periods.

High Tank Pressure

If demand for steam is insufficient to consume all the boil-off gas from the cargo tanks, the firing rate of the gas burners will be increased accordingly and any excess steam dumped to the main condenser. The amount of steam dumped depends on the steam consumption for the plant and the recommended excess BOG amount from the cargo. The dump signal from the cargo tank is inhibited only when burning fuel oil. Steam to the Exh. desuperheater is supplied via a main piston valve, Each desuperheater has a control valve. The main piston valve closes when the following conditions are detected:

- Main condenser pressure high
- Main condenser sea water temperature high
- Manual dump trip
- Atmospheric condenser pressure high
- Closed DS020 and DS021 valves.
- Steam dump main line pressure high

All valves subject to the main condenser vacuum have water sealed glands.

Operating the Steam Dump Desuperheaters

(1) Make sure that the instrument and gauge valves are open and instrument air is supplied to the control units.

(2) Open the inlet and outlet valves of the line drain traps before the piston valve.

(3) Make sure that the spray control valves are in auto mode.

(4) Line up the spray water line from the main condensate pump and the drain pump.

(5) Open the Ext. desuperheater discharge valve to the main condenser DS020.

(6) Open the main supply valve to the desuperheaters DS001.

(7) Open the control valves inlet and outlet valves on each desuperheater DS006, DS007, DS023, and DS024.

(8) Make sure that the dump steam flow control valves (331B & 332B) are in auto mode.

(9) The system is now ready for use. The main piston valve and the control valves will be controlled from the ACC.

HP Exhaust Dump Steam System

Excess pressure from the HP exhaust steam system is dumped to the main condenser. If the main condenser is shut down, the excess pressure can be diverted to the atmospheric condenser.

Turbine Generator Exhaust Steam System

Both turbine generators direct exhaust to the main condenser through independent pipelines. If the main condenser is unavailable, the exhaust can be diverted to the atmospheric condenser with reduced power from the turbine generator.

Operating the Generator Exhaust Steam System

(1) Supply gland steam to the turbine generator.

(2) Make sure that the isolating valves to the atmospheric condenser are closed.

(3) Open the exhaust valve by using the button on the control panel.

(4) Start the turbine after sufficient warming up.

Control and Alarm Settings

DUMP STM ESDHTR OUTL. TEMP. CONT.	200	°C
DUMP STRM EDSHTR OUTL. PRESS. HIGH	0.25	MPag
M/COND TEMP. HIGH-SDC TRIP	70	°C
M/COND PRESS. HIGH-SDC TRIP	80	kPaA
M/T LPT EXH. STM TEMP. HIGH	150	°C

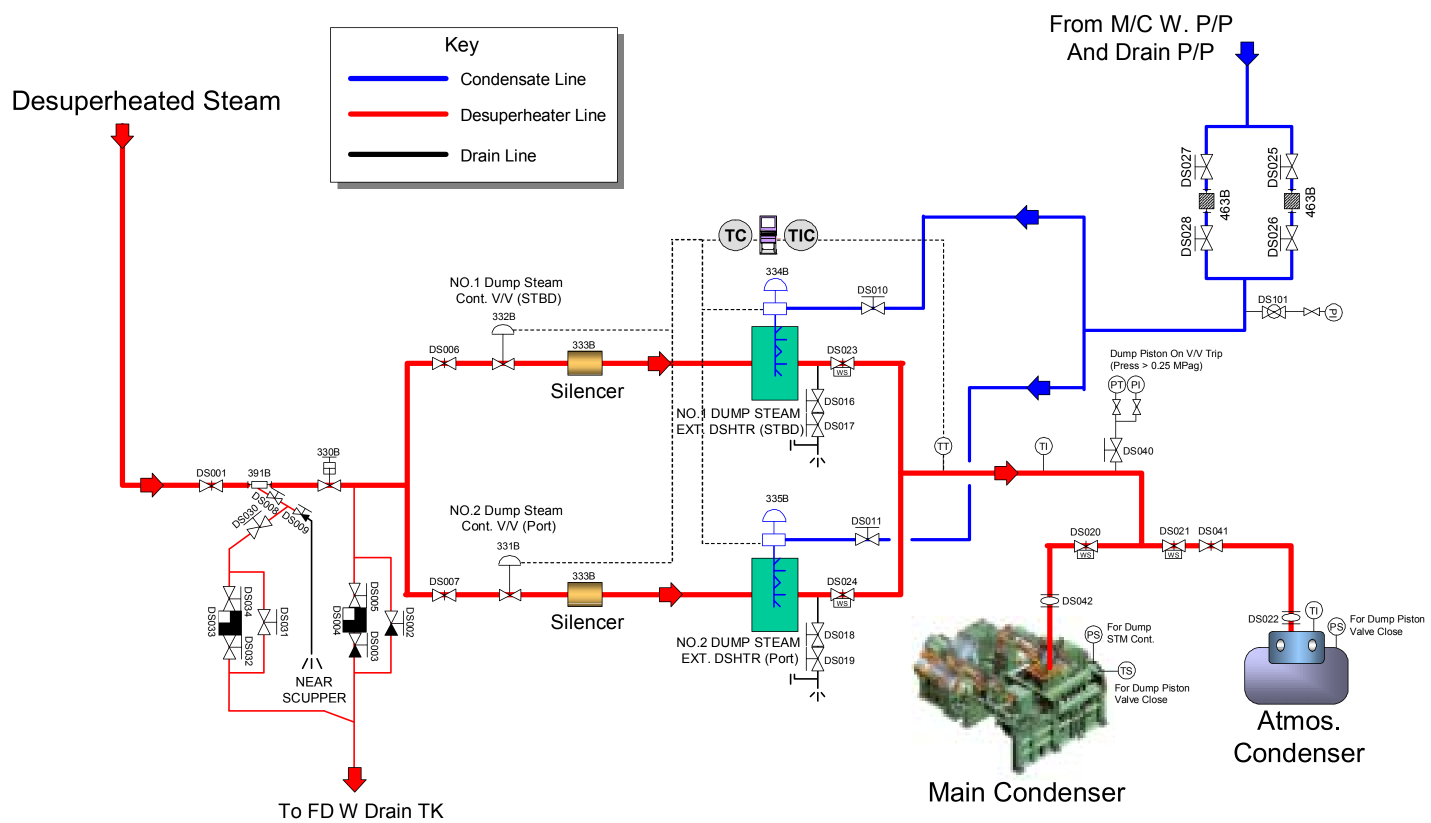
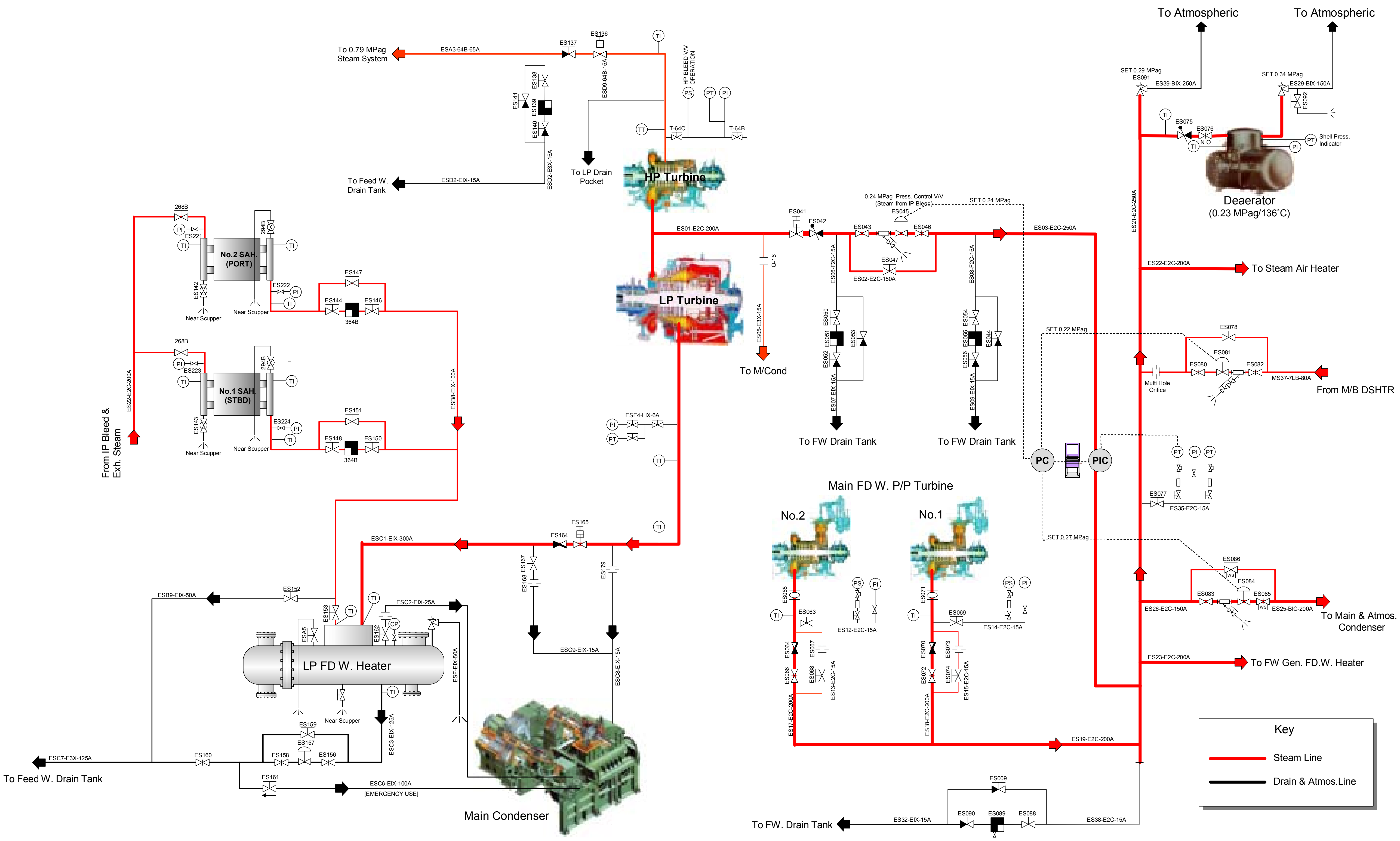


Illustration 2.1.4i High Pressure Exhaust Steam, HP, IP & LP Bleed System



2.1.4 High Pressure Exhaust Steam, HP, IP, and LP Bleed System

High Pressure Bleed System

HP bleed steam is bled from the main turbine at the sixth stage of the HP turbine. The bleed off piston valve opens automatically by a signal from the pressure switch located at the bleed off point. The normal bleed steam pressure of 1.57 MPag adds to the general service and heating steam system, which is supplied by the boiler internal desuperheater. The bleed valve opens at a pressure of 1.25 MPag and closes at 1.15 MPag. The HP bleed piston valve can operate directly by either IAS manual mode, or by changing the control position to ECR console. The HP bleed piston valve can only be closed when a direct operation from the ECR console or the IAS manual is selected. (Opening the HP bleeding steam valve is only permitted in IAS auto mode)

Intermediate Pressure Bleed System

IP bleed steam is bled from the crossover pipe between the HP and LP turbines. The bleed off piston valve opens automatically by a signal from the pressure switch located at the bleed off point. This signal also opens the LP bleed valve. The IP bleed piston valve can operate directly by either IAS manual mode or by changing the control position to ECR console. The IP bleed piston valve can only be closed when a direct operation from the ECR console or the IAS manual is selected. (Opening the IP bleed piston valve is only permitted in IAS auto mode)

The bleed line is continually drained to the main condenser via an orifice before the automatic bleed valve. The bleed valve opens at a pressure of 0.3 MPag and closes at 0.25 MPag. The normal bleed steam pressure of 0.45 MPag is reduced to 0.25 MPag and supplies the high pressure exhaust system.

Low Pressure Bleed System

LP bleed system is supplied directly to the LP feed heater. A control valve on the heater's drain outlet maintains the level of the feed heater.

The drains from the steam air heaters are normally led through the LP feed water heater, but they can also be diverted directly to the feed water drain tank.

The LP bleed piston valve can operate directly by either IAS manual mode or by changing the control position to the ECR console. The LP bleed piston valve can only be closed when those a direct operation from the ECR console or the IAS manual is selected. (Opening the LP bleed piston valve is only permitted in IAS auto mode)

High Pressure Exhaust System

The IP bleed system and the feed pump turbine exhaust normally supply the HP exhaust system. The system is controlled at a pressure of 0.25 MPag. If the pressure drops to 0.25 MPag, make up steam is supplied from the main boiler desuperheater outlet via a reducing valve. If the pressure rises to 0.27 MPag, the excess pressure is dumped to the main condenser or to the atmospheric condenser.

The HP exhaust system provides the requirements for the deaerator, the main boiler steam air heaters, and the fresh water generator heating steam.

Operating of the HP Exhaust Steam System

The main turbine is in the stopped condition, while the main feed pump exhaust supplies the HP exhaust system.

(1) Make sure that the instrument and the gauge valves are open and instrument air is supplied to the control units.

(2) Open the inlet and the outlet valves of the line drain traps.

(3) Open the inlet and the outlet valves of the reducing valve from the main boiler desuperheater system slowly until the control valve takes over.

(4) Supply steam to services as required.

(5) Put the 5.88/0.22 MPag pressure reducing valve (ES081) in automatic operation.

(6) Put the IP bleed valve in automatic operation.

(7) Make sure that the bleed valve opens at a correct pressure when running the turbine up to full speed.

(8) Due to the small band of operation between the make up pressure and the dump pressure, make sure the make up control valve is not open at the same time as the dump valve.

Control and Alarm Settings

M/T BLEED STM PRESS. FOR IP/LP BLEED V/V CONT.	0.304 / 0.255 MPag
M/T HP BLEED STM PRESS. FOR HP BLEED V/V CONT.	0.981 / 0.883 MPag
M/T GLAND PACK STM PRESS. H/L	50 / 5 kPag
M/COND HOT WELL LEVEL H/L	250 / -110 mm

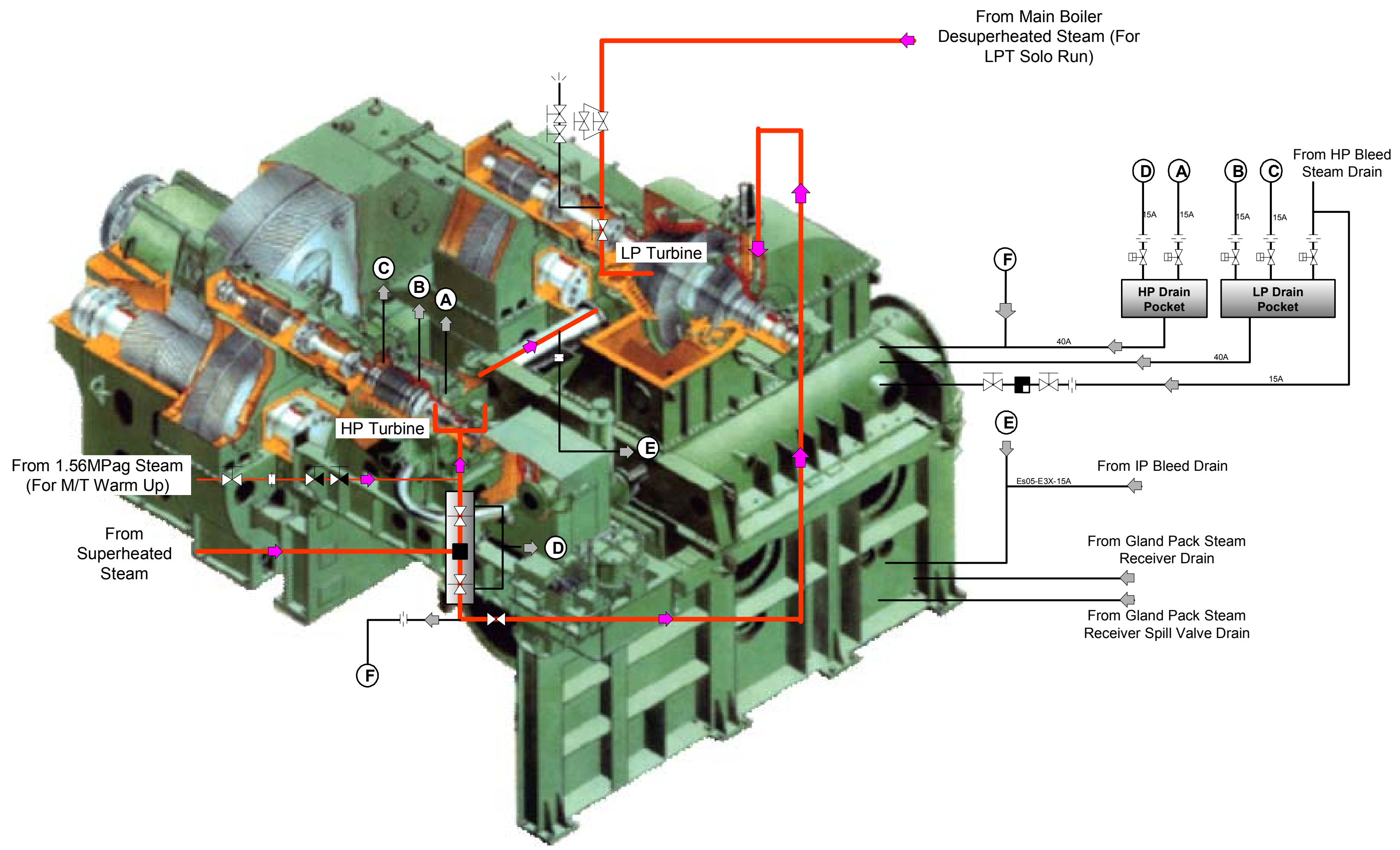
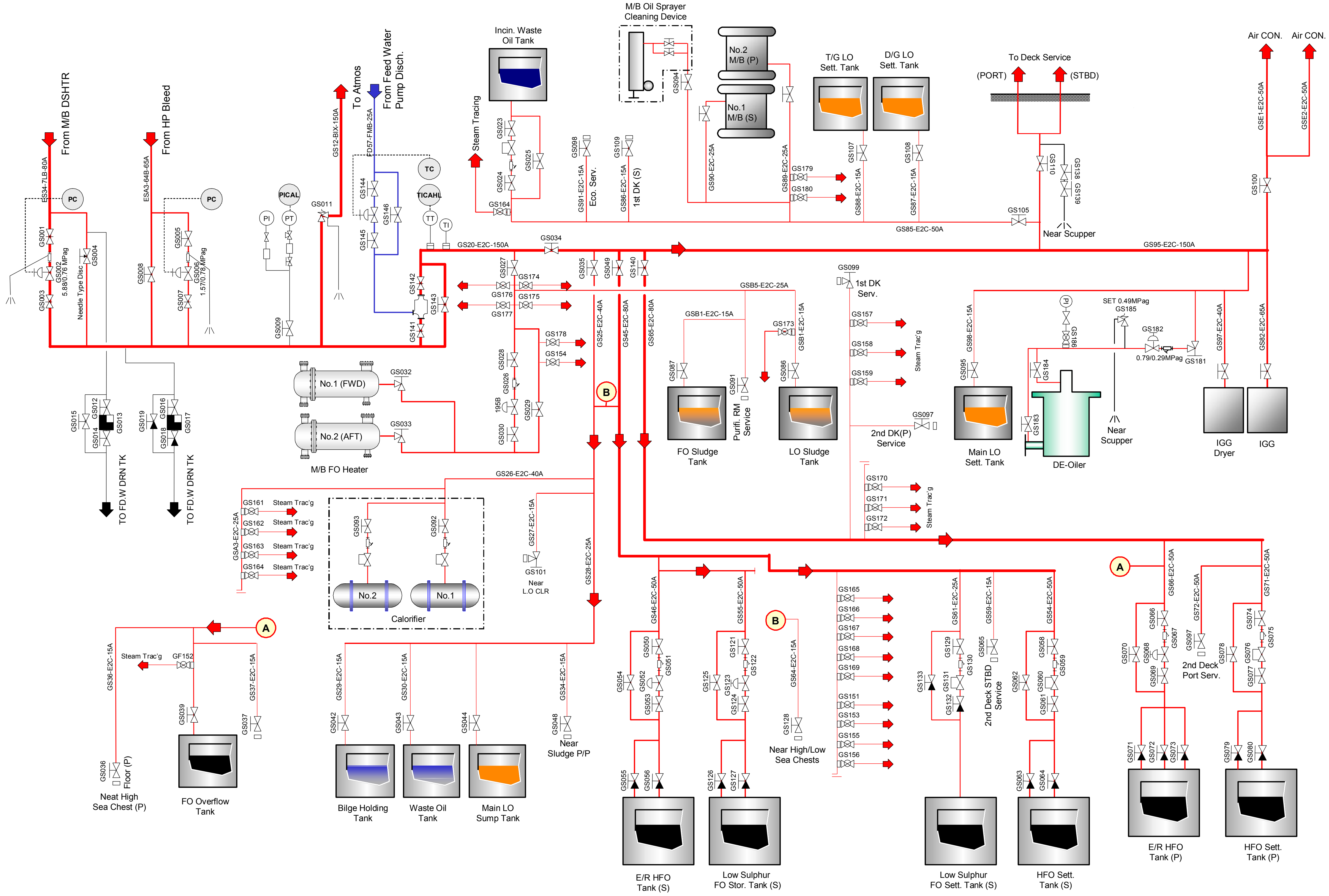


Illustration 2.1.5i General Service Steam System



2.1.5 General Service Steam System

The low pressure steam service system is supplied from the external desuperheater & HP bleed steam at an initial pressure of 0.78 MPag.

The services supplied at this pressure include :

- Inert gas dryer and generator
- Boiler fuel oil heaters
- Air conditioning plant
- E/R H.F.O. tank (P), (S)
- H.F.O. sett. tank (P), (S)
- Low sulphur tank
- Low sulpher FO settling tank
- HFO overflow tank
- Turbine generator LO settling tank
- Diesel generator LO settling tank
- Main LO settling tank
- No.1 & 2 Calorifier
- Boiler smothering steam
- Incinerator waste oil tank
- Bilge holding tank
- Waste oil tank
- LO sludge tank
- FO sludge tank
- Deck services, including the forward HFO deep tank heating
- De-oiler back washing
- Boiler sprayer cleaning device
- Sea chest blowing steam
- Steam trace heating lines
- Steam to hose connections

Cargo Machinery Room

- L/D and H/D gas heater
- LNG vaporiser
- Forcing vaporiser
- Glycol heating system
- LO heater for compressors

General Service Steam Temperature Control

A temperature control external desuperheater is provided to regulate the temperature of the general service steam at 175ºC.
The general service steam is supplied from the HP bleed steam or from internal desuperheater of main boilers, and is connected to the external desuperheater, where the steam temperature is reduced up to the saturation point of that pressure to be stated, and then fed to the consumers throughout the engine room, cargo, and accommodation areas.

Spray water for the external desuperheater is supplied from the outlet of the HP feed water system. The IAS controls the flow of the spray water according to the temperature variation at the outlet of the external desuperheater.

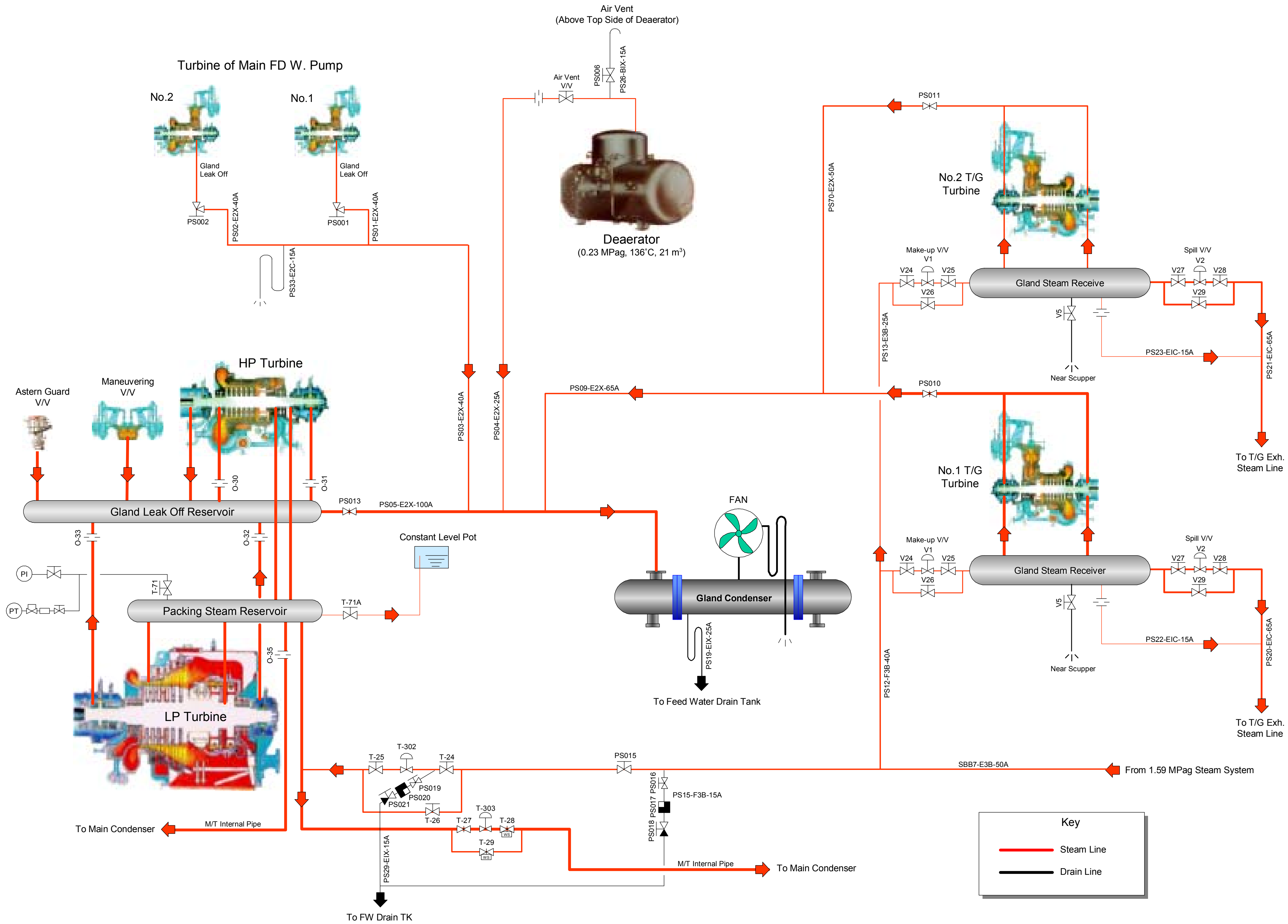
A PID temperature controller is used to reduce steam temperature from 290ºC to 174ºC.

The set point for the external de-superheater can be adjusted in the IAS whilst it is operating in Auto Mode.

Direct operation of the control valve can be achieved by changing the controller to Manual Mode.

If the controller fails, the control valve position of the external desuperheater will be maintained at its last position.

Illustration 2.1.6i Gland Packing and Leak Off System



2.1.6 Gland Packing and Leak Off System

Steam for the gland sealing for both turbine generators and the main turbine is supplied from the 1.57 MPag system, which is supplied from the 5.88/1.57 MPag desuperheated steam system.

Main Turbine

Two air-operated control valves normally control the packing steam. In case of low packing steam pressure, the make up valve opens and supplies the packing steam to the glands. In case of high packing steam pressure, the spill valve opens and the packing steam is dumped to the main condenser.

In order to prevent hunting or cycling, the packing steam controller should be adjusted with a small dead band between the opening of the spill and make up valves. The steam pressure is maintained at about 19.6 kPag.

The packing steam reservoir is permanently drained to the condenser via an orifice. Leak off from the gland packing is collected in the gland leak off reservoir where it is drawn to the gland condenser, and goes to the drain tank.

The gland exhaust can be directed to the gland condenser. Exhaust from the deaerator and leak off from the feed pumps are also drawn into the gland condenser.

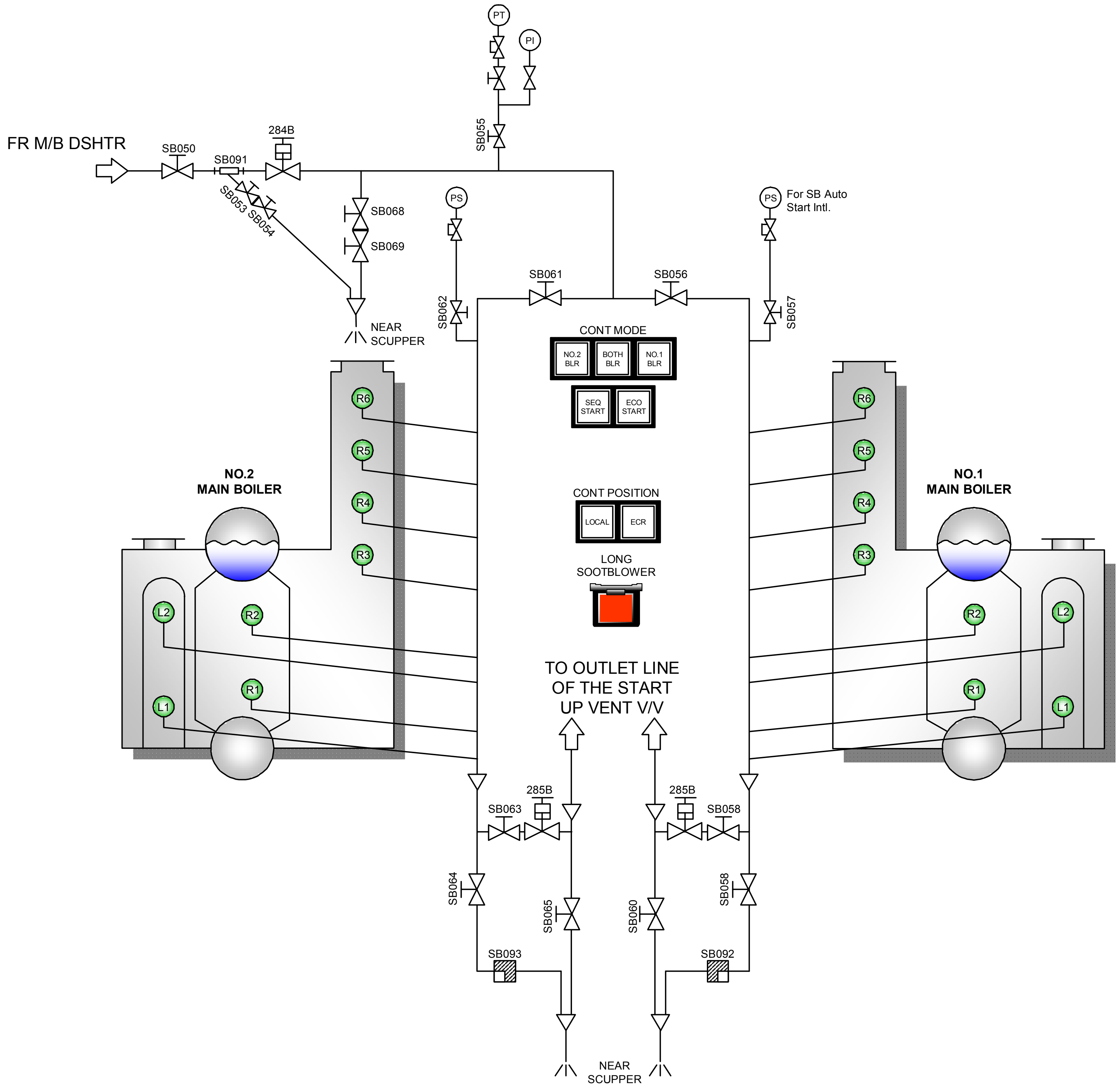
Turbine Generators

The turbine generator gland sealing is supplied in a similar manner, with pressure maintained in the gland packing steam reservoir by the make up and spill valve. Excess pressure is dumped to the respective turbine exhaust line.
The reservoir is constantly drained to the exhaust line via an orifice. The leak off from the glands is drawn to the gland condenser.

Control and Alarm Settings

M/T AST STEAM CHEST TEMP. HIGH	350	°C
T/G GLAND STM PRESS. H/L	20/3	kPag
M/T GLAND PACK STM PRESS. H/L	50/5	kPag

Illustration 2.1.7i Soot Blower Panel



2.1.7 Soot blowers

Six soot blowers are of rotary type and two of long retractable type, two of rotary type are in the main tube bank. Four of rotary type soot blowers are fitted in the economizer. Two of long retractable type soot blower are in the superheater

The soot blowers can be operated from the :

Control panel in the engine control room(auto function)

Local push button

Manual handle

It is recommended to operate the soot blowers twice a day during fuel oil firing, once a day during dual fuel firing and every few days during gas only firing and operate the soot blower on load as high as possible.

The full automation soot blowing sequence can be selected from the control panels. Each soot blower can be operated by a local push button with additional emergency direct mechanical(manual handle) operations.

Operating the Soot Blower System

Common

Inform the bridge of the intention to operate the soot blowers and proceed if permission is given.

(1) Control panel operation (auto function)

Any of the soot blowers can be taken out of the sequence by operating its respective switches. An automatic drain valve is opened when the system is not in use.

a) Initiate the starting operations from one of the control panels.

b) The main steam supply valve is partially opened. The system now proceeds to warm up. After a few minutes the automatic drain valve will close, and the automatic supply valve will fully open.
Any condensation occurring in the steam line will be drained through an automatic drain trap.

c) Sequential operation of the soot blowers then follows. When the sequence is complete, the steam supply valve will close and the drain valve will fully open.

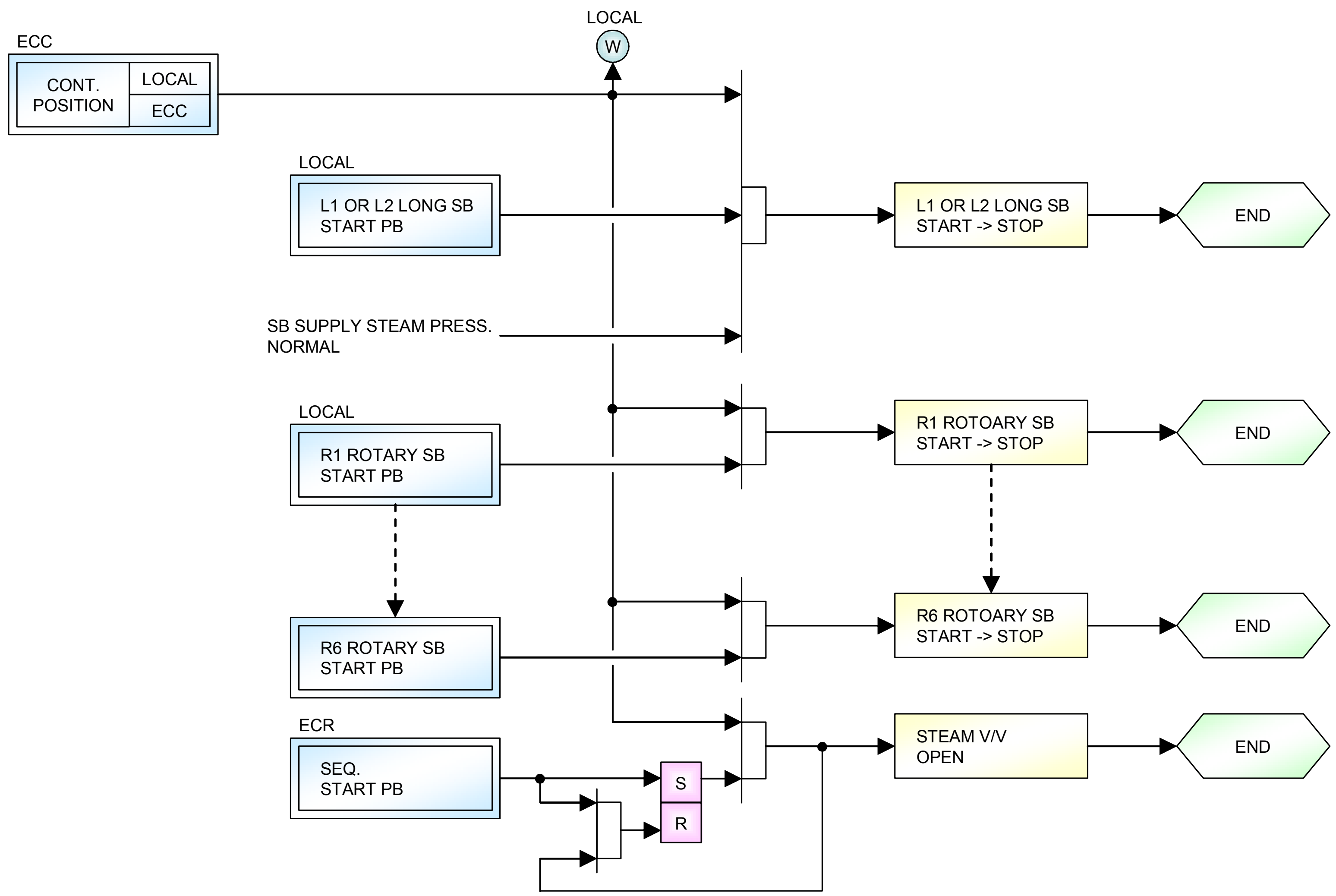
d) Inform the bridge of the completion of the soot blowing operation.

Warning

Before operating a soot blower by using local mechanical means. the unit should be isolated electrically. This is to prevent a soot blower drive motor from being triggered to start with the operation of a limit switch resulting to possible injury to the operator.

(2) Local push button operation

This operation starts with the local push button for each soot blower.
When the operating selection is LOCAL, each soot blower can be started by each local soot blower start push button. Also, local operation condition is show on engine control room control panel.

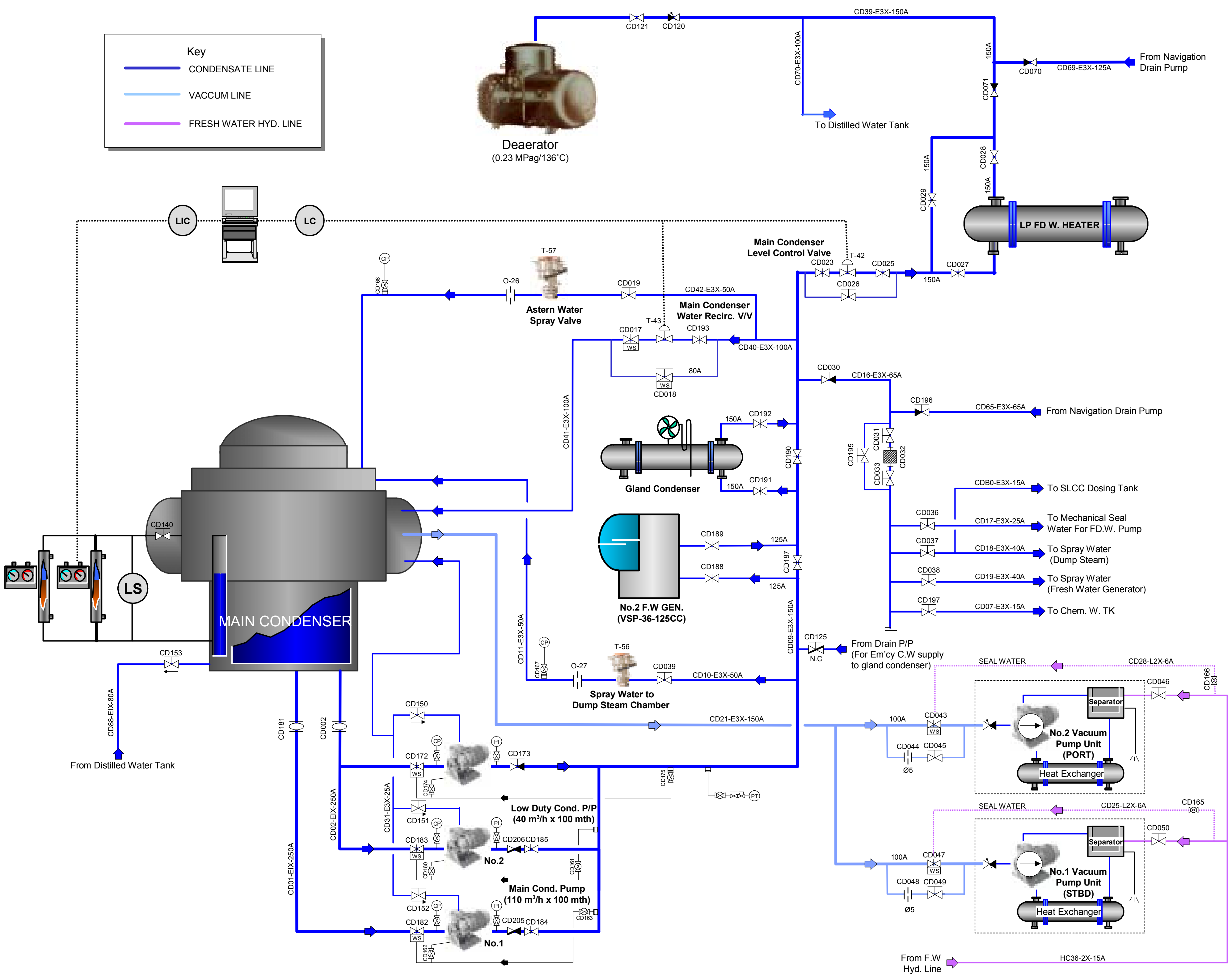


(3) Manual handle operation

This operation is to prevent a soot blower tube from reaching the furnace temperature.
The Manual handle may be used in the following condition:

a) S.B motor overload stop
b) Sudden stop of the S.B due to any reason

Illustration 2.2.1i Main Condensate System



2.2 Condensate and Feed Water Systems

2.2.1 Main Condensate System

General Description

The main condensate system, as part of the closed feed cycle, is the section concerned with the circulation of feed water from the main condenser to the main feed pumps via the deaerator.

Exhaust steam from the main turbines, turbine generators, dump steam and other auxiliaries is condensed under the vacuum in the sea water cooled main condenser. The condensate is extracted by a main condensate water pump and circulated through various heat exchangers before entering the deaerator located at a high point in the engine room. Water in the deaerator provides the main feed pumps with a positive suction head.

During the process of circulation from the main condenser to the main feed pump inlet, the condensate temperature is raised from approximately 33°C to 138°C. This increase is gained with the use of other waste heat in the gland condenser and the LP feed heater, which is supplied by the LP bleed steam from the main LP turbine drains from the boiler steam air heaters and condensate cooled type fresh water generator.

Exhaust steam from the main feed pumps and IP bleed steam from the main turbine, plus make-up from boiler desuperheated steam system, provide the heating steam for the deaerator.

Condensate pumps are provided in a main and low duty by configuration. The main condenser level is controlled by auto-valve T-42 and T-43. These valves are fitted into lines after the gland condenser, ensuring that this has a condensate flow it at all times.

The signal from the condenser level transmitter is compared in a level control block in IAS, with the output signal operating either level control valve T-42, or the re-circulation valve T-43. At normal working conditions, with the main turbine having a high steam flow, the level control valve will be open, allowing condensate through the LP heater to the deaerator. At low main turbine loads, this valve will close, and the recirculation valve will open, ensuring water in the condenser at all times, and that the condensate pumps do not run dry.

The condenser level is alarm-monitored, where high alarm will initiate the automatic start of the stand-by condensate pump. This pump will also automatic stop when the normal level is regained.

The glands of these two condensate pumps are water-sealed to prevent air ingress, with a balance line returning to the main condenser from the highest points of the pump inlets in order to prevent the formation of flash steam in the service pump. The condensate pump discharge pressure is alarm-monitored, with low-low pressure initiating the changeover of the pumps.

All valves are subject to the main condenser vacuum and have water sealed glands.

The main condenser is a potential source of feed water contamination, due to possible cooling sea water leakage. A sample point and salinity monitor system will be used to check condensate quality in the combined pump discharge line.

Condensate discharge flows through the condensate cooled type fresh water generator and the gland condenser. This unit condenses the distilled vapour from the fresh water generator and the vapour from the gland leak-off systems of the main feed pumps, turbine generator, and main turbine as well as the deaerator. The drains produced flows through a U tube water seal to the feed water drains tank.

Air and other non-condensable are extracted from the gland condenser by the gland exhaust fan, which discharges to the atmosphere.

During ship operations, burning excess boil-off gas produces dump steam.
This steam is desuperheated and dumped to the main condenser. A water curtain is arranged by way of this exhaust to the main condenser, with the spray water for the curtain supplied from the condensate line.

Condensate water is supplied to the following systems.

No.1 and No.2 dump desuperheaters

Main turbine astern steam supply

Water spray to dump steam chamber

Evaporator cooler steam supply

No.1 and No.2 main feed water pump mechanical seals

Boiler chemical feed water tank

SLCC dosing tank

The deaerator is a contact feed water heater, feed water deaerator and feed system header tank, providing a positive inlet head for the main feed pumps. Non condensable and associated vapours are drawn to the gland leak off condenser and away from the fan.

The steam cycle is a dynamic system and flow variations require condensate make-up or spill. The deaerator level is controlled by the spilling of excess condensate back to the distilled water tanks at deaerator's high-level signals, and by accepting make-up to the system from the distilled water tanks at low level signals. The unit is also fitted with a low-low level alarm.

A sampling and analysis cooler permits the monitoring of the condensate before and after the deaerator. Hydrazine injection into the system is arranged prior to the main feed pump suction.

Capacities and Ratings

Main Condenser:	3,300 m^2
Main Condensate Pumps:	Shinko Ind. Co., Ltd.
No. of sets:	2
Type:	Vertical centrifugal
Flow:	110 m^3/h
Gland Condenser:	25 m^2
LP Heater:	110 m^2
Deaerator:	SASAKURA
No. of sets:	1
Flow:	126 t/h
Capacity:	21.0 m^3

Operating Procedures

(1) Check that the system is ready for use. Start the main sea water circulation pump through the main condenser.

(2) Check the quantity of any condensate in the condenser. If necessary drain the condensate side of the condenser to the bilge to preclude any risk of feed contamination.

(3) Isolate the condenser level alarms from the condenser, drain the lines to prove clear, and return to service.

(4) Initial filling of the main condenser is through direct drop from the distilled water tanks by filling valve CD153.

(5) Make sure that the main condenser re-circulation valve is operational, inlet and outlet valves open, gland condenser bypassed, with drains and seal line to the main condenser.

(6) Make sure that the control air is supplied to all control valves in the system. Check that the condenser level transmitter and level gauge are on line.

(7) With both condensate pumps isolated, check for rotation by hand. Open one of the pump's suctions, balance line, and gland seal valves. Open the pump discharge valve and line to the salinity probe.

(8) Start the pump and check its operation.

(9) Check and start one main vacuum pump, bringing it into operation and raise the condenser vacuum.

(10) Make sure that the condenser level control valve is operating correctly. Bypass the LP heater, allowing the condensate water to feed into the line from the feed water drain tank to the deaerator.

(11) Open the feed inlet to the gland condenser, vent off the unit, open the outlet valve and close the bypass and vent valves.

(12) Open the feed inlet to the LP feed heater, vent off the unit, open outlet valve and close bypass and vent valves.

(13) Open the master valves for the astern water spray and the dump water spray.

(14) Open all valves on the low duty condensate pump, placing it in stand-by mode. Check that the auto cut-in operation is working when collectly.

(15) Check all seal water and condensate water lines to make sure that valves open correctly.

(16) Continue to raise the main condenser vacuum, bringing into service the gland steam system.

Control and Alarm Settings

M/COND C.S.W TEMP. H-H(TRIP)	70	°C
M/COND HOT WELL LVL H/L	250 / -110	mm
M/COND LVL H-H (M/T SLD)	300	mm
M/COND VACUUM LOW	86.7 kPaA (650 mmHg)	
M/COND VACUUM PRESS. L-L (M/T SLD)	66.7 kPaA (500 mmHg)	
M/COND VACUUM PRESS. L-L (M/T TRIP)	80	kPaA
M/COND P/P OUTL. PRESS. LOW	0.6	MPag
M/COND P/P OUTL. SAL. HIGH	4.2	ppm
FD W DRAIN P/P OUTL. SAL. HIGH	4.2	ppm
G/COND OUTL. TEMP. HIGH	65	°C

Illustration 2.2.2i(1) Condensate Water System

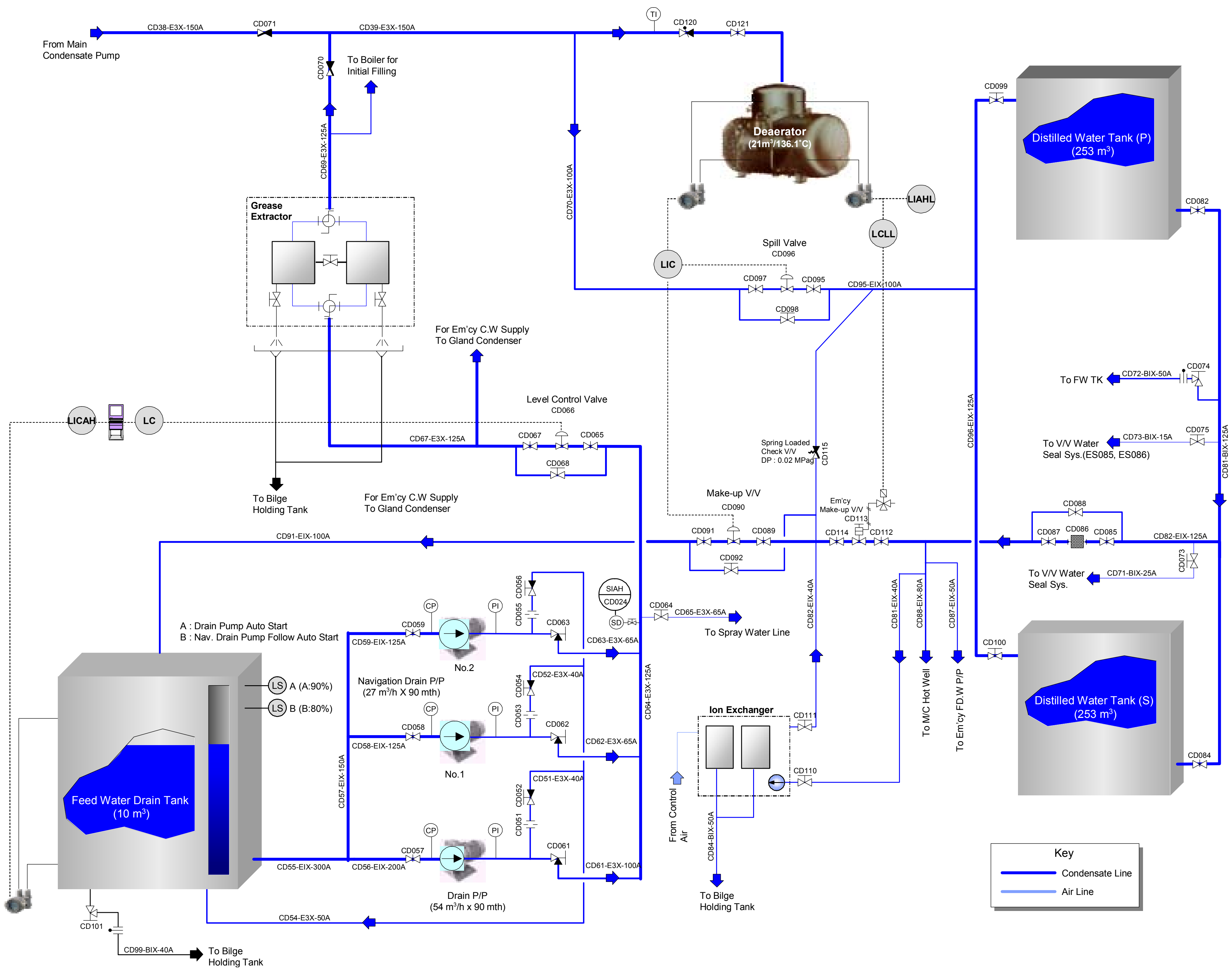
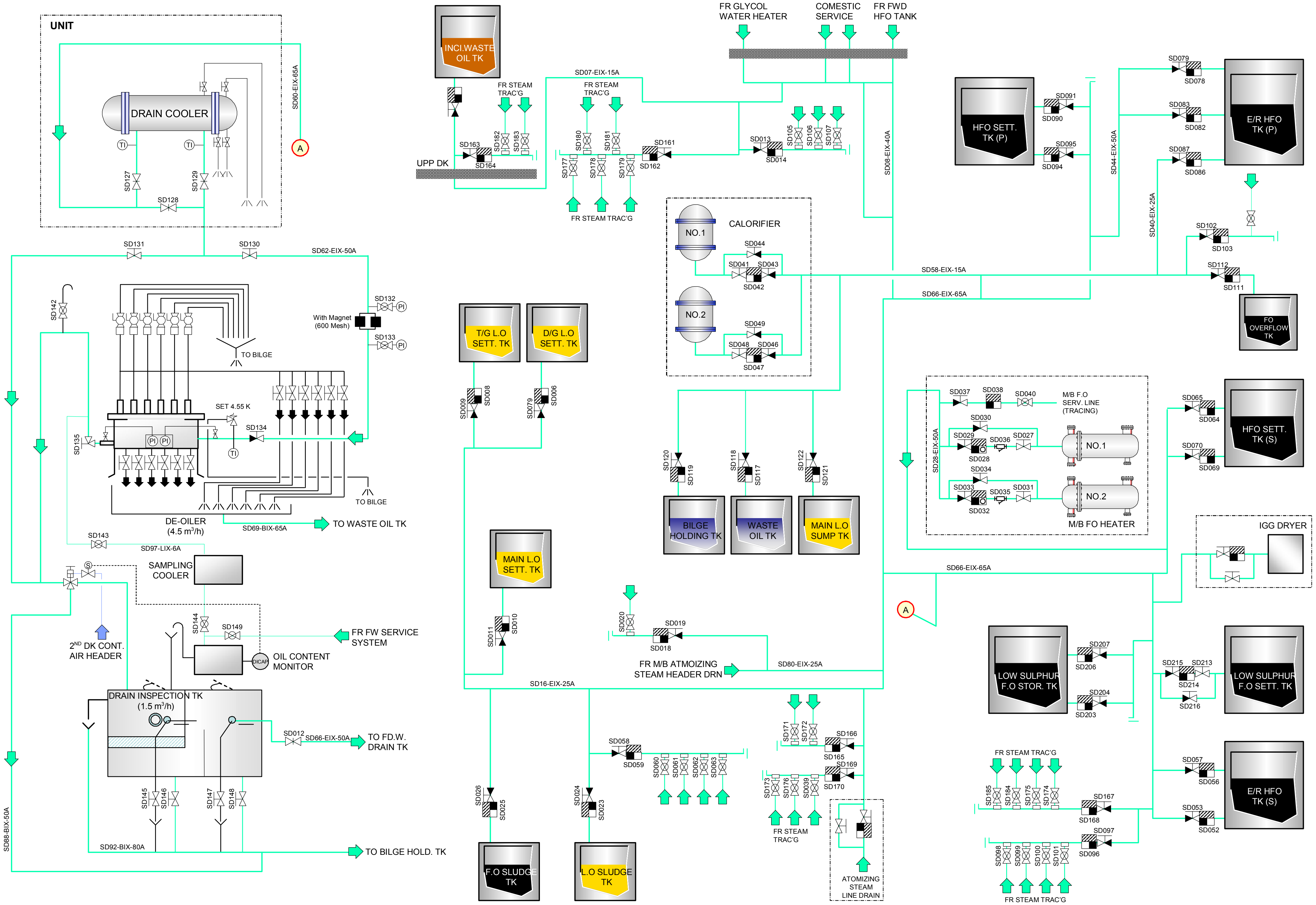
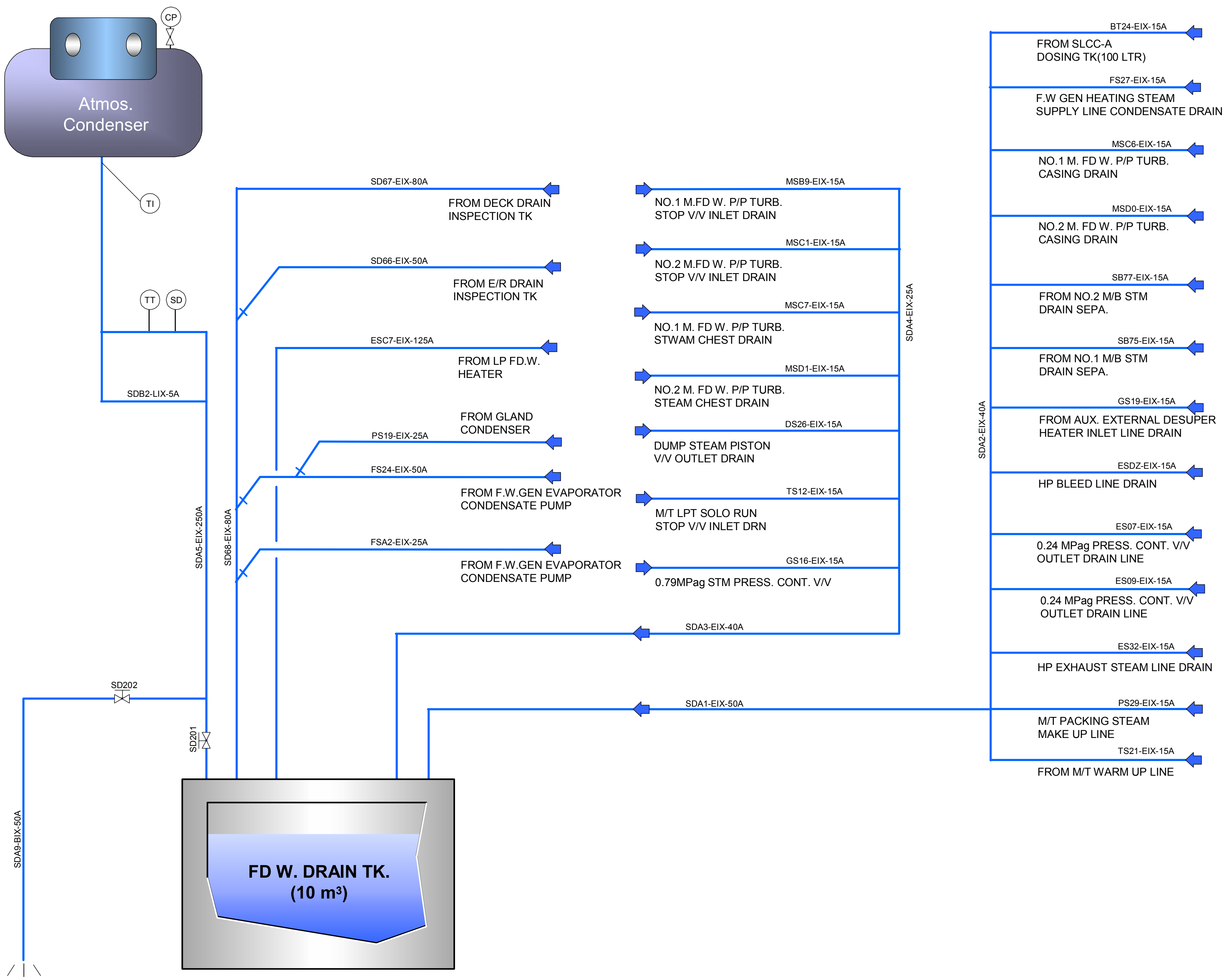


Illustration 2.2.2i(2) Contaminated Steam Drain System



Blank Page

Illustration 2.2.2i(3) Clean Steam Drain System



2.2.2 Condensate Water System

General Description

Condensate from the auxiliary steam services is returned to the main cycle for recirculation by the drain pumps system. Drains that are free of any possible contamination are led directly to the feed water drain tank.

This system operates in conjunction with the main condensate system, whereby the condensate from both systems join together before entering the deaerator. It is due to the combination of both systems that the deaerator make-up and spill control valves operate.

Water entering this system from the distilled water tank enters the feed water drain tank via the make-up valve.
A direct line from the distilled water tanks to the main condenser permits the initial filling of the condenser.

The feed water drain tank has two normal navigation pumps fitted. The nav. pumps pumping out feed water through the feed water drain tank control valve CD066, that maintains the feed water drain tank level. The pumps have a re-circulation line back to the feed water drains tank, via an orifice plate, which guarantees that the pumps do not run dry. Should the tank level increase, then the second navigation drain pump will auto cut-in and stop again when the level returns to normal.

The feed water drain tank also has a larger capacity drains pump fitted.
This pump auto starts on the drain tank's high-high level and when the main dump external desuperheater is in operation, as there is a high volume of water flowing to the drain tank.

The discharge from the drain pumps can be used for the initial filling of the main boilers by opening the valve (FD045) through the auxiliary feed line.

The drains from the atmospheric condenser, gland condenser, LP feed heater plus various other line drains etc, all return directly to the feed water drain tank.

Potentially contaminated drains pass through the engine room drain cooler, which is itself cooled as part of the fresh water cooling system. From the drains cooler, the condensate water passes through the oil content monitor and finally to the feed water drain tank.

These drains are normally from steam used to heat bunker fuel, sludge tanks, deck steam machinery etc, where the drains have a greater chance of filtering oils and other impurities into them.

An oil detection monitors the condition of the water, initiating an alarm should there be any contamination.

The control valve CD066 controls the feed water drain tank. The transmitter for this controller is of the differential pressure type, and may be calibrated to allow for the relatively small increase/decrease in water level that may occur in the tank.

The deaerator water level is controlled by a make-up and spill system. Should the water level rise, then the spill control valve CD096 will open to allow excess water to return to the distilled water tank. Should the water level fall, then the make-up control valve CD090 will open, allowing feed water into the feed water drain tank. This is then pumped to the deaerator via the drain pumps.

The level in the feed water drain tank is controlled by its own control valve CD066, allowing feed water to the deaerator. The combination of feed spill/make-up and feed water drain tank control valves, are critical to ensure that the water level the deaerator remains at a satisfactory level.

Capacities and Ratings

Navigation drain pumps:	Shinko
Type:	EVZ70MH
No. of sets:	2
Flow:	27 m^3/h x 90 MTH
Drain Pump:	Shinko
Type:	EVZ100MH
No. of sets:	1
Flow:	54 m^3/h x 90 MTH
Drain Cooler:	Dongwa Precision Co.
No. of sets:	1
Surface area:	5 m^2
Type:	Shell and tube

Operating Procedures

Feed water Drain Tank System

(1) Open the instrument air supplies to all control valves, level indicators. Stroke all valves to prove operation on local control.

(2) Test the water in the distilled tanks for contamination and, when found satisfactory, open the outlet valve on one of the tanks, ensuring that the outlet valve on the other is closed.

(3) With the drains pumps isolated, check for free rotation by hand. Line up the valves on the pumps, ensuring that the pump and line recirculation valves that return water to the drain tank are open.

(4) Open the inlet and outlet valves on the grease extractor.

(5) Make sure that the inlet and outlet valves to the make-up, spill and feed water drain tank level control valve, are open.

(6) Allow the drains tank to fill to normal levels. When that level is reached, start up the drain pump in use to discharge water to the deaerator. When the correct deaerator level is achieved, the spill valve should open to maintain this level.

(7) When the system is operational, vent off the grease extractor element.

(8) Check that the system is operating satisfactorily. Make sure that there is no water or air leakage. Check that the drain tank salinity probe is functioning correctly.

(9) As soon as operational conditions permit, test the system's high and low alarms and check the drains pump's auto changeover operation. All such operations must be carried out with care, and be closely monitored.

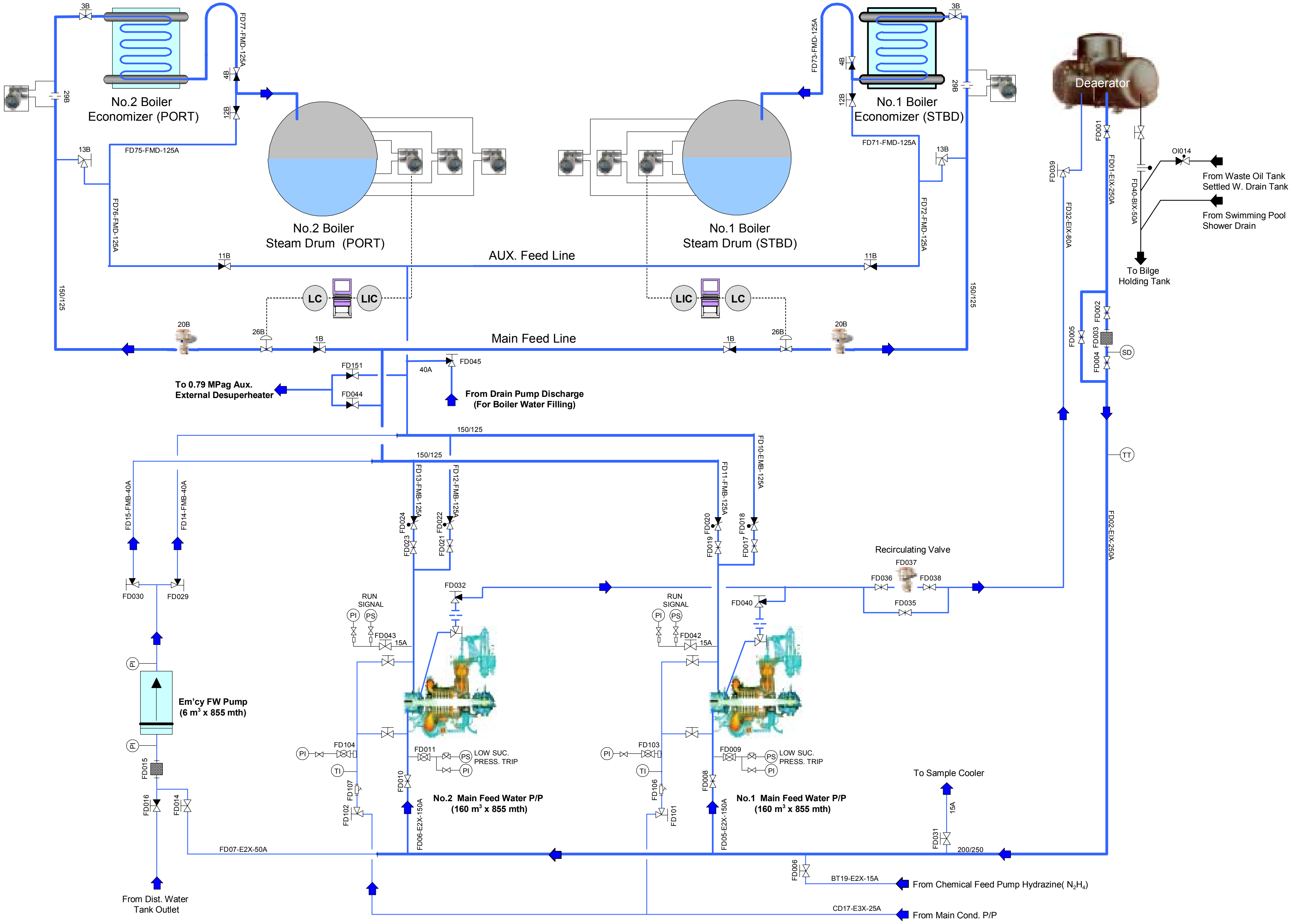
Contaminated Drain System

(1) Make sure that there is cooling water circulation of the contaminated drain cooler from the central fresh water cooling system. Open the inlet and outlet valve of the cooler drain line, ensuring that the bypass valve is closed.

(2) As the drains from the various systems are on line, monitor the drain inspection tank carefully, operating the scum valves if required. Particular care must be taken especially when a system, which has been out of service for some time, is brought on line, as there could be a higher risk of contamination from accumulated leakage in these drain lines.

(3) Perform a function test of the oil content monitor.

Illustration 2.2.3i Boiler Feed Water System



2.2.3 Boiler Feed Water System

General Description

The boiler (or main) feed system is concerned with the circulation of water from the deaerator via the main feed pumps to the boiler steam drum.

Feed water from the condensate systems(section 2.2.1 and 2.2.2), enters the deaerator and mixes with the steam supplied from the HP exhaust and main turbine bleed steam systems. As the two mediums are mixed (raising the water temperature), the deaerator breaks the water into very small droplets, releasing it into the air with other non-combustible gases. These, together with any associated water vapour, are drawn off to the gland condenser, where the water vapour is condensed and returned to the feed system and the non-combustible gases are extracted to the atmosphere by the gland exhaust fan.

The heated feed water is collected in the deaerator, which acts as a system header tank. The level is maintained in the deaerator by the automatic operation of the make-up and spill control valves in the condensate system. The high location of the deaerator in the engine room, provides the main feed pump with a positive suction head of water.

Hydrazine chemical is injected into the drop line to the main feed pumps to remove any remaining traces of oxygen in the feed water. The dosage of hydrazine is arranged to maintain a reserve amount in the boilers. A sampling line is fitted on the feed pump suction line to the boiler water analyser cooler.

The water flows through a simplex strainer before entering the main feed pump suction manifold.

Two main feed pumps are fitted, with one in use, and a the other on stand-by. The S/by pump can be used if the other can't develop pressure, stand-by pump will start automatically.

The main feed pumps are turbine-driven, horizontal, multi-stage units. They have condensate cooled mechanical seals on the pumps. For initial start-up, each is fitted with an electrical lubricating oil pump, but once running, a shaft-driven pump provides the lubrication oil circulating pressure. The electrical lub. oil pump will stop automatically when the shaft-driven pump maintains the correct delivery pressure. The electrical lubricating oil pump only provides oil pressure to lift the steam governor valve, and not as a back up to the shaft driven pump.

Air spaces between the pump and the bearings, and between the turbine and bearings, are fitted with drain passages to help prevent lubrication oil contamination.

The running speed adjustment for the steam flow to the main feed pump turbine is controlled by a loop, which measures and compares the steam drum pressure and common discharge pressure of feed water pumps.

The discharge pipe configuration from the feed pumps is such that any one feed pump can supply the boiler in use. Interconnecting pipelines between the pumps, isolated by non-return valves, are arranged to supply three common discharge lines.

(1) Main Feed Line

The feed water passes through the feed water control valve (26B), then through the feed water shut-off motor valve (20B), and then through the orifice (29B), which measures the feed flow for the control system. After passing through the economizer, at which point there is a signal line to the differential pressure unit for auto start of the stand-by main feed water pump turbine on low pressure, the feed enters the steam drum of the boiler.

(2) Auxiliary Feed Line

This pipeline is usually used if the main line requires repairs, especially to feed the control valve of the flow orifice plate. The feed water can be directed through the economizer, or bypass it and flow directly into the boiler. Whichever path is selected, great caution must be taken when the auxiliary feed line is in use as the feed valve to the boiler is manually operated, and must be attended to at all times. The operator must maintain a careful watch on the boiler level in this mode.

(3) Main Feed Pump Re-circulation Line

An air operated piston valve allow the feed line to recirculate back to the deaerator. When the boilers are operating at low loads with the main turbine in a manoeuvring mode, this valve(FD037) will open automatically, allowing feed water through an orifice on the pump into the bottom of the deaerator.

For boiler filling and very low boiler loads, an emergency feed pump is fitted. This unit is electrically driven, but like the main feed pumps, it will take its suction from either the deaerator or the distilled water tanks. It and is able to discharge through the main or auxiliary feed lines to the boiler.

The discharge from the condensate pumps for boiler filling is connected to the auxiliary feed line through valve(FD045), which in normal operation, is locked.

Each boiler is fitted with a three term feed control system, whereby signals from the actual boiler level feed flow and steam flow are compared for feed pump operation.

Similarly, each boiler is fitted with water level transmitters for level detection and indicator alarm system.

The level transmitters operates the as follows:

	TIMER	LEVEL
Drum high level alarm	10 sec	+130 mm
Drum low level alarm	10 sec	-130 mm
Drum H-H level signal to close F.W motor V/V	10.sec	+220mm
Drum high level signal for M/T auto slow down	10.sec	+180mm
Drum L-L level for M/T auto slow down	10 sec	-180mm
Deaerator high level alarm	-	+400mm
Deaerator low level alarm	-	-400mm
Boiler drum level very high turbine trip	10 sec	+220mm
Boiler high high level trip	-	+240mm
Boiler low low level trip	-	-240mm

Final feed into the boilers is through the economizers, where the feed temperature is increased from 139°C to 224°C. The economizers are placed in the path of the furnace flue gases in order to extract maximum heat from the waste gas before it passes through the funnel.

In case of an emergency, the water in the economizer can be bypassed, and feed water is supplied directly to the boiler steam drum. Should this be necessary, steam flow must be restricted. In this case, the economizer should be drained and vented.

Capacities and Ratings

Main Feed Pumps:	Coffin Turbo Pump Inc.
No. of sets:	2
Type:	DEB-16
Capacity:	136 m^3/h(normal), 160 m^3/h(max)
Speed:	7,850 rpm
Emergency Feed Pump:	Shinko Ind Ltd.
No. of sets:	1
Type:	HLX6
Capacity:	6 m^3/h x 855 MTH
Economizers:	1,787 m^2 Heating Surface Area
No. of sets:	1 Per Boiler
Designed pressure:	9.56 MPag

Operating Procedure

(1) Boiler Filling (Using emergency feed water pump)

a) Check that the steam and water drum drain valves are closed and that the local drum gauge glass and transmitters to remote level indicators are open, with their drain valves shut.

b) Open the drum and superheater vents fully.

c) Open the pump discharge valve to the auxiliary feed line, economizer bypass valve and direct feed valve to the steam drum. Make sure that the boiler drum feed valve from the main line is closed.

d) Check the pump suction valve FD001, from the deaerator is locked, and open the suction valve from the distilled water tank FD016.

e) Start the pump and start filling the boiler. Careful watch the local level gauges until the required level is achieved. Close the direct auxiliary feed valve.

f) Open the feed inlet valve to the economizer and vent valve, ensuring that the unit drain valves are closed. Open the auxiliary feed line valve to the economizer inlet. Continue using the pump until water emerges from the vent, removing all air from the economizer.

g) Arrange for an initial chemical dosage charge to be injected into the boiler from the chemical dosage pump unit as the boiler is filling.

h) The boiler is now ready to flash.

Note!

If both boilers are out of service, then there are two other ways to initial fill them.

i) By filling the deaerator with condensate pumps, and allowing the water to directly drop through the emergency feed pump into the steam drum.

j) By using the condensate system, open the valve, which is locked, and fill it through the auxiliary feed line as described above.

(2) Placing the Feed System in Use

a) During the initial flashing of the boilers, there should be enough steam to place the feed system in use when the pressure reaches approximately 1.96 MPag.

b) Select the main feed pump in use, and open the suction, discharge, recirculation, steam inlet, exhaust and gland leak off valves. Open the turbine drains, and make sure that all trips are reset.

c) Open the drop valve from the deaerator and vent the pump to remove excess air.

d) Supply air to the auto recirculation solenoid valve, checking that its inlet and outlet isolating valves are open. Due to “no flow” conditions, the control valve should remain fully open.

e) Line up the valves on the main feed system to the selected boiler. Supply instrument air to the boiler feed control valve, and check its operation under local control. If found satisfactory, switch to auto control. Make sure that the motorised feed inlet valve to the boiler is open.

f) Check the lubricating oil sump for any water, and fill the sump to the required level using the correct grade of oil. Make sure that the lubricating oil cooler is opened to the fresh water cooling system, and that the pump mechanical seals are supplied from the condensate system.

g) Crack open the isolating valve from the superheated steam range to the feed pump and warm up the line. Drain any accumulated water with the use of manual drains and open the electrically operated main steam stop valve.

h) Open instrument air supplies to the control system.

i) To start the feed pump, start the electric lubricating oil pump. This supplies oil to the oil relay cylinder, which lifts and raises the balanced governor steam valve off its seat, allowing steam into the turbine. As the feed pump rpm increases, the shaft-driven lubricating oil pump pressure is also raised, and at which time the electrically driven lub. oil pump stops. Close the turbine drains once any sign of entrained water drops ceases.

Note !

As the electrically driven lubricating oil pump does not supply oil to the bearings, only to the oil relay cylinder, then should the pump not start and run up to speed within approximately 30 seconds, the electric pump will stop and the feed pump will trip.

j) Once the feed pump is running satisfactorily, and operating remotely with the boiler level being maintained at the correct level, thoroughly check the pump. Make sure that the oil flow through the line sight glasses, condensate flow through the sealed water line flow-meter and the electrically driven oil pump has stopped. Monitor temperatures and pressures, and check for excessive vibration.

k) Line up the second feed pump as the stand-by unit, and when operational conditions permit, check the auto-change operation by tripping the duty feed pump. This must also be performed with the third feed pump.

Note !

Though the feed pump manufacturers recommend the testing/checking of trip and safety functions on a regular basis, the testing of the overspeed trip should be done only when absolutely necessary. Damage to the pump internals may occur during the testing of the centrifugal speed governor, and any test of this function must be carried out with due caution, and in strict accordance with manufacturer's detailed instructions.

(3) Filling the Second Boiler (Main feed pump in use)

Note !

During the filling of the second boiler, and in the transition period before it is brought fully on line, particular attention must be paid to the steaming boiler water level and constant checks must be made to ensure that it is not lacking in feed water.

a) With the economizer bypassed, make sure that the steam drum vent valves are open and the drain valves on the steam drum, water drum and headers are closed. Check if the remote level indicators and the boiler gauge glasses are on line.

b) With the inlet valve to the water level control valve closed, open the auxiliary feed valve on the steam drum.

c) Using the manual auxiliary feed check valve, open it slowly until feed water is entering the boiler. As the boiler fills, maintain a careful check on the gauge glass and that the boiler level remains satisfactory, and is not lacking in feed water. Using the boiler dosage unit, put in the initial chemical dosage as the boiler fills.

d) When the correct level in the boiler has been achieved, the auxiliary feed valves can be closed.

e) Prior to flashing the boiler, the economizer can be vented by filling through either the main feed line with the control valve manually opened, or through the auxiliary feed line.

Illustration 2.2.3.1i Main Feed Water Pump & Turbine Governor Section

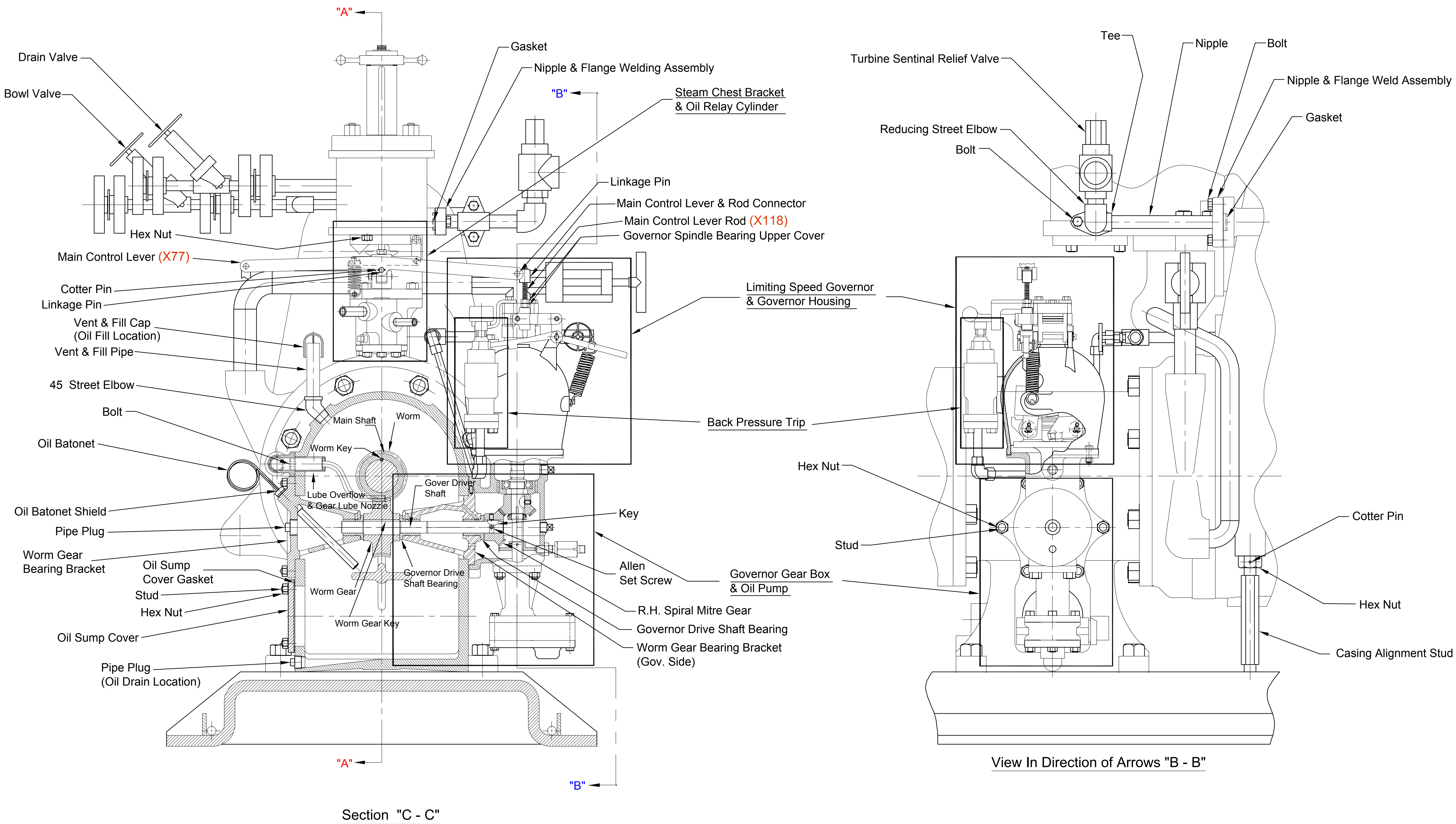
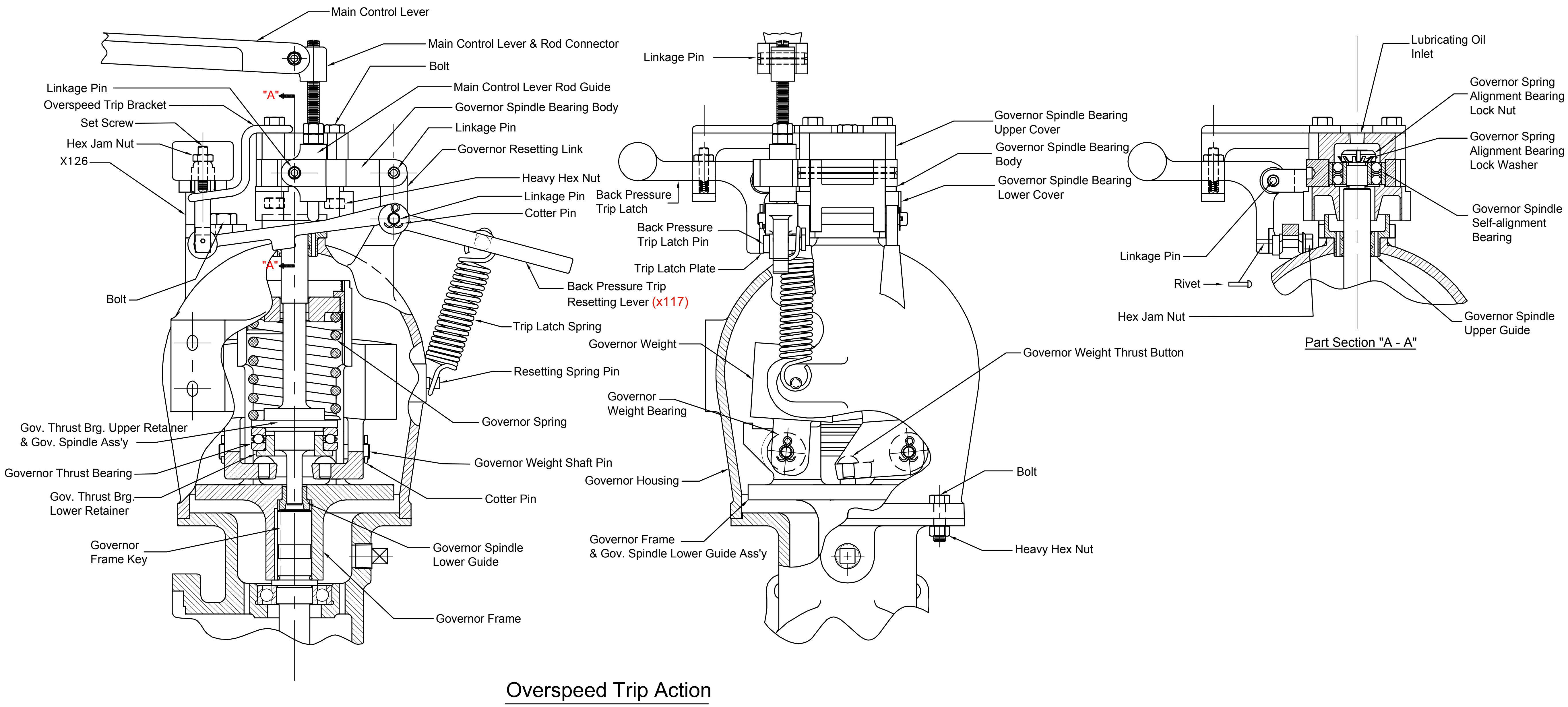


Illustration 2.2.3.1i Main Feed Water Pump & Turbine Centrifugal Speed Governor



2.2.3.1 Main Feed Water Pump & Turbine

Capacity	Normal: 136 m^3 / HR(HVC), Maximum: 160 m^3 / HR(HVO)
Total Developed Head	855 / M.
NPSH Req'd	11.7 / M.(max.)
Steam Inlet	5.88 MPag
Initial Temp.	510°C
Exhaust	0.29 MPag
Type	"DEB-16"
HP/KW	724/540
rpm	7,210
Rated Design rpm	10,000

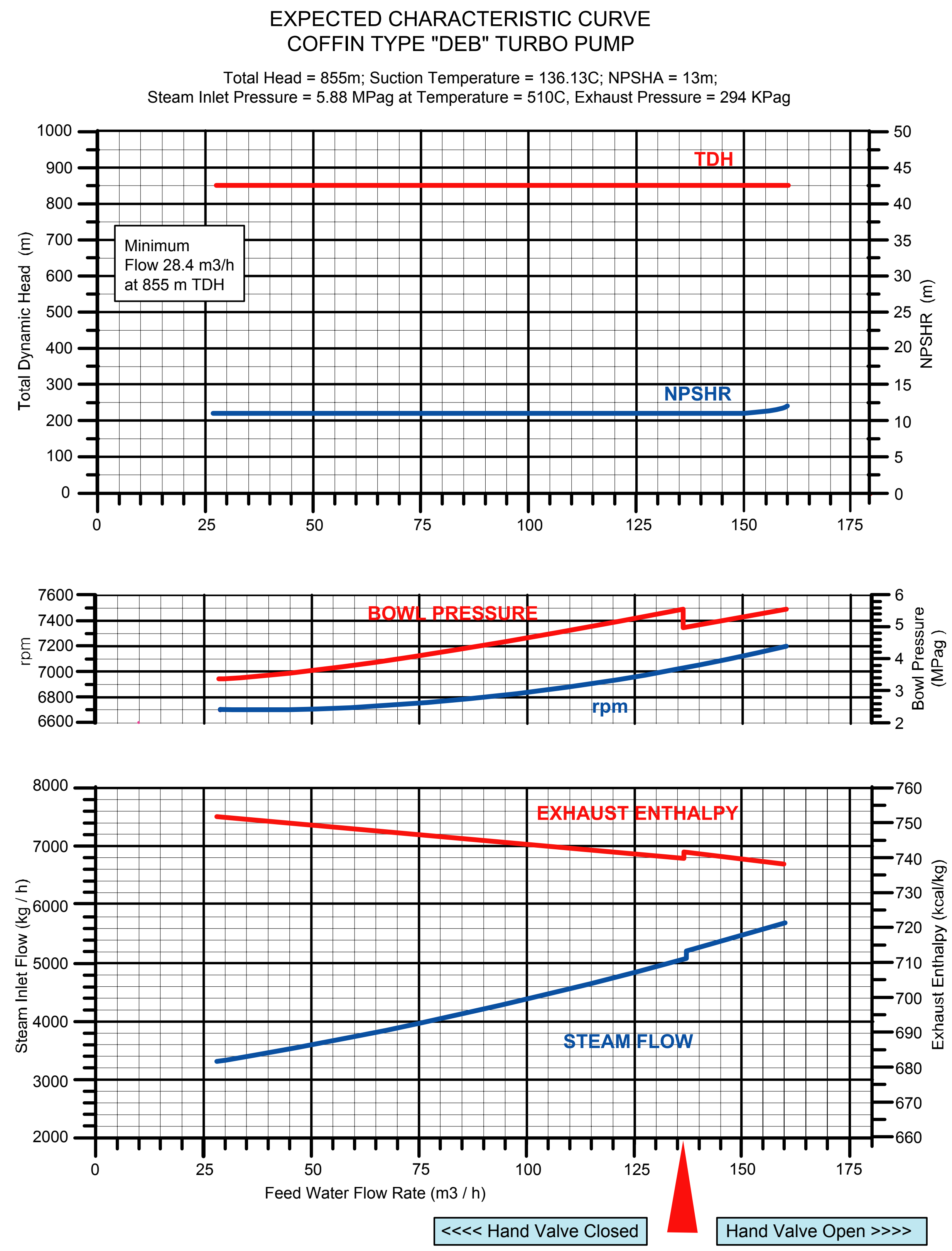
Overspeed Trip	Set	7,900	rpm
Turbine Sentinel Valve	Set	0.34	MPag
Back Pressure Trip	Set	0.41	MPag
Remote Start Pressure Switch	Set	0.20	MPag
High Oil Temperature (Alarm)	Set	80	°C
Low Oil Pressure Switch (Trip)	Set	0.17	MPag
Deaerator Level Low-Low (Trip)	Set	-1100	mm
Aux. L.O. pump remote stop switch	Set	0.22	MPag
Aux. L.O. pump start fail switch (alarm)	Set	0.20	MPag

Turbine Rotor Vibration Alarm : 7.1 mm/sec RMS
Trip : 11.2 mm/sec RMS

Mechanical seal flush line flow meter

Maker	:	BAILEY FICHER PORTER
Type	:	SI-6788/1
Pressure	:	1.21 MPag @ 121°C

Performance Curves



Technical Data

Condition of Service

CAPACITY	NORMAL (HVC)	MAXIMUM (HVO)
CAPACITY	136 m^3/Hr	160 m^3/Hr
TOTAL DEVELOPED HEADER	855 m	855 m
SUCTION HEAD	50 m (WC)	50 m (WC)
WATER TEMPERATURE	136.13°C	136.13°C
STEAM PRESSURE	5.88 MPag	5.88 MPag
STEAM TEMPERATURE	510°C	510°C
EXHAUST PRESSURE	0.29 MPag	0.29 MPag
STEAM CONSUMPTION	5096 kg/Hr	5712 kg/Hr
EXHAUST ENTHALPY	740 Kcal/Kg	738.6 Kcal/Kg
NPSH (REQUIRED)	11 m	11.7 m

Cooling Water Requirements and Gland Leakage

Turbine Gland Steam

Normal Clearance	0.26 Liter/Min (0.25 kg/Hr)
Maximum Clearance	0.36 Liter/Min (0.35 kg/Hr)

Lubrication Oil Cooler

Inlet Temperature	37°C
Outlet Temperature	38.7°C
Cooler Water Flow	4.5 m^3/Hr
Heat Exchanger Duty	8.98 kW

Note!

The gland packing seal and sleeve are designed for five year maintenance intervals.

Main Feed Water Pump Pre-start up Procedure

(Part No. – i.e. X118, X117 etc.- in follow procedure refer to instruction TAB G drawings & illustration)

This procedure is for the purpose of where the pump has started for the first time after installation, has been shut down for a long period of time over a lay-up period and is to be re-activated or after the completion of a major maintenance overhaul.

1. If the pump has been shut down for any reasons, the main steam stop valve needs to be closed for prolonged period. In this case, before opening the stop valve, verify that the motor–operated steam inlet valve is CLOSED. (Main Steam Stop Valve refers to the Shipyard supplied valve located BEFORE the motor operated steam valve.) As good operational practice, always open the pump suction valve before the pump discharge valve, and the steam turbine exhaust valve before the steam inlet valve.

2. Check all exposed pump cavities, as well as check all compartments for debris, tools, parts, etc. before a maintenance overhaul. Make sure the entire pump has been assembled or reassembled completely and correctly before the main steam stop valve is opened.

3. With the balanced steam valve hand throttle closed, check and adjust, the main control lever rod (X118) via the fitted adjusting nut for a distance between the lever centers of 4” (102 mm) for a model “DE” or “DEB” pump, and 6.5” (165 mm) for a model “DEB_22” pump. This procedure is designed to balance the main control lever (X77), though extreme accuracy is not required here, the adjustment should leave clearances of .004”–.008” (.10–20 mm) between the lower end of the main control lever rod and the back pressure trip resetting lever (X117). When the adjustment is complete, the main control lever should be checked and adjusted. See the “Regulator Section” of this instruction manual for instructions on this procedure.

4. If oil has been drained from the oil sump for any reason, refill to the proper mark on the oil bayonet (#653). If oil remains in the sump from the ballast shut–down, sample this oil through the drain valve. If the oil has accumulated condensation, draw off as necessary and refill to the proper level with new recommended turbine oil. In all cases of turbine start–up, ALWAYS check the oil level in the sump BEFORE opening the steam valve.

5. With the proper level of Lube oil in the sump (refer to number [4] above), start the auxiliary Lube oil pump and set the oil pressure at its maximum value, when the lubricating oil in the sump is cold (approximately 21°C), using the pressure regulator (See “Lubrication Section”). Allow the Aux LO pump to run until the level in the oil sump stabilizes to a constant value, then stop the pump. The Lube oil system has now been vented, through the oil vent, of all entrapped air.

6. Establish cooling water flow through the Lube oil cooler and the seal flush water cooler. Cooling water flow rates are specified on each item’s furnished “Specification Sheet” and should be adhered to maintain maximum cooler life. The flow through the seal flush water cooler can be monitored by the supplied flow meter, while cooling water flow through the Lube oil cooler should be monitored by a customer supplied flow meter.

7. Filling and venting the seal flush water system is required after its first time installation, or after the pump has been drained for maintenance. The entire seal flush system, as well as the pump, should be filled and vented once before the operation. The method of filling the seal flush system depends on the type of system supplied, the procedures are as follows:

   a) Self Contained Seal Flush Water System:
   This system is supplied with flush water from the turbo pump’s inter–stage connection and only be filled by filling the pump. To vent this system, there is a vent valve located on the Pressure Chamber, which is part of the self-contained flush water unit mounted in the vicinity of the pump. After opening the pump suction valve to fill the pump, open the vent valve on the pressure chamber to release any trapped air. When water escapes the vent tube, close the valve. To properly vent the seal flush system, the pump should be operated at low flow for 1 minute at 3,000 to 4,000 rpm and stop for at least 10 minutes before starting again. During this time of operation, the seal flush vent valve should be opened periodically to allow air to escape. The seal flush system should be vented once more before the pump is placed on line.

   Note !
   Do not attempt this procedure without FIRST reading on “Filling and Venting the Pump”.

   b) Externally Supplied Flush Water:
   This system is designed to accept flush (fresh) from an external source, such as take-off from the condensate pump. After the pump has been filled, crack the supply stop valve for the flush water and the vent valve located on supply line connection port, located on the pump seal flush piping. After solid water is flowing through the vent tube, close the vent valve and shut the flush water inlet valve, run the pump at 3,000 to 4,000 rpm for 1 minute, and stop for at least 10 minutes before repeating this procedure, vent the flush system via the vent valve periodically. This system should be vented again before the pump has been placed on line.

Note !

This procedure must be followed carefully in order to fill and vent the pump after it has been drained.

8. Before operating the turbo pump at full capacity, the unit must be completely filled and vented to ensure proper operation. Shipyard supplied vent valves should be located as close as possible to the suction and discharge valves. This allows air to escape from the piping at the highest point while the pump being fill. Crack the suction valve about one turn open and allow the pump to fill. Open the discharge valve wide during the filling process and open the discharge vent valve. When water flows from the discharge vent, close the valve. In order to vent the pump, it must run at low flow for about one minute. Run the pump at 3,000 to 4,000 rpm, vent both the suction and discharge sides of the pump by means of the respective valves. Stop the pump after one minute, wait ten minutes and vent again using the same procedure. Repeat this procedure as many times as necessary until all air is removed from the pump housing via the fitted vent valves.

Note !

Do not attempt this procedure without FIRST reviewing the procedure following this section titled "Starting, Operating and Shut down System".

Starting, Operation and Shut-Down System

Note !

Refer to the "Remote Start System Schematic" located in the "Electrical" section of Main Feed Water Pump & Turbine manual for instructions pertaining to units equipped with a Remote Start System.

Starting

(1) Steam inlet, exhaust, oil cooling water, seal flush, pump suction, and pump discharge systems must be in the starting condition as outlined in the pre-start up procedure provided in this manual. This condition must be verified by the operator through suitable means provided in each system prior to starting the turbo pump, for example, gauges and sight glasses.

(2) Various oil line valves supplied in the turbo pump Lube. system (for service reasons only) must be open. Throttle hand wheel, must be positioned wide open. Turbine trip lever located at the governor assembly must be reset if positioned otherwise.

(3) Open the oil cooler cooling water supply valve, make sure it is opened

(4) Open the turbine casing drain valve.

(5) Open the steam chest drain valve. Use of this valve, or a steam trap, may not necessary with a well drained steam line.

(6) Open the pump suction stop valve before the pump discharge valve, and the turbine exhaust valve if closed.

(7) Open the pump vent valve (when an automatic air vent valve is not installed by the customer) and close when all air is expelled from the pump housing. Refer to the "Main Feed Water Pump Pre Start-Up Procedure" provided in this manual for instructions on filling and venting the pump.

Note !

At this point, either the operator or automatic programmer must provide a finite. Delay for complete venting and draining when automatic vents or traps are not installed.

(8) Open the pump recirculation valve. (Unless an automatically controlled valve is used.)

(9) Open the turbine steam inlet valve, either partially or fully. Recommendation as follows:

a) The Turbo Pump may start by first starting the auxiliary oil pump motor to supply the bearings with pre-lubrication. Then "crack" valve a slightly to start the Turbo-pump slowly.
b) After a while, valve can either be opened gradually in incremental steps until it is fully open, or opened fully as operating conditions or operator preference dictates.
c) The steam inlet valve should **NOT** be opened before the governor balanced valve.

(10) Press the auxiliary oil pump motor start button, or energize motor starting circuit from other suitable control devices. Should starting oil pump not function for any reason, or manual starting at the turbo pump be required, proceed as follows: Lift the oil relay, and start the lever by placing a screwdriver or similar tool under the lever at the link end. This will raise the balance governor steam valve permitting the turbine to start. Hold enough this position until the turbo pump's integral oil pump develops pressure to hold the steam valve.

(11) At this time the unit will be running either.
a) At a low rpm, if Valve was partially opened.
b) At a discharge pressure established by the constant pressure regulator setting, if valve was fully open. If valve was partially open, it may be fully opened to place the unit under the control of the pressure regulator after a delay period established either by operator's preference or experience.

(12) Close all non-automatic vent or drain valves if not already closed.

(13) Check all alarm circuits that may have been turned off right after starting . This will help to avoid abnormal signals. Re-energize these circuits to ensure proper protection and monitoring.

Operation

(1) Close the recirculation valve when pump capacity exceeds the minimum rate specified by the provided Pump Performance Curve.

(2) It is recommended that a visual check of the unit, including all oil sight gauges be conducted as soon as possible after starting the unit. Check, the entire unit for any abnormal conditions. If the pump operates abnormally, shut down and attempt to remedy the problem.

If any excessive noise or vibration is experienced, shut the pump down and troubleshoot or contact a registered COFFIN TURBO PUMP agent for assistance.

(3) When operation is at its stable condition, use the turbine hand valve(s) for maximum steam as indicated by the pump's performance curve.

(4) The pump constant pressure regulator may also needs to be adjusted, for maximum steam and also for the minimum pump discharge pressure. This will maintain adequate feed water capacity.

(5) Check routinely each engine room tour to ensure the pump is operating normally. The customer/operator is encouraged to develop a standard checklist and gauge reading schedule to monitor the unit.

Turbo Pump Shut-Down

This procedure is for normal turbo pump shut-down. Instructions are as follows:

(1) Close the turbine steam inlet valve.

(2) Close the oil cooler water supply valve and the recirculating line valve.

(3) At this time, the following valves may be left open or closed depending on local conditions or procedures.

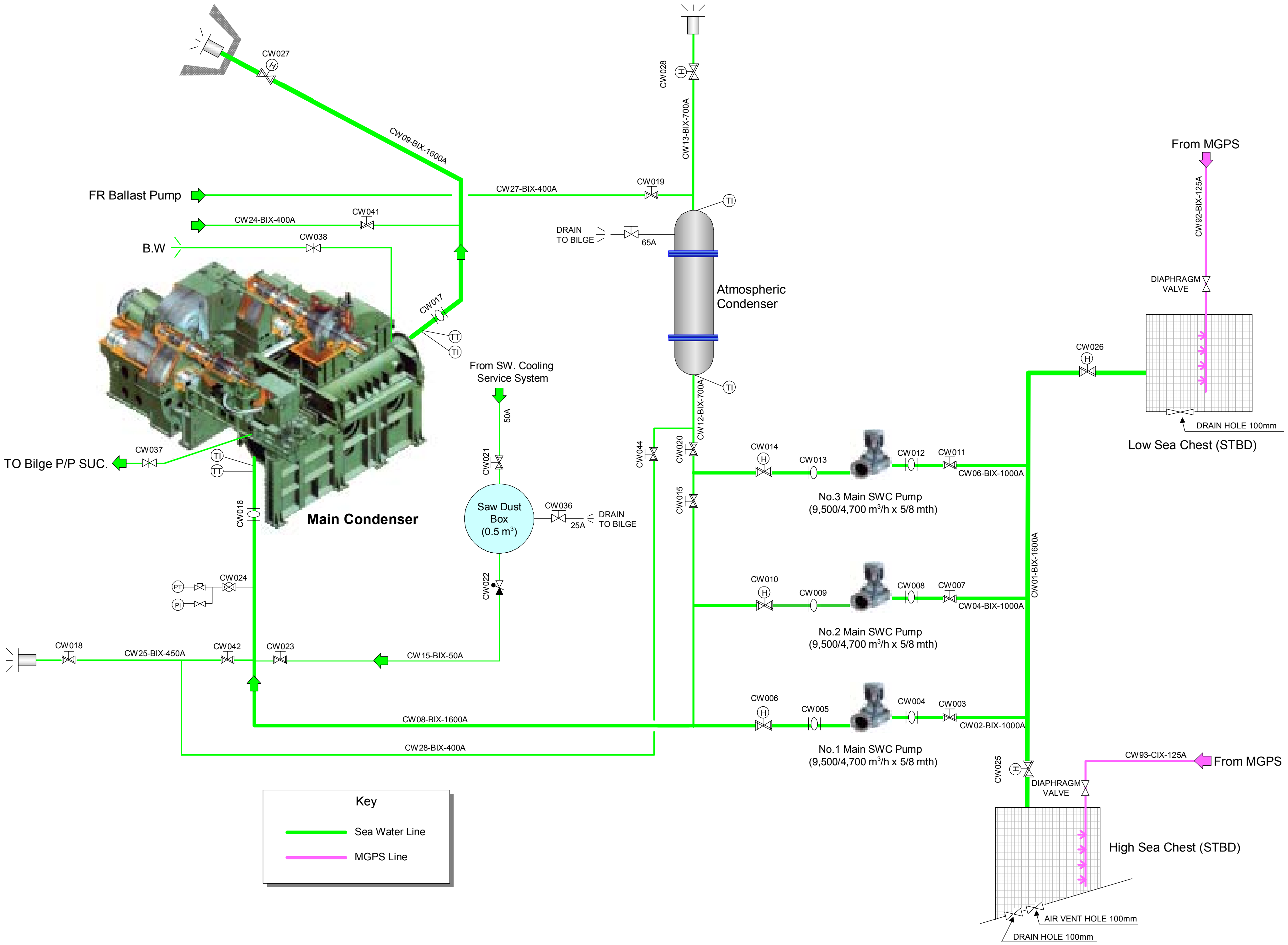
a) Pump discharge stop valve
b) Pump suction valve
c) Turbine exhaust may be closed if exhaust temperature is over 175°C as shown by exhaust enthalpy valve on the performance curve, or it may be open if exhaust temperature is lower.

Note!

It is not recommended that these valves be closed except for service work or abnormal conditions.

(4) Shut-Down for a Prolonged Period of Time:
Repeat the above procedure. Additionally, close all valves named above, including pump discharge stop valve and pump suction valve. Drain the pump housing through the pump housing drain valve, and drain the oil sump through the sump drain valve.

Illustration 2.3.1i Main Sea Water Circulating System



2.3 Sea Water Systems

2.3.1 Main Sea Water Circulating Systems

General Description

The main condenser is supplied with sea water from the circulating pumps:
By the source of the three main sea water circulating pumps.

The main sea water circulating pumps source from the high or low sea chests, and are placed in the lower flat of the engine room. The draft of the vessel will decide which sea chest to use. The discharges from the pumps are connected together through valves CW006, CW010, CW014, and CW015. CW006, CW010 and CW014 are hydraulically operated butterfly valves.

The atmospheric condenser is also cooled by sea-water. The sea-water is supplied through the main sea water circulating pump.

To ensure that the system is ventilated at all times, the main condenser water boxes and the ship's side sea chests ate equipped with vent valves. These remain open and the pipelines lead to a gooseneck at the upper deck level. The atmospheric condenser outlet water box can be vented locally, with its valves close after venting.

The main circulating pumps are all vertical centrifugal pumps driven by electric motors.

The main and atmospheric condensers are horizontal shell and tube heat exchangers, with the sea water passing through the tubes.

The main circulating pump's discharge valves, main condenser sea water inlet and outlet valves are all electro-hydraulic operated motorised valves, and can be operated from either the engine control room or from a local panel.

Minor leaks in the main condenser can be plugged by using sawdust. A sawdust injection unit is fitted for this purpose. The sawdust box is filled with sawdust and water from the sea water service system. It flushes the sawdust into the condenser sea water inlet line. There the vacuum from the condensate side of the tube stack will force sawdust into any hole or crack in a tube.

For the protection of the sea water pipelines in these systems, they are internally lined with polyethylene.

Sea chests, sea water lines and all sea water cooled condensers are protected from environmental hazards by an anti-fouling system. MGPS units further prevent contamination into all sea chests, and any contaminant is then circulated out of the sea water system.

System Control

Once set up locally, all normal operations are carried out from the control room control panel.

As well as providing the stop/start control buttons, a light indicator shows which pump is in use.

The ship's side and circulating pumps' remote hydraulically motorised valves are operated from a separate panel, with a light indicator to show if they are opened or shut. The main condenser overboard valves can be partly open or shut. The main condenser overboard may be shut down in when the main turbine is not in use to allow extra cooling water through the auxiliary condenser.

Valve and pump operation from the control room panel is initiated by a signal to start or stop a pump. A pump start signal is given, either by manual operation or through auto-start.

The standby pump will automatically start should the discharge pressure drop, or the running pump fail.

All pumps have start and stop buttons at a local panel, from where they can be started or stopped. After starting at this panel, the switch must be placed to remote to operate from the ECR panel. The pumps may be stopped from the local panel, even if remote control is in place.

System Capacities and Ratings

Main Circ. Pumps:	Shinko Ind Ltd.
No. of sets:	3
Type:	GVN1000MG/LMG
Capacity:	9,500/4,700 m^3/h x 5/8 mth

Back wash for main condenser

(1) Main condenser not to be used.
(2) CW941, CW042, CW018 to be opened.
(3) Confirmed the closing condition of CW015, CW006, and CW010.
(4) CW027 to be shut down.
(5) The concerned ballast pump to be started to supply the back wash water.
(6) Discharge. valve of the concerned ballast pump to be opened slowly.

Operating Procedures

(1) To circulate the main condenser

a) Make sure that the condenser inlet and outlet water box drains are securely closed.
b) Open and lock the condenser inlet and outlet water box vent valves.
c) Make sure that the switches at the local operating panel for pumps and valves are remotely placed.

(2) The following can be operated from the ECR

a) Open the sea chest valve to the pump suction line.
b) Open the condenser inlet valve and when fully open, slowly open the overboard discharge valve until it is fully open. The condenser will start filling by free flow through the overboard valve, and as it fills, make regular inspection of doors and valves to ensure that there is no leakage.
c) Select the main sea water circulating pump to be used, and open its suction valve. Ventilate the pump casing to ensure that the pump is filled.
d) Start the pump, and once running, its discharge valve will automatically open.
e) Place the following pump on stand-by mode, ensuring its suction valve is open. Inspect all system for leaks.

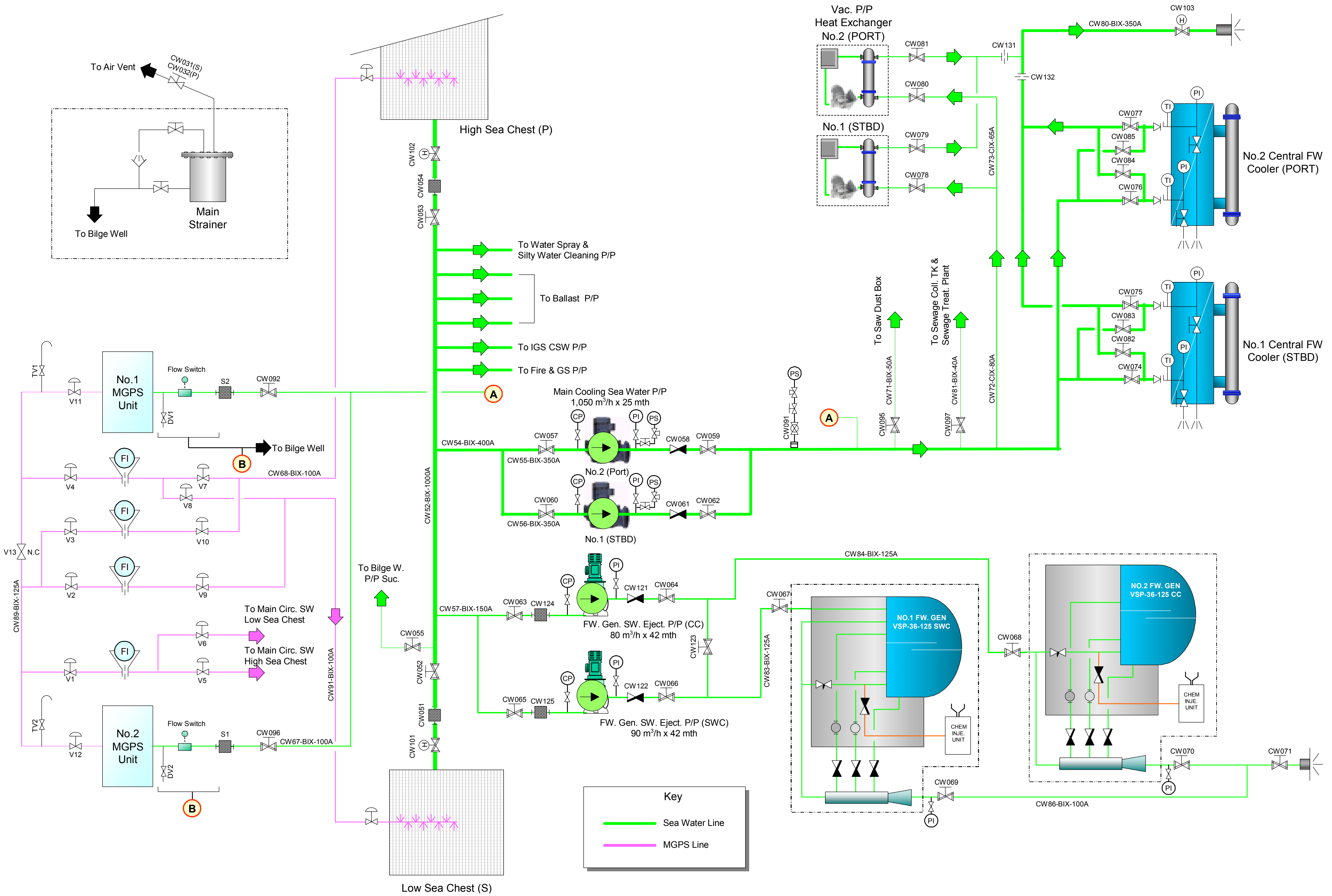
(3) To circulate the atmospheric condenser using the sea water circulating pump

a) Make sure that the condenser inlet and outlet water box drains are closed.
b) Open the sea-water outlet valve from the condenser.
c) Open the butterfly valve of the sea water suction pump, and start the pump. Once running, its discharges valve will automatically open.
d) Open the condenser sea-water inlet's manually operated valve CW020 and ventilate the water box, ensuring that the vent valve is securely closed when no more air is ventted.

(4) To inject sawdust into the main condenser

a) Make sure that the injection unit inlet and outlet valves are closed, and open the drain valve to prove that the unit is empty.
b) Close the drain valve and remove the top cover of the unit.
c) Fill with the required amount of sawdust and refit the top cover.
d) Open the unit outlet valve, and the inlet valve to the condenser sea water inlet line CW023.
e) Open the sea water service line inlet valve unit and allow several minutes to push the sawdust out of the unit and into the condenser.
f) Close all valves once the operation is complete.

Illustration 2.3.2i Cooling Sea Water Service System



2.3.2 Cooling Sea Water Service System

General Description

Other systems requiring sea water cooling services are supplied from the main cooling sea water pumps.

These are vertical electrically driven centrifugal pumps, with one normally in use and the other on stand-by. The sea water suction to these pumps is from a common supply pipeline, which extends from the port high sea chest to the starboard low sea chest.

There is a remotely operated ship's side butterfly valve on each sea chest, which allows sea water to enter a line simplex filter. Each sea chest has a vent valve that normally remains open, ensuring that the chest is full at all times. The outlet butterfly valve on each filter allows the unit to be isolated and cleaned periodically.

The discharge from the two pumps moves into a single pipeline system, which, in turn, allows for feeder lines to each unit requiring cooling water.

The sea water cooling system provides water to the following units:

- No.1 and No.2 main condenser vacuum pump coolers
- No.1 and No.2 central fresh water coolers
- Main condenser sawdust box
- Marine growth prevention system
- Sewage collecting tank

There is also a separate F.W. generator sea water service system, supplied by two vertical electrically driven centrifugal pumps. One pump is running on normal operation, and the second pump on stand-by auto cut-in.

The pumps draw their suction from the same main line as the main sea water cooling pumps, but the discharge is only to the auxiliary cooling fresh water coolers for the cargo machinery system.

After passing through the central fresh water and main turbine vacuum pump cooler units, the water is discharged overboard at a remotely operated ship side valve CW103.

The central fresh water coolers are of the plate type design, one of which is normally in use, while the other is retained in a clean condition and ready for use when the other unit becomes dirty.

Note !
For full information on the set feed levels, temperatures, vacuum and pressures of the distilling plant, see the manufacturer's operating manual.

Capacities and Ratings

Main Cooling SW Service Pumps:	Shinko Ind Ltd.
No. of sets:	2
Type:	GVD360M
Flow:	1050 m^3/h at 25 mth
Central Fresh Water Cooler:	Korea PHE Co., Ltd.
No. of sets:	2
Type:	Plate Type
Capacity:	6,733,300 kcal/Hv
No.1 F.W. Gen S.W. ejector pump	Shinko Ind Ltd.
No. of sets	1
Type	GVC125-2M
Capacity	80 m^3/h(VSP-36-125CC)
No.2 F.W. Gen S.W. ejector pump	Shinko Ind Ltd
No. of sets	1
Type	GVC125-2M
Capacity	90 m^3/h(VSP-36-125SWC)

Operating Procedure

(1) Main Cooling Sea Water Pump System

a) Open the sea chest suction valve to high or low suction, depending on vessel's draft. This valve may be opened remotely, and an indicator light will light up when fully open. Vent off the line suction strainer to check water level.
b) Select the pump to be used and, with the power off, make sure that the pump turns freely by hand. Open the suction valve to the pump.
c) Vent off the pump casing and make sure that it is full.
d) Check the central fresh water coolers and vacuum pump coolers to make sure that the drain valves are shut. Open the ship's side valve for the water coolers overboard discharge line. Make sure that the indicator light is on, and fully open on the panel.
e) Select which vacuum pump and central fresh water cooler to use.
Open the suction and discharge valves.
f) Start up the pump and, when it is rotating correctly, slowly open the discharge butterfly valve until it is fully open.
g) Check both coolers in use, venting off the outlet water boxes to ensure that no air is trapped in the units. Close the vent valves tightly.

(2) Fresh Water Generator Sea Water Service System

A fresh water generator ejector pump with a 80 m^3/h capacity is used to supply sea water to the fresh water generator, VSP-36-125CC and the other with a 90 m^3/h capacity is used to supply sea water to the fresh water generator VSP-36-125SWC.

The fresh water generator sea water pumps draw their suction from the main sea water service suction line between the high port and the starboard center low sea chests. The pumps are both vertical electrically driven centrifugal pumps.

Anti-foaming chemicals are injected into the inlet sea water line, before the water is passed into the distiller unit. These chemicals help prevent excess foaming as the water is heated in the shell vacuum, as well as retaining impurities in suspension to be pumped overboard by the sea water pumps.

As the feed sea water passes through the distiller system, it is heated while at the same time being used to assist in the cooling of the mediums within the various heat exchangers:

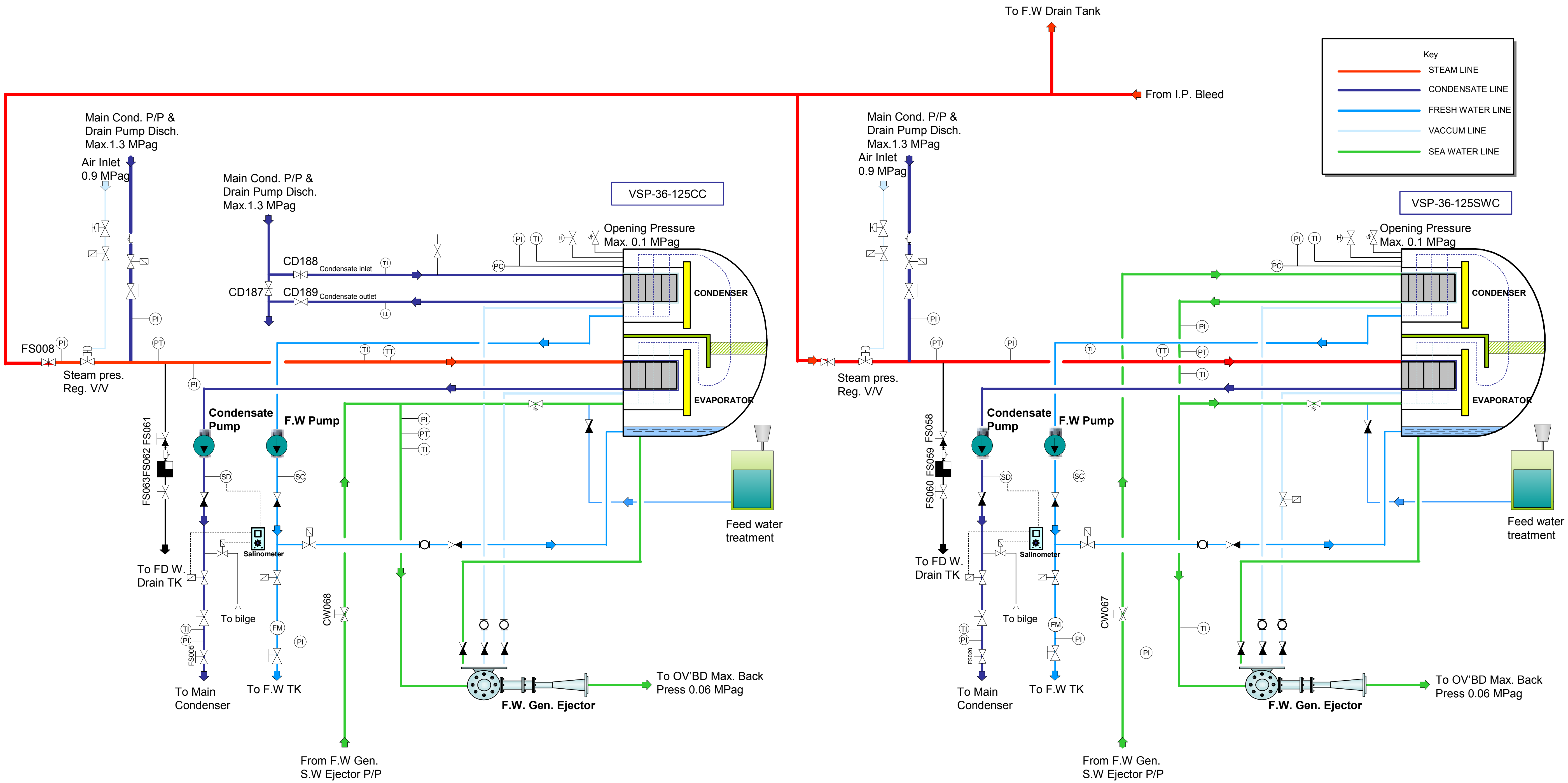
In the distiller cooler, distillate water produced is cooled.

In the feed water heater, the resulting sea water feed is heated to flash off temperature by steam.

Capacities and Ratings

FW Generator:	ALFA-LAVAL
No. of sets:	2
Type:	VSP-36-125CC/SWC
Capacity:	60 t/day
Salinity:	1.5 ppm

Illustration 2.3.2.1i Fresh Water Generator



2.3.2.1 Fresh Water Generator

Starting and Stopping Procedure

! Caution

Before starting, please follow these instructions for feed water treatment, see "Chemical dosing of scale control chemicals".

1) Starting
a) Open the valves on the suction and discharge side of the ejector pump.
b) Open the overboard valve for combined brine/air ejector.
c) Close the air screw on the separator.
d) Start the ejector pump to create a vacuum of min. 90%.

Pressure at combined brine/air ejector inlet minimum 0.3 MPag.
Back pressure at combined brine/air ejector outlet maximum 0.06 MPag.

For V-SP-36-125CC only
e) Open the condensate inlet and the outlet valves.
f) Start condensate supply to condenser by adjusting by-bass valve step wise, inlet in desired condensate flow is reached.

Evaporation

When there is a minimum of 90% vacuum (after maximum 10 minutes).
a) Open valve for feed water treatment.
b) Make sure that the air inlet for steam pressure regulating valve and flow regulating valve is open (0.5-0.7 MPag).
c) Make sure that the condensate inlet for desuperheating is open (maximum 1.3 MPag).
d) Open the valve for condensate to main condenser.
e) Open the valve for deaerating the heat exchanger to main condenser.
f) Open the main steam shut-off valve.
g) Open the steam pressure regulating valve by adjusting the temperature controller in the control panel step-wise 5-10°C until the specified steam temperature is reached (maximum 92°C).

Condensation

After approx. 3 minutes, the boiling temperature will drop again and the vacuum is should be normal.
a) Open the valve to freshwater tank.
b) Turn on the salinometer.
c) Start the freshwater pump.

Note !

The freshwater pump pressure must be between 0.12 and 0.16 MPag.

After starting the freshwater pump the flow sight glass in the air suction pipe must be empty.

! Caution

If water remains in the flow sight glass, please refer to following table.

Cause	Action
Suction pipe leakage	Check and repair suction pipe especially unions and connections
Mechanical seal in freshwater pump defect	Replace Mechanical seal.
Impeller/seal ring in freshwater extraction pipe defect.	Check pump maximum clearance
Pump rotating in wrong direction	Interchange phases.
Valves to freshwater tank closed.	Check all valves.
Inlet filter for water clock blocked.	Clean filter.

Adjustment of Sea Cooling Water

The sea cooling water flow is correct when the pressure at the inlet of the combined air/brine ejector is between 0.3 and 0.4 MPag.

2) Stopping the Plant
a) Pressure control output manually reduce until steam valve closes.
b) Close the valve for air inlet.
c) Close the main steam shut-off valve.
d) Close the valve for condensate for desuperheating inlet.
e) Close the valve for feedwater treatment.
f) Turn off the salinometer.
g) Stop the ejector pump.
h) Open the air screw.
i) Open the air screw.
j) Close all valves on the suction and discharge side of the pump.
k) Close the overboard valve for combined brine/air ejector.
l) Close the valve to freshwater tank.

! Caution

All valves must be shut while the distiller is out of the operation, except for the vacuum breaker.

Specification of Distilling Plant

Type	:	**VSP-36-125CC (Condensate Cooled)**
Number of unit	:	1 set/ship
Capacity per unit	:	60 ton/day
Condensate water temperature inlet	:	33°C
Condensate water temperature outlet	:	59.7°C
Condensate flow	:	53 m^3/24h
Pressure drop	:	0.04 MPag
Steam flow	:	3,031 kg/h
Steam pressure	:	0.075 MPag
Electric source	:	Main power 3x440x60Hz Control voltage 220V

Type	:	**VSP-36-125SWC (Sea Water Cooled)**
Number of unit	:	1 set/ship
Capacity per unit	:	60 ton /day
Sea water temperature inlet	:	32°C
Sea water temperature outlet	:	48.3°C
Sea water flow	:	90 m^3/24h
Pressure drop	:	0.02 MPag
Steam flow	:	2,742.2 kg/h
Steam pressure	:	0.07 MPag
Electric source	:	Main power 3x440x60Hz Control voltage 220V

Set Point for Alarm System

Desuperheating system regulating	:	110°C
Timer relay 5K2	:	10 min
Pressure switch PT-ES-01	:	0.35 MPag
Vacuum switch PT-E1-01	:	0.035 MPaA
Salinometer	:	1.5 ppm

Salinometer

Model	:	DS-20
Power	:	220V x 60Hz x 3.5W
Range of salinity	:	0-20 ppm of seasalt.
Alarm level	:	Adjustable 0-20 ppm 0-10 ppm 1 ppm/step 10-20 ppm 2 ppm/step

Fresh water pump

Maker	:	Alfa Laval
Pump type	:	PVVF 2040
Motor type	:	80 B-2
Nom. flow	:	3.1 m^3/h
Nom pressure	:	39 mwc

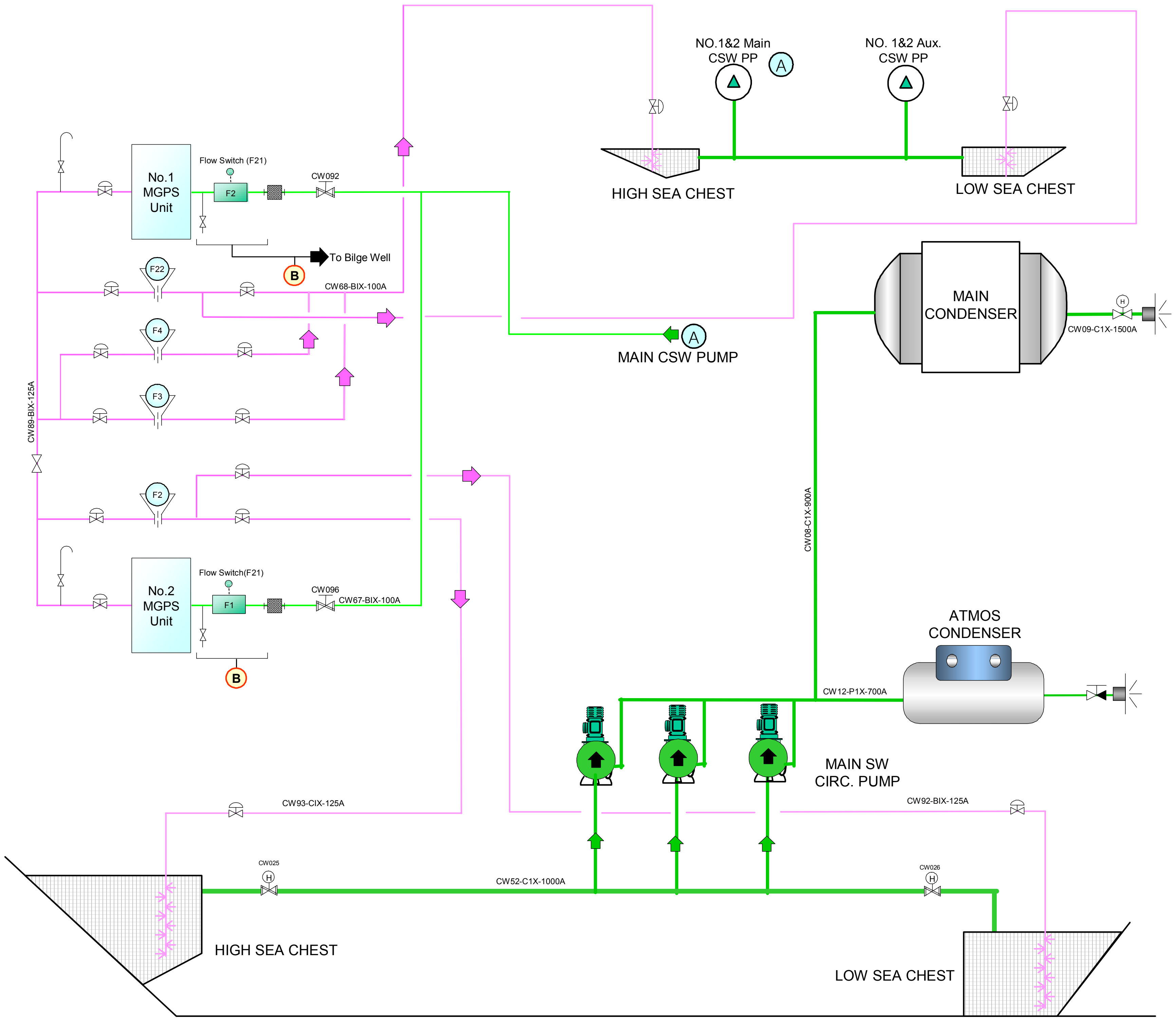
Condensate water pump

Maker	:	Alfa Laval
Pump type	:	PVVF 2040
Motor type	:	71 B-2
Nom. flow	:	3.1 m^3/h
Nom pressure	:	28 mwc

Note !

The production of 60 ton/day can only be achieved under the condition of sea water temperature at 30°C.

Illustration 2.3.2.2i Marine Growth Preventing System (MGPS)



2.3.2.2 Marine Growth Preventing System (MGPS)

Operation Procedure

(1) Open fully Valve fitted on respective Sea Chests into which Electrolyzed Sea Water coming out of Electrolytic Cell is to be injected.

(2) Check Flow Setting Needle (red) of Flow Meter on the inlet side of the Cell so as to ensure that it is set at the correct set value (for example: min. flow rate in the Cell) as follow table "Specifications".
If not, reset it to the correct value.

Flow meter NO.	Flow range (m^3/h)
F1, F21 (Flow Switch)	20.0 ~100.0
F3, F4	3.0 ~15.0
F22	20.0 ~ 100.0
F2	30.0 ~ 150.0

(3) Operate S. W. Pumps in such a way as to keep the seawater flow into the Cell always at not less than the specified flow rate.
(Pertaining to the specified flow rate, i.e., seawater flow rate inside the Cell; for normal rate, refer to "Operation Plan" given in "Specifications" attached hereto).

(4) Check a seawater flow rate with Flow Meter readings and then work on Power Supply instrument panel in the following manner;

a) Turn "OUTPUT ADJUST" knob of DC Output Variable Resistor counterclockwise as far as it can go and set it at the lowest output position.

b) Turn Circuit Protector (CP1, CP2) "ON".

c) Turn No-Fuse-Breaker (NFB2) "ON".

d) Turn No-Fuse-Breaker (NFB1) on the AC input side "ON".
Then, Pilot Lamp lights up, displaying "Source" (clear).

e) And close the door then, turn "START-STOP" Change-over Switch towards "START" to put Rectifier in an operational state with Pilot Lamp, "RUNNING" (green), lighting up.

f) Check an appropriate operation current amperage according to "Operation Plan" given in "Specifications" before setting the operation current of the System.
Then, turn "OUTPUT ADJUST" knob of DC Output Variable Resistor to set the operation current at the specified amperage.
Note: Both the voltage and amperage increase as the "OUTPUT ADJUST" knob of DC Variable Resistor is turned clockwise.

(5) Seawater electrolyzed inside Electrolytic Cell (Electrolyzed Sea Water) is injected into Sea Chests through Injection Nozzles installed in respective Sea Chests and mixed with seawater fed into respective Cooling Water Systems of a ship.
Check the flow rates of seawater to be distributed among respective Sea Chests according to "Operation Plan" given in "Specifications".
Adjust Distribution Valves on the outlet side of Electrolytic Cell for even distribution of Electrolyzed Sea Water among Sea Chests by watching the readings of Flow Meters for distribution.

(6) Check Whether Electrolyzed Sea water is distributed evenly into seawater in respective Cooling Water Systems of a ship.
This can be achieved by determining by use of a colorimeter chlorine compound concentration (dependent on the volume of Electrolyzed Seawater mixed in sea water) of seawater taken out of Air Valve of respective S.W. Pumps sucking seawater in through respective Sea Chests.
Aim at the range of from about 0.02ppm to 0.05ppm as the target level of Chlorine Compounds Concentration of the seawater in respective Cooling Water systems when regulating the flow rate of Electrolyzed Sea Water into respective Sea Chests by means of Distribution Valve.

(7) As to the operating current amperage and the volume of Electrolyzed Sea Water distributed into respective Sea Chests, appropriate for each of various service conditions of a ship including such cases as when she is at sea, when she is in port.

(8) In case that, for some reason, the flow rate of sea water being supplied to Electrolytic Cell drops below the set value (as indicated by Setting Needle in red), the operation of Rectifier will come to a stop automatically by a command signal sent from Differential-Pressure Type Flow Meter located on the sea water inlet side of the cell.
At this point, Pilot Lamp, "Running" (green), goes out.
However in such a case as above, when the sea water flow rate reverts to the set value or a higher value, the operation of Rectifier is automatically resumed and Pilot Lamp, "RUNNING" (green), lights up again.

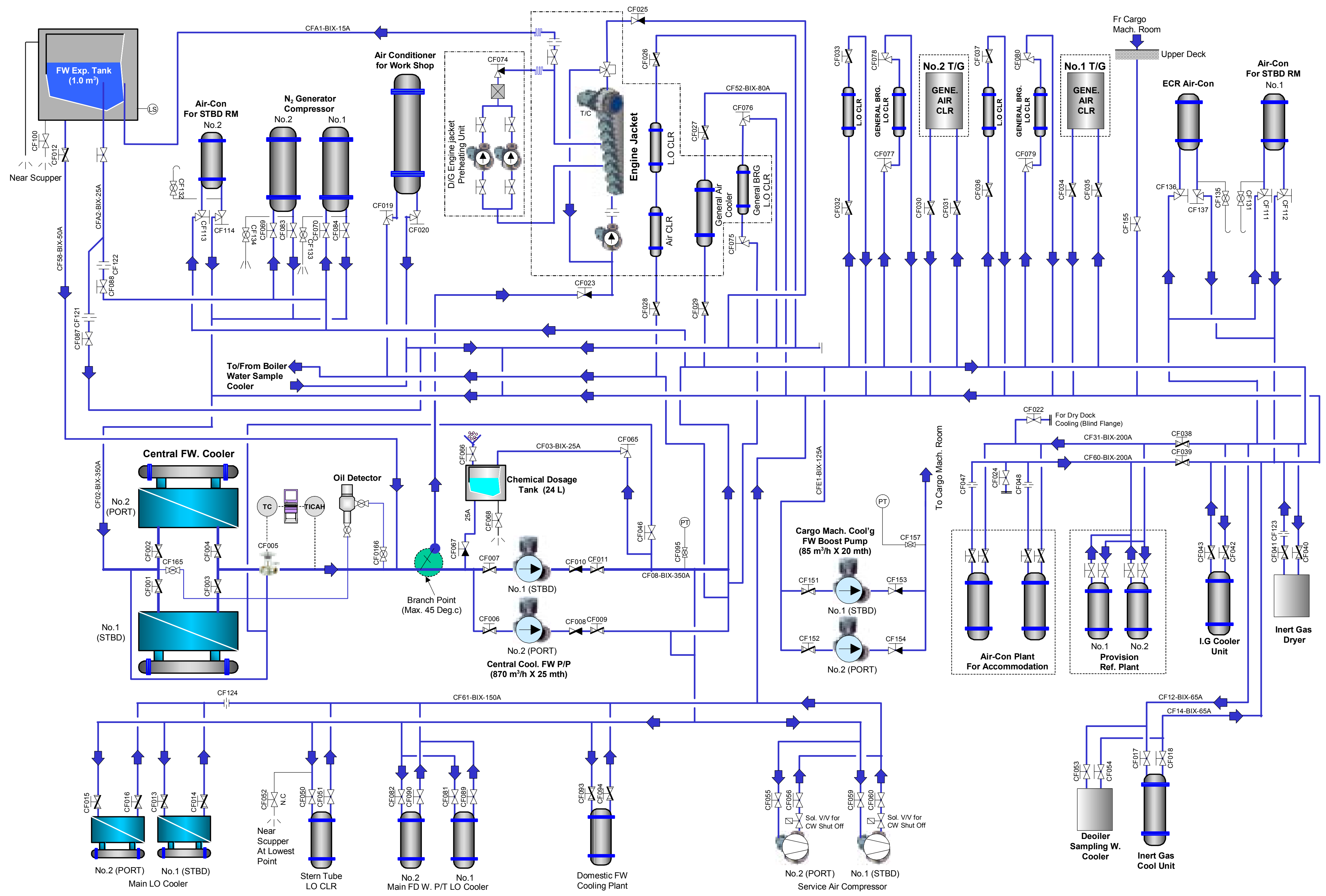
(9) In case of the operation of system being suspended for an extended period of time (for one day or longer);

a) With regard to Power Supply Unit, turn "OUTPUT ADJUST" knob of DC Output Variable Resistor counterclockwise as far as it can go to the lowest output position and turn "OFF" NFB1 on the AC input side after turning "START-STOP" Change-over Switch to "STOP".

b) With regard to Electrolytic Cell, close Valves fitted on Sea Chests, Sea Water Inlet Valve on the inlet side of the Cell and Distribution Valves on the outlet side of the Cell.

Dry dock operation :
Keep main power off.
Clean inside tanks, injection lines, injection

Illustration 2.4i Centralised Fresh Water Cooling System



2.4 Centralised Fresh Water Cooling System

General Description

The centralised fresh water cooling system is a closed system that provides cooling fresh water throughout the engine room.

The two fresh water cooling pumps are situated at the forward end of the 3rd deck in the engine room. These vertical electrically driven centrifugal pumps operate with one in use and the second in stand-by configuration. The pumps draw water from the end of the circulating loop, with make-up available from the header expansion tank. Any shortfall in the system is addressing by filling the expansion tank from the fresh water service line.

The cooling system consists of one loop. The pump in use discharges cooling water into the pipeline system that provides cooling to the following units:

- Stern tube lub. oil cooler
- Main turbine lub. oil coolers (2 units)
- SBD room air conditioning units (2 units)
- Engine control room air conditioning unit
- Work shop air conditioning unit
- Nitrogen generator unit coolers (2 units)
- Main feed water pump lub. oil coolers (2 units)
- Inert gas cooling unit condenser
- Inert gas dryer unit cooler
- Provision refrigeration plants (2 units)
- Service air compressors (2 units)
- Diesel generator engine jacket preheating unit
- Accommodation air conditioning unit (2 units)
- Turbine generator lub. oil and air coolers (2 units)
- Diesel generator lub. oil and air coolers
- Central feed water coolers
- E/R drain cooler
- De-oiler sampling water cooler
- Domestic F.W cooling unit
- Cargo machinery room

Sea water is used as the cooling medium for the fresh water coolers, which is provided by the main sea water cooling pumps. The coolers are of the plate type design. Water temperature is maintained in the system by means of a three way control valve fitted to the outlet side of the coolers. This allows the fresh water to flow through or bypass the coolers, depending on its temperature. The temperature control valve position is adjusted from a transmitter signal fitted to the main line after the coolers.

Capacities and Ratings

Central FW Pumps:	Shinko Ind Ltd.
No. of sets:	2
Type:	GVD360M
Capacity:	870 m^3/h X 25mth
Central FW Coolers:	KOREA PHE LTD.
No. of sets:	2
Type :	B110-MGS7/3
Capacity:	6,733,300 kcal/h

Operating Procedures

Make sure that the main sea water service system is in use, with cooling sea water provided to the fresh water coolers and both inlet and outlet valves to the cooler that will be used are open.

(l) Locally:

a) Make sure that all the vent air valves on the fresh water cooling system returning to the fresh water header expansion tank are open. These are placed as follows:

   i) On the engine room space air conditioning unit outlet line.
   ii) From the diesel generator fresh water cooling system.
   iii) On the main air conditioning plant outlet line.
   iv) On the pump suction line.

b) Make sure that all system drain valves are closed.
c) Open the inlet and outlet valves on the units to be cooled.
d) Open the inlet and outlet valves on the cooler to be used.
e) Open the suction and discharge valves on the CFW pumps, venting off casings to make sure that the units are full.
f) Start one of the pumps and check if it is operating normally.
g) Place the second pump in stand-by mode.
h) Stop the pumps to check if prove that the auto cut-in is operating correctly.
i) Check all systems for leaks, and that the operating temperature is normal.

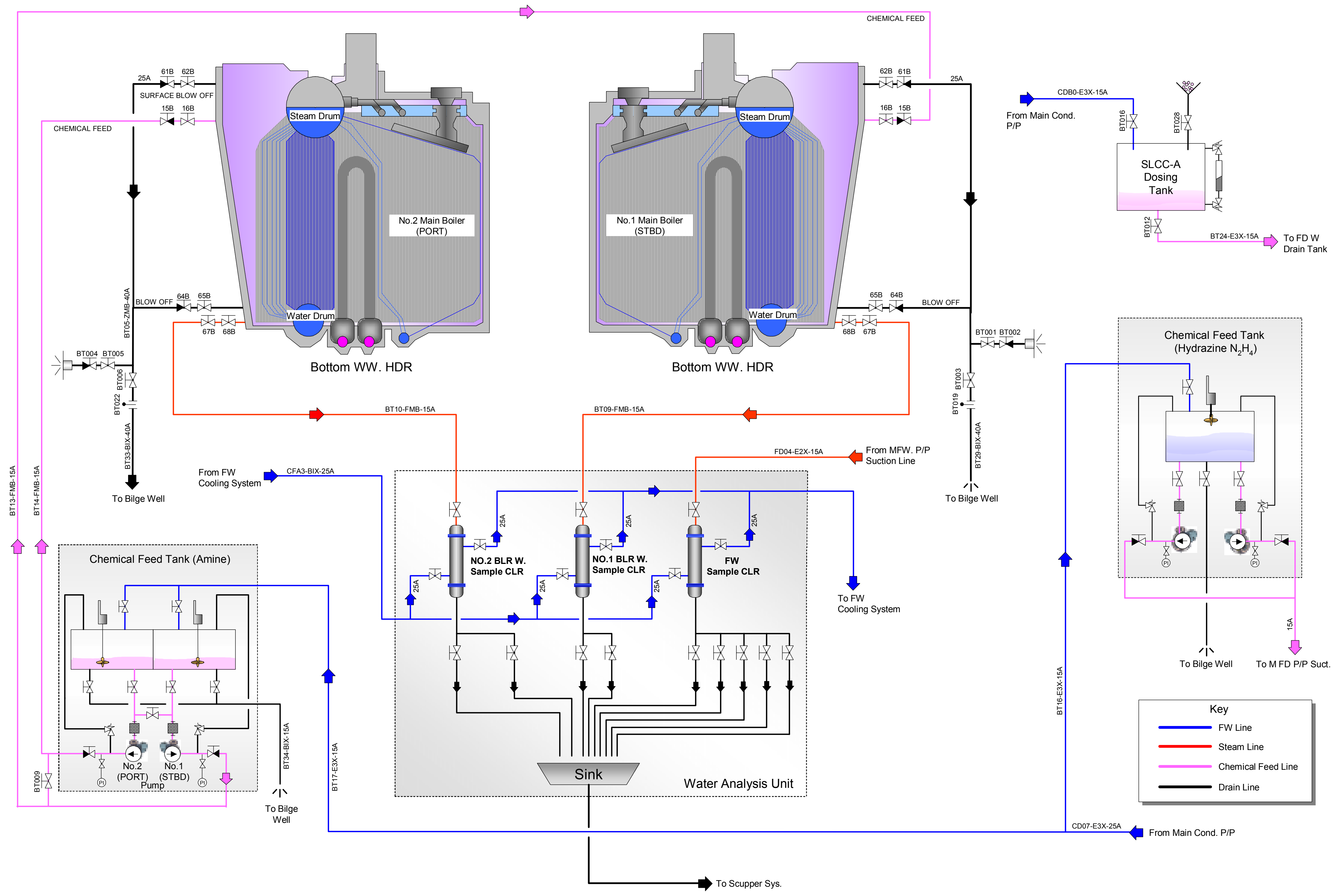
(2) Remotely:

a) Make sure that the pump discharge pressure is correct and that the temperature is maintained. Make sure that the temperature control valve is operating satisfactorily.
b) Start and stop the pumps remotely in the engine control room.

Control and Alarm Settings

CENT. CFW P/P OUTL. PRESS. LOW	0.26	MPag
CENT. FW COOLER OUTL. TEMP. CONT.	30~40	°C
FW EXP TK LVL LOW	35	%
D/G ENG HT CFW INL. PRESS. LOW	0.23	MPag
D/G ENG HT CFW OUTL. TEMP. HIGH	88	°C
D/G ENG HT CFW OUTL. TEMP. H-H (TRIP)	95	°C
D/G A/C OUTL. FW TEMP. HIGH	48	°C
D/G A/C AIR OUTL. TEMP. HIGH	105	°C
EM'CY D/G ENG COOL. W TEMP. HIGH	93	°C

Illustration 2.5i Boiler Water Sampling and Treatment System



2.5 Boiler Water Sampling and Treatment Systems

General Description

A chemical analysis and treatment of feed water is undertaken to prevent corrosion, scale formation in the main boilers, and degradation of the steam quality. Inadequate or incorrect treatment can result in severe damage to the boilers, and constant monitoring is necessary to give an early indication of possible contamination of the feed water.

Chemical treatment and analysis tests must be undertaken in accordance with the detailed instructions given by the chemical supplier, and with the specified water characteristics maintained within the ranges. Test results must be recorded to monitor trends and the effect of treatment.

The dissolved solids in the boiler water are controlled with the use of scum lines in the steam drum and/or water drum valves, through which these impurities are discharged overboard. These systems are an integral part of the boiler water treatment.

The facilities for the chemical analysis of the feed water consist of the following sections:

On line analysers are fitted to various units in the feed system to constantly monitor the water condition and sound an alarm when a specific contamination is detected. They are fitted at the following points:

- Condensate pump discharge - salinity
- Drains pump discharge - salinity
- No.1 distiller distillate - salinity
- No.1 distiller steam heater drains - salinity
- No.2 distiller distillate - salinity
- No.2 distiller steam heater drains - salinity
- Atmospheric condenser drains - salinity
- Main feed pump suction - salinity

The main water analyser unit in the workshop has permanent sample lines fitted, which are led, through coolers, to permanent test meters. These are fitted for the following:

- No.1 main boiler -water drum sample-test for pH and conductivity
- No.2 main boiler -water drum sample-test for pH and conductivity
- Deaerator outlet-water sample-test for pH, conductivity, oxygen and hydrazine

All permanent test points above can be bypassed to enable samples to be taken, and manual testing to be done.

All the coolers use the fresh water cooling system as their supply.

The hydrazine injection unit provides a continuously metered supply of hydrazine into the feed pump suction line. The hydrazine is used as an oxygen scavenger in the system. The unit consists of a tank, which is filled with a mixture of distillate water supplied from the main condensate pumps and hydrazine compound. They are mixed in the tank using an agitator, and the resulting mix is injected into the feed line, through either of the two pumps supplied. The stroke of these pumps can be adjusted to give correctly metered amounts into the system.

The boiler chemical dosage unit consists of two tanks, normally one for each boiler. Chemicals are poured into the tanks and mixed by an agitator before being injected into the boiler steam drum through its chemical injection valves. The pumps are of a reciprocating type and stroke that can be adjusted to measure the time that the chemical takes to enter the boiler. Should one pump become faulty, it is possible to use the other pump to inject to either boiler. The pumps have a non-return valve on their discharge side to prevent boiler pressure in the tank. Any blockage in the system will cause the relief valve on the discharge side of the pumps to be lifted, returning the chemicals back into the tank.

The emergency boiler chemical dosage unit consists of one enclosed pressure tank. Chemicals are poured into the tank through the hopper installed on the top of the tank and mixed with water by crack opening the feed inlet valves with their vent valves open.

After this, close the vent valves and fully open the feed inlet valves before they are injected into the boiler steam drum.
When the tank is fully pressurized by feed water, open the outlet valve and inject the chemicals to the steam drum.

This system is for emergency uses, in case the main system is out of order, or the initial chemical filling is done for a long-term boiler reservation.

Water Specification: (boiler manufacturer's figures)

Boiler Water Characteristics	**Normal**	**Max**
pH @ 25°C	9.6~10.2	10.3
Conductivity	≤ 120 μS/cm	
Total dissolved solids		
Chlorides	≤ 10	max 10 ppm
Phosphates	15~25	25 ppm
Alkalinity		
Silica	≤ 0.5	5 ppm
Ammonia	≤ 1.0 ppm	
Feed Water Characteristics		
pH @ 25°C	8.6~9.0	9
Total hardness		
Oxygen		0.007 ppm
Hydrazine reserve	0.01~0.03	max 0.03

Note !

The following information is for general guidance only. Reference must be made to the specific instructions from the boiler chemical supplier regarding the final data for chemical treatment of the boilers and the feed water.

Low boiler water pH may be a result of sea water pollution or lack of adequate phosphate treatment. A return to the normal state is required at the earliest opportunity. A tendency for a rise in the boiler water analysis figures towards the range maximums, with the exception of hydrazine, may also be the result of sea water contamination, or insufficient blow down of the boilers.

Low or inadequate dosage of ammonia or neutralizing amine may cause a feed-water pH of 8.5 or less. This should be rectified at the earliest opportunity. Too high a dosage of ammonia or neutralizing amine, resulting in a pH in excess of 10, may not be detrimental to the steelwork in the system, though it is not recommended and system levels should be reduced into the specified ranges.

Increase in hardness and/or sodium results from sea water contamination, and should be rectified as soon as possible. Iron contamination is a result of a pH that is too low and/or excess dissolved oxygen. If the oxygen level increases, the source of contamination must be located and rectified as soon as possible and hydrazine dosage must be increased until the feed water content returns within limits.

Contamination by organic matter cannot be rigorously defined, as potential contaminants are diverse. Any source of oil contamination must be identified and isolated as soon as possible, with the use of the scum valves on the drain inspection tank used to clear any accumulation found in the tank.

Operating Procedures

(1) Sampling

The following information applies to whichever of the sample units is used.

a) Check if the cooling water lines from the central fresh water cooling system to the individual analyser coolers are open. Check the individual cooler outlet flow meters, to make sure that the amount of the cooling medium is correct.

b) Make sure the cooler outlet valve to the sensing units is closed, and open the bypass valve to the drain line to the bilge.

c) Open the inlet valve to and the outlet valve from the cooler, allowing the line to be tested to flow through the cooler. Allow several minutes to pass while the line is drained of any standing water, which may be present due to previous use. Some of these lines cover large distances and must be given time to clear. Make sure that a water sample is taken from the water in the system.

d) Check the thermometer in the line to make sure that the sample is at the correct temperature. A sample taken while the temperature is too high may not be tested satisfactorily, as the test chemicals themselves are only rated at certain temperatures.

e) Once the line has cleared and the temperature is correct, the bypass valve may be closed and the valve to the test analyser units opened. Check individual flow meters to make sure that correct water flows through the sensors.

f) Manual samples may be taken from the bypass line.

! Caution

Boiler water samples are taken from the water drum and are thus consequently at a high pressure and temperature. Great care should be taken whenever these valves to the sample unit are opened. This must be done slowly.

If any samples are also to be taken from the analyser unit, then clean the dry flasks with stoppers that will be used. The flask should be overflowing and be sealed with a stopper to prevent any ingress of oxygen while the flask is awaiting testing.

(2) Boiler Compound Injection Unit

Chemicals are injected into the boiler steam drum, under its water level. This is done so that the natural water circulation system within the boiler will move the chemicals around the boiler, and ensure even distribution.

a) With all valves on the unit closed, open the drain valve and make sure that tank is free of any water or previous chemicals. Then close the drain valve.

b) Put the chemicals in the tank and fill the unit with water provided from the main condensate line. Use the agitator to make sure that chemicals are mixed well with the water.

c) Open the two chemical injection valves on the boiler.

d) Open the pump suction and the discharge valves. Start the pump. Once running, adjust the stroke of the pump as required to allow the chemicals into the boiler over a period of time.

e) Upon completion, close all the valves and drain the tank.

(3) Boiler Blow Down

Boiler blow down, through the valves on the water drum, imposes a considerable load on the unit, and must only be undertaken with the boiler in low load conditions. At the port, the duty deck officer should be contacted to make sure that the discharge from the ship's side would not be dangerous.

a) Open the ship's side valve and the double shut off valve fully, BT004, BT005 No.2 boiler, BT001, BT002 No.1 boiler.

b) Slowly open the master blow down valve fully, BV65B port, BV65B starboard side and crack open the intermediate valve BV64B port, BV64B starboard side. Adjust the intermediate valve to control the blow down rate.

c) As the blow down process is continuing, continually monitor the boiler water level and make sure that this is being maintained and the feed pump discharge is coping with the extra load.

d) Upon completion, close the intermediate and master blow down valves, then the ship's side valve.

Note !

More frequently boiler impurities are discharged overboard via the scum valves on the steam drum. As this line is relatively small in diameter, this system can be used with the boiler on higher loads.

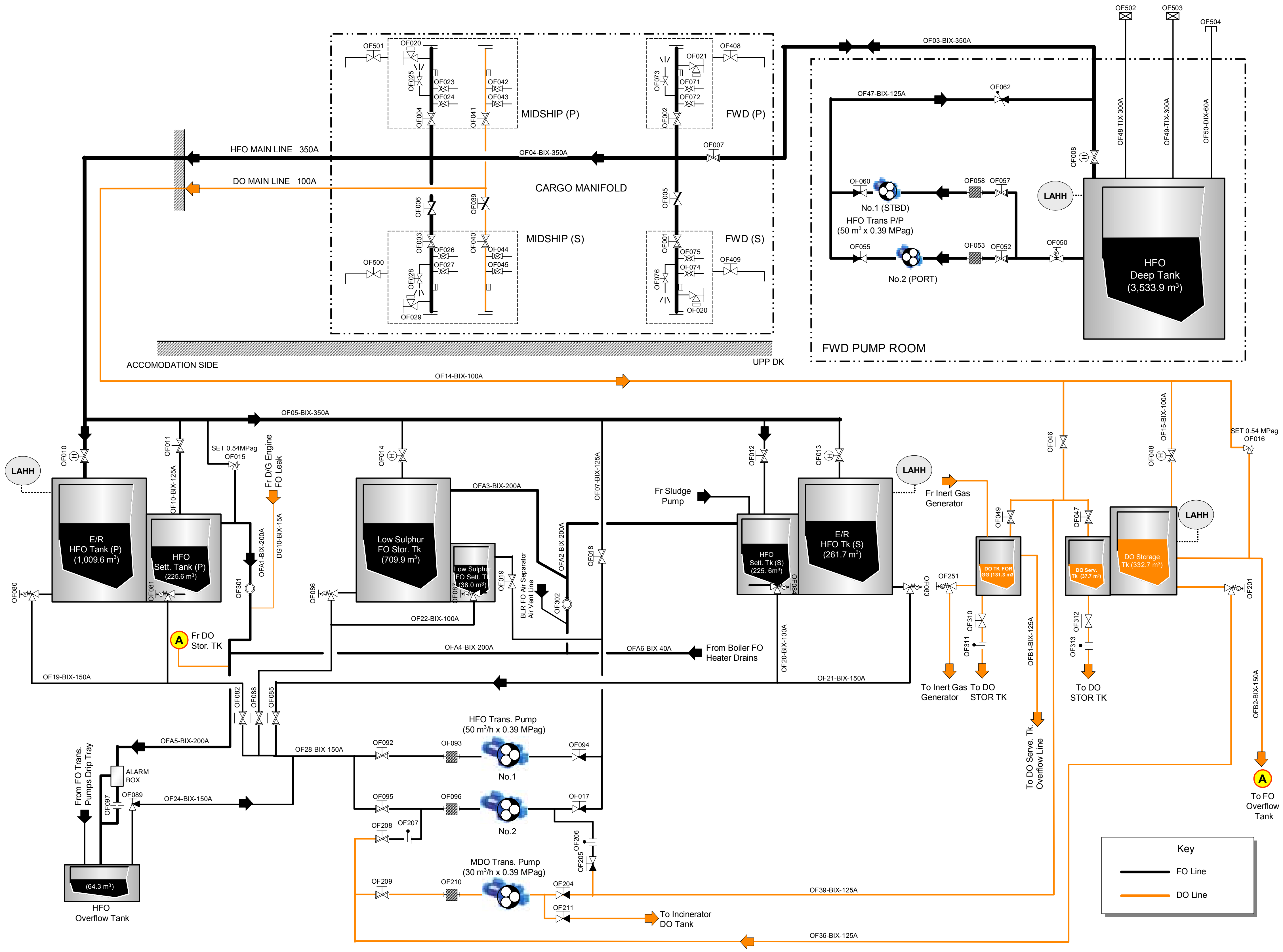
! Caution

Never open the water wall header drain valves(69B) with the boiler under pressure. If possible fit blanks to these lines which are removed only if the boiler is shut down and being drained.

Control and Alarm Settings

BL W. PH HIGH	10.3	PH
BLR CONDUCTIVITY	400	μS/cm
FW GEN DISTILATE WATER SAL. HIGH	4.0	ppm
DEAERATOR OUTL. F.W PH HIGH	9.0	ppm

Illustration 2.6.1i Fuel Oil Bunkering and Transfer System



2.6 Fuel Oil and Fuel Gas Service Systems

2.6.1 Fuel Oil Bunkering and Transfer Systems

General Description

(1) Boiler Fuel Oil System

The port bunker tank (capacity 1,009.6 m^3), and starboard bunker tank (capacity 261.7 m^3) are situated on either side of the engine room. The two settling tanks and the low sulphur tank are located alongside their respective bunker tanks, each settling tank having a capacity of 225.6 m^3, low sulphur storage tank at 709.9 m^3 and low sulphur settling tank at 38.0 m^3. The forward deep tank (capacity 3,533.9 m^3) is situated between the No.1 cofferdam and the bow thruster room.

All the tanks above can filled directly from the deck bunkering line, which runs from the valves at the forward and aft ends of the main manifold, to the forward deep tank and back to the aft tanks. This enables bunkering to be carried out from either a shore installation or alongside barges.

Normally, fuel oil is supplied to the boilers from the settling tanks, in which the fuel oil is allowed to stand for 24 hours. Any entrained water is allowed to settle down, and is drained from the tanks to the fuel oil drain tank through a spring loaded self-closing valve.

The settling tanks are kept filled as necessary by transferring oil from the bunker tanks, using the engine room fuel oil transfer pump. The transfer pumps can used with from any of the fuel oil tanks, and discharge to any of them as well as to the main deck. This can be used to transfer fuel oil back to shore installations or to the forward deep tank.

The marine diesel oil transfer pump can also be used to transfer fuel oil after changing over spectacle blanks. However, great care should be taken if doing so to prevent contamination of the diesel oil system by fuel oil.

All the fuel oil pumps (transfer and service) are gear and screw type driven by electric motors.

The two engine room bunker tanks. Two settling tanks and one low sulphur tank are steam heated, with steam supplied from the desuper heated steam at 0.78 MPag. The port bunker tank have 3 coils, starboard bunker tank, low sulphur storage tank , both settling tank each have 2 coils, low sulphur settling tank have 1 coil, with a control valve to isolate the steam at tank low level.

The settling tanks each have three coils, with a control valve to maintain maximum temperature. The forward deep tank heating is from a connection to the deck steam line system. All the lines to and from the tanks have steam tracing to maintain line temperatures. Drains from the heating coils go to the engine room drains cooler, then to the drain inspection tank.

All the tanks are fitted with high level alarms, should the pump not stop transferring at the correct level. Overflows from the bunker and settling tanks are led to the engine room fuel oil overflow tank, which can hold approximately 64.3 m^3 of fuel. These tanks can also be drained here, if they need to be inspected.
The engine room fuel oil transfer pump is used to pump this oil back to one of the tanks. There is a level alarm fitted to this tank to warn of overflow conditions.

Drains from all around equipment that uses fuel, either heavy fuel oil, or diesel are led to the fuel oil drains tank, where a level alarm will sound, indicating a leak in the system.

The suction valves from the bunker and settling tanks are fitted with remotely operated quick-closing valves. These can be closed from a fire control station. After being operated they have to be reset manually.

The forward fuel oil deep tank has its own fuel oil transfer pumps, which discharge the oil down the deck main fuel oil line to any of the aft bunker or settling tanks. The tank is equipped with a high level alarm. Either of the two pumps can be used to transfer the oil into the main deck.

The heating device of a drum type is provided for heating the fuel oil.

(2) Diesel Oil System

The diesel oil systems as follows:

Emergency diesel generator
Inert gas generator
Incinerator
Boiler when in cold condition
Diesel generator engine

The storage tank(332.7 m^3)/service tank(37.7m^3) in the engine room: Each tank is fitted with high level alarms, but any overflow will go to the fuel oil overflow tank.

As with the heavy fuel oil tanks, all storage and service tanks are fitted with remotely operating quick-closing suction valves, which enable them to be closed from a fire station in case of an emergency. These valves have to be reset manually.

The fuel oil overflow tank can be pumped out by the engine room fuel oil transfer pump, the engine room diesel oil transfer pump (if spectacle blanks are turned), and the HDO transfer pump.

All storage tanks, both heavy fuel oil and diesel oil, are fitted with a float type air vent pipe with flame screens to prevent tank pressurization.

Capacities and Ratings

Engine Room HFO Transfer Pump:	IMO
No. of sets:	2
Type:	ACF090K4IRBO
Capacity:	50 m^3/h
Pressure:	0.39 MPag
FWD HFO Transfer Pump:	IMO
No. of sets:	2
Type:	ACF090K4IRBO
Capacity:	50 m^3/h
Pressure:	0.39 MPag
Engine Room MDO Transfer Pump:	IMO
No. of sets:	1
Type:	ACF0800K4IRBO
Capacity:	30 m^3/h
Pressure:	0.4 MPag

HFO/D.O Transfer System Tank List

HFO DEEP TANK	3,533.9 m^3
E/R HFO TANK(P)	1,009.6 m^3
E/R HFO TANK(S)	261.7 m^3
HFO SETT TANK(P)	225.6 m^3
HFO SETT TANK(S)	225.6 m^3
LOW SULPHUR STORAGE TANK	709.9 m^3
LOW SULPHUR SETTLING TANK	38.0 m^3
D.O STORAGE TANK	332.7 m^3
D.O STORAGE TANK FOR IGG	131.3 m^3
D.O SERVICE TANK	37.7 m^3
F.O OVERFLOW TANK	64.3 m^3

Note !
Heating steam will normally be applied to bunker storage tanks as long as oil is above the minimum level, at which point the steam heating control valve will automatically be closed.

(1) To Transfer Fuel Oil from the Forward Deep Tank

The forward transfer pumps discharge into the filling line to transfer oil aft.

a) Put steam heating on the forward fuel tank and make sure that the temperature is raised for easy pumping.

b) Make sure that blanks are fitted to manifold valves, and that the valves are closed. Open the deck line valves and inlet valves on the tanks to be filled.

c) Make sure that the forward tank-filling valve is closed, and open the pump discharge valve.

d) Open the suction, discharge valves and the valve (OF007) on the pump to be used, making sure that the line is full by testing the vent valve on the suction filter.

e) Start the pump with the relief/bypass valve partly open. Once oil is flowing, set the valve to give optimum discharge pressure.

f) Have personnel inspecting the line throughout the transfer, Making sure that there is no leakage and that they are able to stop the transfer immediately should any problems occur.

g) As the transfer continues, continuously monitor the levels in the forward fuel tank as well as the tanks being filled.

h) When the receiving tank is at the required level, stop the transfer, and close all valves on the pump and tanks. Check all tank levels, and record the amounts transferred and received.

(2) Diesel Oil Transfer

Diesel oil is transferred from the storage tank to the service tank through its own transfer pump.

a) Open the following valves:

Service tank filling valve	OF047
Quick closing valves from the storage tank	OF201
Pump suction and discharge valves	OF209, OF204

b) Vent off any air at the pump suction filter.

c) Start the pump and monitor the service tank filling.

d) Upon completion, stop the pump and close all valves. Note and record the quantities transferred with current tank levels.

(3) Empty FO Overflow Tank

This tank can be emptied in the following ways:

a) Using the engine room fuel oil transfer pump to transfer to the heavy fuel oil tanks.

Open and close the following valves:

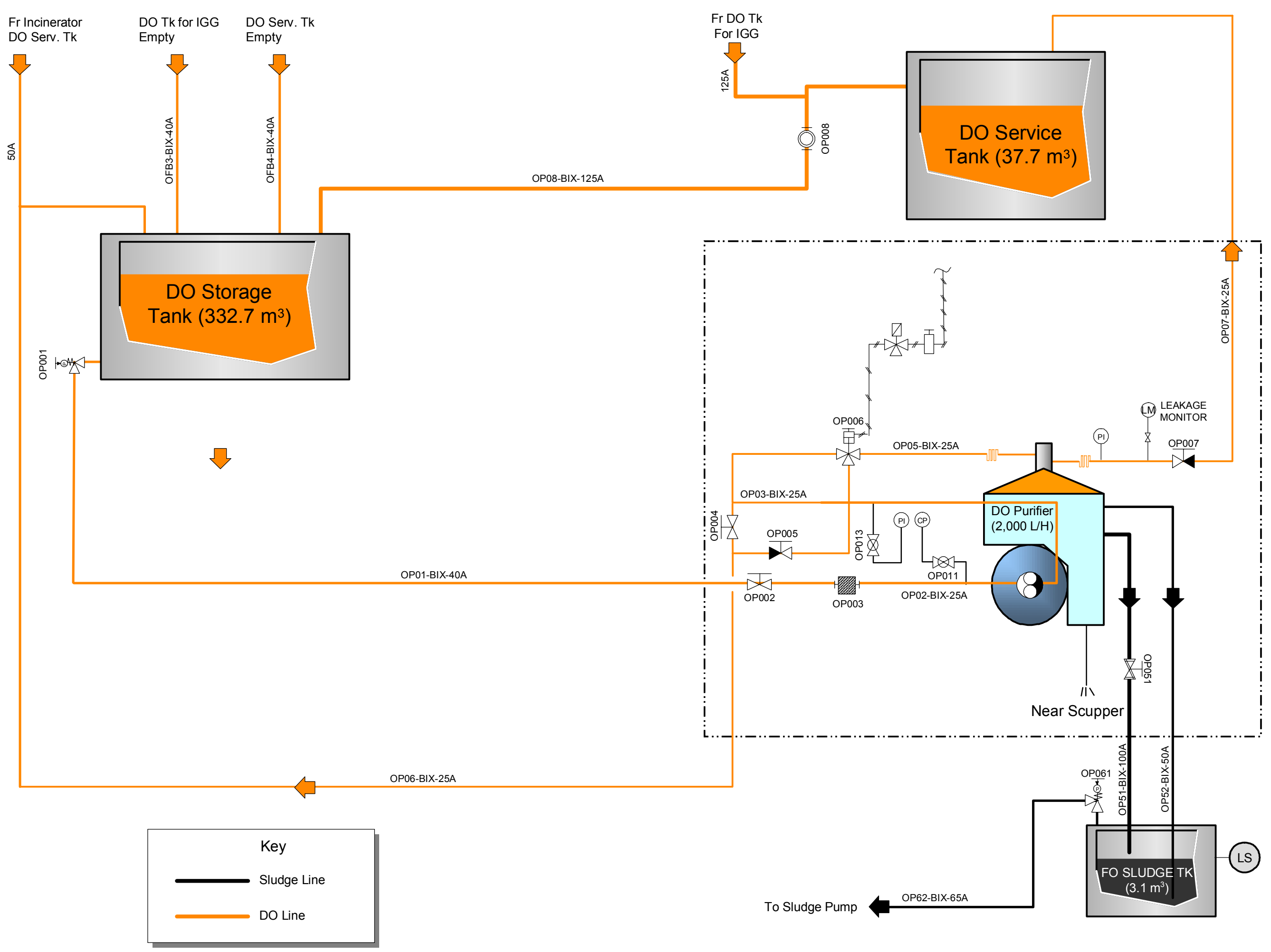
Open the HFO overflow tank outlet valve	OF089
Close the HFO tank suction valve	OF082, OF085, OF088
Pump suction valves	OF092, OF095
Pump discharge valves	OF017,OF094
Discharge valve onto the main transfer line	OF018

Control and Alarm Settings

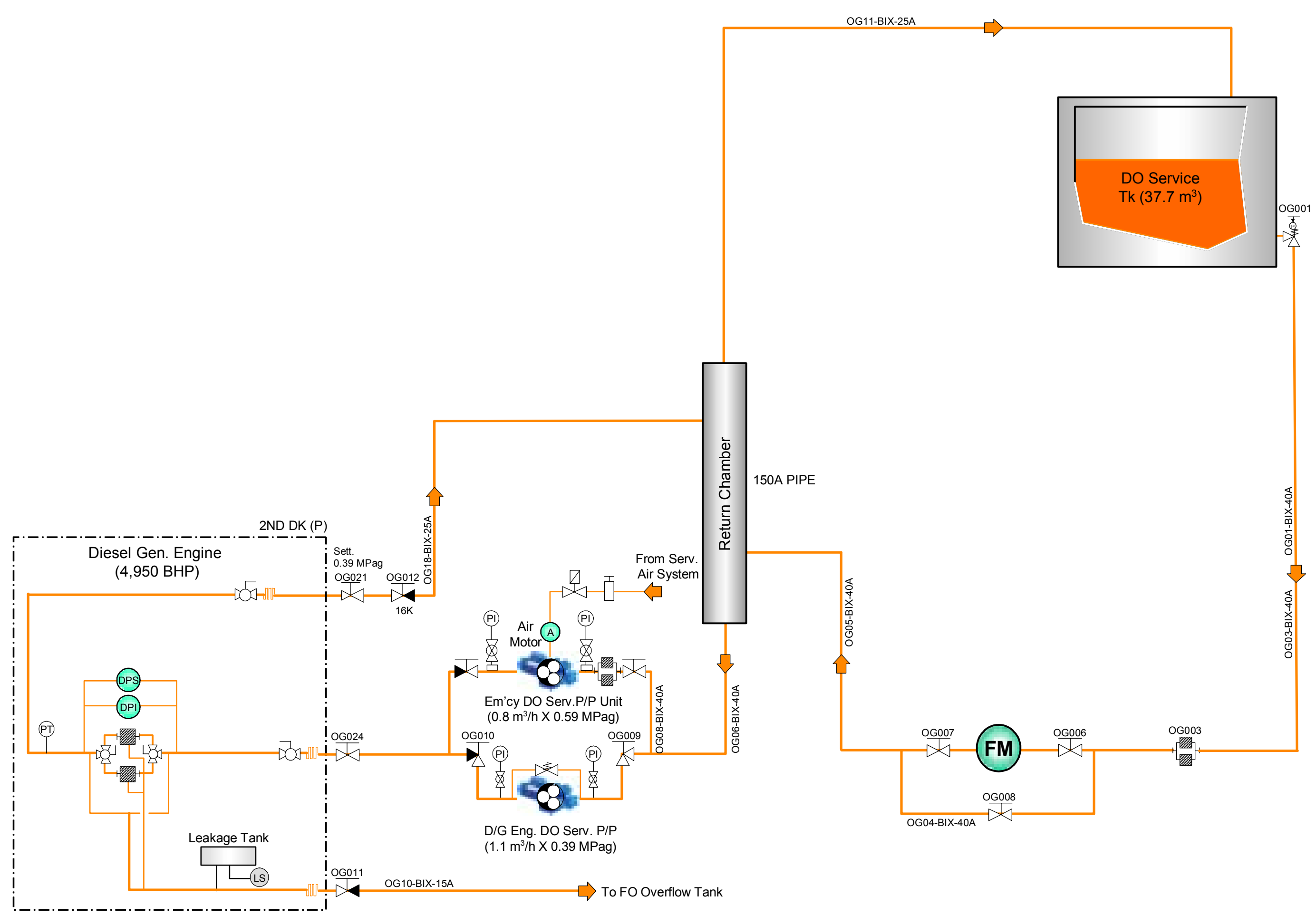
HFO DEEP TK H-H	95	%
HFO DEEP TK LVL H/L	17.0 / 5.93	m
E/R HFO TK(S) LVL H/L	19.4~8.66	m
E/R HFO TK(S) LVL H-H	95	%
E/R HFO TK(P) LVL H/L	19.4~8.66	m
E/R HFO TK(P) LVL H-H	95	%
FO SLUGE TK LVL HIGH	90	%
DO STOR TK LVL H/L	5.4~2.05	m
DO STOR TK LVL H-H	95	%

Illustration 2.6.2i DO Purifying and G/E Fuel System

Diesel Oil Purifier System



Diesel Generator Fuel Oil System



2.6.2 DO Purifying and G/E Fuel Oil System

General Description

The diesel oil storage tank is on the port side of the engine room. The purifier feed pump takes suction from the storage tank, which, after the purification process, discharges to the diesel oil service tank.

Waste oil from the purifier flows into the fuel oil sludge tank, under the base of the purifier. The sludge pump can pump this tank out.

The suction filter is monitored with a different pressure alarm, and the fuel line with a low-pressure alarm, to ensure a full fuel supply at all required times. Excess line pressure in the system is protected by a spring-loaded regulating valve, which recirculates the oil back to the return chamber.

Both service and storage tank suction valves are of the spring-loaded, quick closing type, and can be operated remotely should an emergency situation arise.

Capacities and Ratings

Diesel Oil Storage Tank:	332.7 m^3
Diesel Oil Service Tank:	37.7 m^3
Fuel Oil Sludge Tank:	3.1 m^3
Diesel Oil Purifier:	SAMGONG
No. of sets:	1
Type:	SJ10F
Capacity:	2,000 l/h

1) To Run the Diesel Oil Purifier System

The operation and running of the diesel oil purifier should be undertaken with reference to the manufacturer's instruction manual. The following highlights the operation of the system.

a) Open and set the storage tank suction line quick closing valve(OP001) to the purifier inlet.

b) Open the inlet line suction valve to the filter and ventilate to ensure that the line is full with DO. Open the purifier discharge valve to the service tank.

c) Run the purifier as per manufacturer's instructions and make sure that the service tank level is rising.

d) Monitor the purification process. Set up the cut-out process of the purifier on the service tank level, and check that the unit stops when the required level is reached. Test the purifier alarms to prove that all are operational.

2) To Run the Diesel Generator Fuel Oil System

The operation of the diesel generator should be done in conjunction with the manufacturer's instruction manual. The following outlines the use of the fuel system.

a) Open the quick closing valve(OG001) on the service tank to the generator engine.

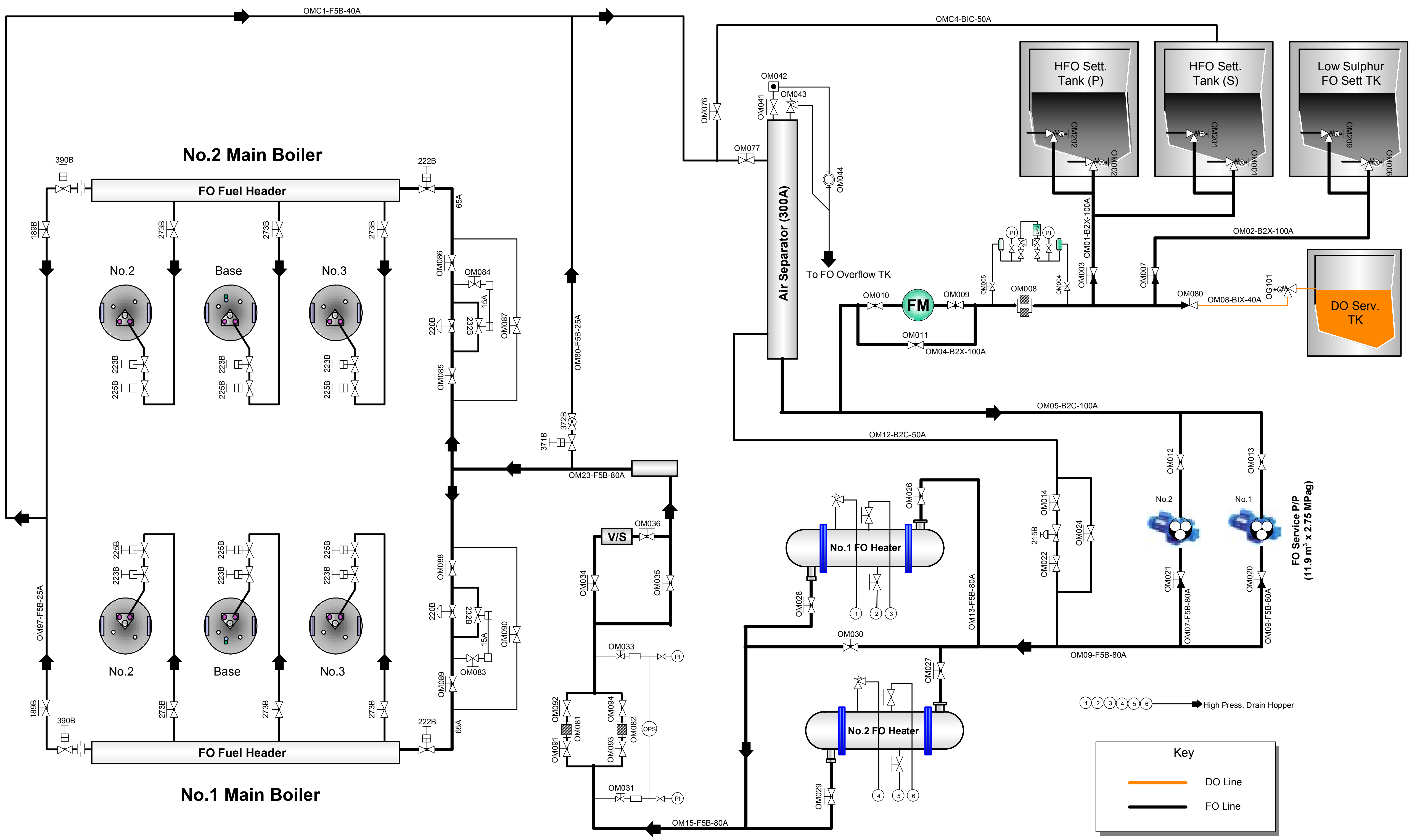
b) Check the line suction filters and vent off any air at the cock, making sure that they are closed upon completion.

c) Open the inlet (OG006) and outlet (OG007)valves to the flow meter.

d) Start the generator engine and monitor the differential pressure across the suction filters, as well as the spill line pressure.

e) Check if the flow meter is operating correctly.

Illustration 2.6.3i Boiler Fuel Oil Service System



2.6.3 Boiler Fuel Oil Service Systems

General Description

Fuel oil is normally supplied to the three burners of each boiler from either of the two fuel oil settling tanks, by one of the two fuel oil service pumps.

Diesel oil may be used for flushing through lines or for flashing the boilers from cold when no heating steam is available.

The fuel oil service pump takes suction from the settling tank in use, through a manually cleaned suction strainer. The strainer has a differential pressure alarm fitted and care should be maintained to have a positive suction pressure at all times. One pump will be running with the other on auto-start stand-by, in case the discharge pressure from the pump in use falls.

The fuel oil passes through a flow meter and counter, from which the consumption can be calculated, and then to the pump suctions. The pumps are electrically driven horizontal rotary type, with auto-start changeover.

The system pressure is controlled by a recirculation valve 215B, which allows oil to recirculate to the suction side of the pumps, and maintains a constant set pressure. The pressure is set as part of the automatic combustion control system.

The oil then passes through the fuel oil heaters, normally one is in use, with the other clean and ready for use. These are steam heated, at the 0.78 MPag range of the saturated steam.

Temperature is controlled by the viscometer, which measures the viscosity of the oil and, from its signal, opens or closes the steam valve to the heaters to alter the temperature. The viscosity value is set at the control station, with temperature signals from before the FO heater and after the viscometer compared with the set point.

On the fuel inlet rail, both boilers have the same arrangements, after passing through a flow meter. There are three valves placed in parallel to each other, and oil is able to pass through as follows:

(1) At all steam loads except the minimum fuel demand from the boilers, the oil will pass through the fuel oil flow control valve(215B) to the rail.

(2) The minimum fuel pressure-keeping valve(232B) will be open to maintain the boiler flame, even when the steam load is in an extremely low condition.

(3) A bypass valve, which allows fuel oil to bypass the other valves. It can also be used for emergency boiler operations, for instance, when the flow control valve is out of order.

At each burner there are three solenoid-operated valves. When the burner operation is initiated, the first valve closes, stopping fuel from passing through the recirculation line to the pump suctions. The other two valves open, allowing fuel into the burner. These last two valves form a double shut off when the burner is not in use. Also fitted to the line is another solenoid operated valve which opens for a set time when the burner is first taken out of use, and allows steam to pass through the burner, preventing any fuel in the line from turning to carbon and blocking the burner.

Operating Procedures

(1) Supplying fuel oil to the boiler.
It is assumed that steam has been raised using diesel oil, with all inlet and outlet valves to the pumps and heaters open.

a) When sufficient steam pressure is raised on a boiler to supply the desuperheater system, start supplying steam to the heating coil of the settling tank to be used. Open the heating coil drains valve to the bilge and the steam inlet valve. Check the drains for contamination and, if they are satisfactory, open the outlet valve to the drains cooler and the valve to the bilge.
b) As the temperature rises, check the tank for water. The temperature would normally need to be around 50°C for good pumping conditions.
c) Start to supplying steam to the fuel oil heater in use. As above, open the drains to the bilge until it is certain they are uncontaminated, and then place them to the engine room drains cooler. Use the steam temperature control bypass valve to allow steam through the system slowly.
d) As diesel fuel will be in the system, with the fuel oil pump being used from the diesel oil service tank, make sure that the temperature in the heater does not rise above 50°C.
e) When the line temperature rises to approximately 80°C, open the settling tank outlet valve, and close the supply valves from the diesel oil system OM080, OG101.
f) As the heavier fuel oil purges the system of diesel oil, the system pressure will rise. Care should be taken to manually control the pump back pressure, and maintain it at a suitable level. The fuel oil heater inlet steam valve should be opened further to bring the line temperature to over 100°C, for good combustion.
g) As the boiler was flashed using diesel oil, air will have been supplied as the atomizing medium at the burner. Continue to use the air for this purpose until the system has been cleared of diesel oil.

Warning

At no time should atomizing steam be used in conjunction with diesel oil when flashing the boiler. Explosions with resultant injuries and damage could occur.

h) Open the atomizing steam valves on the 1.57 MPag line from the boiler external desuperheater unit. Open manually the atomizing steam valves on the burners not in use, and allow any condensation in the lines to be blown through. When it is certain that no water remains in the lines, slowly open manually the valves to the base burner, and shut off the atomizing air supply. Close the atomizing steam valves to the burners not in use.
i) With the base burner now being supplied by fuel oil with atomizing steam, the boiler pressure can be continued to be raised as the fuel pressure is increased.
j) Start the viscometer unit, and shut the unit bypass valve. As the viscosity reading rises to coincide with the fuel oil line temperature, set the control value, place the unit on automatic, and allow the temperature to be on auto-control.
k) Check and inspect all systems for leaks. Ensure all bypass valves are closed, and flow meters at cold filter for the counter, and at the boiler fuel rail for the automatic combustion control system are operating.
l) Open all master valves on the fuel and steam lines to other burners. These can now be operated from the control panel, when required.

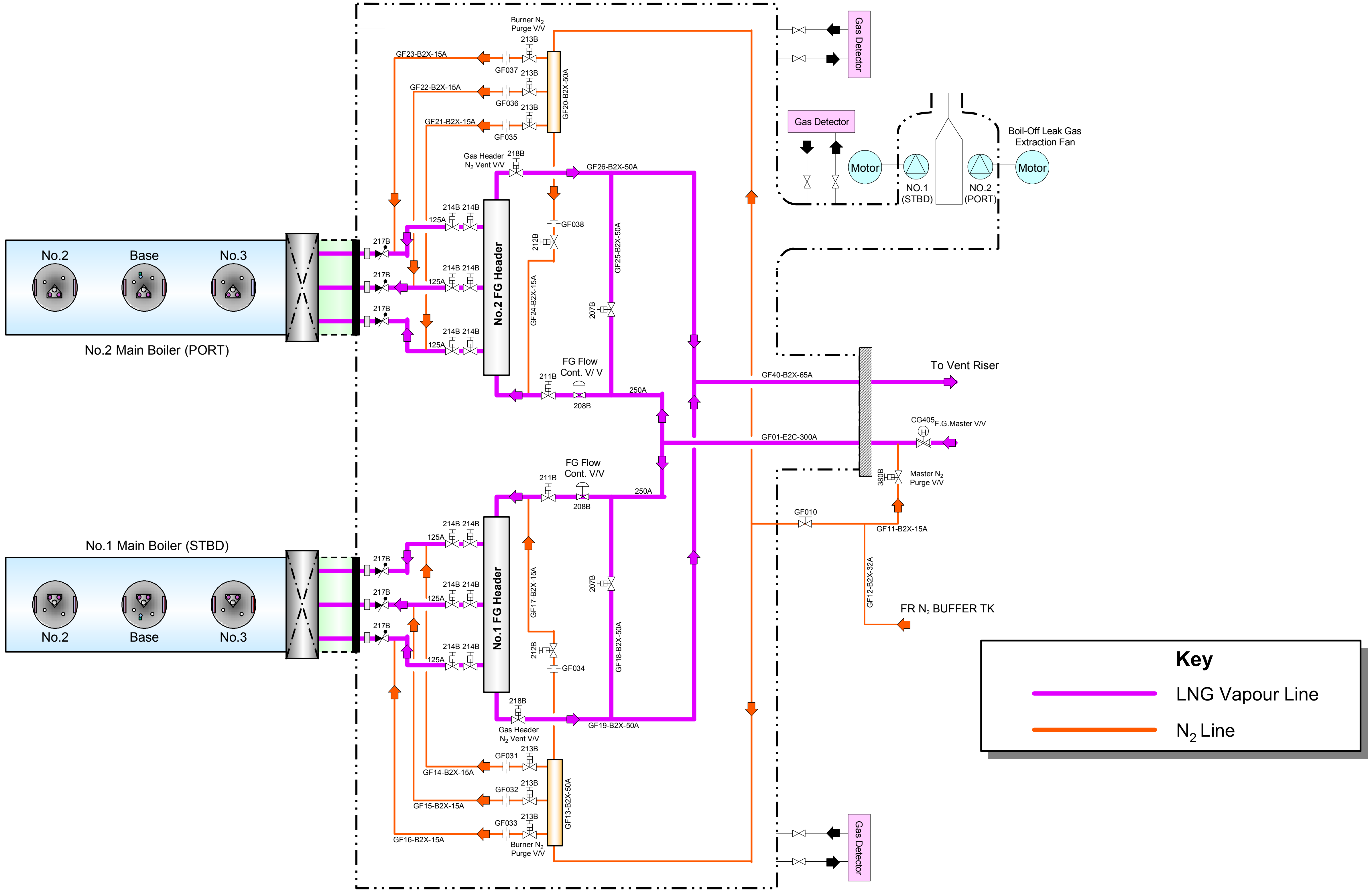
(2) To Circulate Fuel to the Second Boiler
It is assumed that one boiler is already on line, using fuel oil and atomizing steam.

a) Slowly open the fuel rail recirculation isolation valve for the second boiler. This allows fuel oil to flow along the inlet rail to the three burners, and back to the pump suction.
b) Open the instrument air supply to the fuel flow control valve.
c) Open the inlet and outlet valves to the rail flow meter, and reset the emergency shut off valve, allowing fuel oil to the control valves.
d) With boiler ACC control on manual mode, slowly open the fuel oil control valve until pressure is noted in the rail. Make sure that the fuel oil pressure on the boiler in use is not affected by this operation.
e) Check pressure gauges and thermometers for ongoing readings, and bring the fuel temperature up to approximately 100°C to enable a satisfactory flashing process.

(3) To Change to Diesel Oil Firing Prior to Shut Down
It is assumed both boilers are firing. This operation should be undertaken approximately 15 minutes before total plant shut down.

a) Shut off steam lines and the steam tracing line to the fuel oil settling tanks and fuel oil heaters.
b) Maintain a close watch of the fuel oil temperature, and when this has dropped to approximately 95°C, open the diesel oil service tank outlet to the fuel oil pump suction line valve.
c) Open the diesel oil supply valves and close all fuel oil valves to pump suction from the settling tanks.
d) Change over from atomizing steam supply to the boiler burners, closing the steam valves, and replace it with atomizing air supply.
e) With the ACC system on manual control, make sure that the pressure drop in the fuel line with diesel oil in use, is compensated by further opening the fuel oil valves.
f) Change to the spare bank of both the fuel oil pump suction and discharge strainers, to ensure that both banks are flushed out.
g) Change to the second fuel oil heater to ensure that this is also flushed out.
h) Stop the pump in use, allowing the stand-by unit to be in use, and flushed out.
i) After a few minutes, shut down one boiler. The action of stopping the burner opens each burner rail recirculation valve, allowing it to recirculate for a short time. After a few moments close the main fuel oil shut off valve to the fuel oil rail. Do not leave the diesel oil recirculating to the boiler longer than necessary, as the diesel oil will be recirculating to the fuel oil settling tank.
j) Repeat operation i) for the second boiler, when steam supply is no longer required.
k) Stop the pumps and close all fuel oil valves in the system.

Illustration 2.6.4i Boiler Fuel Gas Service System



2.6.4 Boiler Fuel Gas Service System

General Description

The boil off gas system enables fuel gas to be supplied to the boilers. The boilers are equipped with three(3) sets of fuel oil and gas combination burners to allow burning fuel oil, fuel gas, and the fuel oil/fuel gas combination mode.

The gas is produced by three different methods; first by natural boil-off during the voyage, second from boil-off produced by spraying during cargo tank cooling down during ballast passage, and last, by forcing boil-off using a forcing vaporiser in conjunction with either of the first two methods.

To enable the gas to be supplied to the boilers from the cargo tanks, the following equipment is provided;

Two low duty (LD) compressors.
Two steam-heated High & Low duty heaters.
One steam heated forcing vaporiser.

A master gas valve is provided to isolate the engine room gas burning system from the cargo in case of emergency situations, such as when Emergency Shut Down System (ESDS) is activated.

A boiler gas valve (211B) is provided for each boiler to shut fuel gas supply in an emergency situation concerning each boiler and to secure the boiler from burning gas entirely.

Burner gas valves (214B) are provided so as to control the operating burner numbers during gas burning. According to the boiler load, the burner gas valves (214B) shall be operated to increase or decrease the operating gas burner numbers automatically or manually.

A gas flow control valve (208B) is operating to control gas flow through fuel demand signals from boiler ACC.

Upon closing the gas supply valves, each gas line is automatically N_2 purged internally. Also, the master gas line and the boiler gas header line can be manually given master N_2 purging or gas header N_2 purging if the master gas valve and boiler gas valve are closed.

In the master N_2 purge, the piping from the master gas valve outlet to each boiler gas valve (211B) inlet is internally N_2 purged for 60 seconds.

In the gas header N_2 purge, the piping from the boiler gas valve (211B) outlet to the gas burner valve (214B) inlet is internally N_2 purged for 35 seconds.

In the gas burner N_2 purge, the piping from the burner gas valve (214B) outlet to the gas burner nozzle is internally purged for 15 seconds.

System Capacities and Ratings

Low Duty compressor	:	Cryostar
No. of sets	:	2 sets
Type	:	CM 300/45-LD
Inlet/Outlet Pressure	:	106/196 kPag
High duty gas heater	:	Cryostar
No. of sets	:	1 set
Type	:	108-UT-38/34-3.8
Capacity(max/nor.)	:	33,250/22,600 kg/h
Low duty gas heater	:	Cryostar
No. of sets	:	1 set
Type	:	21-UT-38/34-3.2
Capacity(nor./vent)	:	7,906/3,951 kg/h
Forcing vaporiser	:	Cryostar
No. of set	:	1 set
Type	:	34-UT-25/21-3.6
Capacity	:	6,790 kg/h
Combination Burner	:	Hamworthy
No. of burners per boiler	:	Three
Fuel oil pressure available	:	0.22 MPag
Fuel gas pressure at burner	:	63.7 kPag
Atomizing steam pressure	:	1.0 MPag
Atomizing steam temperature	:	270 to 300°C
Burner turn down on oil	:	15:1
Burner turn down on gas	:	7:1
Grade of oil	:	C Heavy oil (7000SRI @ 38°C)
Type of fuel gas	:	Boil off Gas (CH_4)

Gas Burner Operating

(1) Starting the Gas Burner
Before starting the gas burner, prepare the LD gas compressor, Low duty heaters, and related systems. Initial gas burning should be done in free-flow condition, without LD compressor running. The starting of the gas burner may be conducted at BGB manually or automatically at ECR. Securing all the conditions of the open master gas valve and the open boiler gas valve is required at the start of gas burning with the FO burner also under burning.

(2) Selection of the Operating Position
This is conducted in accordance with (BGB Position).

(3) Open Master Gas Valve
Pressing the master gas valve “Open” push button causes the valve to open. However, when it remains in master gas valve shut-off condition, the valve will not open even though the push button is pressed. (“Close” PB(Push Button) lamp flickers) If so, the interlock condition should be brought back to the normal state in accordance with boiler gas shut-off. When the master gas valve opens, the master N_2 vent valve closes 10 seconds thereafter.

(4) Open Boiler Gas Valve
Press “Open PB” to open the boiler gas valve. However, the valve will not open if it is shut off, even if PB is pressed. (“Close” the PB lamp flicker.) If so, the interlock condition should be brought to the normal state in accordance with the boiler gas shut-off. When the boiler gas valve opens, the header N_2 vent valve closes after 5 seconds. This is to replace existing N_2 gas in the boiler gas header piping by the boil-off gas and to fill the line with boil-off gas. Thereafter, the boiler will be burning gas on stand-by.

(5) Increasing the Burning Capacity of the Gas Burner
Pressing base No.2 or No.3 gas burner to “ON” PB causes the gas burner to increase its burning sequence, and it starts burning to burn. After starting the gas burner, start the LD compressor and set LD compressor control mode to “Auto” position.

Master gas valve trip conditions:

Both boilers trip
E.S.D.S. activated
Gas duct EXH. fan stop
Gas leak detected
Fire detected
B.O.G. temp. Low/Low
Master gas valve manual trip
Cargo tank press. Low/Low
B.O.G. header abnormal

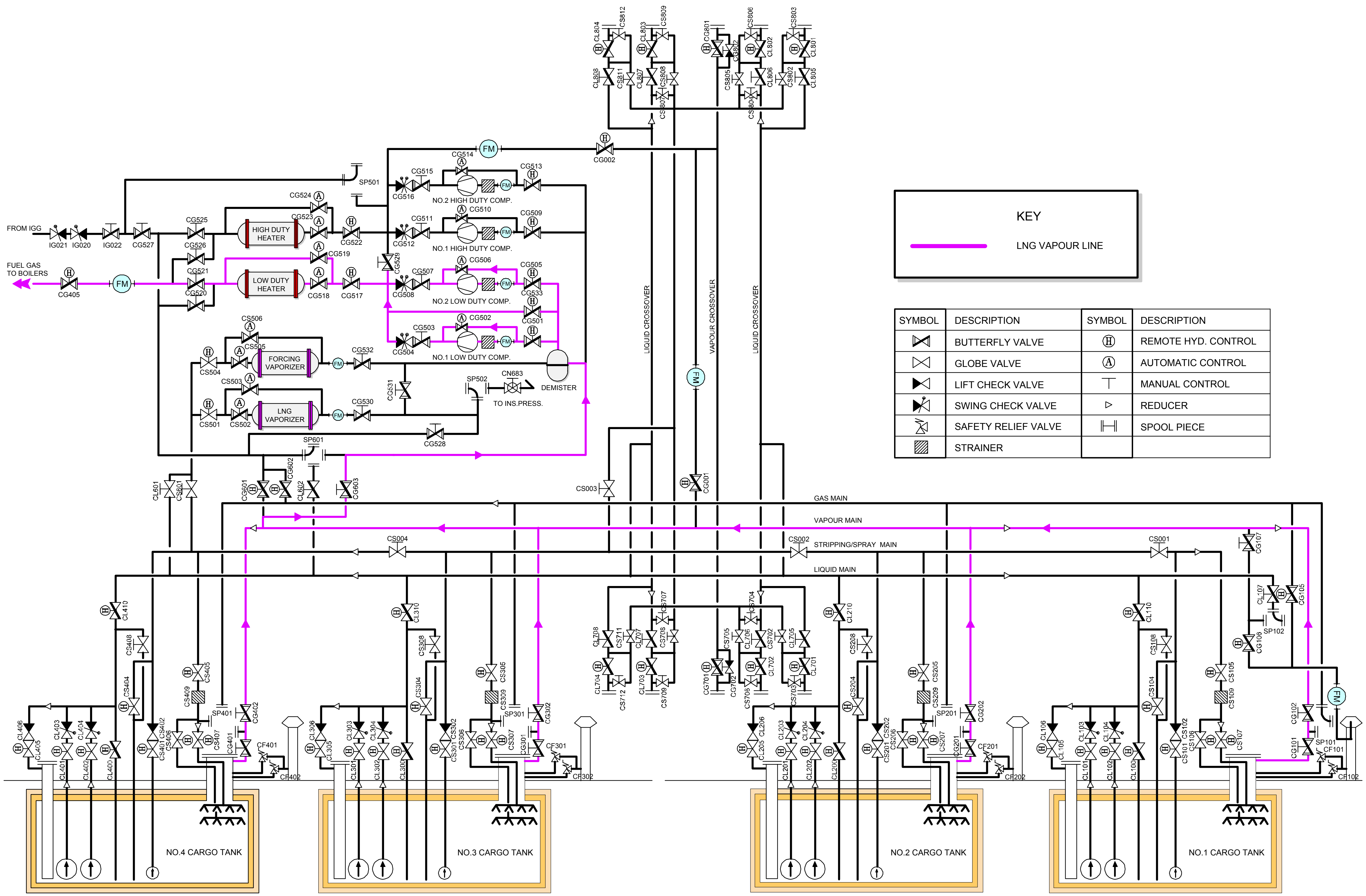
BLR gas valve trip conditions

B.O.G. press. low
B.O.G. press. high
Boiler trip condition
Boiler gas valve manual trip

Control and Alarm Settings

BLR F.G TRIP BY BOG PRESS. L-L Trip	0.7	kPag
BLR F.G TRIP BY BOG PRESS. H-H Trip	75	kPag
N2 BOG PIPE PURGE LINE PRESS. Low Alarm	0.05	MPag
M/B FG TEMP. Low Low Trip	5	°C

Illustration 2.6.5i Normal Boil-Off Gas Burning



2.6.5 Loaded Voyage with Boil-Off Gas Burning

Introduction

During a sea passage when the cargo tanks contain LNG, the boil-off from the tanks is burned in the ship's boilers. The operation starts on deck and is controlled by the ship's engineers in the CCR and Engine Control Room. If for any reason the boil-off cannot be used for gas burning, or if the volume is too great for the boilers to handle, any excess vapour will be vented to the atmosphere via the No.1 vent mast.

Operation

The cargo tank boil-off gas enters the vapour header via the cargo tank vapour domes. It is then directed to one of the LD compressors, which pump the gas to the low duty heater. The heated gas is delivered to the boilers at a temperature of +35°C via the control valve CG405. The inlet guide vane position is governed by fuel gas demand from the boiler(s) and the cargo tank's pressure. The system is designed to burn all boil-off gas normally produced by a full cargo, and to maintain the cargo tank pressure (i.e. temperatures) at a predetermined level.

If the propulsion plant steam consumption is not sufficient to burn the required amount of boil-off, the tank pressure will increase and eventually the steam dump will open, dumping steam directly to the main condenser. The main dump is designed to dump sufficient steam to allow the boiler to use all the boil-off produced, even when the ship is stopped.

Adjusting the inlet guide position controls the flow of gas through the LD compressors. This is directed by the boiler combustion control when gas burning is initiated. The normal boil-off in the boiler combustion control has to be selected as well as the allowed maximum and minimum tank pressures and the tank pressure at which the main dump operates.

For normal operation the normal boil-off valve is selected at 60% (boil-off provides 60% of the fuel required to produce 90% of the boiler full steam capacity) and the minimum and maximum tank pressures are selected at 105 and 109 kPag respectively.

If the normal boil off valve has been correctly adjusted, the tank pressures will remain within the selected values. If the selected normal boil off value is too large, the tank pressure will slowly be reduced until it reaches the minimum value selected. If the tank pressure value reduces to below the minimum value selected, the normal boil-off value will be reduced until the tank pressure has increased above the selected value.

If the selected normal boil-off value is too small, the tank pressure will slowly increase until it reaches the maximum value selected. If the tank pressure value increases above the maximum selected value, the normal boil-off value will be increased until the tank pressure decreases below the selected value.

If the tank pressure continues to increase because steam consumption is not sufficient to burn all the required boil-off, the steam dump will open.

The steam dump is designed to open when the normal boil-off value is 5% above the original selected value, and when the tank pressure has reached the pre-selected dump operating pressure.

With the present setting, an increase of 5% of the normal boil-off corresponds approximately to an increase of tank pressure by 4 kPag above the maximum tank pressure selected.

The cargo and gas burning piping system is arranged so that excess boil-off can be vented should there be any inadvertent stoppage of gas burning in the ship's boilers. The automatic control valve CG106 at the No.1 vent mast is set at 23 kPag to vent the excess vapour to the atmosphere to protect the tank.

If the gas header pressure falls to less than 4 kPag above the primary insulation space pressure, an alarm will go off.

In the event of automatic or manual shut down of the gas burning system (or if the tank pressure falls to 5 kPag above the insulation space's pressure), valve CG405 will close and the gas burning supply line to the engine room will be purged with nitrogen.

Operating Procedures

It is assumed that all valves are closed prior to use:

a) Prepare the LD compressors, low duty heaters and the engine room gas burning plant.

b) Check that the following valves on the vapour domes are open and locked in position:

   (Tank No.1) Open and lock in position valve CG101, 102.
   (Tank No.2) Open and lock in position valve CG201, 202.
   (Tank No.3) Open and lock in position valve CG301, 302.
   (Tank No.4) Open and lock in position valve CG401, 402.

The valves should already be locked in the open position.

c) Open valves CG603, 604 and CG501, 503 vapour supply to the LD compressors and low duty heaters.

d) At low duty heater:
   Open valves CG517, 521 heater inlet and outlet.
   Open the steam supply to the heater.

In CCR

e) Adjust set point control to 115 kPag on the No.1 vent mast.

f) On the gas compressors, adjust the normal boil-off valve (IGV) to 60% for a loaded condition, with the tank pressures minimum and maximum at 105 kPag and 109 kPag respectively, and the steam dump opening pressure at 113 kPag.

When the engine room is ready to start gas burning, make sure that there is sufficient nitrogen to purge the lines to the boiler, i.e. > 500 kPag in the buffer tank.

g) Make sure that the gas outlet temperature of the heater is approximately 35°C. Open valve CG405 and start the LD compressor(s).

This operation will then be controlled and monitored from the CCR and the Engine Control Room.

Note !
If the volume of boil-off exceeds demand in the boilers, the steam dump should be switch on.

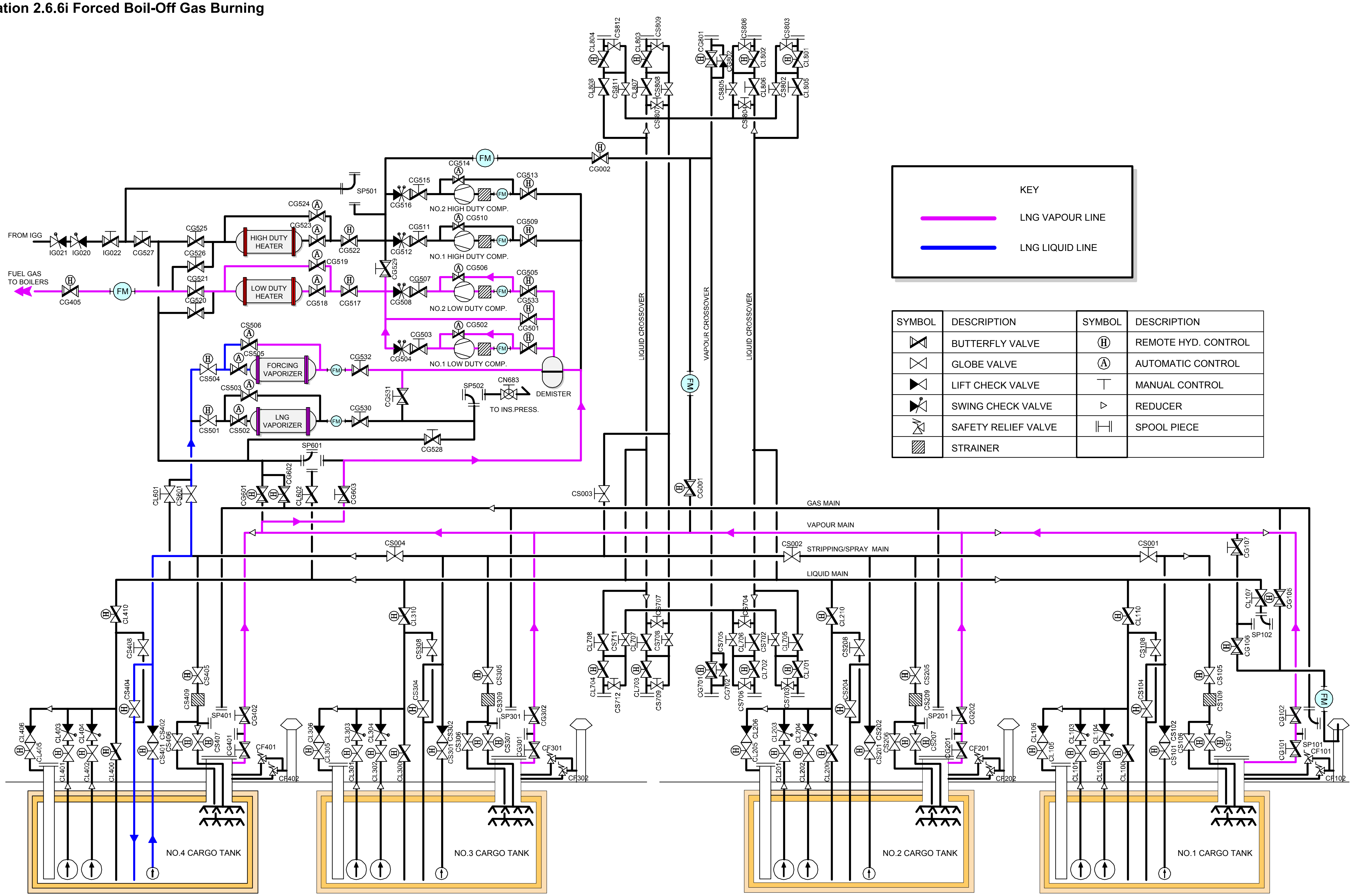
If the system shuts down for any reason, valve CG405 will close automatically.

Trip causes:
- Boiler manual trip (ECR, and local)
- Both boilers trip
- Gas content High-High at common vent hood
- Fuel gas temperature Low-Low
- ESDS activated
- Vent duct exhaust fan stop
- Remote/manual shutdown from local, CCR and ECR
- Fire detection in E/R

When stopping gas burning :

h) Stop the LD compressor(s), shut down the boil-off heater. Close valve CG405's gas supply to the engine room and adjust the set point of the vent mast control CG106 to 110 kPaA.

Illustration 2.6.6i Forced Boil-Off Gas Burning



2.6.6 Forced Boil-Off Gas Burning

Introduction

Consider the economics of gas versus fuel oil burning before undertaking a forced boil-off.

If, during a loaded passage, additional fuel gas from the cargo tanks is required to be burned in the ship's boilers, it can be made available by forced vapourisation by using the equipment on board.

The above operation, called Forced Boil-Off will be used to complement gas burning up to 100% of the boiler's fuel requirement.

Operation

The normal gas burning arrangement is maintained, and the forcing vaporiser is brought into operation.

A single stripping / spray pump is used to pump LNG to the forcing vaporiser. The excess flow from the pump is returned to the tank through the stripping header pressure control valves CS104, CS204, CS304, and CS404.

Note !

In normal operation the controlled return is directed back to the same tank where the liquid is being drawn from.

After vaporization, the LNG vapour passes through the demister where the possibility of liquid LNG carryover is eliminated. The vapour then combines with the natural boil-off gas from the vapour header before being drawn into the suction of the LD compressors.

One LD compressor is used for this operation.

The gas flow through the compressors is controlled via the boiler combustion control unit by adjusting the opening of the inlet guide vanes and motor speed. The split control is as follows:

Low load:	Inlet guide vane control (-30 to +80 deg).
High load:	Motor speed control (30-60Hz).

The boiler combustion control has to be switched to Forced Boil-off (FBO) mode.

The amount of forced boil-off produced is controlled by the throttling of the FCV to the forcing vaporiser of the Boiler Combustion Control.

When changing over to 100% gas burning, the fuel oil flow through the FO rails is adjusted to the minimum. The FO supply to the burners will then be cut out, and the FO system put on recirculation. The FO combustion control loops are maintained and energised to enable re-lighting of the FO burners during an emergency.

In the event of automatic or manual shut down of the gas burning system (or if the tank pressure falls to 3 kPag above the insulation spaces pressure), valve CG405 will close and the gas burning supply line to the engine room will be purged with nitrogen. FO booster devices are incorporated in the control loop to allow a quick changeover should the gas burning be tripped.

Operating Procedures

For illustration purposes, the No.4 tank stripping/spray pump and return operation are shown.

The cargo piping system is arranged for normal gas burning during loaded voyage.

It is assumed that all valves are closed prior to use.

a) Prepare the forcing vaporiser.

b) Open the stripping/spray isolating valve on the tank's to be used.

Tank No.1:	CS001, CS002, and CS004
Tank No.2:	CS002, CS004
Tank No.3:	CS004
Tank No.4:	

If cargo tank No.1 is used, open the stripping/spray header isolating valve CS001, CS002, and CS004. If tank No. 2 is used, open the stripping/spray header isolating valve CS002 and CS004. If No.3 tank is used open the stripping/spray header isolating valve CS004.

c) Open the valve CS601 stripping/spray header supply to the forcing vaporiser.

d) Open the stripping pump discharge valve, CS101, CS201, CS301, and CS401. Start the stripping/spray pump and adjust the return flow to the tank through the stripping header pressure control valves CS104, CS204, CS304, and CS404.

e) Run the forcing vaporiser.

f) Set the boiler combustion control on FBO mode.

g) Start the No.1 LD compressor, depending on gas demand.

h) Set the control of the liquid supply to the vaporiser and LD compressor control to auto mode.

Set point of cargo tank pressure control, 'Gas Management System'

Control range at ballast and laden voyage:

Ballast voyage:	4.7~6.7 kPag
Laden voyage:	105~108 kPaA

Set point of safety valve and alarm point

Set point of safety valve:	Pressure	25 kPag
	Vacuum	-1 kPag

Alarms:

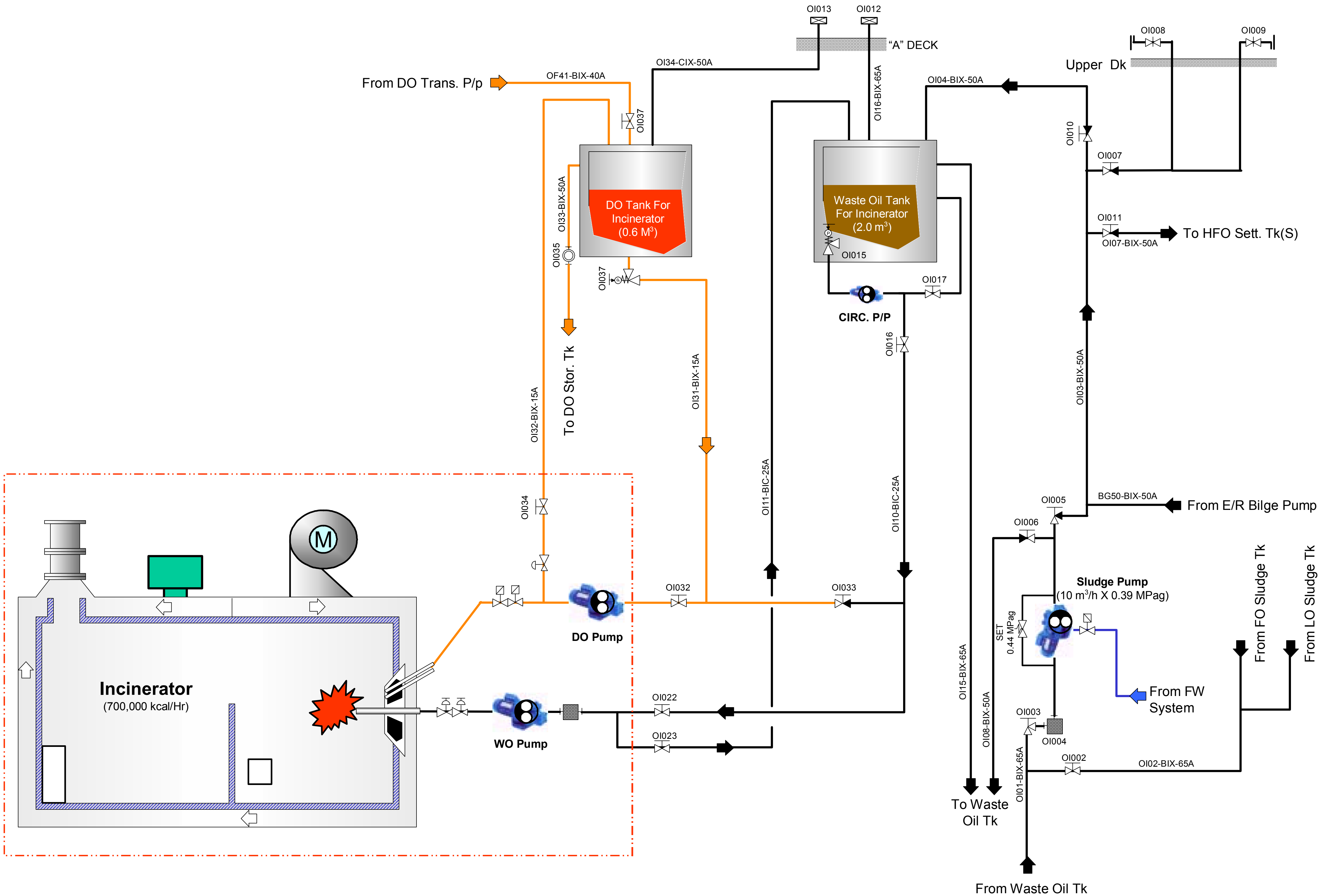
Vent valve open	23 kPag
Vent valve close	21 kPag
High pressure alarm	20 kPag (For./LNG Vap. trip)
FO back-up order ON	3 kPag
Low pressure alarm	1 kPag
Low Low pressure alarm	0.3 kPag

Set point controller:

Set point of tank press. Control	7 kPag
Set point of tank protection control	5 kPag
Min. gas flow of F/V control	1,400 kg/h (20-100%)
Set temperature of BOG temp. control	40°C
Preferred FGV position of LD comp. control	87%

Permissible range: 1~23 kPag

Illustration 2.6.7i Incinerator Fuel Oil and Sludge transfer System



2.6.7 Em'cy G/E and Incinerator Fuel Oil System

General Description

The diesel generator, emergency generator, IGG and incinerator all use diesel oil as their operating fuel supply.

The diesel oil can be bunkered to the diesel oil storage tank and/or diesel oil service tank directly, using the same line to the mid-ship manifold.

The emergency diesel generator service tank supplies the diesel engine by direct suction from the tank, through a remote operating quick-closing valve.

The diesel oil can also be co-mingled with the waste oil to the incinerator, both to flush through the suction line to the unit, and to lower the viscosity of the oil to be incinerated.

The incinerator waste oil tank is fitted with the gauge cocker to monitor the levels, and remote operated quick-closing valves are used on their suctions and overflows, which return to the oily bilge tank. The incinerator waste oil tank is also fitted with high and low level alarm

The inert gas generator is supplied from the IGG diesel storage tank by an electrically driven rotary pump. The spill line from the burners being returned to the storage tank.

System Capacities and Ratings

DO Transfer Pump (normal use):	IMO
No. of sets:	1
Type:	ACF0800K4/RBO
Flow:	30 m^3/h
Pressure:	0.4 MPag
DO Storage Tank:	332.7 m^3
DO Service tank:	37.7 m^3
Emergency Generator DO Service Tank:	6.0 m^3
Incinerator MDO Service Tank:	0.6 m^3
Incinerator Waste Oil Tank:	2.0 m^3

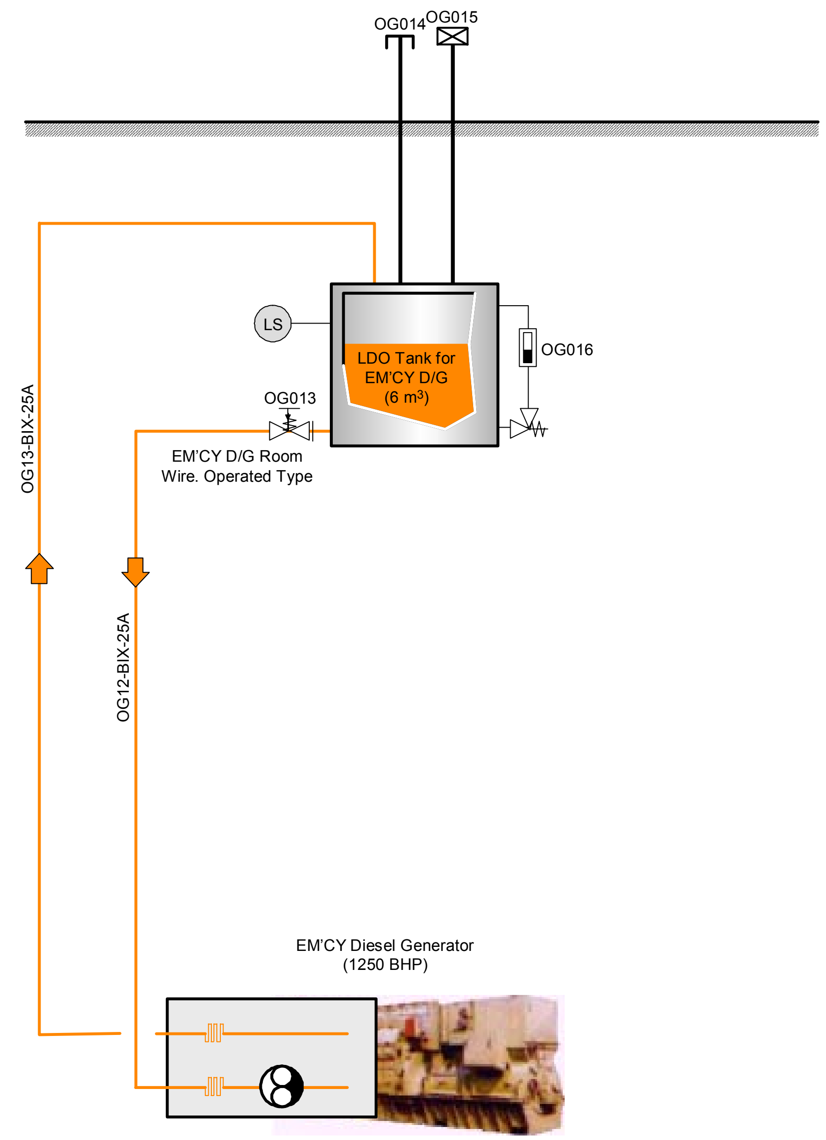
Operating Procedures

(1) To Supply Diesel Oil to the Incinerator Service Tank

a) Check the diesel oil storage tank for water through the spring self-closing valve and open the remotely operated quick closing valve OF201.
b) Open the tank filling valve to the incinerator DO tank OI037.
c) Open the transfer pump inlet and outlet valve OF209, OF211 and vent off any air in the suction strainer.
d) Make sure that the following valves are closed:
IGG DO storage tank filling valve OF049
DO service tank filling valve OF0047
Main isolating valve OF046
e) Set the transfer pump relief/bypass valve to approximately half open and start the pump.
f) When the pump is operating satisfactorily, adjust the relief valve to the correct discharge pressure.
g) Ensure that the service tank gauge glass valves are open, and monitor them as the level rises. Stop the pump when the required level is reached.

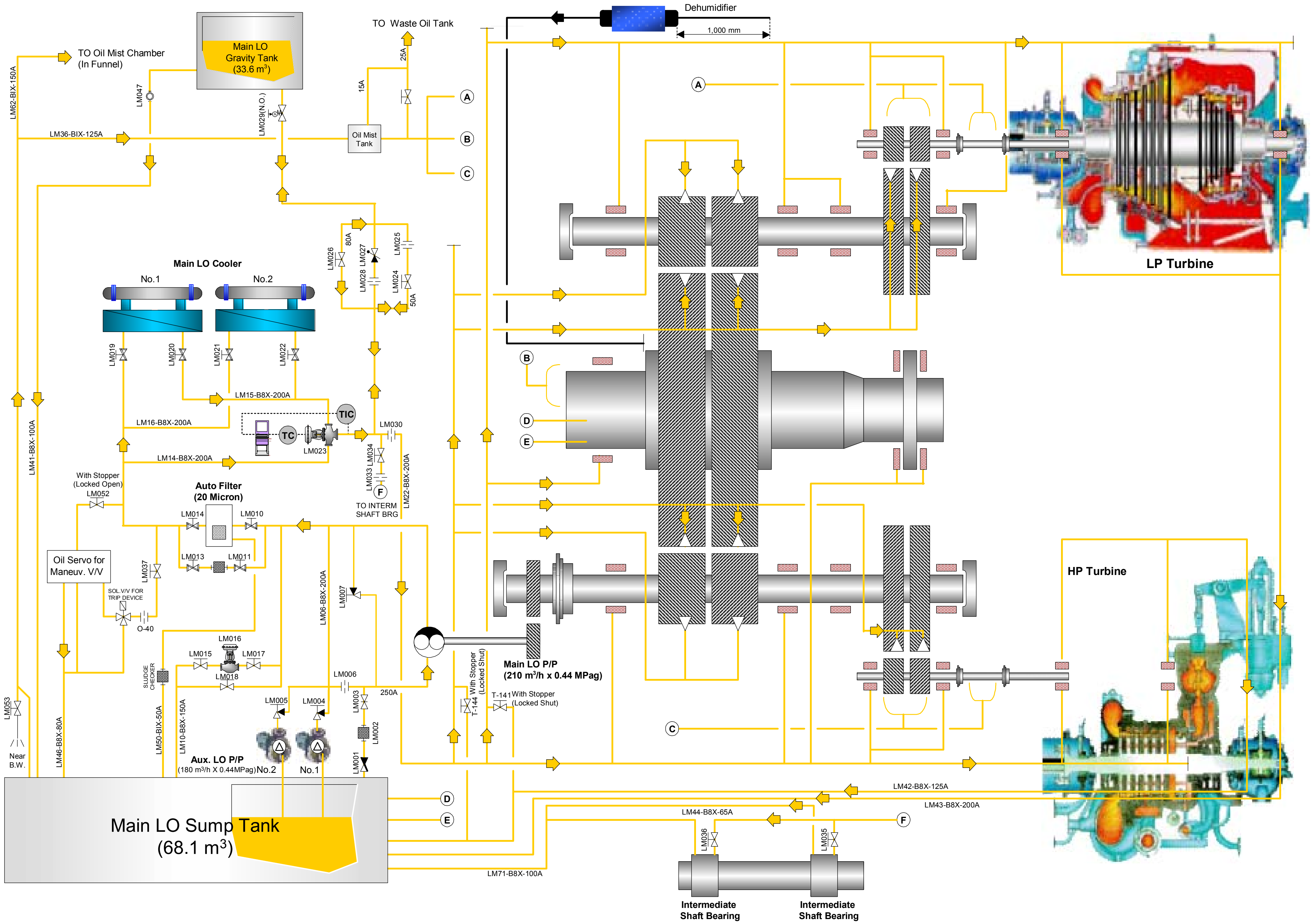
Control and Alarm Settings

EM'CY D/G ENG OVER SPEED (TC)	2,070	rpm
EM'CY D/G ENG LO INL. PRESS. L-L (TC)	100	kPag
EM'CY D/G ENG CFW TEMP. H-H (TC)	98	°C
EM'CY D/G ENG LO PRESS. LOW	150	kPag



Emergency Diesel Generator Fuel Oil System

Illustration 2.7.1i Main Turbine Lubricating Oil System



Control and Alarm Settings

M/T HP THR BRG TEMP. HIGH	75	°C
M/T HP FORE BRG TEMP. HIGH	75	°C
M/T HP AFT BRG TEMP. HIGH	75	°C
M/T LP THR BRG TEMP. HIGH	75	°C
M/T LP FORE BR TEMP. HIGH	75	°C
M/T LP AFT BRG TEMP. HIGH	75	°C
M/T HP 1P FORE BRG TEMP. HIGH	75	°C
M/T HP 1P AFT BRG TEMP. HIGH	75	°C
M/T HP 1W FORE BRG TEMP. HIGH	75	°C
M/T HP 1W AFT BRG TEMP. HIGH	75	°C
M/T HP 2P FORE BRG TEMP. HIGH	75	°C
M/T HP 2P AFT BRG TEMP. HIGH	75	°C
M/T LP 1P FORE BRG TEMP. HIGH	75	°C
M/T LP 1P AFT BRG TEMP. HIGH	75	°C
M/T LP 1W FORE BRG TEMP. HIGH	75	°C
M/T LP 1W AFT BRG TEMP. HIGH	75	°C
M/T LP 2P FORE BRG TEMP. HIGH	75	°C
M/T LP 2P AFT BRG TEMP. HIGH	75	°C
M/T MAIN WHEEL FWD BRG TEMP. HIGH	55	°C
M/T THRUSTER BRG TEMP. HIGH	55	°C
M/T MAIN WHEEL AFT BRG TEMP. HIGH	55	°C
M/T MAIN THR PAD TEMP. HIGH	100	°C
M/T MAIN THR PAD TEMP. H-H (M/T SLD)	110	°C
INTERMEDIATE SHAFT FWD BRG TEMP. HIGH	65	°C
INTERMEDIATE SHAFT AFT BRG TEMP. HIGH	65	°C
M/T MAIN GEAR LO INL. PRESS. LOW	70	kPag
M/T MAIN BRG LO INL. PRESS. LOW	70	kPag
MAIN LO PRESS. LOW	350	kPag
M/T AUX. LO P/P PRESS. LOW	320	kPag
M/T LO SUMP TK LVL H/L	1.58 / 0.87	m
MAIN LO GRAVITY TK LVL LOW	3.56	m

2.7 Lubricating Oil Systems

2.7.1 Main Turbine Lubricating Oil System

General Description

Lubricating oil is delivered to the main turbine bearings and double reduction gearing through a system that ensures the continuity of supply of high quality oil. Two electrically driven pumps, arranged in main and stand-by configurations and one shaft-driven pump, draw oil from the main turbine sump tank and discharge into a common line. The shaft driven pump has a magnetic filter in its suction line.

During normal full remote operations, at over 90% full ahead revolutions, the discharge pressure from the shaft driven pump is sufficient to supply the system. At this rpm, a signal from the main turbine control unit stops the running auxiliary lub. oil pump, without starting the stand-by pump, and placing the stopped pump as first start stand-by. Reducing the turbine speed below the 87% full rpm, initiates the start of the first stand-by the auxiliary electrically driven pump, without sounding off any alarm. If, for any reason, there should be a further reduction in lub. oil pressure, the other electrically driven auxiliary pump will cut in.

To make sure that the shaft driven pump picks up suction as the engine revolutions rise, the oil from the auxiliary pump discharge line passes through an orifice to keep a continuous oil pressure to the shaft driven pump.

The discharge line from the pumps passes through one of two in-line filters. Under normal operations, the auto back flushing unit will be in line, where flushed oil is returned to the sump through a sludge check filter, in order to prevent any unwanted impurities returning to the sump. The other filter is a manual magnetic type.

The system pressure is maintained constantly at around 0.4 MPag by a pneumatic control valve fitted before the line filters. This allows excess oil pressure to be eliminated by the oil returning to the sump tank.

Oil from the main line is used as a control medium for the main turbine manoeuvring, Block operating mechanism. Oil from this line is also fed through an orifice plate to the emergency trip valve, which will allow the oil to return to the sump, closing the manoeuvring valve and stopping the turbine.

Twin lub. oil coolers (main and stand-by), and the associated control system, regulate the temperature of the oil under normal operating conditions. A three-way control valve allows oil to pass through or bypass the cooler to maintain the cooler outlet temperature of approximately 40°C. The coolers are of the plate type, and are cooled by water from the fresh water cooling system.

The oil then passes through an orifice plate, which reduces its pressure, and a line is led to the bottom of the gravity tank, which is constantly fed to overflow back to the sump. A visual check of this overflow can be observed through a sight glass in the line. The gravity tank is supplied by an aux. L.O. pump, and a Main L.O. pump through a quick-closing pneumatic valve(LM029), which remains open under normal conditions.

In the event of a failure in the pressure supplies to the main turbine lub. oil system, the oil flow from the bottom of the gravity tank reverses, and the positive head of oil in the tank (minimum 5 m above the shaft), is supplied through a non-return valve to the bearings and gears.

The oil passes through another orifice plate, and flows to the turbine and gearing bearings and the reduction gear oil sprays. A separate line leads the oil to the two shaft bearings. All the oil from the bearing and gearing supplies is returned to the sump.

To maintain system purity, in addition to in-line filtration, the oil in the sump is circulated through the lub. oil purifier system.

Capacities and Ratings

Shaft Driven Lub. Oil Pump:	Kawasaki
No. of sets:	1
Type:	LBS-190kH
Capacity:	210 m^3/h
Pressure:	0.46 MPag
Auxiliary Lub. Oil Pumps	
Maker	SHINKO IND. CO.
No. of sets:	2
Type:	SAF150-2
Capacity:	180 m^3/h
Pressure:	0.45 MPag
Auto Filter	
No. of sets:	1
Type:	200-K8E8Z-WC20+X/BF
Mesh:	200 μm
Lub. Oil Coolers	
No. of sets:	2
Type:	Plate type TITANINM
Capacity:	912,000 kcal/h

Operating Procedures

To activate the main turbine lubricating oil system:

(1) Verify the system's integrity. Check the oil level in the main turbine sump and fill up as required.
(2) Under cold operating conditions, it may be necessary to increase the sump oil temperature by heating steam.

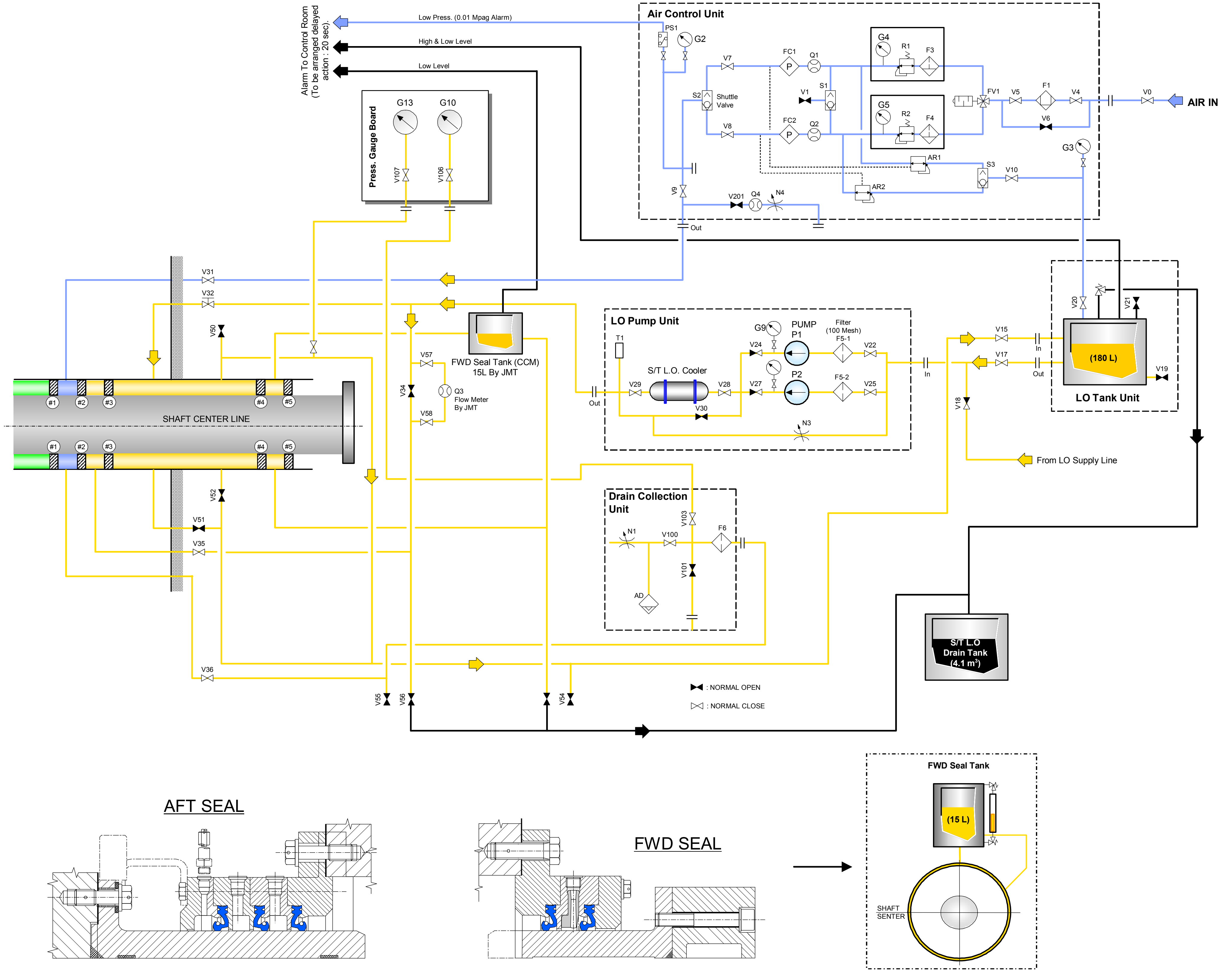
Note !
Depending on service requirements, a certain degree of heating can be achieved by the circulation of the sump through the lub. oil purifier system.

(3) Select and line up the duty auxiliary lub. oil pump. Make sure that the cooling water is operating through the lub. oil cooler that will be used.
(4) Supply the instrument air to the pressure control valve and the cooler three-way valve. Check the operation of both units on manual control and, when satisfied, return to automatic setting.
(5) Start the pump; vent off the system at the auto filters and at the selected lub. oil cooler.
(6) If the gravity tank level is low, open the flow restrictor bypass valve LM026, and fill the tank until oil is seen at the overflow line sight glass. Shut the bypass valve, and make sure that the overflow continues.
(7) Line up the stand-by auxiliary lub. oil pump and, when operational conditions permit, check the auto changeover of the unit.
(8) With the system in operation, visually check all sight glasses on gears and bearings. Check if local and remote thermometers and pressure gauges are reading correctly.

Normal Operation

(1) With the lub. oil system in use, the turbine itself can be brought back into operation, as well as the turning gear.
(2) With the engine at over 90% of its full sea rpm, make sure that the auxiliary lub. oil pump stops, and that the pressure in the system is maintained by the shaft driven pump.
(3) Similarly, when speed is reduced, make sure that the auxiliary pump cuts-in, and provides the system oil pressure.
(4) When operational requirements permit, test the system alarms to check that all functions are working.
(5) Monitor the system filter units and the operation of the auto back flush unit.

Illustration 2.7.2i Stern Tube Lubricating Oil System



2.7.2 Stern Tube Lubricating Oil System

General Description

The aft seal requires three pipings. Two of which are for supplying air and for discharging the drain between #1-#2 chamber, and the other one is used to circulate L.O. between #2-#3 chamber.
The major feature of this system is, unlike the conventional seal, to purge the compressed air of constant flow from the aftermost seal ring to the outboard at all times, and depending on the air pressure, to automatically control the L.O. pressure in the stern tube and in the #2-#3 seal chamber.
This system is composed of the air control unit that controls the amount of air and air pressure, the stern tube L.O. tank unit that adjusts the L.O. pressure at the #2-#3 chamber and in the stern tube, L.O. circulation pump unit, drain collection unit and press, gauge unit, etc.
This instruction specifies the installation of the equipment, and the precautions regarding the proper functioning of this 3AS air seal system.

FWD SEAL

The fwd seal consist of four major parts, i.e., two rubber rings, a metal housing the rubber seal ring, a liner that rotates together with the propeller shaft, and a clamp ring that holds the liner.
From the stern side, the metal housing is made up, of casing flange, intermediate ring, and seal cover.
The metal rings of the fwd seal are bolted together, so that the rubber seal rings can be readily clamped and assembled, similar as that of the aft seal.
The material of the liner is used because of its excellent wear-resistant and lip-lubricating properties.

AFT SEAL

The aft seal consists of three major parts, i.e., three rubber seal rings and a P-ring, a metal housing holding the rubber seal ring, and a liner that rotates together with the propeller shaft.
From the stern frame side, the metal housing is made up, of spacer, aft casing flange, aft intermediate ring, and a split-type P-ring cover "F", "A". Rubber seal rings are inserted between three metal rings, and are bolted together. The clamp section of each seal rings are securely fitted to the metal rings inner circumferences, and to the small grooves on the inner side of the metal rings, so that the clamp part is made rigidly oil-and-water-tight. Provide the P-ring between aft P-ring cover "F" and "A", as protection against fishing nets.
The material of the liner is highly resistant to corrosion and wear.

Operation

The method of using this device is explained refer to attached 4. In the air control unit, change "A – LINE" and "B-LINE" periodically. Stern tubes L.O. pump are periodically changed. The handling of a forward sealing device remains the same.
Before carrying out the operation in 5.1 ~ 3.4, confirm that the main shaft has stopped running in all cases.

Note!
Adjustment of the aft seal pressure at first installation and in case if replacing each part must be done according to the "INSTALLATION MANUAL".

(1) PREPARATIONS AND CONFIRMATION BEFORE USE

a) Supply oil to the stern tube and the #2-#3 L.O. circulation line.
   - Confirm that respective valves V15, V17 V21, V22, V24, V25, V27, V28, V29, V32,V35, V57, V58, and V107 are open.
   - Confirm that respective valves V18, V19, V30, V34, V50, V51, V52, V54, and V56 are closed.
   - Close V17, open V18 and supply L.O. into the L.O. tank unit of the L.O. supply pump.
   - When the oil level in the LO tank unit has reached the point between high and low levels, close V18.
   - When air in the oil in the LO circulating line has nearly disappeared, close V21.

b) Confirm the condition of the valves for the air control unit and the drain collection unit.
   - Confirm that V1, B1, V6, V201, and V0 on the air control unit are closed, and other valves(including V20 on the top of the LO tank unit, and V31 in the vicinity of the aft bulkhead.) are open.
   - Confirm that V100 and V103 are open, N1 is slightly open(Before shipment from our factory, it has been adjusted to discharge air at a rate of 4 NL/min.), V36 is open, V101 is closed in the drain collection unit, and V55 is closed.

c) Set respective changeover switch FV1 on the air control unit on "A–LINE" side.

(2) METHOD OF USE

a) Open V0 on the air source line slowly and fill air into #1-#2 chamber.
b) Confirm that the indications of the respective pressure gauges have begun showing.
   "A-LINE" : G2, G3, G4, G9, G10, and G13
   "B-LINE" : G2, G3, G5, G9, G10, and G13
   (When either pressure gauge is not starting, please refer to the troubleshooting guide and corresponding countermeasures.)
c) Turn the knob of the flow controller FC1, and set the flow, meter Q1 around 35NL/min. (Usually, it has been adjusted before shipment from the factory)

Note!
If air venting from the stern tube and piping is not sufficient, replace the oil and see if the air and oil levels have dropped to alarming levels in the L.O. tank unit

d) Open V15 and close V13 and V14.
e) Adjust the V32, and set the flow meter to q3 120 ±50 L/H, if necessary. With this, the aft seal and steam tube have returned to normal working conditions. The pressure in the respective chambers at the center of a main shaft can be determined as follows from the indicated values of pressure gauges G10, G13 and others.

   - Sea water (MPag) : $Psw = \gamma s \text{ X } (Da - Hs) \text{ X } 0.0098$
   - #1 - #2 chamber (MPag) : $P_{12} = G10$
   - #2 - #3 chamber (MPag) : $P_{23} = P_{34} + 0.015$

Stern tube (MPag) : $P_{34} = G13 + (\gamma_0 \text{ X } H3 \text{ X } 0.0098)$

Where, γ_s : specific gravity of sea water(1.025)
γ_0 : specific gravity of oil(0.90)
Da : draft of ship(m)
Hs : height from ship bottom to the center of main shaft(m)
H3 : height from the center of main shaft to G13(m)

Accordingly, from theses pressure values, the differential pressure on each seal ring can be calculated.

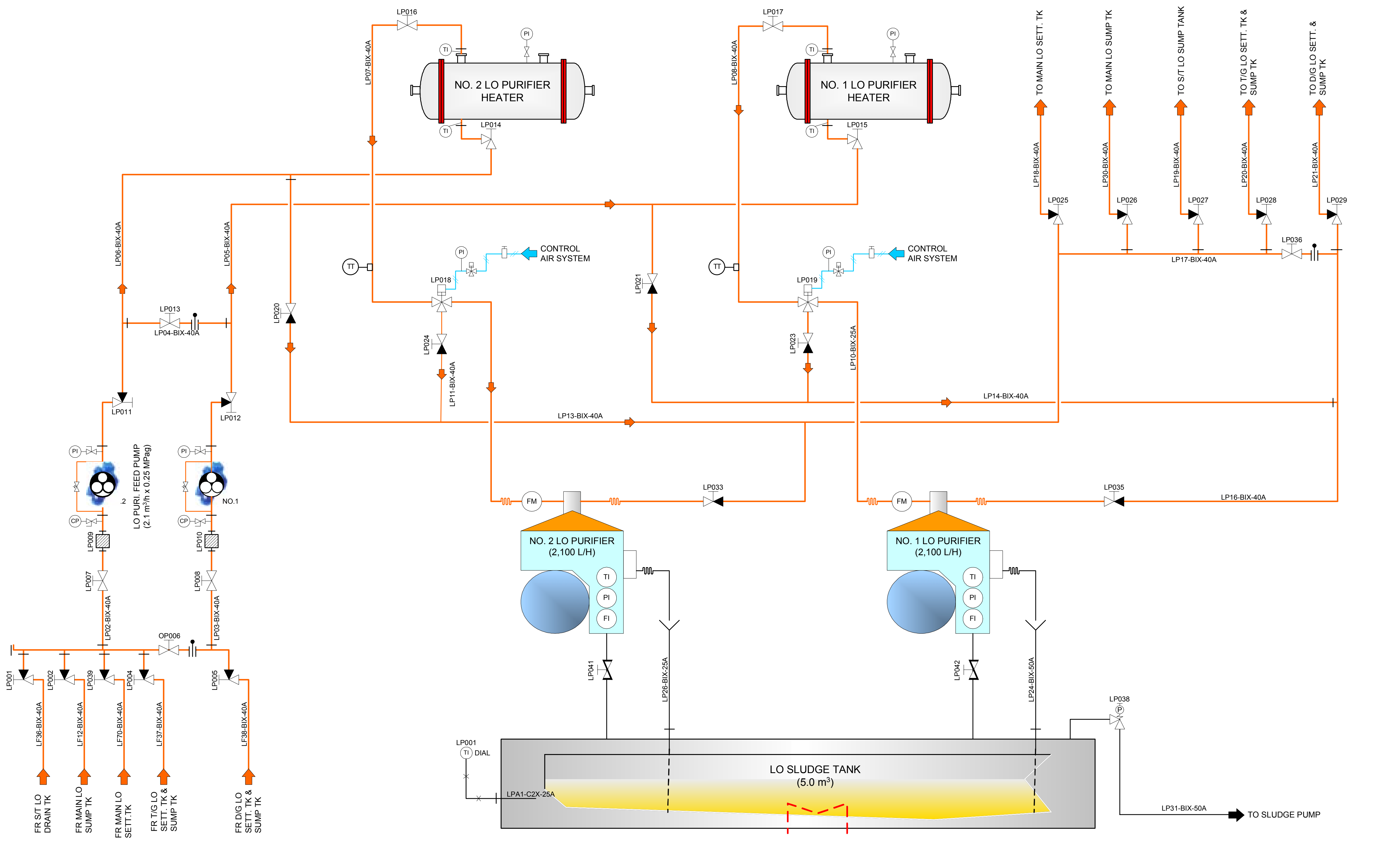
Specification

Maker:	Japan Marine Technologies ltd.
No. of set:	1
Type:	AIRGUARD 3AS
Seal size:	#850

Control and Alarm Settings

S/T LO P/P OUTL. PRESS. LOW	230	kPag
S/T FWD SEAL TANK LEVEL LOW	90	%
S/T AIR CONT. UNIT PRESS. LOW	10	kPag
S/T LO TEMP. HIGH	60	°C
S/T AFT BRG TEMP. HIGH	60	°C
S/T BRG TEMP. H-H (M/T SLD)	65	°C

Illustration 2.7.3i Lubricating Oil Purifying Systems



2.7.3 Lubricating Oil System

1. Lubricating Oil Purifying Systems

General Description

The purifying and transfer system supplies bulk oil to the main machinery systems within the engine room, and facilitates the circulation of lub. oil through purifiers.

Main storage and settling tanks are provided as follows:

M/T lub. oil storage tank

M/T lub. oil settling tank

T/G lub. oil storage tank

T/G lub. oil settling tank

D/G lub. oil storage tank

D/G lub. oil settling tank

The main storage tanks have facilities for direct filling from the deck, and drop lines to the main consumer sump tanks. The settling tanks are located adjacent to their main storage tanks and, though it is possible to drop lub. oil from these tanks to the consumers, the valves connecting them to the storage tank drop lines are normally locked. If it is required to transfer lub. oil from the settling tanks, this is normally done through the lines after the oil has passed through the purifiers. For safety, the drop valves from the storage and settling tanks are fitted with remotely operated quick closing valves.

The lub. oil transfer pump is able to take suction from all the main storage and settling tanks, either turbine lub. oil or oil for the diesel engine. Other suctions available are as follows:

Stern tube lub. oil drain tank

T/G lub. oil sumps

Main turbine lub. oil sump

D/G engine lub. oil sump

The pump can transfer the oil to any of the main storage and settling tanks, and to the deck through the tank filling lines.

There are two lub. oil purifiers for the turbine oil systems, which are used primarily to circulate and purify the main turbine sump. They have options to purify the following:

Main turbine oil sump and settling tanks

Turbine generator sumps and settling tanks

Diesel generator sump and settling tanks

They discharge to the following:

Main lub. oil settling tank

Main turbine sump

Stern tube lub. oil sump

Turbine generator lub. oil settling tank

Turbine generator lub. oil sumps tanks

Diesel generator lub. oil settling tank

Diesel generator sump tank

The main lub. oil purifiers are supplied through two electrically driven rotary feed pumps. The pump discharges can be crossed over so that either purifier can be supplied from either pump. The lub. oil pass through an electric heater. Automatic operation of all the self-cleaning purifiers is programmed, and a supply of fresh water provides seal, flushing, and bowl operating water.
The three-way solenoid operated inlet / bypass valves are operated under the same program. The drains / sludge from the purifiers is led to a sludge tank under the units, and are emptied by the engine room sludge pump.

To Purify the Lub. Oil

a) Check if the purifier is ready for operation. Take particular care regarding the correct and clean assembly of the bowl and the selection of the gravity disc.

b) Carry out all pre-service checks of the purifier as per manufacturer’s instruction/operating manuals.

c) Line up the system to be purified and, for the main lub. oil unit -start the feed pump.

d) Bring the purifier heater on line. Open the condensate line to the bilge. Slowly open the steam inlet valve, checking the condensate for contamination. If clear, change the drain discharge to the engine room drains cooler system.

e) Monitor the oil temperature through the heater, and check if the temperature control valve is operating correctly. Check the level of the tank being purified, ensuring that there is no leakage or unintentional transfer of oil.

f) Check the operation of the de-sludging cycle of the purifier, and monitor the unit for leakage in the sludge tank.

Apart from the above mentioned main lub. oil tanks, which may be filled through the transfer systems, other daily use tanks are provided, and have to be filled manually. These are as follows:

Clean oil tank : 1 of 1.0 m^3 at 2nd deck FWD

Turbine oil tank : 1 of 0.5 m^3 at 2nd deck FWD

Main feed pump daily use tank : 1 of 0.2 m^3

Emergency generator daily use tank : 1 of 0.2 m^3

Air compressor daily use tank : 2 of 0.2 m^3

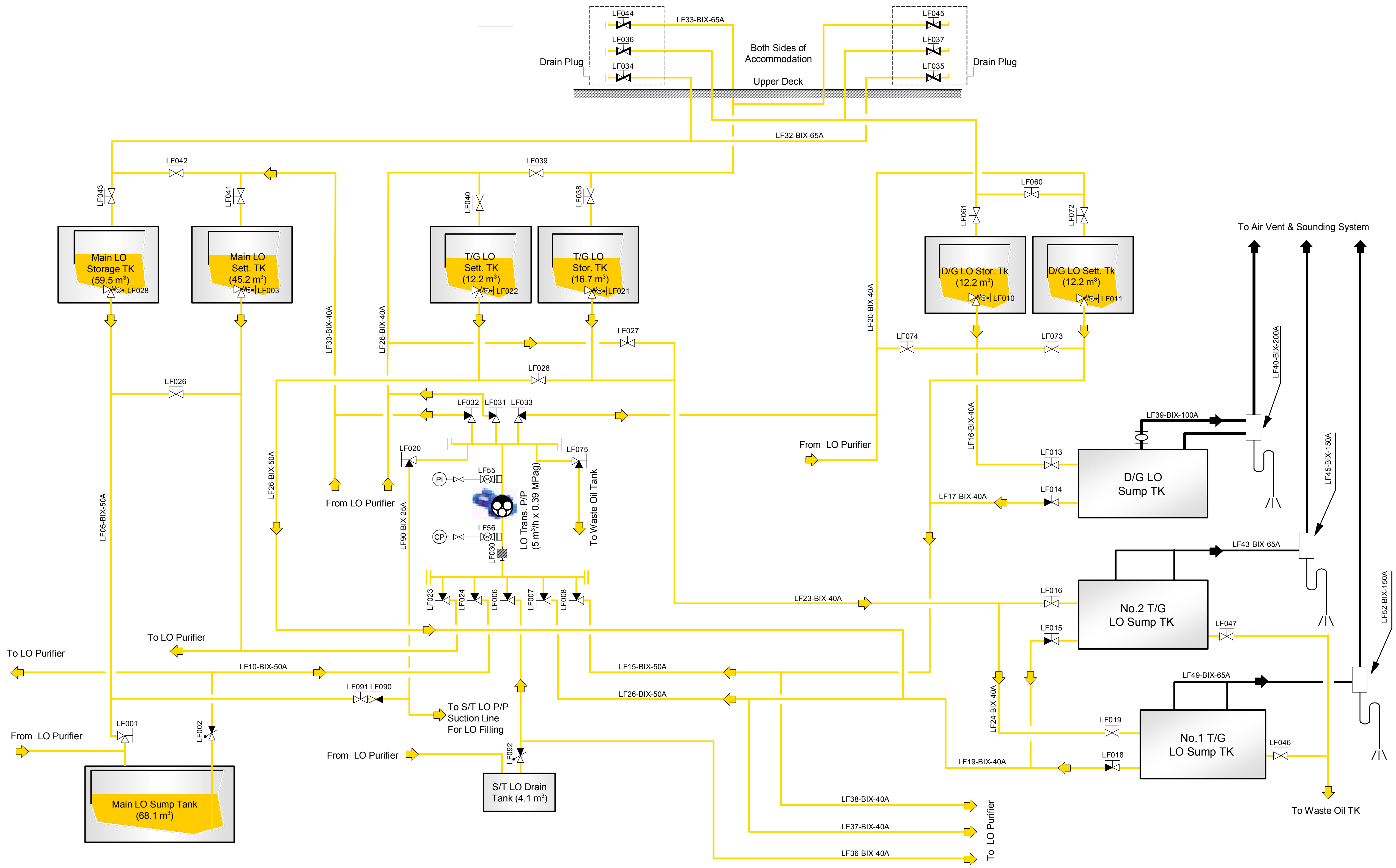
Capacities and Ratings

Main Lub. Oil Purifiers:	Samgong
No. of sets:	2
Type:	SJ30F
Capacity:	2,100 l/h
Main Lub. Oil Purifier Feed Pump:	IMO
No. of sets:	2
Type:	ACE025N3 NVBP
Capacity:	2.1 m^3/h
Pressure:	0.25 MPag
Lub. Oil Transfer Pump:	IMO
No. of sets:	1
Type:	ACE032N3 NVBP
Capacity:	5.0 m^3/h
Pressure:	0.4 MPag
Main Lub. Oil Purifier Heaters:	Donghwa Co., Ltd.
No. of sets:	2
Type:	DHEH-018504
Capacity:	2.1 m^3

Storage Capacity

Main lub. oil storage tank	59.9 m^3
Main lub. oil settling tank	45.2 m^3
Main lub. oil sump	68.1 m^3
Turbine generator lub. oil storage tank	16.7 m^3
Turbine generator lub. oil settling tank	12.2 m^3
Diesel generator engine lub. oil storage tank	12.2 m^3
Diesel generator engine lub. oil settling tank	12.2 m^3
Lub. oil sludge tank	5.0 m^3

Illustration 2.7.3i LO Filling and Transfer System



2. Lubricating Oil Transfer Systems

Operating Procedures

(1) To Bunker the Lubricating Oil

a) Check and record the level of the tank that will receive the oil. Check the supplied oil specifications.

b) Inspect the bunker connections, Making sure that the area is clean and the save-alls are secure in case of any leakage. Remove the blanks and connect the hose at the manifold. Start bunkering, checking for leakage and monitoring tank levels.

c) Upon completion, re-check tank levels and record them. Disconnect the hose and refit the blank. Contain and clear any spillage. Record the amounts received, and how much is now on board.

(2) To Drop the Lub. Oil from Storage Tanks to Sumps and Services

a) Check the oil in the storage tank for water contamination, draining as necessary.

b) Check the levels in both the storage tank and the receiving tank. Check if all branch valves from the drop line are closed, then line up the valves between the tanks, leaving the local receiving tank valve closed until ready to start the dropping.

c) Monitor the tank levels, stopping at the required level. Record the amount of oil transferred.

(3) To Use the Lub. Oil Transfer Pump

As the transfer pump can be used to pump oil from many tanks and systems, great care must be taken to ensure that the valves are open only on the lines required, and all other valves are closed.

a) Make sure that all inlet and outlet valves on the pump are closed. Check lines through which the oil is to be transferred, that all valves on the branch lines are closed, both on the suction and discharge sides of the pump.

b) Line up the suction side of the pump, making sure that only the valves on the line from which the pump is to take suction are open.

c) Line up the discharge side of the pump, making sure that only the valves on the line to which the pump is to discharge are open. If it must be discharged ashore, check that the line blank is removed and that the connection of the hose is satisfactory.

d) Monitor the tank level before, during and after the transfer. When given the authority, start the pump, check the discharge pressure, and inspect lines for leakage.

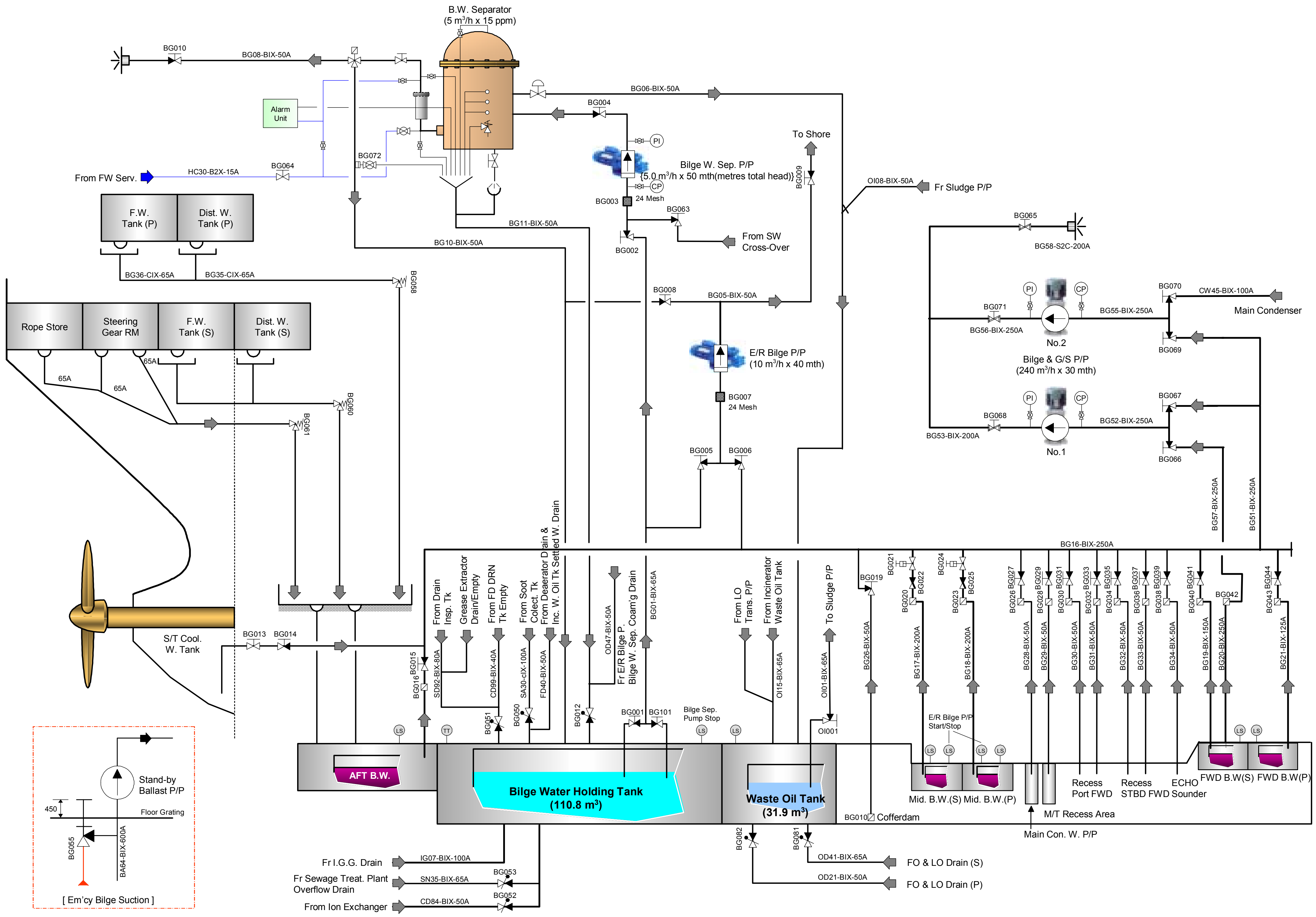
e) Upon completion of the transfer, stop the pump and shut down the system, making sure that all valves are closed. Return all blanks that were removed, or the spectacle pieces to their normal positions.

f) Contain and clear any spillage. Record all tank levels and amounts transferred.

Control and Alarm Settings

MAIN LO STOR TK (S) HIGH	4.44	m
MAIN LO SETT TK LVL HIGH	4.37	m
D/G ENG LO SETT TK LVL HIGH	90	%
T/G ENG LO SETT TK LVL HIGH	90	%
LO SLUDGE TK LVL HIGH	90	%
LO PURI. HTR OUT TEMP. HIGH	90	°C

Illustration 2.8i Bilge System



2.8 Bilge System

Discharge of Oil Prohibited

The Federal Water Pollution Control Act prohibits the discharge of oil or oily waste into or upon the navigable waters of the United States or the waters of the contiguous zone if such discharge causes a film or sheen upon or a discolouration of the surface of the water or causes a sludge or emulsion beneath the surface of the water. Violators are subject to a penalty. (USCG Rule # 155.445)

General Description

There are bilge water holding tank and waste oil tank in the engine room..

The capacity of bilge holding tank and waste oil tank are as follows:

Waste oil tank (31.9 m^3)

Bilge water holding tank (110.8 m^3)

The waste oil tank is filled with drains and/or oily residues from the oily water separator, as well as any oily water that may be directed from incinerator waste oil tank, M/T LO pump coaming and sludge pump coaming. This tank is normally emptied by the sludge pump and can be transferred to shore installations through the deck shore connection, or to the waste oil settling tank for use in the incinerator (Refer to Illustration 2.6.7i Incinerator Fuel Oil and Sludge Transfer System). A limit switch is fitted to the tank for a high level alarm at incinerator waste oil settling tank high level.

The bilge water holding tank accepts drains from the soot correcting tank, deaerator drain tank, incinerator settled water drain tank, sewage drain, FDW drain tank, E/R bilge pump coming, grease extractor drain, drain inspection tank, IGG drain, ion exchanger and bilge water separator. This tank is pumped out using the bilge water separator pump and transferred through the oily water separator unit, before passing overboard. A limit switch is fitted for the auto stop of the bilge water separator pump as the level drops.

All other scupper drains from the E/R decks drained down to E/R bilge wells.

All the tanks are fitted with high level alarms.

There are five main bilge wells in the engine room as follows:

Port and starboard forward bilge wells

Port and starboard midships bilge wells

Aft well bilge well

All of the above are linked to a suction ring main and can be pumped out using the bilge pumps, the ER bilge pump or the bilge line suction on the bilge & G/S pumps. Attached to this suction ring main are suctions from the bilge hat under the main condenser, the cofferdam around the main turbine and to drain the stern tube cooling water tank around the main stern tube shaft.
The port and starboard forward bilge wells are fitted with high level alarms, and the starboard well can be pumped out by direct suction through No.1 bilge & G/S pump.

The port and starboard middle bilge wells are fitted with a high level alarm and level switch, which will automatically start and stop the engine room bilge pump.

The aft bilge well collects drains from the save-alls in the steering gear room, which can be emptied into the well through spring loaded valves. Also draining into this well can lower the level in the stern tube cooling water tank. It has a high level alarm.

The bilge water separator pump is an electrically driven rotary unit and can take suction from the bilge holding tank and the main bilge line. Normally it pumps the bilge water through the bilge water separator unit to discharge overboard.

The engine room bilge pump is an electrically driven reciprocating pump, which takes suction from the main bilge and the bilge water holding tank. The pump can transfer the bilge water to the bilge holding tank or to shore facilities. A limit switch on the mid-ships bilge wells enables this pump to start and stop automatically, as the bilge levels rise and fall.

The sludge pump is an electrically driven rotary pump, which can take suction from the waste oil tank, fuel oil sludge tank, and lub. oil sludge tank. It normally transfers the sludge to the incinerator waste oil tank, or to the main deck for shore disposal.

Bilge Water Separator

The bilge water separator pump is used to transfer the bilge water into the bilge water separator with the separated water discharged overboard.

When the separator is filled with bilge water, and if the free oil at the top is detected, the oil is discharged to the waste oil tank.

On leaving the bilge water separator, the water flows through a filter unit, which removes any solids in the residue.

Before passing overboard, the water is discharged through a solenoid operated three-way valve, and should the oil content monitor alarm detect any oil traces at 15 ppm, this valve will automatically open, preventing any water flowing overboard, until the monitor detects no more oily traces.

Note !

The bilge water separator is not designed to separate emulsions or chemicals in the water.

See the manufacturer's instruction and operating manual for the correct operation of this unit.

System Capacities and Ratings

Bilge Water Separator:	HANYOUNG ENG. CO., LTD.
No. of set:	1
Type:	OS-5.0
Flow:	5 m^3/h at 15 ppm
Pressure:	0.32 MPag
Pump:	HORIZONTAL, PISTON
Engine Room Bilge Pump:	Shinko Ind Co.
No. of set:	1
Type:	VPS10
Flow:	10 m^3/h
Pressure:	0.44 MPag
Sludge Pump	IMO pump
No. of set	1
Flow:	10 m^3/h
Pressure:	0.39 MPag

Note !

All level alarms have a 25-second delay to avoid false alarms due to ship movement.

Operating Procedures

Note !

Unless safety of the vessel and/or personnel is at risk, water that may contain oil must not be pumped directly overboard. International pollution regulations must be followed at all times.

Whenever bilges or other oily water spaces have been pumped or transferred, a suitable entry must be made into the oily water record book, indicating times, amount transferred, amount currently being transferred to the tanks, and must be signed by the captain.

(1) Using the Engine Room Bilge Pump in Manual Operation

a) Check the bilge pump gear case oil level and fill up as required.
b) Check if the guides are adequately lubricated.
c) Check if all oil lubricators are filled.
d) Open the pump discharge, either to the bilge primary tank or to shore.
e) Open the required suction valve on the space to be pumped.
f) Start the pump; making sure that suction and discharge pressures are working well.
g) Monitor the space being emptied and change over the suction to a further well to be emptied, if required.
h) Stop the pump and close all valves upon completion.

(2) Using the Engine Room Bilge Pump in Automatic Operation

a) Check the gear case oil level, and fill up if required.
b) Check if the guides are adequately lubricated.
c) Check if all oil lubricators are filled.
d) Check if the ER bilge pump discharge valve to the required tank is open.
e) Open the instrument air to port and starboard mid bilge well solenoid valves and making sure that the manual valves are open.
f) Place both automatic bilge suction valves' control switches in the auto position.
g) Place the starter switch for the bilge pump to the auto position.
h) The engine room bilge pump should now start if either of the well's level rises above the higher level switch, and stop when it reaches the lower switch.
i) When using the engine room bilge pump in auto start/stop mode, great care should be taken in monitoring the engine room bilge pump operation, particularly the "long time run" and "frequent start" alarms. These may indicate a problem with leakage into the bilges requiring further investigation.

(3) Use of the Sludge Pump

This pump is used to maintain the incinerator oil settling tank level.

a) Open the pump suction from the tank requiring its level to be lowered.
b) Open the discharge valve OI005 to the waste oil settling tank, or to the main deck if required to transfer to shore facilities.
c) Start the pump and observe the suction and discharge pressures. Make sure that the suction filter is not blocked, thus causing a high vacuum.

If on manual control:

d) Make sure that a check is maintained on the waste oil tank level as the pump is discharging. When the tank being pumped out is empty, stop the pump and shut all valves.

(4) Using the Bilge Water Separator

a) Be good not to supply power for oil level sensor until filling it up with water.
b) When full of water, the needle of pressure indicator will start to move. Then manipulate the final outlet valve to keep the set press steadily.
c) After running 5~10 minutes at the set pressure, replace pump suction valve with bilge suction valve in clean water. (Change them with slowly opening and closing valve s without neglecting at keeping the set pressure.)
d) For a ship equipped with oil content alarm unit, check if zero-point is well aligned with feeding fresh water and if discharging water is satisfactory at regulations. (3 way valve will activate where the ingredient of drainage is below or over 15 ppm)

(5) Stoppage

- When stopping the operation due to completion of treatment with bilge or other inevitable circumstances, close valves after repeating circulation for 5~10 minutes in a replacement with fresh water.
- Also cut off input power source.

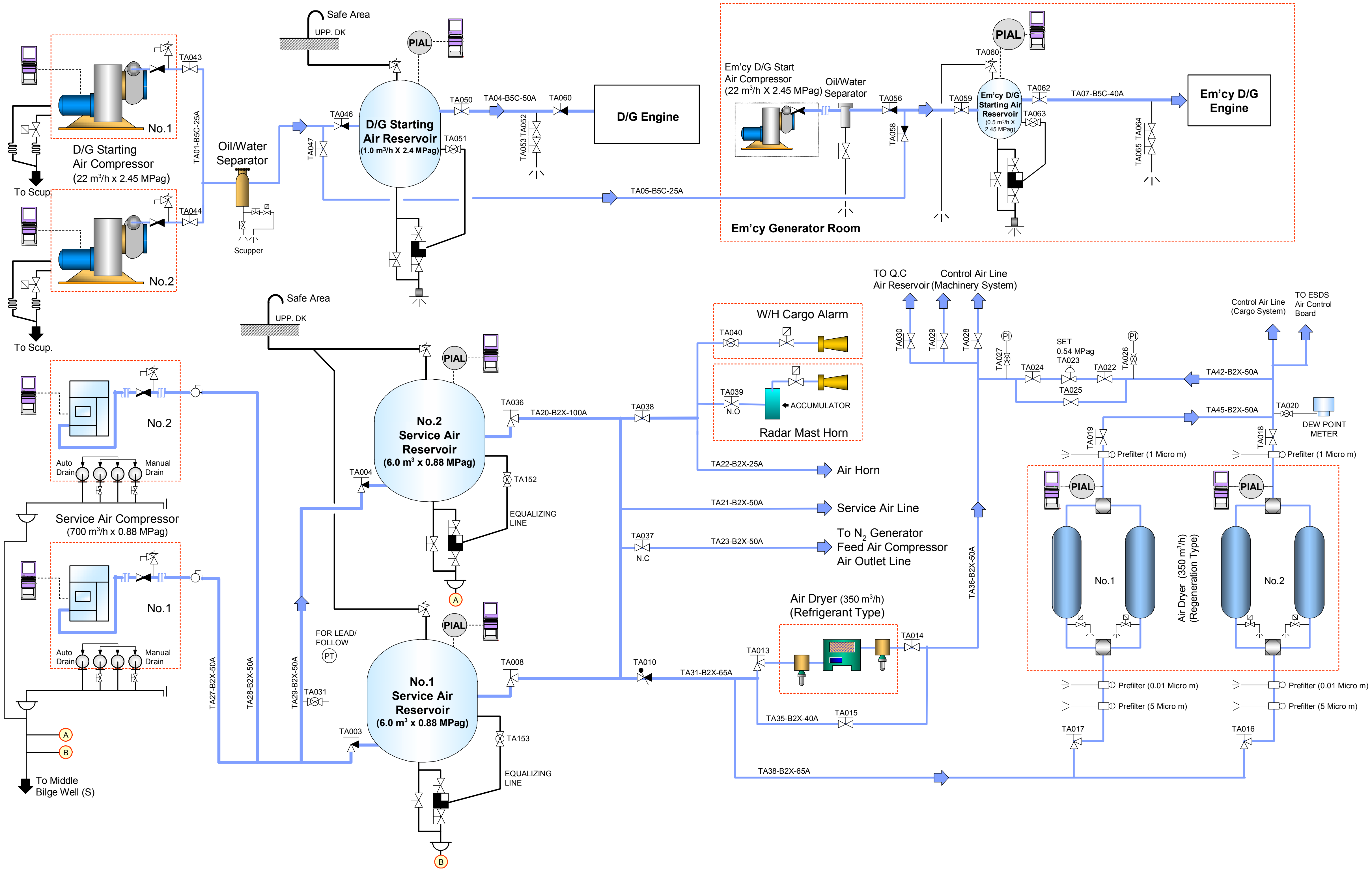
Note !

Use the manufacturer's operating manual for correct use of the bilge water separator.

(6) Using Bilge Pumps to Pump Bilges

a) Open the suction valve from the space to be pumped out.
b) Open the ship's side discharge valve BG065.
c) Start the pump, and using the attached self-priming vacuum pump, ensure a satisfactory suction is achieved.
d) Check levels carefully, ensuring the pump does not run dry.
e) When the level is reduced, stop the pump and close all valves.

Illustration 2.9.1i Compressed Air System



2.9 Compressed Air Systems

2.9.1 Control Air Systems

General Description

The control or instrument air system provides dry, clean air at 0.88 MPag pressure, to operate control valves (both pneumatic and electro-pneumatic) and the dampers throughout the vessel.

Two electrically driven compressors supply air to the service air receivers. If the air is for the cargo operating systems it will then pass through a desiccant type dryer. If it is for the engine room control systems, it will pass through a refrigerant type air dryer.

(1) Service Air Compressors

The compressors are identical machines of the two stage water-cooled screw type, and arranged to run in auto start and stop conditions. The pressurized air is produced with a screw compressor unit drive by an electric motor. The pressurized air and the oil are cooled with separate coolers.

Although the compressors can be started locally, they are normally on remote control. one unit on auto start, the other on stand-by. The compressor in use will cut-in with the receiver pressure at approximately 0.7 MPag, and stop when the pressure is raised to approximately 0.9 MPag. Should the receiver pressure continue to fall to approximately 0.6 MPag, the second compressor will start and assist in pumping up the receiver.

The receiver is fitted with a relief valve set to lift at 0.97 MPag.

Note !

Control air system is joined in front of refrigerant type air dryer on service air system.

Before starting

a) Check the oil level, which must be in the middle of the sight-glass. Fill up, if necessary, with the correct type of oil.
b) Close the condensate drain valves.
c) Open the air outlet valve.
d) Check if the water drain valves are closed. Open the water inlet valve and outlet valve.
e) Open the water flow regulating valves. The opening of these valves can be overlooked if, after previous use, the setting has not been changed.
f) Switch on the voltage and check if the voltage LED lights up.

Routine starting

a) Press start button. The compressor starts running in an unloaded condition and automatic operation LED lights up.
b) Approx. 25 seconds later (programmable), the compressor starts running loaded. The message on display changes from <<Automatically unloaded>> to <<Automatically loaded>>
c) Regulate the water flow with the loaded compressor running.

Starting after emergency stopping or shut-down

Press the emergency stop button, switch off the voltage, and then depressurize the compressor. After checking the fault, unlock the emergency button by pulling it out and restart the compressor as described above.

If the automatic restart function after voltage failure is activated and the duration of repair is shorter than the programmed power recovery time, reset the display after checking the fault: press the key <<Reset>>, the message <<All protection functions are OK>> will appear, and the compressor can be restarted. Press the keys <<Menu>> and <<Main Screen>> to return to the main display.
Minimum stop time
The compressor will not be allowed to restart within a programmed time (20s) after it has stopped running for whatever reason. A start command given during the minimum stop time will be stored in its memory; automatic operation LED lights up. The compressor will start when the minimum stop time has run out.

Manual restarting

In automatic operation, the regulator limits the number of motor starts. For low-voltage motors, observe an interval of minimum 20 minutes between each manual start.

Note !

a) If the compressor is stopped, it may start automatically.
b) The key switch allows the operator to select four control modes. To avoid unauthorized switching over to another control mode, take out the key after selecting the required mode.
c) The control module will only react to a new control mode if the new position of the control mode switch is maintained for 3 seconds.

Manual unloading

Press the key <<Unload>>. The message <<Manually Unloaded>> appears on the display.

Manual loading

Press the key <<Load>> LED lights up. The command does not force the compressor in a loaded condition, but it will switch the compressor to automatic operation again, i.e. the compressor will be loaded if the air net pressure drops below the programmed level.

Stopping the operation

a) Close the air outlet valve.
b) Press the stop button. The compressor will run unloaded for 3 seconds, after which it will stop.
c) To stop the compressor immediately, press the emergency stop button. Alarm LED starts blinking. After troubleshooting, unlock the emergency stop button by pulling it out.
d) Open the drain valves
e) Close the cooling water inlet valve.
If the compressor is installed in a room where freezing temperatures are expected, drain the cooling system completely by opening the main drain valves in the water inlet and outlet pipes (customer's installation) and by removing following plugs:
- Underneath the oil cooler
- Underneath the aftercooler, intercooler and oil cooler
- Underneath the compressor elements
- Remove the condensate drain plug from the intercooler and aftercooler. Reinstall them before restarting

(2) Desiccant Type Drier

The Desiccant Air Dryer is designed to remove moisture from compressed air. As 100% saturated air moves across the desiccant, water vapour leaves the air and coats desiccant surfaces until they are saturated.
Once saturated, the desiccant must be regenerated or replaced.

Adsorptions (Drying Cycle)
Water vapour leaves the inlet compressed air as it is adsorbed on the desiccant surface. As the rapidly moving water molecules are adsorbed and their motion stopped, their kinetic energy is converted to thermal energy, raising the local temperature. This thermal energy is called Heat of Adsorptions and it is heat source for reactivating.

Desorptions (Reactivating Cycle)
Dry purge air draws moisture off the surface of the desiccant bead.
Water molecules released from the surface must acquire kinetic energy. They draw this energy from their surroundings lowering local temperature.
This required thermal energy is called heat of desorptions and is covered by heat of adsorption that was retained in the desiccant bed during the drying cycle.

(3) Refrigerant Type Drier

Operation principle

The humid ambient air flows into the air inlet, and pre-cooled in the heat exchanger, and enters the cooler.
As the air passes through the cooler which was cooled by evaporation of liquid refrigerant, temperature drops down to 4℃ dew point temp., and the moisture in the air is condensed.
Condensed moisture, becomes water separated from air, and purged out of the system by the drain separator and discharged through the drain outlet.
The refrigerant, evaporated by hot air is pressurized by refrigerant compressor to become high-pressure discharged gas.
This gas condenses again to the liquid refrigerant in the condenser cooled by fan.
While passing through expansion valve, the high pressure liquid gas evaporates in the cooler, pulled to the compressor, and compressed again continuing the refrigeration cycle.

System Capacities and Ratings

Service air compressor:	Atlas copco
No. of sets:	2
Type:	TWO STAGE, SCREW TYPE
Capacity:	700 M3/H
Pressure:	0.9 MPag

Heatless type air drier:	Kyung Nam Dryer Co., Ltd.
No. of sets:	2
Type:	KHDM-400
Flow:	350 Nm^3/h

Refrigerant type air drier:	Kyung Nam Dryer Co., Ltd.
No. of sets:	1
Type:	KHAM-400
Capacity:	350 Nm^3/h

Operating Procedures

(1) Control Air System

a) Make sure that the air compressor is ready for use, that the sump oil level is satisfactory, cooling water to inter-coolers is in use and the discharge valve from the compressor is open.
b) Open the inlet valve to the receiver, closing the drain valve. Make sure that the valve to the auto drain is open and the bypass valve is closed.
c) Check if all valves and lines to the pressure switches for starting and stopping the compressor are open.
d) Start the compressor. Check the air pressure and lub. oil pressure. Make sure that the compressor discharge line to the auto drain opens for a short time, allowing any moisture to the bilge well via a high pressure hopper, and that it closes correctly.
e) Switch the compressor to auto control, and allow the receiver to reach its full pressure. Check if the compressor stops.
f) Open the receiver discharge valve.
g) Open the inlet and outlet valves to one set of line dust and oil filters, ensuring the other set is isolated.

(2) For the Cargo Control Air System

a) Open the inlet and outlet valves to the heatless driers, making sure that all drain valves are closed.
b) Switch on the power supply. Start up the driers in conjunction with the manufacturer's operating instructions.
c) Once the driers are in operation, maintain checks on the line pressure and dew point in the system.

(3) For the Engine Room Control Air System

a) Open the air inlet and outlet valves to the refrigerant drier unit in use.
b) With power to the unit, start the compressor and make sure that the fan is blowing over the evaporator coil.
c) Check that the compressor is running satisfactorily. Usually the outlet control airline feels cooler than the inlet as refrigeration takes effect.
d) Make sure that the unit auto drain is operating correctly.
e) When operations permit, check and test all cut-ins and alarms. Check the operation of the crossover valve from the GS. air system.

2.9.2 Starting Air Systems

(1) General Description

Both the diesel generator and the emergency diesel generator have air-starting systems and both units are provided with air at 2.45 MPag.

The generator engine starting air compressors for the system are two electrically driven reciprocating units, which supply air to the diesel generator air start receiver, with a line from this receiver to the emergency generator receiver.

An engine driven compressor can also supply the emergency generator air receiver. This is used if, for any reason, the generator engine starting air compressors are not operable, e. g. no electrical supply.

(2) Air Compressors

Before starting

- Read from time to time each pressure gauge to verify that air pressure, and oil pressure levels are normal (in case of forced lubrication by gear pump).
- Carefully read the ammeter.
- Check the temperature of each part.
- Check the bearings and the cylinders to verify that they are free from abnormal temperatures.
- Also, check the temperatures of the cylinder head and the discharged air. In the event of any leakage from the valves, the temperature of the cylinder head and the discharged air increases.
- Confirm the leakage in the pipe.
- Operate the safety valve from time to time to keep it in good condition.
- Are there abnormal noises in each part?
- Perform draining from the air tank and the drain chamber once in a while.
- Record the daily running hours. (when deemed necessary)

Pressure gauge		Standard pressure(MPag)
		AHV series
Low press. 1st stage		0.45 ~ 0.65
High pressure	2nd stage	3.0
	3rd stage	-
Oil pressure		-

Automatic Operation of Compressor

a) Automatic Operation
The compressor starts and stops automatically with the pressure switch. The pressure switch is activated by pressure in the air receiver, affecting the motor ; that is, when the pressure in the receiver rises up to the specified upper limit, the contacts of pressure switch open, stopping the motor. On the contrary, when the pressure drops to the lower limit, the contacts close and starting the motor.

b) Starting under unload Condition
Start with the use of a timer relay system.
This system works as follows:
When the compressor starts, compressed air at the delivery side is released to the atmosphere with the help of magnetic valve kept open for short period of time, while time relay electrically connected with each other. The recommended delay range given to timer relay should be kept between 5 and 10 seconds.

Note !

When the compressor is to be operated after it has been isolated from service for a long period follow the necessary steps as mentioned under paragraph of Test Run.
In case where the compressor is cut of from service for prolonged time it must be attended with necessary care, otherwise, the compressor may be affected by dust deposit, change of oil quality, and corrosion by impure gases in the air.

(3) System Capacities and Ratings

G/E Starting Air Compressors:	Jong-hap Maritime Inc. Korea
No. of sets:	2
Type:	AHV20
Capacity:	22.0 m^3/h
Work Pressure:	2.45 MPag

Em'cy D/G Starting Air Compressor:	Jong-hap Maritime Inc. Korea
No. of sets:	1
Type:	AHV20E
Capacity:	22.0 m^3/h
Work Pressure:	2.45 MPag

G/E Starting Air Receiver:	Kumkang Precision Ind Co., Ltd.
No. of sets:	1
Capacity:	1.0 m^3
Working Pressure:	2.45 MPag

Em'cy D/G Starting Air Receiver:	Kumkang Precision Ind Co., Ltd.
No. of sets:	1
Capacity:	0.5 m^3
Working Pressure:	2.45 MPag

(4) Operating Procedure

a) Main Diesel Generator Air Starting System

i) Check the compressor that will be used. Make sure that the oil sump level is correct. Check that the fresh water cooling system valves are open, and there is a flow through the inter and after coolers.
ii) Open the discharge valve from the compressor and the inlet valve to the air receiver.
iii) Line up the drain valves from the receiver for the auto drain valve that will be in use.
iv) Make sure that all valves are open to the pressure switches for the cut-in and cut-out of the compressor.
v) Start the compressor in manual mode, and start to raise the pressure in the receiver. Inspect the pressures of the compressor local gauges and, when all is satisfactory, change to auto mode.
vi) Make sure that the compressor stops when the receiver pressure reaches approximately 2.5 MPag, and restarts when the pressure drops to approximately 2.0 MPag
vii) As the compressor starts, check the operation of the magnetic unloader, if the unit drains to the bilge in order to exclude any moisture already in the compressor, before pumping to the receiver.
viii) When the operation of the compressor is satisfactory, open the receiver outlet valve to the diesel generator engine air start system.

Note !
At the lowest point along the line from receiver to the generator engine, a double shut off valve is fitted. Periodic opening of these valves will ensure that no moisture stays in this line and is unable to enter the engine air start system.

ix) Open the emergency generator air start receiver inlet valve. Check that the receiver auto drain unit is lined up and that bypass drains valve is closed.
x) Open the air line valves TA047 and TA058 to enable the emergency generator air receiver to be pressurized. As the working pressure is the same as for the generator engine starting receiver, the compressor start/stop pressure switches on the generator engine. The starting receiver will prevent the emergency receiver from becoming over pressurized.
xi) Periodically open the generator engine starting receiver manual drain valves and the generator engine starting receiver to ensure all moisture is drained from them and to ensure the auto drain valve is operating correctly.
xii) When the system is operating satisfactorily, place the second compressor on stand-by mode and when operating procedures allow, check if all alarms and changeovers operate satisfactorily.

b) Emergency Air Start for Emergency Generator

The diesel engine driven compressor is only for emergencies, if no air start pressure is available from the generator engine starting air start compressors. The unit should be tested regularly and proved operational.

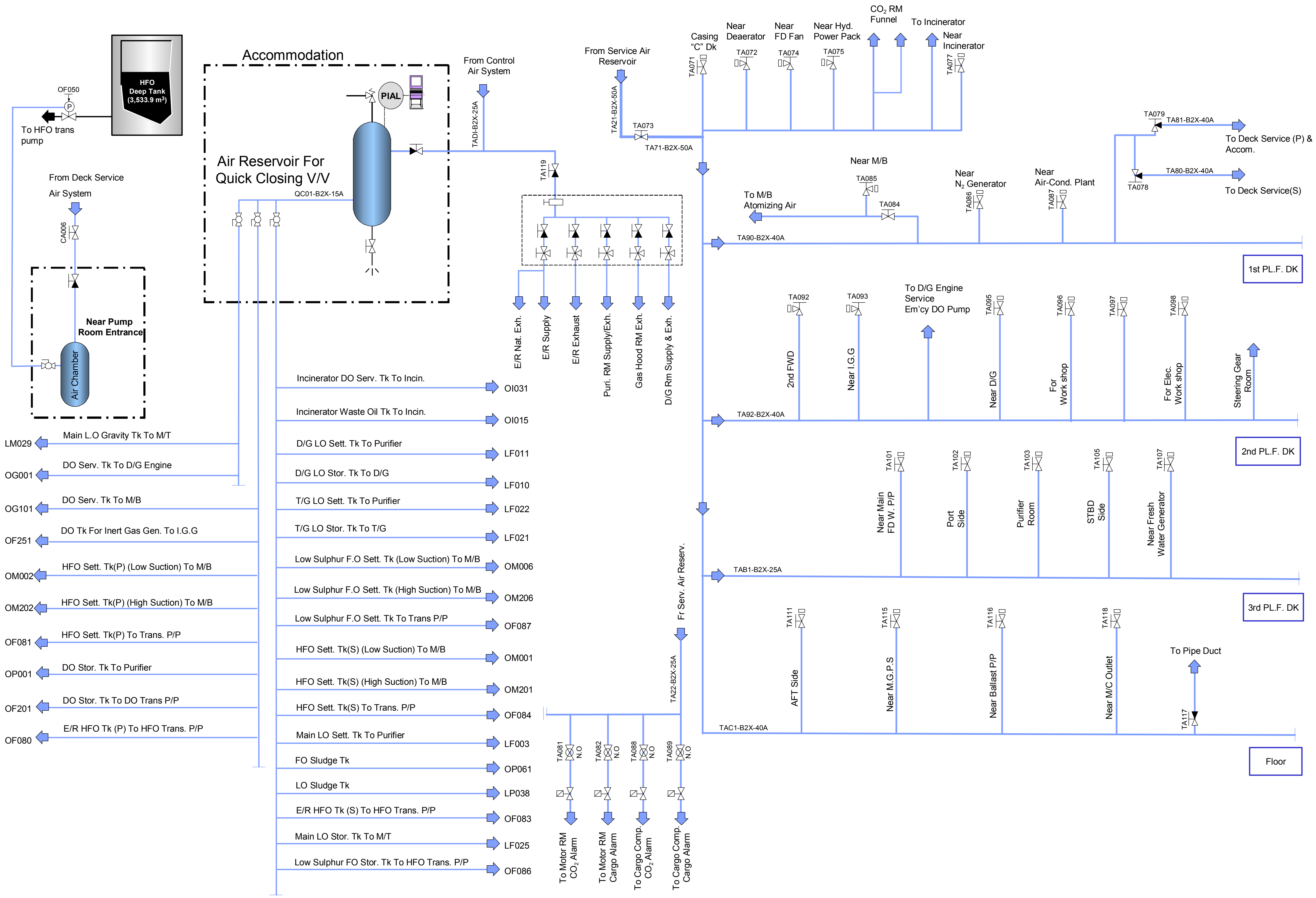
i) Isolate the emergency diesel generator starting air compressor from the generator engine starting air compressor line, by closing valve TA058.
ii) Open the discharge valve from the compressor TA043 and TA044.
iii) Check the compressor oil level.
iv) Check the engine oil level and the fuel level. Start the engine as per manufacturer's instructions.
v) Allow the initial discharge of air to blow through the separator drain, to ensure that all moisture in the system is removed.
vi) Open the inlet valve to the receiver TA046, close the separator drain valve.
vii) Maintain a careful watch on the receiver pressure and when at approximately 2.5 MPag, stop the engine. As the engine can only be started and stopped manually, its operation must be carefully monitored at all times.
viii) Periodically open the oil/water separator drain to ensure that dry clean air is entering the receiver.

Control and Alarm Settings

D/G START AIR RSVR PRESS. LOW	1.5	MPag
NO.1 SERVICE AIR RSVR PRESS. LOW	0.7	MPag
NO.2 SERVICE AIR RSVR PRESS. LOW	0.7	MPag
EM'CY D/G AIR RSVR PRESS. LOW	1.5	MPag
AIR DRYER (REFRIGEN TYPE) OUTL. CONT. AIR PRESS. LOW	0.7	MPag
AIR DRYER (REFRIGEN TYPE) DEW POINT IND. HIGH	10	°C
1 AIR DRYER (REGEN TYPE) OUTL. CONT. AIR PRESS. LOW	0.7	MPag
2 AIR DRYER (REGEN TYPE) OUTL. CONT. AIR PRESS. LOW	0.7	MPag
AIR DRYER (REGEN TYPE) OUTL. DEW POINT IND. HIGH	-21	°C

Blank Page

Illustration 2.9.2i General Service Air System



2.9.3 General Service Air Systems

General Description

The general service (GS) air system provides service air at 0.9 MPag to the following auxiliaries and locations:

On deck:
- Mast air horn
- Deck air service line
- Accommodation air lines

Engine room:
- Casing deck
- Near deaerator
- Near FD Fan
- Near Hyd. power pack
- CO_2 room funnel
- Near incinerator
- In the incinerator burner
- Main boiler atomizing air
- Near main boiler
- Near N_2 generator
- Motor RM CO_2 & Cargo alarms
- Comp. RM CO_2 & Cargo alarms
- N_2 generator feed air compressor
- Near air-con plant
- D/G engine Em'cy DO pump
- Near IGG
- Near diesel generator engine
- Work shop
- Electric work shop
- Steering gear room
- Near fresh water generator
- Near main feed water pump
- Purifier room
- Near ballast pump
- Near main condenser outlet
- 3rd platform deck port & Stbd side
- Floor deck after side
- Near MGPS
- Air-con plant
- 2nd platform FWD

Note !
There is also a direct line with air from the control air system to w/h cargo alarm horn, radar mast horn, etc.

One electrically driven compressor supplies air to the GS air receiver. From here the air is discharged to the various lines and connections as detailed above.

(Group 1/2/3 : Fire Control Station / Group 4 : Near p/p room entrance)

Group 1 -when operation stop:

HFO Deep tank to trans pump
Incinerator DO serv. Tank to incin.
Incinerator waste oil tank to incin.
D/G LO sett. tank to purifier
D/G LO stor. tank to D/G
T/G LO sett. tank to purifier
T/G LO stor. tank to T/G
Low sulphur FO sett. tank(low suction)to M/B
Low sulphur FO sett. tank(high suction)to M/B
Low sulphur FO sett. tank to trans pump
HFO sett. tank(s) (low suction) to M/B
HFO sett. tank(s) (high suction) to M/B
HFO sett. tank(s) to trans pump
Main LO settling tank to purifier
FO sludge tank
LO sludge tank
HFO storage tank(s) to HFO trans pump
Main LO storage tank to M/T
Low sulphur HFO storage tank to HFO trans pump

Group 2 -when operation stop:

DO service tank to M/B
DO tank for inert gas generator to IGG
HFO sett. tank(p) (low suction) to M/B
HFO sett. tank(p) (high suction) to M/B
HFO settling tank(p) to trans pump
DO storage tank to purifier
DO storage tank to DO trans pump
HFO storage tank(p) to HFO trans pump

Group 3 -when operation stop:

Main LO gravity tank to M/T
DO service tank to D/G engine

Group 4 -when operation stop:

HFO deep tank

d) Air supplied directly from the control air system can be used to open dampers on various fans.

Group No.1 -dampers closed: Engine room nat. exhaust
Engine room supply

Group No.2 - dampers closed: E/R Exhaust

Group No.3 - dampers closed: Purifier room exhaust

Group No.4 - dampers closed: Gas hood room exhaust

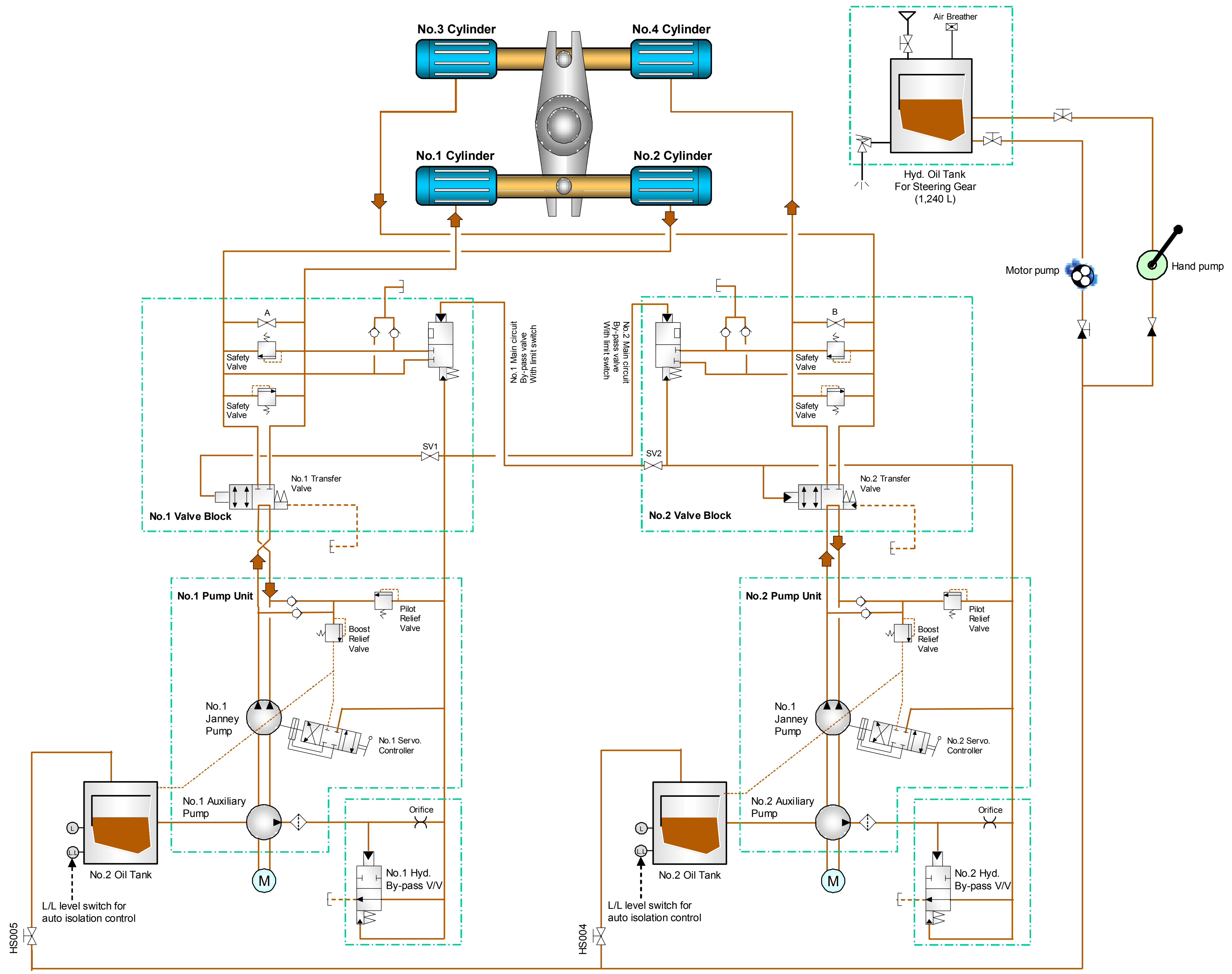
Group No.5 - dampers closed: D/G room supply & exhaust

Note !
A wire situated outside the emergency generator room, runs the emergency generator diesel oil service tank quick closing valve.

Control and Alarm Settings

QUICK CLOSING V/V AIR RSVR PRESS. LOW	0.3	MPag

Illustration 2.10i Steering Gear Flow Lines



2.10 Steering Gear

General Description

YOOWON – MITSUBISHI Electro – hydraulic steering gear is compact in construction and high in reliability and practical application.
This steering gear is 2-Ram, 4-Cylinders, Rapson-slide type. Two variable displacement pumps operate the steering rudder angle.
This steering gear operates as auto. pilot, follow-up control and non follow-up control.
The maximum rudder angle is designed so that the ram stop at 47.5° for maximum rudder angle of 45° to each side.

Particulars

Max working press.	21.7 MPag
Rudderstock diameter	588.16 mm
Maximum rudder angle	45 degrees
Relief valve setting	27.0 MPag
Design torque	3,334 kNm

Pump Unit

Type	3V-FH2B-MK X 2
Design tilting angle	97 %
Theoretical delivery of oil quantity	386 l/min

Oil Capacity

Total oil quantity	abt 3,000 ltr.
Storage tank capacity	abt. 1,500 ltr.

Motor Unit

Output	90 Kw X 2
Revolution	1,200 rpm
Power source	440V, 3ϕ, 60Hz
Rating	25% Cont.
	100% 1 hr.
	200% 60 sec.

Alarm Function

Pump motor overload
Power failure
Low oil level

Operating procedure

Remote steering

a) Supply the remote steering gear control system and power units with electrical power.
b) Operate the mode selection switch of the remote steering gear control system.
c) Operate the power units by means of E/M start switch.

Mechanical lever steering(S/G compartment)

a) Put the selector switch of the auto pilot control box(rudder servo unit) to local or off position.
b) Select which janney pump will be used for manual steering.
c) With the mechanical control lever in mid-position, operate the selected janney pump.
d) Operate the manual control lever in accordance with the steering command.
e) Return the mechanical control lever its neutral position upon reaching the ordered rudder angle.

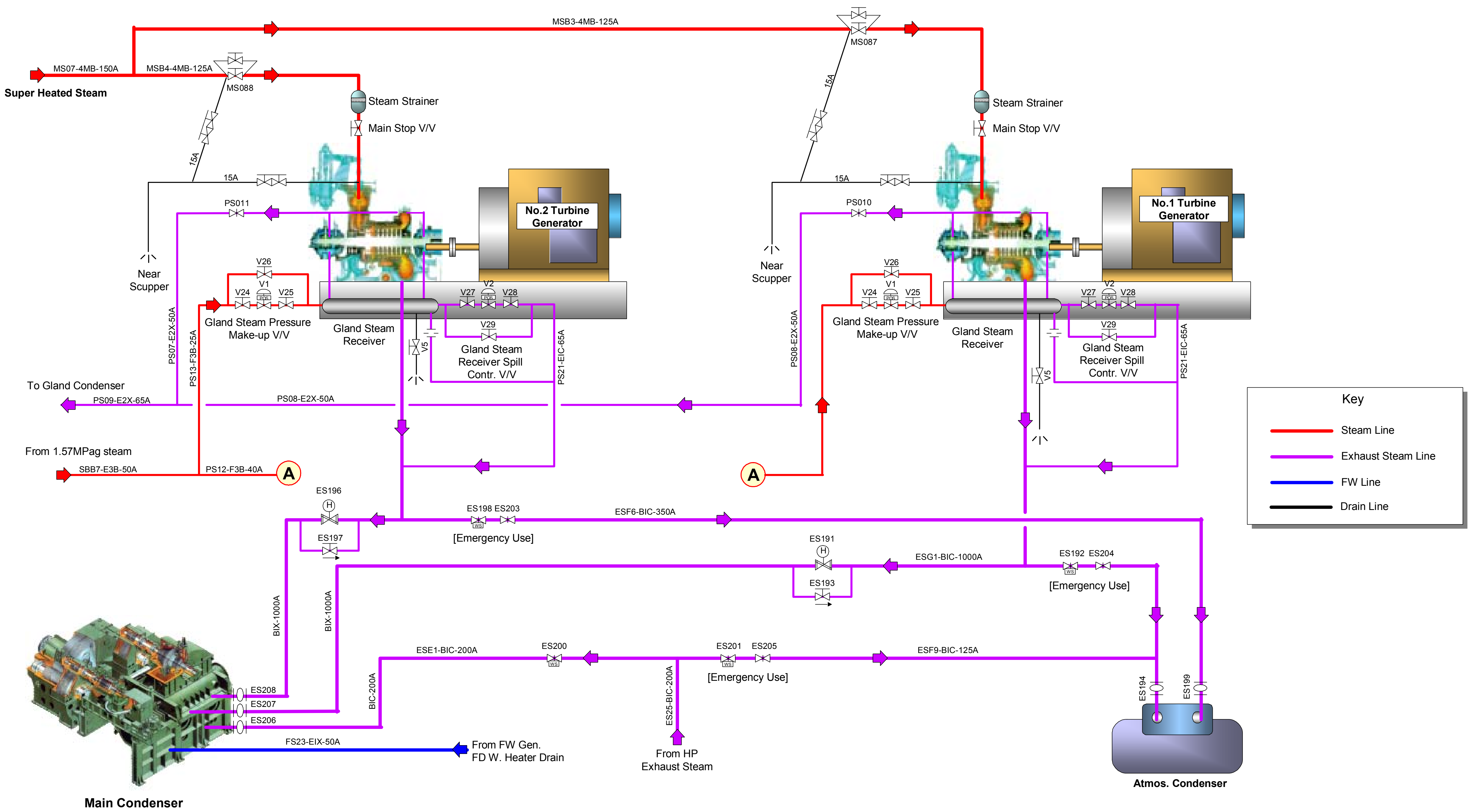
Note !

1. The changing of the power units should be done with the electric motor start/stop switches.
2. When an alarm should off due to for failure in any power unit ;
   Stop the concerned power unit, and then start another power unit. In this case, investigate the defective part.
3. In case of any failure in the hydraulic circuit, operate the power unit and the valves in accordance with the operating instruction mounted in the steering gear compartment.

Operating Mode Valve Positions

Case	Working pump	Working cylinder	By-pass valve		Stop valve		Notices
			A	B	SV1	SV2	
1	1	1,2	X	X	O	O	O-V/V to be opened
2	2	3,4	X	X	O	O	X-V/V to be closed

Illustration 2.11i Turbine Generator



2.11 Electrical Power Generators

2.11.1 Turbine Generator

2.11.1.1 Turbine Generator System

General Description

The two turbine generators are supplied with a superheated steam at boiler conditions (5.88 MPag, 510°C) and a normal exhaust to the main condenser.

The turbines drive the generators through a single helical reduction single gearbox with forced lubrication. The turbine speed is maintained at a constant 10,036 rpm (pinion), corresponding to a generator speed of 1,800 rpm by a mechanical hydraulic-type Woodward governor.

The turbine and gearing bearings are force lubricated by a shaft driven pump, when the unit is at full speed, which takes suction from the built-in sump and discharges to the bearings, gears and control oil circuits. The steam valve is maintained in the open position by the control oil and is tripped by venting the control oil to the sump, thereby closing the steam supply valve.

Prior to starting, and during the turbine run down period after the steam supply is shut off, an electrically driven lub. oil pump operates to supply oil to the systems. When starting, the oil supplied to the control system opens the steam supply valve as well as the bearings and, when stopping, supplying oil to the turbine and generator bearings as the turbine runs down. The electrically driven lub. oil pump can be operated in the manual or automatic modes, according to circumstances and requirements.

Drains from the steam supply piping and the turbine wheel housing keep the turbine free of water.

The turbine is a impulse type, driving the gearbox pinion through a flexible coupling. The turbine rotor runs on plane radial bearings, with any axial thrust taken by a tilting pad type thrust bearing fitted at the front pedestal bearing. The thrust bearing face is divided into many separate fan shaped pads, each of which is inclined by a fulcrum and thus a wedge like oil film is formed.

The axial position of the rotor is constantly monitored, with excess axial movement (from thrust bearing failure) tripping the turbine. Failure of this trip could allow the turbine blades and nozzles to come into contact. Also fitted is an excessive vibration monitor, which will trip the unit to prevent major mechanical damage.

The pinion and wheel of the gearbox are connected to the turbine rotor and the generator by a gear type flexible coupling. The coupling should be inspected occasionally to ensure the oil/grease level is maintained prevent wear.

The generator is supported on two plain bearings. It is cooled through a closed LO circuit, with the temperature being maintained through a fresh water cooler.

(1) Lubricating Oil System

Three lub. oil pumps take suction from the lub. oil sump, built into the base of the turbine generator. The main oil pump is shaft driven, and supplies all the oil requirements when the turbine is running. The electric oil pump is an electrically driven motor, and supplies control and lubricating oil before and after the shaft driven pump delivers full pressure, and also if the shaft driven pump fails to deliver. The third pump is hand-operated and only used to supply pressure to open the steam regulating valve prior to starting the turbine generator if the electrically driven pump is inoperable. If the electrically driven pump is inoperable, the manual pump must be used as the turbine is slowing down and stopping, and will continue to be used during the turbine cool down period as the turbine is being turned.

All three pumps deliver into a common line, which divides into a high pressure line for the control oil, and a low pressure line for the bearing and reduction gear lubrication. The main lub. oil cooler is the surface cooling shell and tube type, where the main fresh water system is used as the cooling medium. The temperature is maintained at 45°C by a three-way control valve, which allows oil to pass through or bypass the cooler. The oil to the bearing system passes through a duplex lub. oil strainer, while the oil for the control system passes through a separate line strainer. The oil is utilised in the control circuit at the pump discharge pressure of 0.5 MPag, and in the Lubricating circuit at 0.1 MPag.

The generator has a separately fitted cooler for its two bearings, though the oil is supplied through the main Lubricating oil system.

When the turbine is started, the auxiliary (electrically driven) lub. oil pump is switched on. The pump builds up the oil pressure to allow the opening of the main stop valve steam regulating mechanism and, provided that all other services and valves have been set, the turbine will run up to speed. As the turbine speed rises, and the shaft driven lub. oil pump taking over the oil supply to the systems, the auxiliary pump will stop. This pump should be placed in automatic mode, and will start automatically should the main line oil pressure drops either as the turbine is slowing down or if there is a fault in the main lub. oil pump. After the turbine has stopped and has been allowed to cool down, the auxiliary lub. oil pump can be switched off.

The turbine is fitted with an electrically operated turning gear to allow the shaft to be turned slowly during the cool down period with the auxiliary lub. oil supply also turned on.

(2) Control Oil System

The main stop quick closing valve trip oil cylinder, the speed governor power cylinder, and the over-speed trip have a continuous supply of oil to maintain their running positions. Should any of these trips be activated, the oil in the system is allowed to drain to the sump, closing the main steam stop valve. After tripping on over-speed, the trip must be manually reset, but only when the turbine speed has reduced 75% below normal, to prevent damage the cut out pawl.

The constant turbine speed is maintained by controlling the amount of steam admitted to the turbine nozzles, meeting the varying load demands imposed by the electric generator. The steam regulating valves are controlled through a lever arm by the power cylinder, which amplifies a signal from the centrifugal Woodward governor. The governor transmits pulse signals to the power cylinder as load changes, altering the valve’s position in the power cylinder, and allowing the steam valve to open to a greater or lesser extent as the turbine speed is adjusted. A feedback system stabilises the output of the power cylinder when the required movement has taken place.

To prevent the turbine generator from over-speeding if the circuit breaker trips, a solenoid circuit within the governor is energised shutting off the steam supply prior to any speed increase. This arrangement is not effective during, nor does it interfere with, the normal speed control of the governor.

(3) Steam System

The turbine generators are supplied with superheated steam from both boilers systems.

The steam to both turbines passes through a line stop valve MS009, through the main stop valve and the governing system, and then over to the turbine stages driving the unit. The exhaust steam is led to the main condenser through the exhaust valve. However, the unit can run under back pressure conditions to either the main or atmospheric condenser, should circumstances require it.

Gland steam is supplied to both HP and LP ends of the turbine glands, and surplus steam is directed to the condenser through a spill valve. The gland steam system is operated by a control system of supply (make-up) and spill control valves, which maintain the system at a constant pressure, ensuring no air leakage at the glands. The gland steam supply and spill are directed to a packing steam receiver which acts as a reservoir for the gland steam, with excess pressure in the reservoir passing through the spill valve to the main condenser. Excess steam pressure at the turbine glands passes to the gland condenser.

System Capacities and Ratings

Technical Data

Turbine

Type	Mitsubishi Multi-stage, Single Cylinder Condensing Turbine
Number of unit	2 set
Rate output (Electrical Load)	3,450 kW
Turbine rated speed	10,036 rpm
Generator rated speed	1,800 rpm
Rotation (Viewed from generator)	Clockwise
Main steam condition	5.88 MPag x 510°C
Turbine exhaust vacuum	6.7 kPaA
Permanent speed variation	Within 4%

Limits of Main Steam Pressure and Temperature

Max. main steam pressure (Before main stop valve)	6.37 MPag
Max. main steam temp. (Before main stop valve)	538°C

Reduction Gear

Type single	Helical Single Reduction Gear with Forced lubrication	
Module	3.75	
Pressure angle	Abt. 20°	
Helix angle	Abt. 11.5°	
Forced widths	145 mm	
Pitch circle diameters	Pinion	126.3 mm
	Wheel	704.1 mm
Number of teeth	Pinion	33
	Wheel	184
Revolutions per minute	Pinion	10,036 rpm
	Wheel	1,800 rpm
Gear ratio	5.576	

Main Oil Pump

Maker	Taiko Kikai Ind.
Type	Turbine driven vertical type FN30-10L
Capacity	400 liter/min
Discharge pressure	0.6 MPag
Kind of oil	ISO VG 68

Oil Cooler

Type	Horizontal surface cooling type
Cooling surface	30 m^2
Quantity of cooling water	30 m^3/h
Cooling tube size	Φ 12.7 mm low fin tube

LO Tank

Capacity	1,400 liter
First oil charge	1,600 liter

Auxiliary Oil Pump

Maker	Taiko kikai industries Co..,Ltd
Type	NHG-6C
Capacity	150 liter/min
Discharge pressure	0.2 MPag
Motor output	3.7 kW x 1,800 rpm

Main Lub. Oil Cooler:	Taiseikogyo Co.
Type:	N-H2272-30-2517
Capacity:	Shell side : 350 l/min Tube side : 500 l/min
Lub. Oil Duplex Strainer:	Taiseikogyo Co.
Type:	BCS-20-L-100W
Control Oil Line Filter:	Taiseikogyo Co.
Type:	AK-08-100K-N
Gland Steam Make-up Valve:	Nakakita Seisakusho Co.
Type:	DY-GCSSF20
Gland Steam Spill Valve:	Nakakita Seisakusho Co.
Type:	DY-CODOF10
Flexible Coupling:	Kyushu Hasec Co.
Type:	GB-25-SS-170R/180K-SD281-B

Generator:	Hyundai Heavy Ind.
Type:	HSJ7 717-46 Brushless

Approximate Weight

Turbine, common bed and equipment	15,600 kg
Reduction gear	2,850 kg
Oil cooler	600 kg
Tools and spares	250 kg
Total weight (Not including generator weight)	19,300 kg

Governor

Type	WOODWARD UG-8D
Adjustable speed range (no-load/full-load) :	+15% ~ -5% / +4% ~ -2%
Speed variation (Momentary/Permanent) :	Max. 10% / Max. 5%

Gland packing steam control device

Type:	Air operated valve & controller
Max. steam quantity supplied :	150 kg/h x 1.7 MPag It is preferable that temperature of supplied packing steam is more than 230˚C.
Max. steam quantity spilled :	300 kg/h
Control air pressure range :	0.49~0.98 MPag
Require dry air :	5N λ/min

Safety and Alarm System

Over speed trip (Mechanical) :	1962 ~ 1998 rpm
LO pressure low trip :	0.04 MPag
Turbine exh. press. high trip/(alarm) :	-0.055/(-0.030) MPag (vac. condition) 0.03/(0.05) MPag (atmos. condition)
Sentinel valve setting pressure :	0.03 MPag
Aux. oil pump auto-start/stop pres. :	Start : LO 0.055~0.065 MPag Stop : LO 0.080~0.090 MPag
Turbine rotor excess vib. trip/(alarm) :	80/(50) µm p-p
Turbine rotor excess displacement trip/(alarm) :	±0.7 mm / (±0.55) mm (+ : To turbine exh. side)
Gland packing steam press. low alarm & high alarm :	Low alarm : 0.003 MPag High alarm : 0.02 MPag

2.11.1.2 Turbine Generator Construction & Operation

General

The turbine is a uniflow single-cylinder, multi-stage impulse type, condensing turbine with a single reduction single helix gear.

The turbine has sufficient power for continuous rated generator output. The turbine is designed to minimize the steam consumption rate for economical output.

The turbine is equipped with a Woodward speed governor (UG-8D type). The governor controls the turbine speed within the range of 10 % of the rated speed for momentary variation and 5 % of permanent variation, when full load are suddenly changed.

The governor setting can change manually at turbine side or electrically from the control room. The range are +15 % to -5 % of the rated speed at no-load and +4 % to -2 % at full-load.

The turbo-generator unit has complete independent pressure Lubricating oil system for the lubrication of turbine, gear and generator bearings, also for other necessary parts. The system attached gear wheel drives oil pump, motor driven pump for starting, oil tank level indicator, strainer and cooler.

The motor driven oil pump is provided and pressure switch for LO press & limit switch for main inlet valve are installed.
When LO press low or main steam inlet valve close, the motor driven oil pump is started automatically (OR circuit). When LO press is normal and main steam inlet valve full open, the motor driven oil pump is stopped automatically (AND circuit).

The emergency trip devices consist of over speed, Lube. oil low-low pressure, exhaust steam high high pressure, excess vibration, excess axial displacement, remote emergency stop from engine control room and hand trip.

The LO cooler is fin tube and designed to cool Lubricating oil temperature from 60°C to 45°C when supplied with 36°C cooling fresh water and with a cleanliness factor of 85 %, when the generator develops rated load.

(1) Turbine casing
The turbine casing is split into two halves horizontally and supported by the lower gear casing and pedestal with panting plate which has flexibility for the thermal expansion. The main stop valve and regulating valves are installed on the high pressure side casing, and the exhaust sentinel valve is installed on the exhaust chamber.

(2) Rotor shaft
The rotor has a solid forging with integral discs. The rotor assembly is dynamically balanced before shop test. The rotor shaft is connected to pinion by means of a rigid coupling.
The blades are fastened to the rotor in fine tree type root arrangement. The blades of the 1st to 4th stage are fitted with shrouds, whereas the blades of following two stages are free standing construction.

(3) Nozzle and diaphragms
The nozzle is precision casting and welded to the diaphragms. The diaphragms are split on the horizontal centerline and located in the grooves of the turbine casing.

(4) Gland and diaphragm packing
The labyrinth type packings are provided on each diaphragms and both side of the turbine casing.

(5) Bearings
The turbine rotor and gears are supported by journal bearings which are split into two halves horizontally. Turbine thrust bearing is fitted at pinion end to maintain the correct rotor position. The bearings are arranged so that they can be replaced without removing the turbine upper casing and rotating elements.

Journal bearings and thrust bearing are housed in horizontally split bearings brackets. The turbine rotor journal bearing and pinion bearings are of tilting-pad type and thrust bearing are of tilting-pad type. The wheel bearings are of sleeve type.

(6) Speed governor
The Woodward speed governor is mounted on the gear casing and connected to the regulating valves through the power cylinder with link mechanism which maintains the speed of the generator at the prescribed value, working automatically, rapidly and reliably in response to change in steam or load condition.

(7) Steam system
The steam passes through the strainer and the main stop valve to the regulating valves which regulate the quantity of steam flowing into the turbine in accordance with variation of load.
In other words, the regulating valve automatically keeps a constant speed even if the load changes.
After having worked through the nozzles and blades, steam is led to the condenser from the turbine exhaust chamber.
The gland sealing steam pressure is automatically regulated with air operated diaphragm type valves.

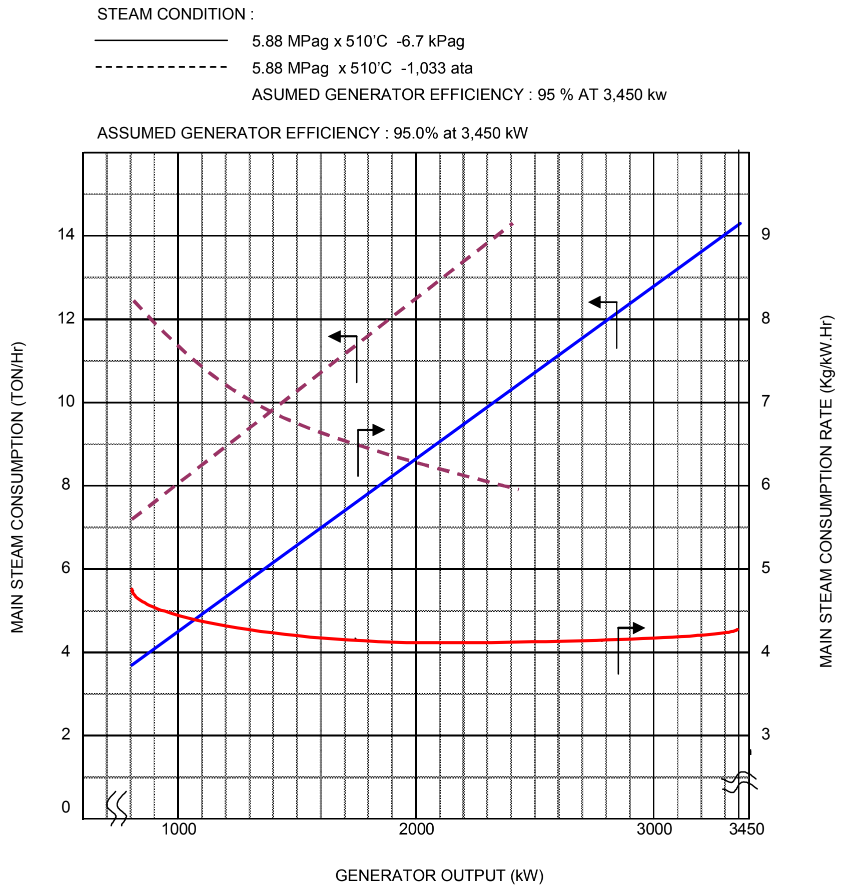
(8) Oil system
The oil system consists of oil tank, shaft driven main oil pump, motor driven auxiliary oil pump for priming, pressure and temperature regulating valves, oil strainer, oil cooler, power cylinder for regulating valves, trip oil cylinder, pipings and other fittings. The high pressure oil controlled by pressure regulating valve is led to the power cylinder and trip oil cylinder. The low pressure oil is led to all bearings of the turbine, gear, generator and other necessary parts to lubricate and cool the moving parts, and return to the oil tank.

(9) Reduction gear
The reduction gear is single reduction single helical type.
The gear casing are split into two halves horizontally. The lower casing are rigidly mounted on the common bed by the bolts and dowel pins and supports the one side of the turbine casing.

The upper casing has a peep hole to facilitate the interior inspection. The pinion is solid and one of its end are connected to the turbine shaft. The gear wheel is shrinkage fitted on the shaft and its one end drives the main lube. oil pump and the governor gear.

The other end is connected to the generator rotor with flexible coupling. The teeth of the gear pinion and wheel are precisely ground to the smooth operation.

GENERATOR TURBINE
ESTIMATED PERFORMANCE CURVE



(10) Hand wing pump
If there's problem within Aux. Lub. Oil pump prior to starting the turbine generator, then the main stop valve trip device will not function due to Lub. Oil low pressure. In this incident, increase Lub. Oil line's pressure through hand wing pump and, then, reset the main stop valve trip device. Afterwards, the main stop valve will be operational.

(11) Blades and Shrouds

Blades and shrouds are made from 12% Cr. Steel.
Blades are secured by the side entry type of fastening.
During disassembling, remove the accumulate foreign matters and, then inspect carefully for blade tips erosion, blade surface corrosion, other cracks, and scratches in the blade tips and roots.

(12) Main Stop Valve and Regulating Valve

The main stop valve is the single seat diffuser type fitted with a removable steam strainer and a small pilot valve for pressure equalization. It is installed on the top of the turbine upper casing.
The steam chamber for the main stop valve is made from Cr. Mo. Cast steel, the valve spindle and the bush are nitriding steel, and the valve disc and valve seat are stellited Cr. Mo. Steel.
An Emergency shut-off oil cylinder is incorporated in the main stop valve.
When the main stop valve opens, steam is admitted into the turbine, causing the turbine to revolve overrides. The main oil pump is pressure overrides the force of the spring in the emergency shut-off oil cylinder, pushing the piston up ware until the valve spindle is set in the emergency claw. If the oil pressure in the oil cylinder decreases for any reason, the piston pulls the emergency claw and releases the valve spindle, causing the main stop valve to close immediately.
Once the main stop valve is closed, it cannot be opened unless the handle is returned to the fully closed position.
When steam in the valve spindle bush leaks, it is drained to the gland condenser.
The regulating valve consists of three efficient valve of single seat diffuser type, and depending upon the load, No.1 valve, No.2 valve, and No.3 valve open in this order controlling the steam flow into each nozzle box. The regulating valve chamber is also made from Cr. Mo. Cast steel.
The valve disc and the valve seat are made from stellited Cr. Mo. Steel. The three valves are connected to on lift plate and are connected to the power cylinder piston for regulating valve by one valve spindle through the connecting rod. The valve spindle and the bush are made from nitrided Cr. Mo. Steel. The leaking steam is drained to the gland condenser.

(13) Turning Device

The disc wheel turning gear is electrically driven.
Turning clutch is Synchro-Self-Shifting type which engages and disengages automatically.
The starter circuit of turning motor includes interlock. The turning motor can start by pushing the start button when lube. oil pressure is normal and main stop valve is closed.
Start the turning gear motor by pushing the start button once lube. oil pressure has been checked and is satisfactory.

Note !
Generator turbine can operate up to 2400 kW when the exhaust steam is led to atmospheric condenser.

Trip Tests

Manual, lub. oil, overspeed, back pressure, vibration and rotor displacement trips should all be tested on a regular basis.

The lub. oil and back pressure trips can be tested using the test pump and manometers.

The overspeed trip can be tested with the turbine running at full speed, off load and increasing the speed using the manual governor regulating knob until the trip operates.

Control and Alarm Settings

T/G MAIN STM INL. PRESS. L/L	5.0	MPag
T/G MAIN STM INL. PRESS. L-L (D/G ENG START)	4.8	MPag
T/G MAIN STM PRESS. V-L (T/G TRIP)	4.0	MPag
T/G GLAND STM PRESS. H/L	20-3	kPag
T/G EXH. STM PRESS. HIGH	53.3	kPaA
T/G ENG ROTOR VIB. H-H	80	μm
T/G ENG ROTOR POS. H-H	+0.7	mm
T/G LO INL. PRESS. LOW	0.7	kg/cm2
T/G LO INL. PRESS. L-L (1 T/G TRIP)	40	kPag
T/G LO INL. TEMP. H/L	50-30	°C
T/G LO PRESS. LOW (AUX LO P/P AST)	60	kPag
T/G ENG EXH SIDE BRG TEMP. HIGH	75	°C
T/G ENG P THR SIDE BRG TEMP. HIGH	75	°C
T/G ENG P GEN SIDE BRG TEMP. HIGH	75	°C
T/G ENG W THR SIDE BRG TEMP. HIGH	75	°C
T/G ENG W GEN SIDE BRG TEMP. HIGH	75	°C
T/G ENG THR BRG TEMP. HIGH	75	°C
T/G WIND R TEMP. HIGH	140	°C
T/G WIND S TEMP. HIGH	140	°C
T/G WIND T TEMP. HIGH	140	°C
T/G FWD BRG TEMP. HIGH	90	°C
T/G AFT BRG TEMP. HIGH	90	°C

Preparation for Operation & Starting (Start operation under Cold condition)

(1) Check oil level
Ascertain whether the oil level in the oil tank would be at a normal position or not. As the oil level will lower in this case if the oil pump is put in operation, this should be taken into consideration.

(2) Check oil
Whether the oil contains water or whether the oil properties have changed due to contamination should be checked.
If it is found that water is included in the oil, treat it so as to eliminate the water completely.

(3) Start-up Auxiliary Oil Pump
It should be confirmed that lube. oil pressure and temperature are in "Normal condition"

(4) Close Power Source for Emergency Trip Device
Regulating valve is opened to about a half of the total lift.

(5) Warm up Main Steam Pipe
After confirming that the main stop valve for turbine is definitely closed, open the drain valve of the main steam pipe and open by degrees the main steam valve to warm up the main steam pipe.

(6) Open Drain Valve for Main Stop Valve.

(7) Start Turning gear operation to rotor shaft (for 30 min.)
Rotate the rotor shaft with the turning gear operation device for 30 min.

(8) Supply Aux. Steam to Turbine Gland
(Controlled at about 0.005~0.02 MPag by packing steam controller)

(9) Set Emergency Trip Device
The emergency trip device should be set by raising the reset lever for overspeed emergency trip device and whether the lever for main stop valve emergency trip device is at a set position (the position in which the handle can be opened with claw in main stop valve stem) or not should be checked.

(10) Warm up Every part of Turbine Steam Turning (for 5 min.)
After confirming that there is nothing wrong with all parts of the turbine during rotation, start turning and open slightly the main stop valve to operate the turbine of a revolution of 100 rpm for about 5 min. to warm up every part of the turbine uniformly.
In case the turbine would not rotate even if the main stop valve handle is opened slightly, the following should be checked;

a) If the regulating valve is not opened due to no oil pressure of governor oil.
b) If there is some drain remain in the casing.
c) If the lever for the main stop valve emergency trip device and the reset lever for the overspeed emergency trip device are not

set at the correct position.

d) If the handle for the main stop valve is idling.

Make sure to start the turbine after eliminating there causes.

(11) Confirm Operation of Trip Device & Inspect the Interior
When the turbine revolution rises to about 500 rpm by gradually opening the main stop valve, maintain this revolution (500 rpm) for a while (for about 3 min.) and after this, ascertain whether the regulating and the main stop valve would close momentarily when the emergency button is pushed down.

(12) Set Turbine at Steady Speed
Raise the reset lever for emergency trip device and open by degrees the main stop valve and increase the speed up to the rated speed of 1,800 rpm for about 5 min.

(13) Auxiliary Oil Pump Stops Automatically
When the delivery oil pressure of the main oil pump develops to normal pressure (0.085 MPag) and main stop valve opens fully, the aux. oil pump stops automatically.

(14) Supply Water to Oil Cooler
The oil temp. in the turbine is adjusted at all times by means of oil cooler and lubricating oil temp. controller.

(15) Pay Attention to Oil Temp.
As there are great possibilities of local overheating of the bearing and of ma-function of the governing devices when the oil temp. is abnormally low, please take every precaution. When LO temp. is lower than 30 °C, continuous steam tuning at lower speed (500 ~ 700 rpm) should be maintained until LO temp. exceeds 30 °C.

(16) Care to be Taken after Full Opening of Main Stop Valve
After full opening of the main stop valve, return the handle by one half revolution towards the original position.

(17) Set Turbine at Steady Speed
The turbine speed should be adjusted to the rated speed of 1,800 rpm with the speed control knob and then the turbine will be in the condition of the rated speed and entire no load.

(18) Close Drain Valves
After setting to rated speed, confirm there is no drain and close drain valves.

(19) Put Load on Turbine
Load is put on turbine at once by means of "ABC" close.
As a big load put on the turbine immediately after starting of the turbine would also cause bad effect on the turbine, operate the turbine under full load condition in about 10 min. after adjusted to the rated speed.

(20) Take care of the turbine in no load operating conditions, as follows.

a) Vibration of turbine rotor is less than 50 μm

b) Bearing drain oil temp is less than 75 °C

Compare above a), b) with previous operations.

During Operation

(1) Maintain Constant Steam Condition
It is recommended to maintain consistent main steam pressure and temperature as much as possible.

(2) Maintain Constant Oil Pressure
The lubricating oil pressure and the delivery oil pressure of main oil pump are designed to maintain about 0.1 MPag and about 0.5 MPag respectively.
There is something wrong when pressure fluctuates.

(3) Check Oil Level
Periodical observation should be made for the oil level of oil tank.

(4) Check Bearing Drain Oil Temperature and Lub. Oil Temperature
The most suitable temperature for the bearing drain oil is 45 to 65°C. Take care that the bearing drain oil temperature would not exceed the 75°C and that the lubricating oil temperature at the outlet of the lub. oil temperature controller would be within the range from 40 to 50°C.

(5) Pay Attention to Abnormal Sound
When any abnormal vibration, rubbing and other abnormal sounds are noticed in the turbine, stop the turbine and remove the cause immediately.

Shutting down the turbine

(1) Reduce by degrees the load on turbine down to no load.

(2) Close the main stop valve. An operator may also push the emergency button to shut-down(to stop rotating) the turbine in emergency.

(3) After closing the main stop valve, open each drain valve immediately.

(4) When the turbine is shut-down, start motor turning at once, and continue motor turning for 10 hours to prevent uneven cooling of rotor shaft.

(5) As the turbine speed goes down, the lubricating oil pressure drops gradually and when it becomes less than 0.06 MPag or when MSV is closed, the lubricating oil pump starts automatically. Keep the auxiliary oil pump running during motor turning operation (10 hours).

(6) Close the main steam gate valve and open the drain valve fitted before the main stop valve

(7) When the turbine temp. drops to some extent, close each drain valve.

(8) Don't draw the pin from the nail, because the reset button of main stop valve is interlocked in normal operation.

Re-start Operation Procedure under Hot Condition

MHI define hot condition as a condition of turbine within 10 hours of turning gear operation period, and cold condition as a condition of turbine after 10 hours or more of turning gear operation period.
Continuous turning gear operation for about 10 hours is required for cooling down of turbine.
Followings are hot restart procedure during this turning gear operation period.

(1) Pre-caution During Turbine Stop

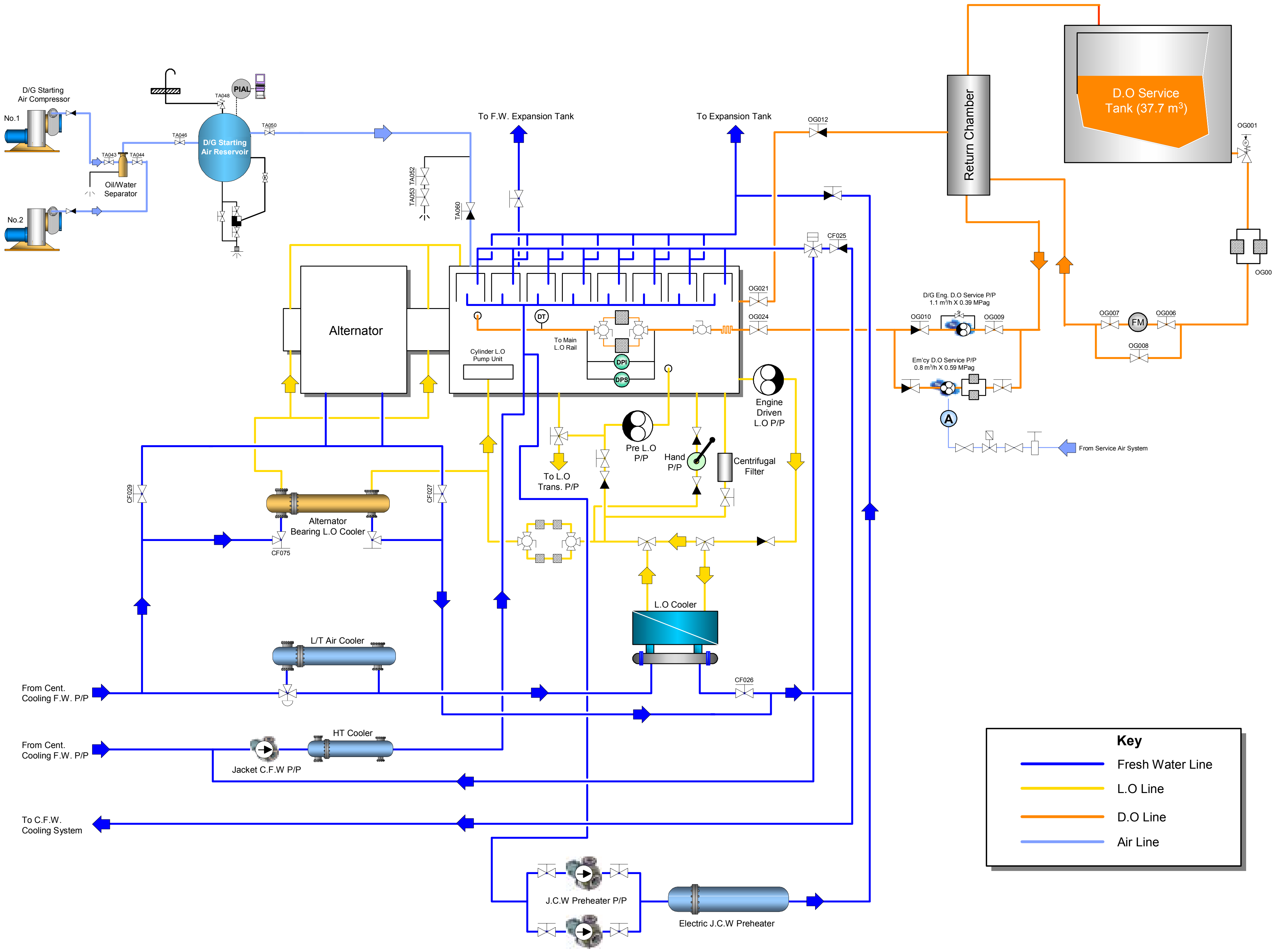
a) When turbine stops, (within 1 minute) engages immediately and operates continuously.
At this time, confirm turbine shaft is actually rotating.
b) Confirm Lube oil pressure and temperature are in "Normal condition" during turning gear operation.
c) Confirm no abrasive sound is coming from the turbine's inside by using the sounding bar.
d) During turning gear operation, gland packing steam will be supplied continuously.

(2) Turbine Restart

a) crack open drain valves until speed is set to the rated speed.
b) Just before start-up the turbine, do not leave the turbine under no turning gear operation condition.
Turbine shall be restarted in 1 minute after turning gear operation device is disengaged.
If shouldn't start in 1 minute, turbine shall be restarted with carefully paying attention to vibration.
c) At turbine re-start, main stop valve handle should be opened carefully and slowly.
When turbine starts rotation, the main stop valve handle should be turned clockwise direction to prevent the excess speed-up.
d) Pay careful attention to make sure the generator speed is maintained about 100 rpm at starting.
e) Continue the steam turning for about 5 minutes at about 100 rpm and then increase the speed up to 1,800 rpm in about 5 minutes.
f) Make sure the lube oil temperature is over 30°C.
g) At the above condition, the operator needs to check the rotor vibration.
When the operator feels sudden vibration increase and vibration level is over 25 μm p-p, turbine should be stopped and continue turning gear operation about an hour.
h) After an hour, please restart again, please pay close attention to the increase in vibration

(3) Other Caution
a) During starting operation, make sure there's no vibration in steam drain piping and LO piping..

Illustration 2.11.2i Diesel Generator Engine



2.11.2 Diesel Generator Engine

General Description

Under normal circumstances, the diesel generator will be used as a stand-by unit to the turbine generators. The main diesel generator will deliver the same output as the turbine generators and can be used in parallel with them, or as an independent unit producing enough power to cover normal loads.

The main switchboard control will provide facilities for monitoring the voltage, frequency, power and phase as well as manual facilities for synchronisation, speed and voltage adjustment.

Engine particulars

Maker	:	STX MAN B&W
Engine quantity per ship	:	1 Set
Model	:	8L32/40
Number of cylinders	:	8 cylinders
Cylinder arrangement	:	In-line
Cylinder bore	:	320 mm
Piston stroke	:	400 mm
Engine rating		
- Max. continuous output	:	3664 kW at 720 rpm
- Over load capacity	:	110%
- At the standard condition of		
Altitude	:	Sea level (1000 mbar)
Ambient temperature	:	Max. 50°C
Relative humidity	:	60%
L.T water temperature	:	36°C
Revolution	:	720 rpm
Piston speed	:	9.6 m/sec
Mean effective pressure	:	2.36 MPag
Max. cylinder pressure	:	18 MPag
Direction of rotation	:	Clockwise viewing from flywheel side
Starting	:	Compressed air
Installation	:	The engine and generator are direct coupled and installed on a common bedplate.
Cooling system		
- By H.T water	:	Cyl. liner, Cyl. Cover, H.T. air cooler
- By L.T water	:	Lub. Oil cooler, L.T air cooler
- By Lub. Oil	:	Piston, Turbocharger
Firing order	:	1-4-7-6-8-5-2-3

Main specific characteristics

Fuel oil spec. : M.D.O of 13 cSt at 40˚C (ISO 8217/DMC)

Fuel oil consumption
The following figures are values on test bed at MCR (power measured on flywheel) : 185 g/kW.Hr
Tolerance +5% without eng. driven pp

The figures are given in accordance with the ambient conditions chosen by ISO and using a diesel oil with a lower calorific value of 42,700 kJ/kg (10,200 kcal/kg) as a basis :

- Ambient air temperature	:	25˚C
- Ambient air pressure	:	0.1 MPag
- Charge air coolant temperature	:	25˚C
- Back pressure after turbine	:	Max. 250 mmAq

The mentioned consumptions are for engine without built-on pumps with built on pumps, the consumption be increased by :

- Lub. oil pump	:	+2 g/kw.Hr
- H.T fresh water pump	:	+1 g/kw.Hr

Lub. oil consumption
- Specific lub. oil consumption is as follows : 3.1 kg/hr at MCR
Above figure is subject to a tolerance of +20%.

Governing characteristics

- Speed regulation
When full load is suddenly taken off and, when 0 → 35% → 70% → 100% load of the rated load is suddenly applied.

Transient	:	within 10%
Permanent	:	within 5%
Recovery time	:	according to rules (8 sec)

Exhaust gas data (Based on ISO condition)

- Gas amount	:	About 28571 Kg/hr ± 5% at MCR
- Gas temp.	:	360˚C ± 15% after turbocharger
- Max. allowable back pressure	:	0.0025 MPag
- Air consumption	:	2.7905 kg/h + 5% at MCR

Starting air consumption : 1.29 Nm^3 per start

Engine performance

Fuel oil system

Fuel oil injection pumps for each cylinder
Fuel duplex filter (split type)
Fuel oil leakage tank with floating switch (LAH42)
Protection cover of F.O in & outlet pipe where flange joint

Pressure regulating valve		
- Setting point (0.4 MPag)	:	1 unit/ship (loose supply)
Em'cy MDO pump unit	:	1 unit/ship (loose supply)
- Drive by air motor	:	0.6 m^3/h, 0.6 MPag

Lub. oil System

Oil sump in engine	:	Max. 3745 L for SAE 40
Lub. oil pump driven by engine		
- Gear type		
- Working pressure	:	0.4 ~ 0.45 MPag (after filter)
- Safety valve	:	0.7 MPag
- Capacity	:	100 m^3/h
Lub. oil cooler	:	Plate type (SUS304)
Prelubricating pump by electric motor driven		
- Capacity	:	26 m^3/h
- Motor	:	AC 440 V, 3 phase, 60 Hz, 8.6 kW
- Insulation	:	F class
- Protection grade	:	IP 55
Lub. oil filter with differential pressure switch		
- Duplex, paper cartridge type		
- Fineness	:	15 micron
Thermostatic 3-way valve (wax type)		
- Setting point	:	66˚C
Lub. oil centrifugal by-pass filter		
Cylinder lub. oil pump by motor		
- Motor	:	AC 440 V, 3 Ph, 60 Hz, 0.15 kW
- Insulation	:	F class
- Protection grade	:	IP 55

Cooling water system

Lub. oil and charge air cooler cooled by fresh water
Thermostatic valve on outlet, H.T system

H.T fresh water pump driven by engine
- Centrifugal type
- Capacity : 48 m^3/h
- Working press : 0.5 MPag

H.T jacket preheater unit with control panel : 1 unit/ship (loose supply)
- Capacity : 40 kW

Compressed air System

Starting piston valve, local/remote start and stop
Turning device by electric motor driven
- Motor : AC 440 V, 3 Phase, 60 Hz, 0.75 kW
- Insulation : F class
- Protection grade : IP 54

Combustion air system

Turbocharger
- Maker : ENPACO-MAN B&W
- Type : NR 34/S

Two stage charge air cooler
Water washing of turbocharger compressor : Mounted on engine
Automatic drain from charge air receiver
Jet assistance system

Exhaust gas system

Water washing of turbocharger turbine
Gas outlet for pipe connection : Vertical pipe connection

Exhaust gas expansion joint after turbocharger
- Flange size : DN 700
- Bellows type, stainless steel

Pressure reducing unit including reducing valve, press. Gauge, flexible hose (20 m) and quick coupling for T/C turbine cleaning
- Yard connection type : JIS M42 male

Speed control system

Hydraulic governor
- Maker : EUROPA

Each System Description

1) Engine

Engine with the type designation L32/40 are turbocharged, unidirectional, four-stroke, in-line engines with a cylinder bore of 320 mm and a stroke of 400 mm. They are used for marine propulsion and auxiliary applications, and as stationary engines in power stations. The characteristic features of the larger engine types of MAN B&W Diesel AG's production program have been adopted for this engine. The engine benefits from the design principles and the rich experience gained with approx. 550 engines (status 12/96).

When viewing onto the coupling end, the exhaust gas pipe is at the right (exhaust side AS), and the charge air pipe at the left (exhaust counter side, AGS).

The engine has two camshafts. One of them is used for inlet/exhaust valve actuation on the exhaust side, the second one serves to drive the injection pumps on the exhaust counter side. A hydraulically actuated adjusting device allows to adjustment of both valve and injection timing, depending on the design ordered.

The turbochargers and charge-air coolers are at the coupling end on most of the propeller engines, and at the free engine end on generator engines. Cooling water and lube oil pumps can be driven via a drive unit on the free engine end.

The type L32/40 engine has a large stoke/bore ratio and a high compression ratio. These characteristics facilitate an optimization of the combustion space geometry and contribute to a good part-load behavior and high efficiency.

The engines are equipped with NR-type MAN B&W turbochargers.

2) Jacket Cooling Water System

Conditioned fresh water is normally used for cooling. Charge-air coolers are also cooled by fresh water.
Single-stage charge-air coolers are usually integrated in the secondary circuit. Where two-stage charge-air coolers are used, engine cooling water passes through the first stage (primary/high-temperature circuit), and fresh water from the secondary/low-temperature circuit passes through the second stage.

The cylinder head is cooled from the annular space around its lower part, from where the water is supplied through bore holes into the annular space between the injection valve recess and the inner part of the cylinder head, with some of the water flowing around the valve seat rings. The other, large cooling spaces of the cylinder head are served from this annular space.

The water leaves through a passage via the upper area of the backing ring and into the return manifold, which runs along the supply pipe (front). This return manifold re-circulates the heated water to the charge-air cooler or to the system, at the drain connection.

3) Fresh Water Cooling System

Fresh water, supplied from the engine room central fresh water cooling system, is used to cool the charge air, Lubricating oil and alternator and alternator bearing LO cooler.

4) Lubricating Oil System

All the lubricating points of the engine and the turbocharger are connected to the forced-feed oil circulation system.

Lubricating points to, in which the oil flows freely back into the oil sump, and from the oil sump into the lube oil tank underneath.

The integrated distributor pipe also supplies oil to

- Camshaft bearings of the injection and valve camshafts, and
- Spray nozzles and bearings of the camshaft valve.

The oil ducts required for supplying oil to the camshafts continue above the camshafts, where short lube oil pipes are connected serving the:

- Rocker arms on the exhaust side, and
- The fuel oil pumps and control levers on the exhaust gas counter.

5) Diesel Oil System

The fuel is supplied to the engine on its front face. The injection pumps are connected to the distributor pipe at the exhaust gas counter side by short pipe. They deliver the fuel oil under high pressure through the injection pipe of the injection valves. The injection pumps are operated by the cams on the camshaft.

Excess fuel not needed by the injection pumps passes through the overflow pipe, and delivered into the manifold returning it to the service tank.

6) Starting Air System

The following are the primary elements for engine starting

- The main starting valve with the control valve, located at the free engine end.
- The starting slid valve located beside the fuel injection pumps, and
- The starting valves located in the cylinder heads

These valves/slides are opened when certain prerequisites are met. The main starting valve is opened by the control valve. Air is admitted to the starting slide valves as soon as the solenoid valve in the control console is opened, and they are finally opened in the order of ignition as soon as the relevant starting cam of the camshaft approaches. The air flow from the starting slide valve opens the relevant starting valve.

Operating Procedure

1) Starting

The engine should normally be standing idle and ready for use. To start, the only action required is to switch to local control in the engine control room, and press the engine start button. The unit should then run up to speed, put itself on the switchboard after synchronizing with the generator in use, parallel and sharing the load.

The engine can be started manually by depressing the air start solenoid on the air system to the engine. Always make sure that the hand lub oil pump has been operated to ensure initial lubrication of the unit.

This engine has a turning device. By allowing the starting air to flow through a needle valve to each cylinder, in turn, the flow being too small to turn the engine fast enough to raise the cylinder compression level, the engine can be rotated to turn freely. Once this sequence is completed, the needle valve will close, and the full pressure starting air allowed into the cylinders will begine to rotate and run the engine.

2) Stopping

After shedding the electric load from the unit, the engine should always be allowed to run with no load for a few minutes to allow the unit to cool down slowly. Once this has been done, the stop switch in the engine control room can be pressed operating a solenoid valve in the fuel line, and stopping the engine. The unit should then come to a standstill, with the solenoid valve reset ready for the next start.

Safety and Alarm System

1) Shut Down Function

Over Speed Trip	rpm	828
Lub. Oil low-low	MPag	0.25
H.T.C.F.W Temp. High-High.	°C	93

2) Alarm

Lub. Oil Pressure Low	MPag	0.28
Lub. Oil Temp. High	°C	70
Lub. Oil Diff. Press. Filter High	MPag	0.12
Oil Mist Conc. High	%	2.5
Fuel Oil Press. Low	MPag	0.15
Fuel Oil Filter Diff. Press. High	MPag	0.12
Cylinder 1~9 Exhaust Temp High.	°C	575
T/C Turbine Exhaust Inlet High Temp	°C	575
T/C Turbine Exhaust Outlet High Temp	°C	500
Wind R/S/T Temp. High	°C	140
Fwd / Aft Bearing Temp. High	°C	90
Power Failure	-	-
rpm Pick Failure	-	-

2.11.3 Emergency Diesel Generator

General Description

The Emergency Diesel generator is rated for 850kW at 450V, 60Hz for use in emergency or dry dock conditions. The generator feeds the emergency switchboard and, through tie-breakers, the main switchboard. The unit will start automatically should the main running unit fail, or it can be started manually either from the engine control room or locally to the engine.

Under normal operating conditions, the emergency switchboard is fed from the main switchboard through a tie-breaker, with the emergency generator start mode selector switch in the auto condition at the starter panel, and remote condition in the engine control room. Under these conditions, a loss of voltage in the bus bars will be sensed thus starting the emergency generator. The unit can be stopped using the switch in the engine control room or turning the mode switch to stop emergency switchboard has selector switch as manual, semi-auto and auto.

- Semi-auto : Synchronizing and short parallel connection before disconnecting on power restore.

- Auto : Direct disconnection (no synchronizing), stop after five minutes.

(1) Engine

The engine is a V-12 turbocharged diesel engine, running at 1,800 rpm. The engine has an air start motor and a back-up electrical starter motor.

Crankshaft, camshaft bearings, etc. are lubricated by a forced lubrication system from an engine driven gear pump. The pump draws oil from the sump pan and, after passing through a cooler and a filter, a pressure regulating valve maintains the line pressure. Two heating elements are fitted to the sump to provide preheating of the lub. oil and two heating elements are fitted to the cooling water jacket. These are normally left running.

An engine-mounted radiator with a v-belt driven fan cools the jacket water and an engine driven pump circulates the water through the jacket spaces.

Fuel is supplied from the emergency diesel generator oil tank of 6.0 m^3, located in the emergency generator room and is gravity fed to the fuel injection pump. Air for starting is supplied from a separate air receiver, which is filled up by the gasoline engine driven emergency diesel generator starting air compressor or generator engine starting air compressors. Starting air is supplied to the starter motor after initiating the operation of a solenoid valve in the line.

(2) Alternator

The generator gives an output of 850kW at 0.8 power factor at 450 volt 3 phase 60Hz at 1,800 rpm. The generator is a brushless type, self-excitation, and self-regulation system with an automatic voltage regulator maintaining a constant output. A space heater coil is fitted to the generator enclosure to prevent condensation while the unit is idle.

The generator is coupled to the emergency switchboard via a circuit breaker, which is closed automatically by the engine starting sequence or manually at the emergency switchboard. Manual control of voltage is provided together with voltage, current and frequency meters at the emergency switchboard.

The Emergency Generator Set Auto Start Panel in the emergency generator room has two positions-AUTO and MANUAL with START and STOP pushbuttons.

The Emergency Switchboard EG section has twist switches with Generator AUTO and MANUAL and START and STOP functions. The normal position for both switches is AUTO.

When a no-volt signal is received at the emergency switchboard, this initiates the engine start sequence. On receipt of the signal, the lub. oil heater and generator heater are switched off, the air start solenoid operates and air is admitted to the starter motor. The generator ACB on the emergency switchboard will close automatically when the engine is running at the correct speed and voltage. The emergency generator engine can be stopped at the emergency switchboard or locally at the emergency generator set auto start panel.

In the MANUAL position, the generator can be started and run manually. Starting may be by manually operating the air start solenoid valve and, when the generator is running, the circuit breaker can be manually closed on the switchboard. Interlocks prevent the closure of the circuit breaker when the emergency switchboard is being fed from the main switchboard through the ACBs BT-EL1 and BT-EL2.

System Capacities and Ratings

Emergency Generator Engine:	STX Corporation
Type:	KTA38DMGE
Emergency Generator:	RELOY SOMER
Type:	Horizontal, Self Extinguishing
	Brushless, Drip Proop-type
Main LO System:	114 litres
W/W Governor:	2~3 litres

Operating Procedures

(1) To Start the Generator Only
at the engine instrument panel:

a) Set both SPEED ADJUST switch to RUN. Set MANUAL START switches to CRANK and RUN at the same time, then release.

The engine will receive start signal. The starting will fail if low speed is not detected.

(2) To Start the Generator from the Emergency Generator Set Auto Start Panel

a) Set the engine start switch to MANUAL.

b) Press START.
The engine will run.

(3) Auto-Start

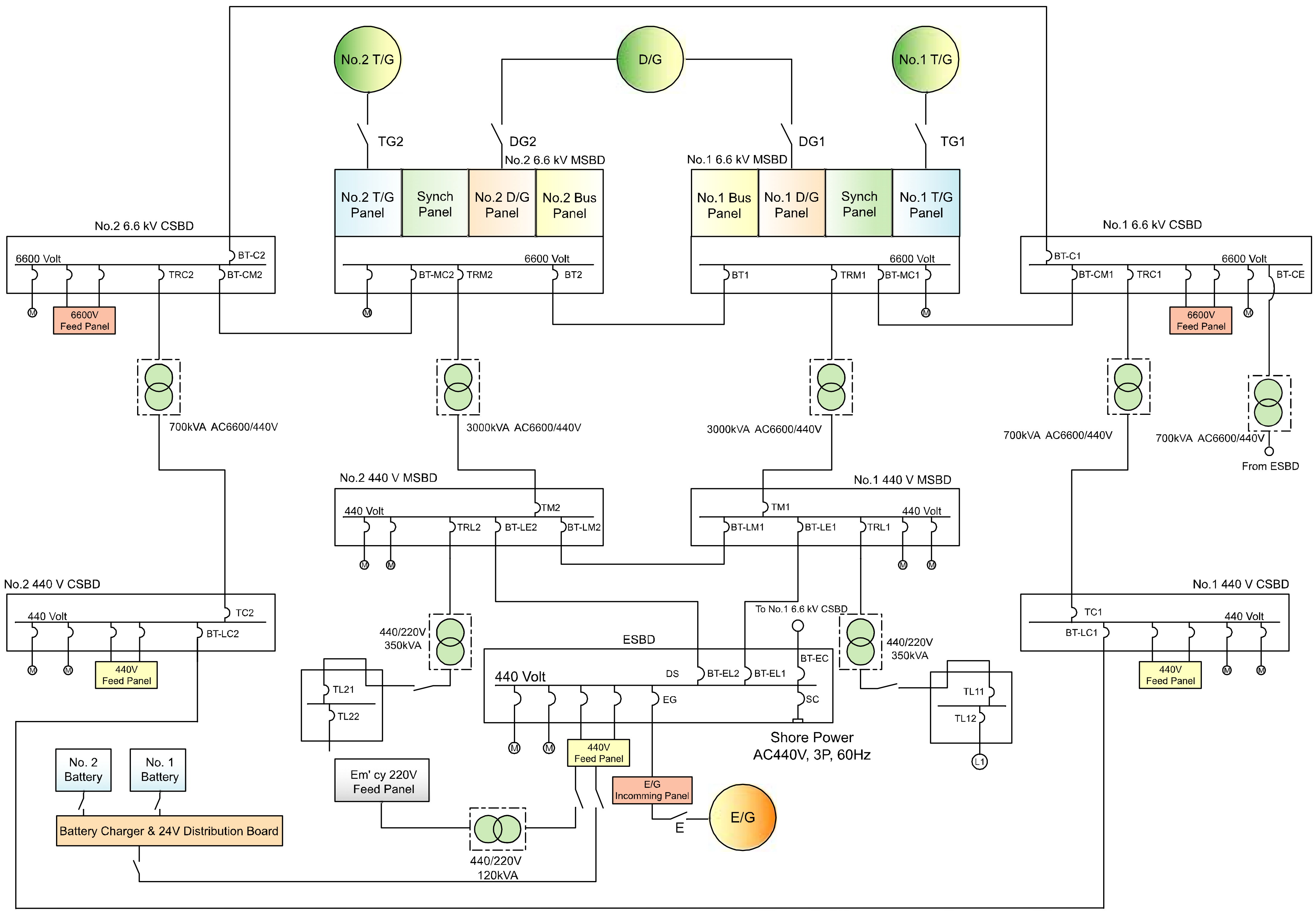
a) Check the engine lub. oil sump level and the fuel oil pump lub. oil level and top up as required.
b) Set the engine instrument panel switches to the RUN position.
c) Check the fuel tank level, check for water and fill up the tank as required. A full fuel tank will give approximately 18 hours running at 100% MCR. Note and record all fuel transfers.
d) Open the fuel tank outlet quick closing valve; make sure that there is fuel at the filters.
e) Check the air start receiver air pressure. Drain off any moisture.
f) Open the receiver outlet valve and the air line to the starter-motor.
g) Set the lub. oil and generator heaters to ‘ON’.
h) Set the operating mode switch to ‘AUTO’.
i) Check if the emergency generator set auto start panel STAND-BY lamp is lit.

The unit is now ready for auto start in the event of a power failure.

(4) Manual Start

a) Carry out checks and inspections as above
b) The hydraulic driven start motor can also be started with hydraulic power generated with a hand operated pump.
c) Start the engine by operating the buttons on the generator control panel.
d) When the engine is running at 1,800 rpm, and the voltage and frequency are normal, manually close the circuit breaker at the emergency switchboard if required.

Illustration 2.12.1i Distribution and Loading



2.12 Electrical Power Distribution

2.12.1 Distribution and Loading

Generating Plant

The electric power generating plant consists of the following:

Turbine generator
No. of sets: 2
Rating: 6600 volts, 3 Ph, 60 Hz, 3,450 kW

Diesel generator
No. of sets: 1
Rating: 6600 volts, 3 Ph, 60 Hz, 3,450 kW

Emergency diesel generator
No. of sets: 1
Rating: 6600 volts, 3 Ph, 60 Hz, 850 kW

Introduction

One turbine generator is used during normal sea going conditions. Two generators are required when:

Manoeuvring with bow thruster in use
Cargo loading
Cargo discharging

The emergency generator has sufficient capacity to supply the auxiliaries required to start a diesel generator in the event of total power failure. All three generators can operate in parallel, but not with the emergency generator. The emergency generator power can be fed back to a dead main switchboard. The emergency generator will start automatically in the event of a blackout and feed the emergency switchboard.

Power Distribution System

(1) General Description

The main switchboard is situated in the main switchboard room. The main switchboard, under normal operating conditions, feeds the emergency switchboard, which is situated in the emergency switchboard room. The emergency switchboard can be supplied from either 440V feeder panel via interlocked breakers.

The main switchboard is divided into two parts. They can be operated independently, but are normally linked together by a bus tie breaker on each switchboard. One turbine generator supplies each switchboard. The diesel generator can be connected via a breaker on either switchboard, which are provided with separate synchronising panels. Each switchboard supplies its respective switchboard.

A power management system controls the starting and stopping of the diesel generator and the connection and load sharing of the generators. If a failure occurs with any of the turbine generators, shedding non-essential loads and auto starting the diesel generator can reconfigure power distribution. Panel boards are provided in suitable positions for the supply of power to the various power, heating, lighting, communication and navigation equipment throughout the vessel.

Two 6.6kV cargo switchboards supply the cargo pumps and H/D compressors. The other large motors for cargo system are supplied from 6.6kV/440V cargo switchboard directly and power for other smaller power consuming devices are supplied through 440V cargo switchboard.

Each distribution circuit, in general, is protected against overcurrent and short circuit current by a molded case circuit breaker fitted on the switchboard or panel board, with inverse time overcurrent trip and instantaneous trip. Each steering gear motor is fed from an independent circuit, two sets of steering gear motor are connected to the main switchboard and the other is connected to the emergency switchboard. A general service battery charging and discharging panel supplies the alarm monitoring system along with other essential low voltage services.

Each supply system is provided with a device for continuously monitoring the insulation level to earth, giving an audible and visual indication of an abnormal low insulation level.

440V/220V transformers supply the normal and emergency 220V distribution systems. Each of the 220V feeder panels can be fed from each of the 440V feeder panels.

A shore connection is provided at the emergency switchboard to supply power to the main and emergency 440V switchboards, either independently or simultaneously

(2) Switchboards

The switchboards are of dead front box frame construction without a bottom plate and have hinged front panels that can be opened without disturbing the meters, pilot lamps, etc. mounted on them. Bus bars, cubicle rows and tiers are segregated so that a fault in one cubicle cannot spread to another. A synchronising panel is supplied on each switchboard.

(3) Cargo Switchboards

Four switchboards are dedicated to cargo related auxiliaries. These switch-boards can be supplied from either 6.6kV and 440v feeder panels or the emergency switchboard.

(4) Emergency Switchboard

This switchboard is normally supplied from the main switchboard, but in an emergency is supplied from the emergency generator. During refit it would be supplied from the shore power connection. The emergency switchboard supplies emergency equipment and duplicates back up units.

(5) Feeder Circuit Breaker

The feeder circuits fed from the 6600V feeder panel of the switchboard is protected by vacuum circuit breaker. The VCB is electrically operated, and drawn-out for maintenance purposes. The control power supplies 110V DC from the outside of 6.6 kV MSB.

The feeder circuits fed from the 440V feeder panel of the switchboard is protected by a moulded case circuit breaker with inverse time thermal over current trip, instantaneous magnetic trip and short circuit current interruption features, except the steering gear motor feeders, which are protected against short circuits only.

The AC220V feeder circuit is protected by a moulded case circuit breaker with inverse time thermal over current trip, instantaneous magnetic trip and short circuit current interruption features.

The moulded case circuit breakers for main and emergency switchboard are of the plug-in type, so that the breakers may be removed from the panel front without de-energising the main busbar. However, the moulded case circuit breakers for group starter panels and distribution panels are of the fixed type.

(6) Automatic Synchronising Control

An automatically controlled synchronising apparatus, which consists of the automatic speed matcher and the automatic synchroniser, is provided for the ship's service generator sets. The automatic speed matcher equalises the generator frequency with busbar frequency. The automatic synchronizer energises the circuit breaker to connect two parallel circuits when both phases coincide.

(7) Automatic Power and Frequency Control

An automatically controlled power and frequency control system is provided for each ship's service generator.

The power management system controls the effective output and frequency of the generators.

(8) Preferential Tripping

The power management system is designed to match the generator capacity of the power requirements of the vessel. However, if overcurrent occurs in any of the main generators, non-essential services would be tripped. Preferential tripping will be initiated when one or more generators are supplying the main switchboard and an overcurrent is detected. Load shedding is carried out in two stages.
The following non-essential preferential trip services will be shed immediately.

Group 1 (PT-1)
- PD-1 (E/R 440V D/B)
- PD-2 (E/R 440V D/B)
- PD-3 (W/SHOP 440V D/B)
- PD-4 (GALLEY 440V D/B)
- LD-7 (GALLEY 220V D/B)
- NO. 1 & 2 FRESH WATER GENERATOR
- NO. 1 & 2 SBR PACK. AIR CON.
- ACCOM. AIR-CON. COMPRESSOR
- ECR PACK. AIR-CON.
- ACCOM. A.H.U. FAN

Group (PT-2)
- NO. 1, 2 & S/BY BALLAST PUMP
- FWD/AFT DECK MACH.
- NO. 1 CARGO PUMP FOR NO 1, 2, 3, & 4 CARGO TANK
- NO. 2 CARGO PUMP FOR NO 1, 2, 3, & 4 CARGO TANK

When normal conditions are restored, the above breakers will have to be manually reset.

(9) Sequential Restart

When normal power is restored after a blackout, all essential services motors that were in service before the blackout will be started automatically in sequence when the main switchboard has regained power. Motors that were selected for duty before the blackout will be automatically returning to duty when power is restored. Similarly, motors selected for stand-by will automatically return to stand-by mode. If the machinery designated for duty does not restore normal system conditions, such as pressure, within a preset time, the stand-by motor will cut in automatically. If power is only restored to the emergency switchboard, motors whose supply is from the emergency switchboard will start regardless of any previous selection.

The following services will start immediately on restoration of power
No. 1 & 2 Steering gear motors
No. 1 & 2 Stern tube LO pump
No. 1 & 2 aux. LO pump
No. 1 & 2 boiler seal air fan
No. 1 & 2 BOG extraction fan
D/G eng. DO/EM'CY DO service pump
No. 1 & 2 T/G aux. LO pump
M/T gland cond. exh. fan

The following will start after 5 seconds
No. 1 & 2 main condensate pump
No. 1 & 2 central CFW pump
No. 1 & 2 main condenser vacuum pump
No. 1 & 2 cargo mach. CFW boost pump

The following will start after 10 seconds
No. 1, 2 & 3 Main SW circ. pump

The following will start after 15 seconds
No. 1 & 2 main CSW pump
No. 1 & 2 navigation drain pump
Drain pump

The following will start after 20 seconds
No. 1 & 2 Boiler FO service pump
No. 1, 2, 3 & 4 Engine room supply fans
No. 1 & 2 Engine room exhaust fans
LD condensate pump

The following will start after 30 seconds
No. 1 boiler FD fan
Steering gear room supply fan

The following will start after 50 seconds
No. 2 boiler FD fan

The following will start after 70 seconds
No. 1 & 2 cargo compressor room exhaust fan
No. 1 & 2 Glycol W. Circ. Pump
EM'CY feed water pump
No. 1 & 2 electric motor room supply fan
Foam/Co2 room exh. fan
Battery room exh. fan

INTERLOCK SYSTEM

6.6kV MSB
a) BT1 and BT2 VCBs are normally closed.
b) DG1 and DG2 VCBs are mutually interlocked electrically so that only one of them can be closed.

6.6kV CSB
a) BT-C1(or BT-C2) VCB is normally opened.
b) BT-CM1(2) VCB can be closed only when BT-MC1(2) VCB has closed. If the BT-MC1(2) VCB was tripped, the BT-CM1(2) VCB is also tripped automatically.
c) BT-CE and BT-CM1 VCBs are mutually interlocked so that only one of them can be closed and BT-CE and BT-CM2 VCBs are mutually interlocked by the state of BT-C1 and BT-C2.
d) BT-CE VCB can be closed only when BT-EC ACB has closed. If the BT-EC ACB was tripped, the BT-CE VCB is also tripped automatically.
e) BT-CM1/2 and BT-C1/2 VCBs are mutually interlocked so that only three of them can be closed electrically.

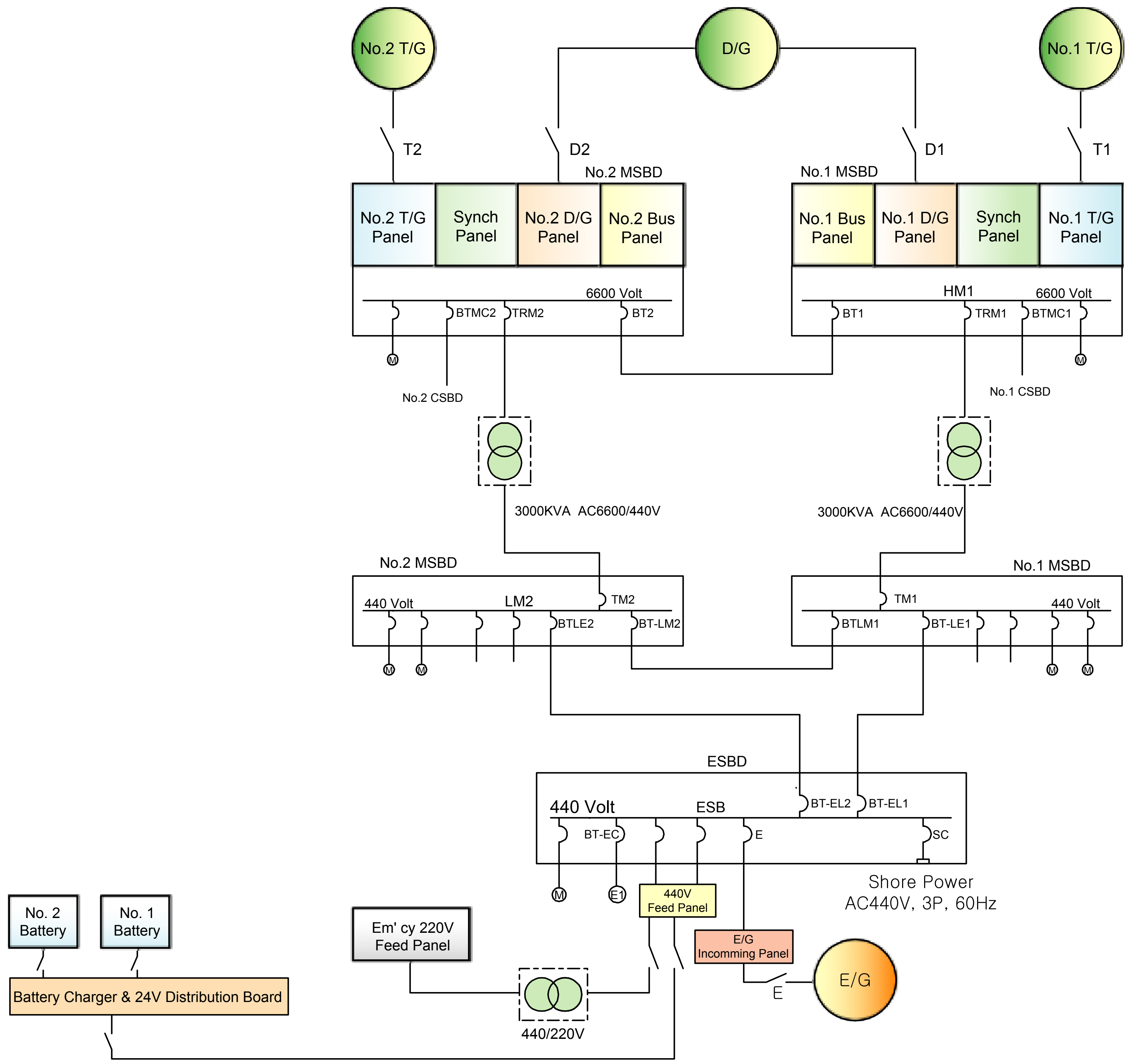
LV MSB
a) BT-LM1(or BT-LM2) ACB is normally opened.
b) TM1, TM2, BT-LM1 and BT-LM2 ACBs are mutually interlocked so that only three of them can be closed by using keys.
c) TM1(2) ACB can be closed only when TRM1(2) VCB has closed. If TRM1(2) VCB was tripped, TM1(2) ACB is also tripped automatically.

LV CSB
a) BT-LC1(or BT-LC2) ACB is normally opened.
b) TC1, TC2, BT-LC1 and BT-LC2 ACBs are mutually interlocked so that only three of them can be closed by using keys.
c) TC1(2) ACB can be closed only when TRC1(2) VCB has closed. If TRC1(2) VCB was tripped, TC1(2) ACB is tripped automatically too.

220V Feeder Panel
a) TL11, TL12, TL21 and TL22 MCCBs are mutually interlocked so that only three of them can be closed by using keys.
b) TL12(or TL21) MCCB is normally opened.
c) TL12(or TL21) MCCB can be closed only when TRL1(or TRL2) MCCB has closed.

ESB
a) BT-EL1, BT-EL2, EG and SC ACBs are mutually interlocked so that only one of them can be closed. This interlock is released after EG or SC feedback to LV MSB.
b) BT-EC, BT-EL1 and BT-EL2 ACBs are mutually interlocked so that only one of them can be closed.
c) During feedback operation to LV MSB, TM1 and TM2 ACBs can not be closed.
d) BT-EC ACB can be closed only when BT-CE VCB has connected. If BT-CE VCB was set at a draw-out position, BT-EC ACB is tripped automatically.

Illustration 2.12.2i Shore Power



2.12.2 Shore Power

Shore connections

Shore connections are made at the rear of the Emergency Switchboard and cables are led into the board via a cable port on the switchboard room, port side.
A kWh meter, pilot lamp indicating shore power is available and a circuit breaker is provided in the emergency switchboard.

A phase sequence indicator is provided on the shore power ACB control panel. The sequence should be checked by pressing the phase sequence test pushbutton before closing the ACB to connect shore power to the emergency switchboard. If the sequence is found to be incorrect (red LED instead of Green LED), change over two phases.

The shore power breaker is rated for 440V AC, 3 Ph, 60Hz, 1,000A.

Under normal settings, BT-EC, BT-EL1 and BT-EL2 ACBs are mutually interlocked so that only one of them can be closed.

Operating Procedure : Feeding the Main Switchboard from Shore Power

With emergency switchboard fed from shore supply ACB SC.

(1) Check if the diesel generator and turbine generator ACBs are open (D1 and D2, T1 and T2).

(2) Check if the additional load will not exceed the capacity of the shore supply.

(3) Set ACB control switch on ESB to feedback to override interlocks.

(4) Close bus-ties.

2.12.3 Emergency Diesel Generator

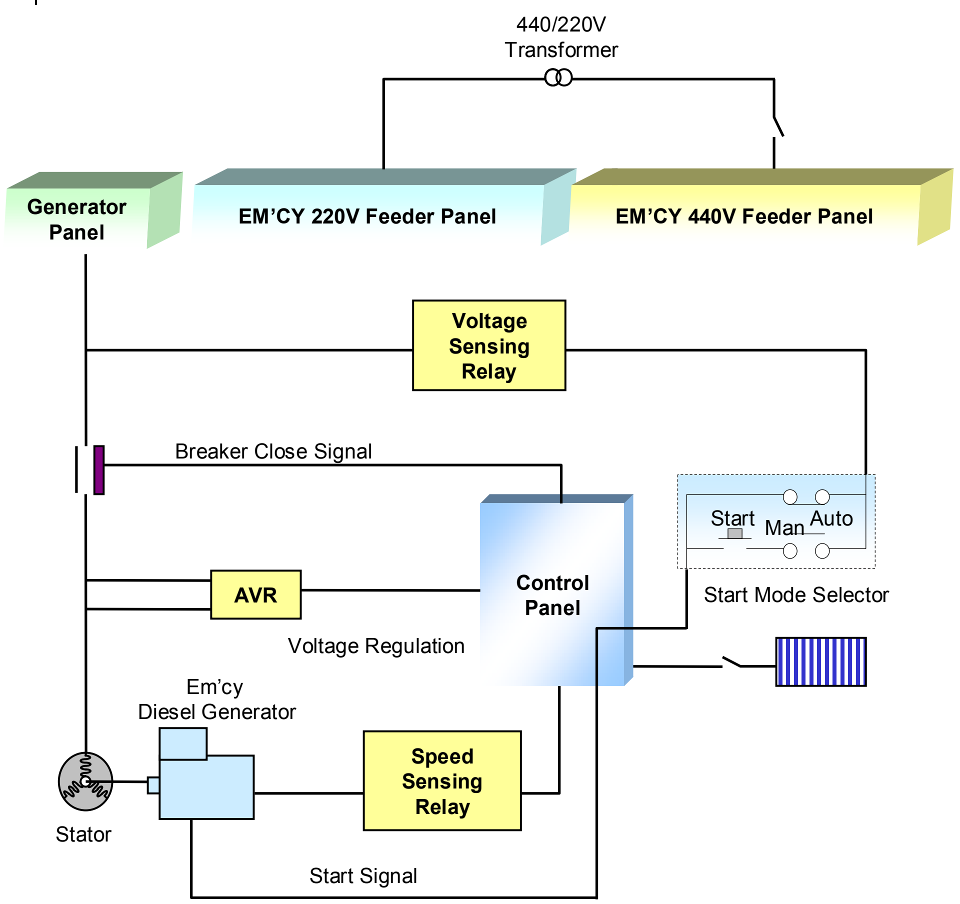
General Description

Maker:	RELOY SOMER
Model	LSA M50.1 M6
Type	Horizontal, Self Exciting brushless, Drip proof-type

A self-contained emergency diesel generator rated at 850 kW is fitted adjacent to the emergency switchboard for use in an emergency or to start up a dead ship. The generator is the self excited brushless type, and can be set for manual or automatic operation. AUTO will be normally selected, with the MANUAL setting being used for testing the generator.

The emergency switchboard is normally supplied from the main switchboard. When auto is selected, the emergency generator starts automatically by detecting no-voltage in the emergency switchboard bus. The emergency generator ACB will connect automatically to the emergency switchboard after confirming the no-voltage condition.

The emergency generator should restore power to the emergency switchboard within 45 seconds. The ACB on the emergency switchboard, which feeds from the main switchboard, is opened automatically when no-voltage is detected on the main switchboard.



The generator is fitted with space heaters to prevent condensation when the generator is stationary or idling. The heater is interlocked with the air circuit breaker.

The generator is capable of starting the plant from dead ship condition.

Operating Procedure : Testing the Emergency Generator

Test procedure of emergency generator sequence test

- ESB power supply from LVMSB.
- Emergency engine condition - normal
- Control position switch (COS-L) on local control panel – REMOTE
- Mode select switch (COS-A) on ESB – AUTO

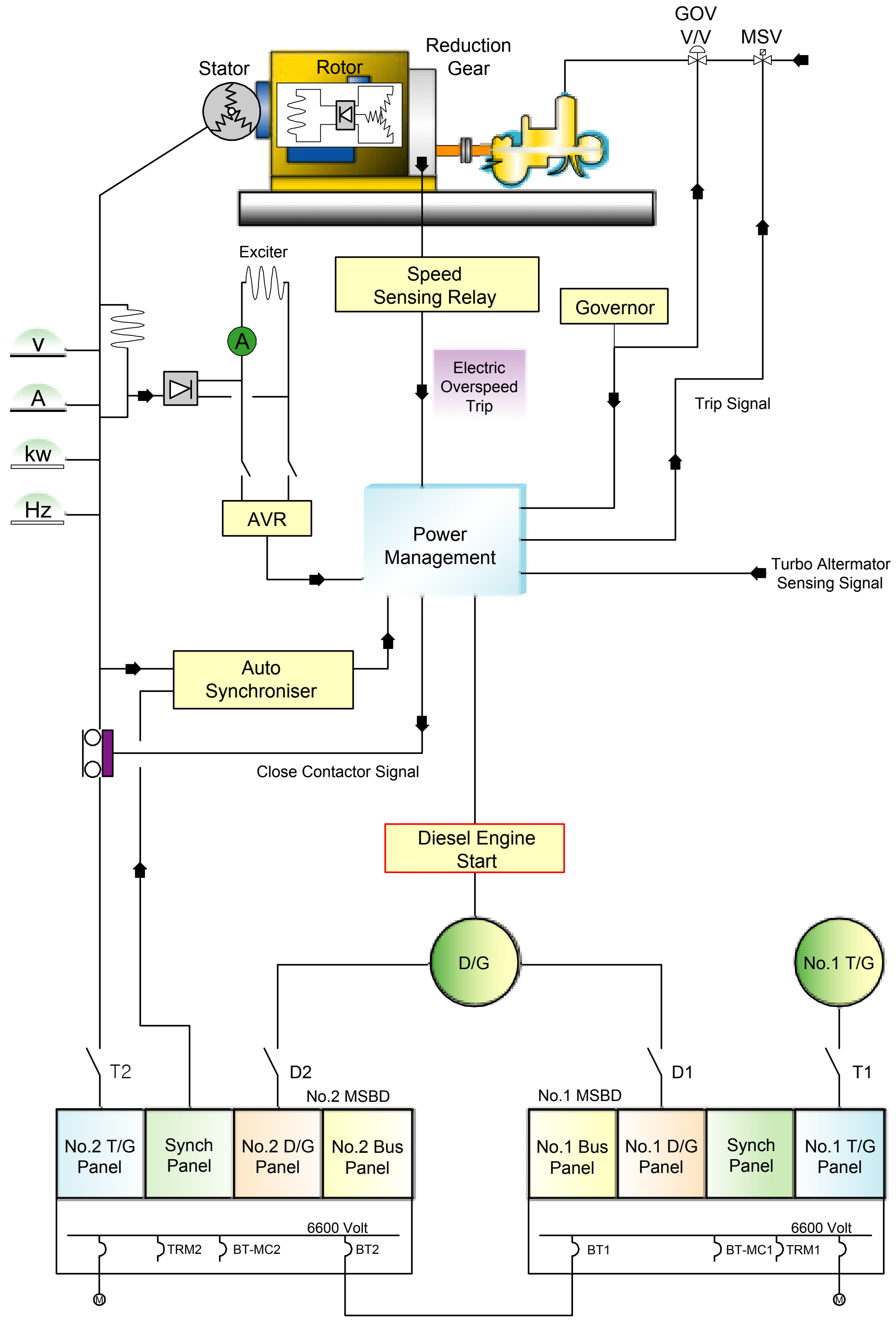
EG Sequence Test (ENGINE and ACB)

a) Turn the EG SEQUENCE TEST switch (TS) to ENG and ACB positions.
b) The closing BUS TIE ACB opens automatically.
c) The emergency generator engine start, and ACB closes automatically.
d) Turn the EG SEQUENCE TEST switch (TS) to NORMAL position.
e) Change the BUS TIE ACB CONTROL MODE switch (COS-BT) to MANUAL position.
f) Close the No.1 or No.2 BUS TIE ACB by manual synchro.
g) The emergency generator ACB trips automatically.
h) The emergency generator engine stops manually.

EG Sequence Test (ENG)

a) Turn the EG SEQUENCE TEST switch (TS) to ENG position.
b) The emergency generator engine starts automatically.
c) The emergency generator engine stops manually.

Illustration 2.12.4i Turbine Generator



2.12.4 Turbine Generators

Maker: Hyundai Heavy Industries
Type: HSJ7 717-46E

Two turbine generators are provided. They each supply one of two main switchboards independently, but under normal conditions the two switch-boards will be linked.

Each generator is rated at 3,450 kW at AC6600volts, 3Ph, 60Hz. They are the totally enclosed, self excited, brushless type. The load voltage is kept constant by controlling the excitation current to the exciter. Output power from the stator is fed into a current/voltage compound transformer, and the output is rectified and fed through the exciter stator windings. The magnetic field in the exciter stator induces AC in the excited rotor, which is rectified by the rotary diodes and passed to the DC main rotor windings. Initial voltage build-up is by residual magnetism in the rotor. Constant voltage control is achieved by the automatic voltage regulator, which shunts a variable current through the exciter windings via a thyristor to keep the AC stator output voltage constant.

The generator is cooled bypassing air over an integral fresh water cooler, and using a closed circuit air supply. The cooling spaces are fitted with internal baffles to prevent water from reaching the stator windings in the event of cooler leakage. Space heaters are fitted, which are energised when the generator circuit breakers are open, which protects against internal condensation during shut down periods. The breakers are normally operated by the power management system, but can be operated manually at the switchboard front. An embedded sensor monitors the stator temperature in each phase, a water leakage, and a temperature sensor is fitted in each air cooler. The bearings have a temperature sensor.

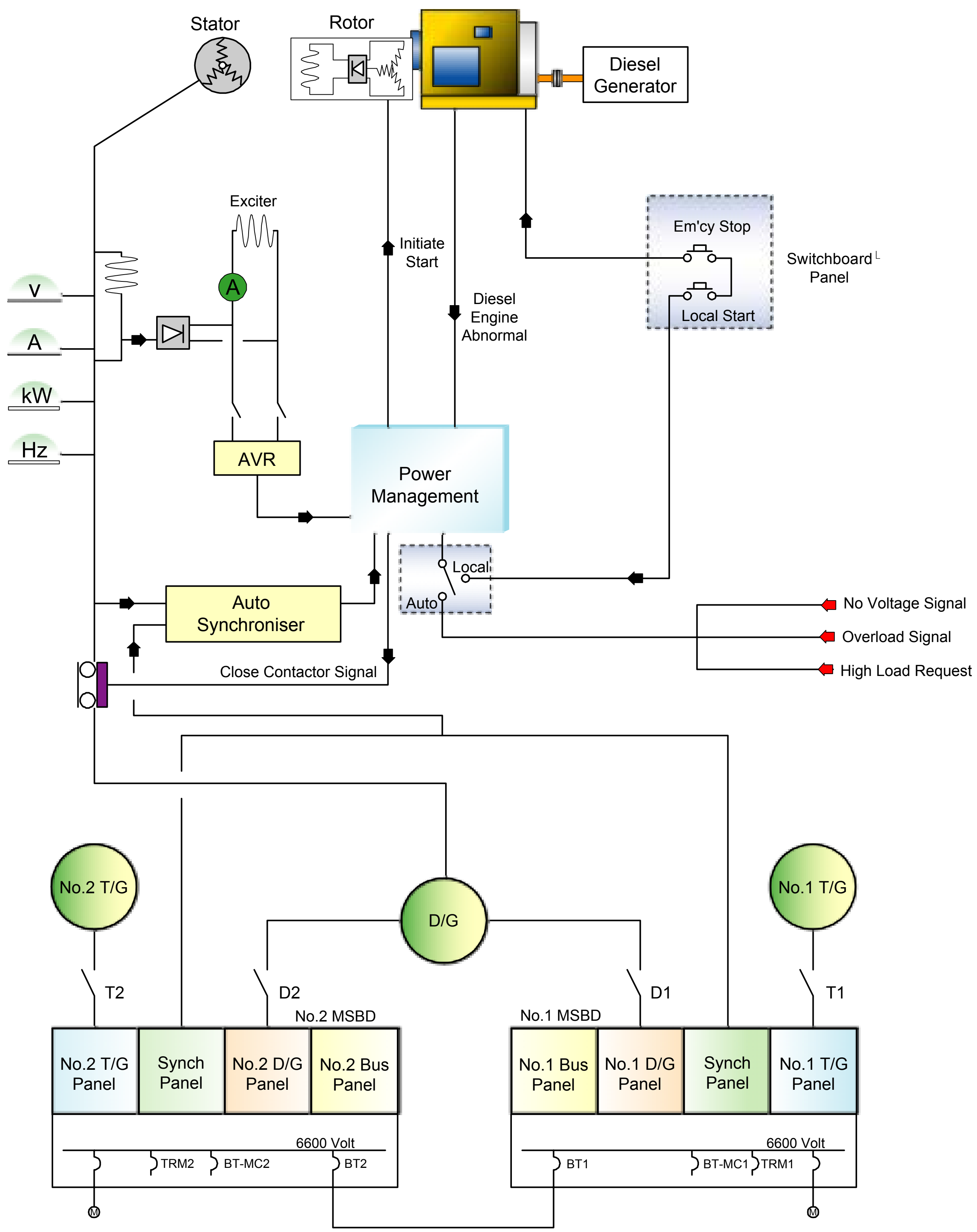
The electric power system is designed with discrimination on the distribution system, so that the generator breaker is the last to open if any abnormalities occur.

A turbine generator, with the diesel generator on stand-by at sea, provides electrical power. The order of the stand-by start is selected through the power management system.

Starting of large motors is blocked until there is sufficient power available. The diesel generator will be started to meet the shortfall.

Two generators will be required to operate in parallel when:
- Discharging cargo
- Loading cargo
- Manoeuvring with bow thruster in use

Illustration 2.12.5i Diesel Generator



2.12.5 Diesel Generator

Maker: Hyundai Heavy Industries
Type: HSJ7 809-16E

One main diesel generators is provided. It can supply both main switchboards independently, but under normal conditions the two switchboards will be linked.

The generator is rated at 3,450 kW at AC6600volts, 3Ph, 60Hz. It is the totally enclosed, self excited, brushless type. The load voltage is kept constant by controlling the excitation current to the exciter. Output power from the stator is fed into a current/voltage compound transformer and the output of this is rectified and fed through the exciter stator windings. The magnetic field in the exciter stator induces AC in the excited rotor, which is rectified by the rotary diodes and passed to the DC main rotor windings. Initial voltage build-up is by residual magnetism in the rotor. Constant voltage control is achieved by the automatic voltage regulator, which shunts a variable current through the exciter windings via a thyristor to keep the AC stator output voltage constant.

The generator is cooled bypassing air over an integral fresh water cooler, using a closed circuit air supply. The cooling spaces are fitted with internal baffles to prevent water reaching the stator windings in the event of cooler leakage. Space heaters are fitted, which are energised when the generator circuit breakers are open, which protects against internal condensation during shut down periods. The breakers are normally operated by the power management system, but can be operated manually at the switch board front. An embedded sensor monitors the stator temperature in each phase. A water leakage and temperature sensor is fitted in each air cooler. The bearings have a temperature sensor.

The electric power system is designed with discrimination on the distribution system, so that the generator breaker is the last to open if any abnormalities occur.

A turbine generator, with the diesel generator on stand-by at sea, provides electrical power. The order of the stand-by start is selected through the power management system.

Starting of large motors is blocked until there is sufficient power available. The diesel generator will be started to meet the shortfall.

Two generators will be required to operate in parallel when:

- Discharging cargo
- Loading cargo
- Manoeuvring with bow thruster in use

The diesel generator will start under the following conditions:

- ACB abnormal trip (Dead bus due to blackout)
- Bus abnormal (High or low voltage, Low frequency)
- ACB abnormal trip (Bus alive)
- Over load

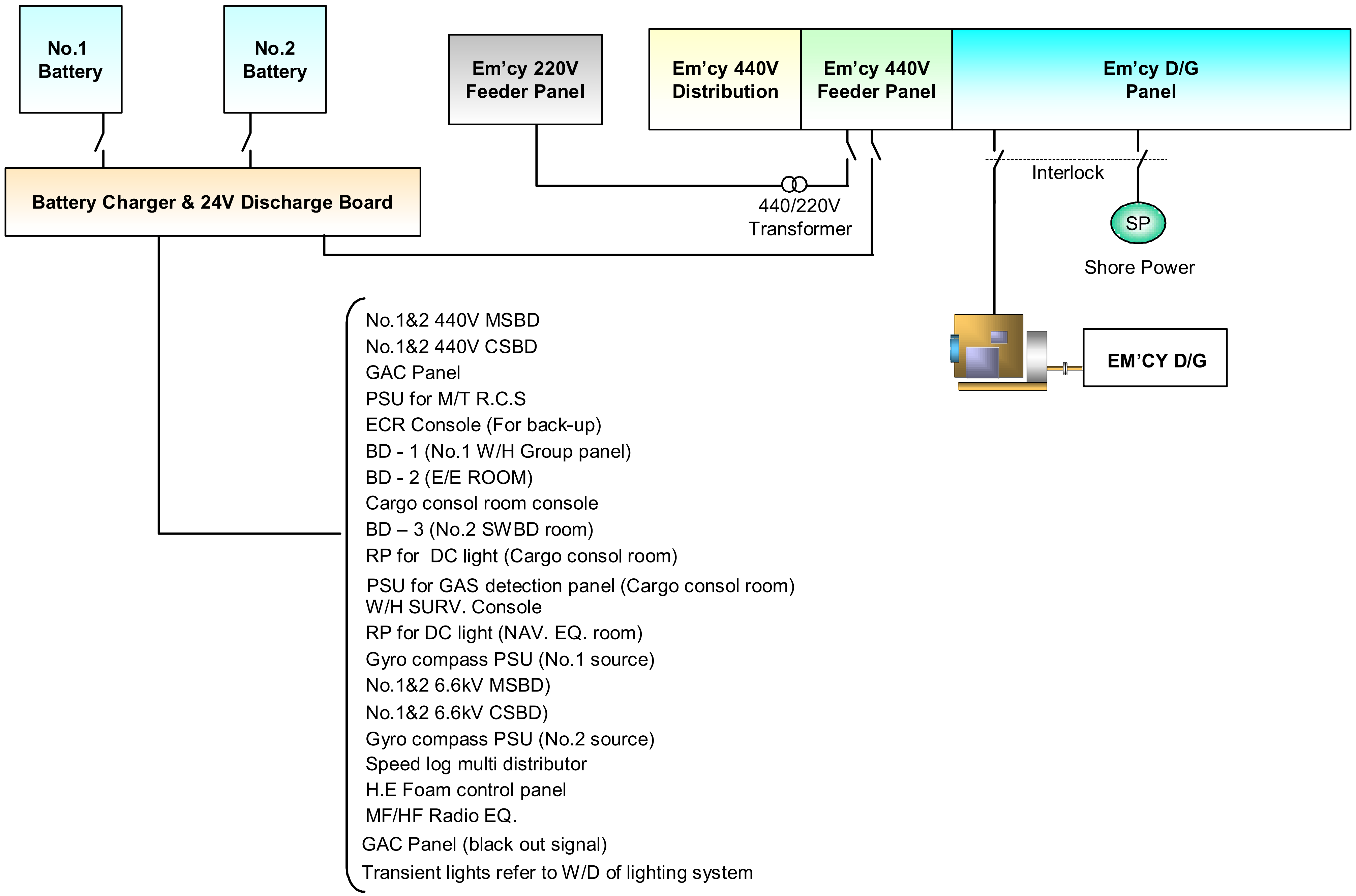
Condition 1: The generator will start and connect to the bus bar.

Condition 2: The generator will start and connect to the bus bar.

Condition 3: The generator will start, be synchronized, be connected to the bus bar and run in parallel with proportional load sharing.

Condition 4: The preferential trip system will shed non-essential loads. The diesel generator will start, synchronize, connect to the bus bar and run in parallel with proportional load sharing.

Illustration 2.12.7i Battery Charging and 24V Distribution



2.12.6 Un-Interruptible Power Supplies

The un-interruptible power supply (UPS) units are fed from the 440V feeder panel on the main switchboard and the emergency switchboard 440V feeder panel.
The UPS provides battery at DC 240V, 30kVA for at least 30 minutes. The UPS units supply power to essential navigation and safety equipment. Essential services in the cargo control room and engine control room are also supplied.

2.12.7 Batteries, Transformers, Rectifiers and Chargers

Batteries, Rectifiers and Chargers

(1) Auto Function

- Floating and Equalizing

In case AC input source or the source 440V is put first, or source is put again after the source fails (turns to ”Off”), it switches to the equalizing status, and reverted to floating charging after equalizing charging.

(2) Manual Function

There are 3 operation of Floating 26.5V
Equalizing 28.5V
Boosting 30.0V
The Operations can be manually selected with each push button switch.
The selective function (Equalizing and Boosting) is automatically reverted to floating charging status after time progresses with each timer.

(3) Timer Adjustable

- Equalizing Time : 0~100 Hour Adj. (Normal 30/Min)
- Boosting Time : 0~100 Hour Adj. (Normal 10/Min)

(4) Voltage Adjust (± 20%)

Equalizing/Floating/Boosting are used in the change of each charging voltage. The voltmeter selector switch is put in the position of the battery, the desired function is selected with the manual push button switch, and when the voltage is adjusted at this time, the battery makes switches “off” (Fuse of NFB).

Meter

(1) Volt Meter

Rectifier/Battery Charging/Load voltage normally divided by the selector switch and the set position of the battery.

(2) Amp. Meter

The current of the rectifier/battery/load normally divided by the selector switch and the set position of the load.

The battery means full charged in case of “O” Amp, and it means it is in discharging condition “-BBB” Amp is indicated.

Transformers

- No.1/2 L.V Main Transformer (3PH, 350kVA): 440V/225V
- Em’cy Transformer (120Kva, 1PH X 4SETS): 440V/225V
- F’cle Transformer (3PH, 30kVA): 440V/225V
- Gally/Pantry Transformer (120kVA, 1PH x 3Sets): 440V/440V
- Gally/Pantry Transformer (60kVA, 1PH x 3Sets): 220V/220V
- No.1/2 H.V Main Transformer(3PH,3000kVA): 6,600V/450V
- No.1/2 H.V Cargo Transformer(3PH,700kVA): 6,600V/450V
- Step-up Transformer(3PH,700kVA): 440V/6,600V

Illustration 2.12.8i(1) Bow Thruster

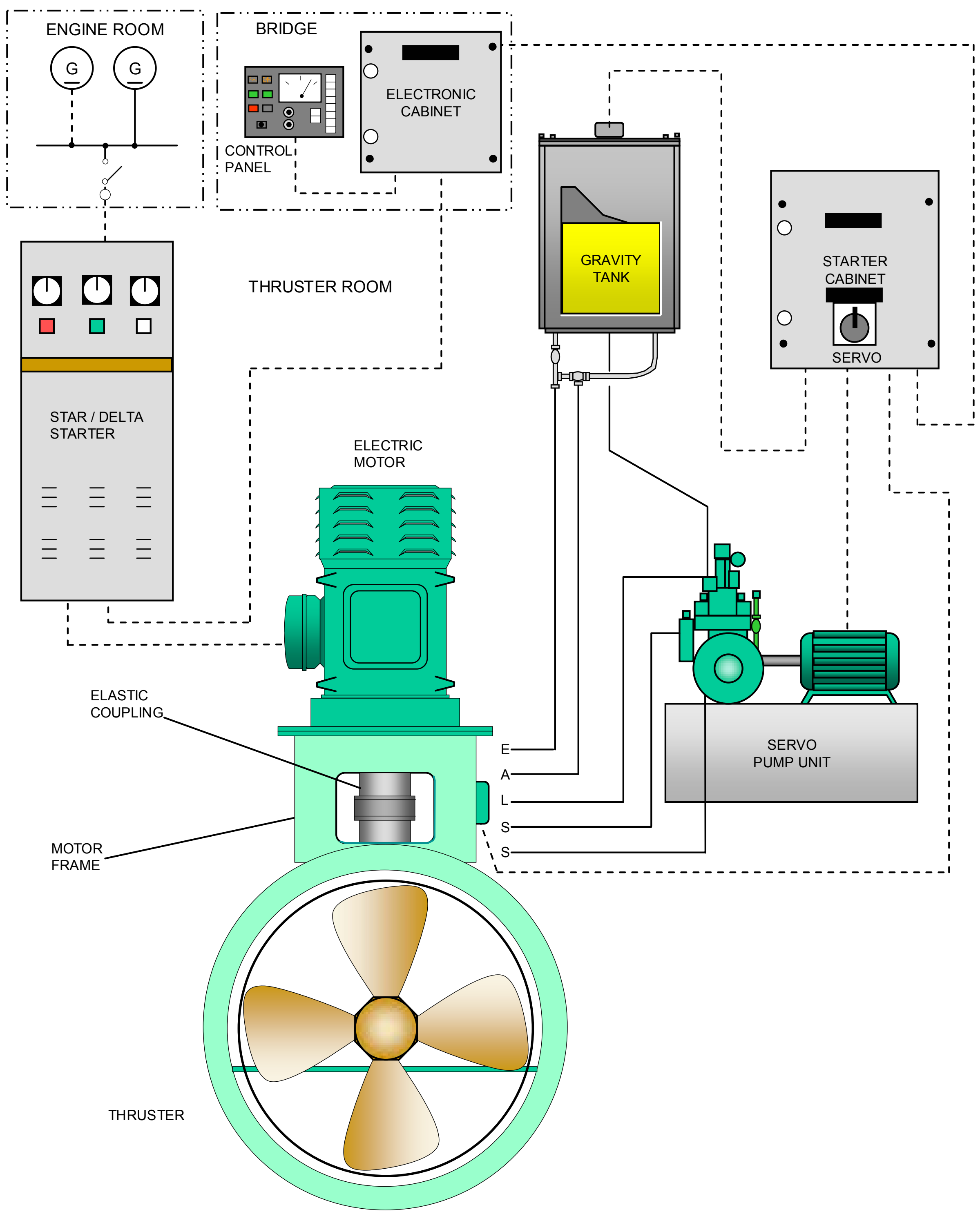
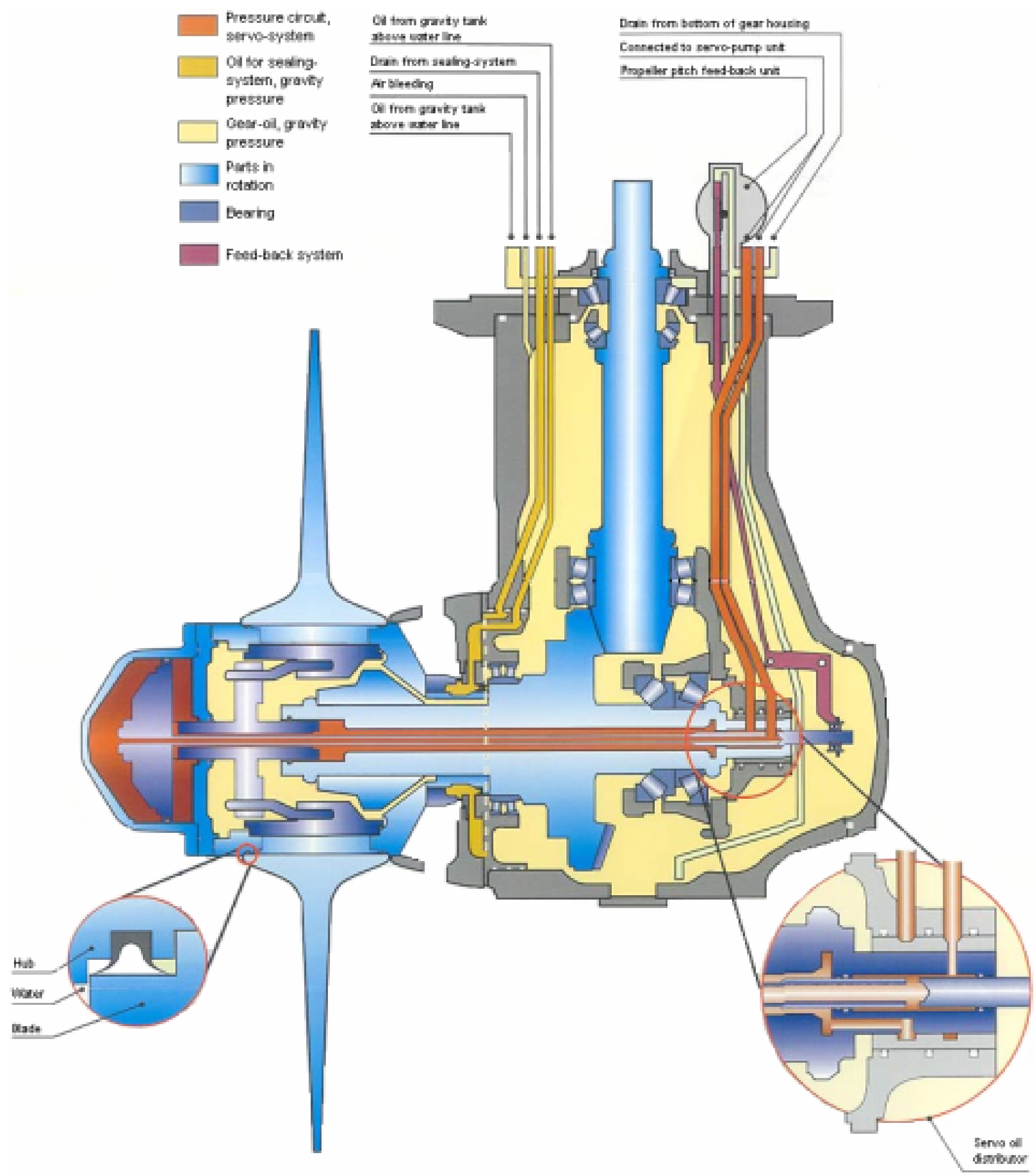


Illustration 2.12.8i(2) Bow Thruster



2.12.8 Bow Thruster

Maker	KAWASAKI HEAVY IND. LTD
No. of sets	1 SET
Type	FU-100-LTC-2450
Motor	1700kW
Model / Serial No.	KT-187B3
Hyd. Power unit	1 SET, 7.5 kW-4P X 440

General

The side thruster is a transverse propelling device with its propeller mounted in the lateral through tunnel in the hull such that the water jet generated by this propeller gives a lateral thrust to the hull. Thus facilitating the departure of the ship from and its coming alongside the pier. Also helping improve the ship's manoeuvreability when it is running at a low speed or in a narrow waterway.
Kawasaki's KT-B type side thruster is a controllable pitch thruster having incorporated in it a propeller pitch controlling mechanism. So planned that the propeller pitch can be remote controlled from the control stand on the bridge.
This device is composed of the actuating section comprising a drive motor. Flexible coupling and thruster proper and the propeller pitch control device. Its features being as follows;

(1) Adoption of 4-bladed skewed controllable pitch propeller which is effective for reducing vibration.
(2) Highly rigid construction and compact design. Hence easy installation.
(3) Propeller pitch is controllable. This allows the use of a constant speed motor with its revolving direction fixed.
(4) The possibility of controlling propeller pitch also enables continuous and quick change of the thrust in either port or starboard direction.
(5) Easy operation for all operation controls from that for starting the motor to that for regulation of the propeller pitch are collectively arranged in the control stand on the bridge.
(6) The propeller blade are capable of dismantling in the thruster tunnel by means of removing the blade bolts.

The thruster can have its performance retained over a long period, if simple preoperational checking and the recommended routine maintenance and checking procedures are observed.
This manual is intended to give cautions and hints on the operation of the thruster to be observed as well as the maintenance and inspection standards.

Operating Limits

(1) Be sure to observe the specified draft.
(For the specified draft refer to the separate "Technical data.")
If the draft is insufficient, it is not only interferes with the thruster exhibiting the specified performance but also causes cavitation or air drawing, and the resultant vibration may possibly cause damage to the device.
(Air drawing can be detected as marked hunting of the drive motor ammeter.)
(2) In some cases, it is also possible that air drawing is caused when the ship's speed is below 5 knots. If it is the case, the propeller pitch is to be so controlled that there is no risk of air drawing with the lower blade pitch zone.

Note !

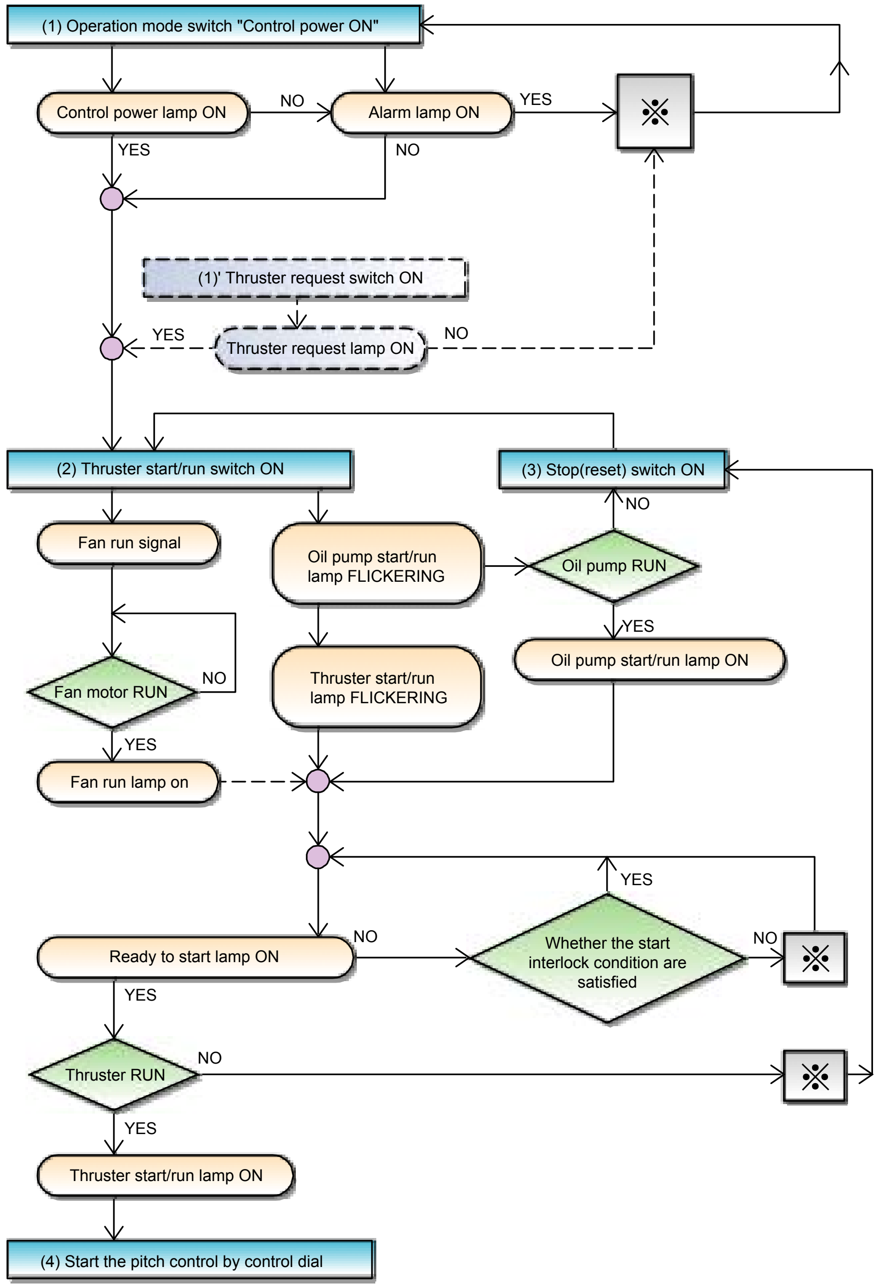
When the ship's speed exceed 5 knots, the vibration of the propeller is increased. Hence it is required for the thruster to be operated more than 5 knots.

Procedure for Operating the Thruster Units

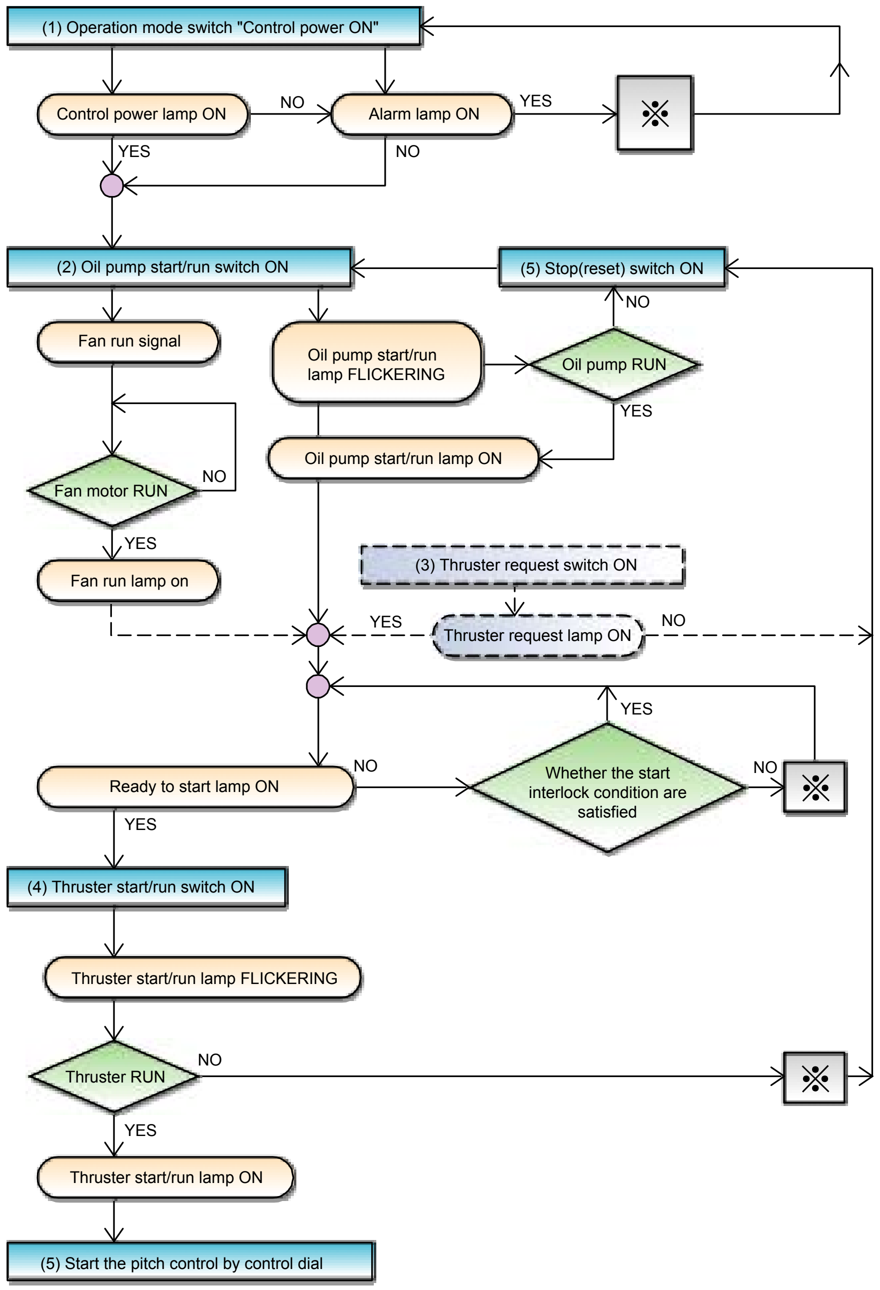
Note

The main motor must not be restarted after stopping until the transformer has had a chance to cool; a period of about 30 minutes is required for cooling.

Sequential start



Individual start



Stopping thruster

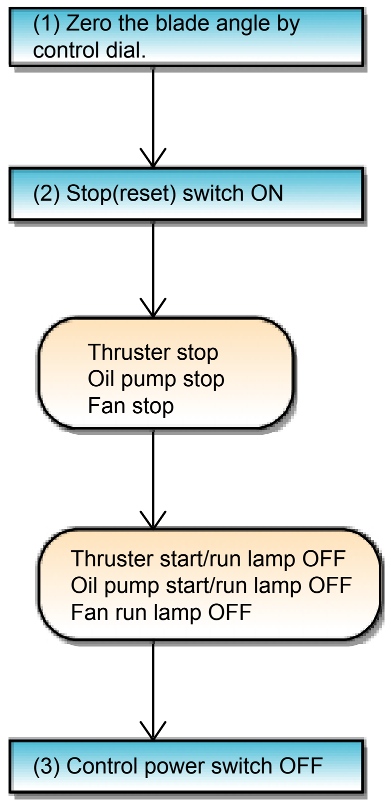
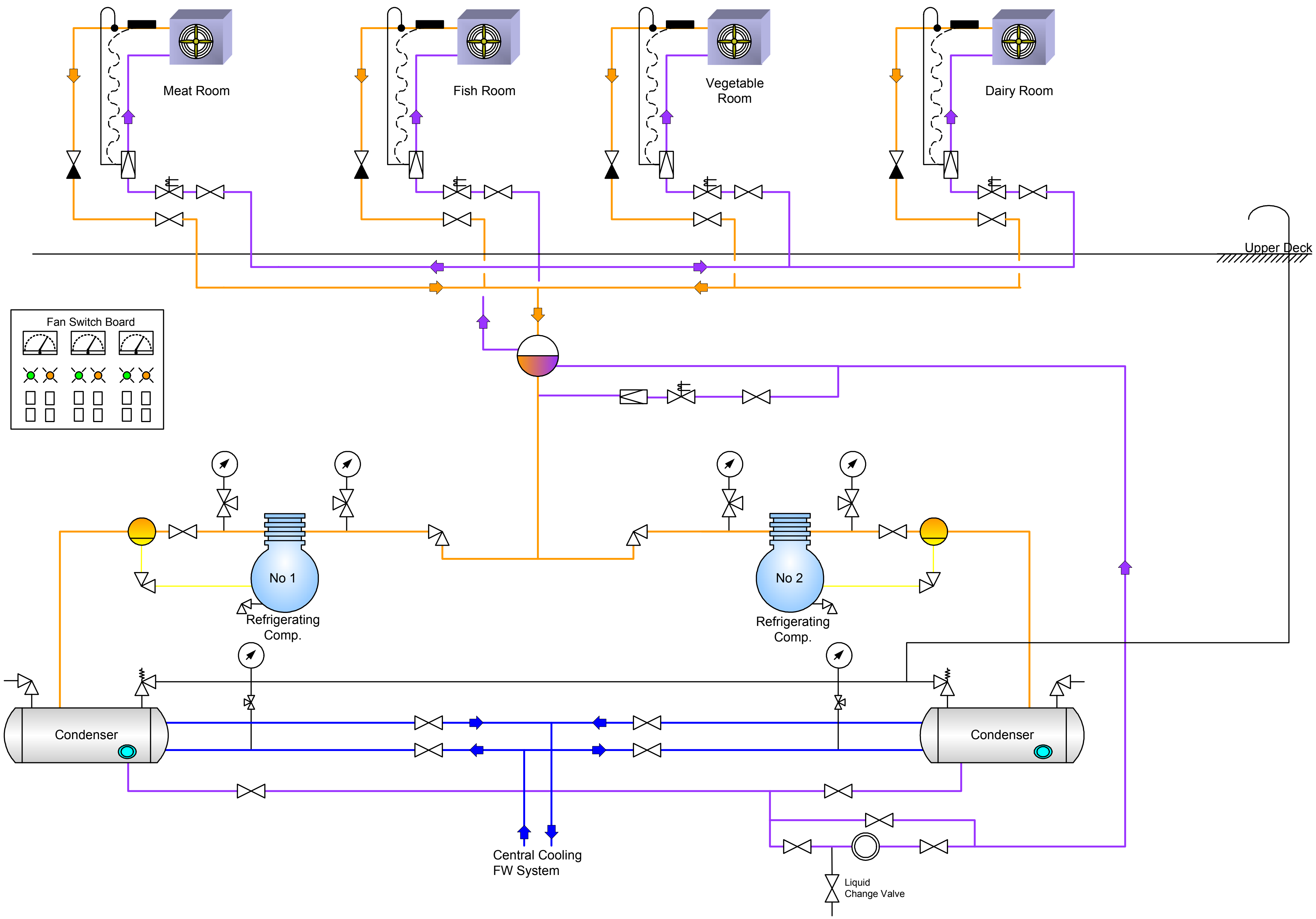


Illustration 2.13.1i Domestic Refrigeration System



2.13 Accommodation Services

2.13.1 Provision Refrigeration System

Introduction

The Cooling unit for the meat room, fish room, vegetable room, and dairy room is provided by a direct expansion R-404A system.

The plant which is in the engine room on the 1st deck starboard side is automatic and consists of two compressors, two condensers, and an evaporator coil in each of the five cold rooms. Air in the cold rooms is circulated through the evaporator coils by electrically driven fans. The meat room and fish room evaporators are equipped with a timer controlled electric defrosting element. The frequency of defrosting is chosen by means of a defrosting relay built into the starter panel.

Under the normal conditions one compressor/condenser unit is in operation, with the other on stand-by but on manual start up, with all valves shut until required.

The plant is not designed for continuous parallel operation of the two systems because of a risk of the transfer of lubricating oil between the compressors. To bring down the room temperatures after storing in tropical climates, both compressors may be run in parallel operation for a short period only.

The compressor draws R-404A vapour from the cold room cooling coils and pumps it under pressure to the central fresh water cooled condenser where the vapour is condensed. The liquid refrigerant is returned through a dryer unit and filtered to the cold room evaporators.

The compressors are protected by high pressure, low pressure and low lubricating oil pressure cut-out switches. Each unit is also fitted with a crankcase heater. A thermostat in each room enables a temperature regulating device to operate the solenoid valves independently, in order to reduce the number of starts and the running time of the compressor. The air coolers accept the refrigerant as it expands, into a super cooled vapour, under the control of the expansion valves. This vapour is then returned to the compressor through the non-return valves. The low pressure switches will stop the compressors when all the solenoid valves at the air coolers are closed.

A back pressure controlled constant pressure valve is included in the vegetable and dairy rooms to prevent these rooms from dropping too far below the normal set point. This would damage the provisions, should the inlet solenoid valve fail to close properly. Any refrigerant gas leaks from the system will result in the system becoming undercharged. The symptoms of a system undercharge include be low suction and discharge pressures with the system eventually becoming ineffective. Bubbles will appear in the sight glass. A side effect of low refrigerant gas charge is apparent low lubricating oil level in the sump. A low charge level will result in excess oil being entrapped in the circulating refrigerant, thus the level in the sump will drop. When the system is charged to full capacity, the excess oil will be isolated and returned to the sump.

During the operation the level in the condenser level gauge will drop. If the system becomes undercharged, the whole system should be checked for leakage. When required, an additional refrigerant can be added through the charging line, after first venting the connection between the refrigerant bottle and the charging connection. The added refrigerant will be dried before entering the system. Any trace of moisture in the refrigerant system will lead to problems with the thermostatic expansion valve icing up and causing subsequent blockage.

- Compressor
  Maker: SABROE
  No. of sets: 2
  Model: SBO 42

- Condenser
  Model: CRNF 271230
  No. of sets: 2

Operating Procedure

(1) To Start the Refrigeration Plant

a) All stop valves, except the compressor suction, in the refrigerant line should be opened and fully sealed to prevent the pressure in the valve from reaching the valve gland.
b) The crankcase heater on the compressor that will be used should be switched on a least three hours prior to starting the compressor.
c) Check if the oil level is correct.
d) Start the ancillaries, pumps etc.
e) Open the valves for condensation water. Check to make sure if there is sufficient flow.
f) Open the suction valve.
g) Start the compressor.
h) Continue opening the suction valve slowly, taking care not to allow liquid into the compressor and keeping the suction pressure above the cut out point.

While running:

Check the inlet and outlet pressure gauges
Check the oil level and oil pressure
Check for leakages

(2) To Put the Cold Chamber System into Operation

a) Open the refrigerant supply to one cooler room.
b) Open the refrigerant returns from the cooler room.
c) Repeat the above for each of the cooler rooms.

Defrosting

The air coolers in the meat room and fish room are fitted with electrical defrosting. i. e., an evaporator and drip trays are provided with electric heating elements. The frequency of defrosting is chosen by means of a defrosting relay built into the starter panel. The defrosting sequence is as follows:

(1) The compressor stops and all solenoid valves in the system are closed.

The fans in the meat room and fish room stop working but the fans in the vegetable room continue the circulation of the warm air over the coolers, keeping the cooling surfaces free from ice.

(2) The electric heating elements in the meat and fish room are switched on.

As long as the coolers are covered with ice, the melting takes nearly all of the heat supplied the temperature of the cooler and the refrigerant are constantly kept near zero. When the ice has melted, the refrigerant temperature rises in the meat and fish rooms. When the temperature reaches the set point (approximately +10°C) of the defrosting thermostat, the heating elements are switched off.

(3) The compressor starts.

When the coil surface temperature has gone below the freezing point, the fans in the meat and fish room start working. The system has switched back to the refrigerating cycle. If the defrosting is not completed at the expiration of the predetermined defrosting period, the timer will program a new cycle.

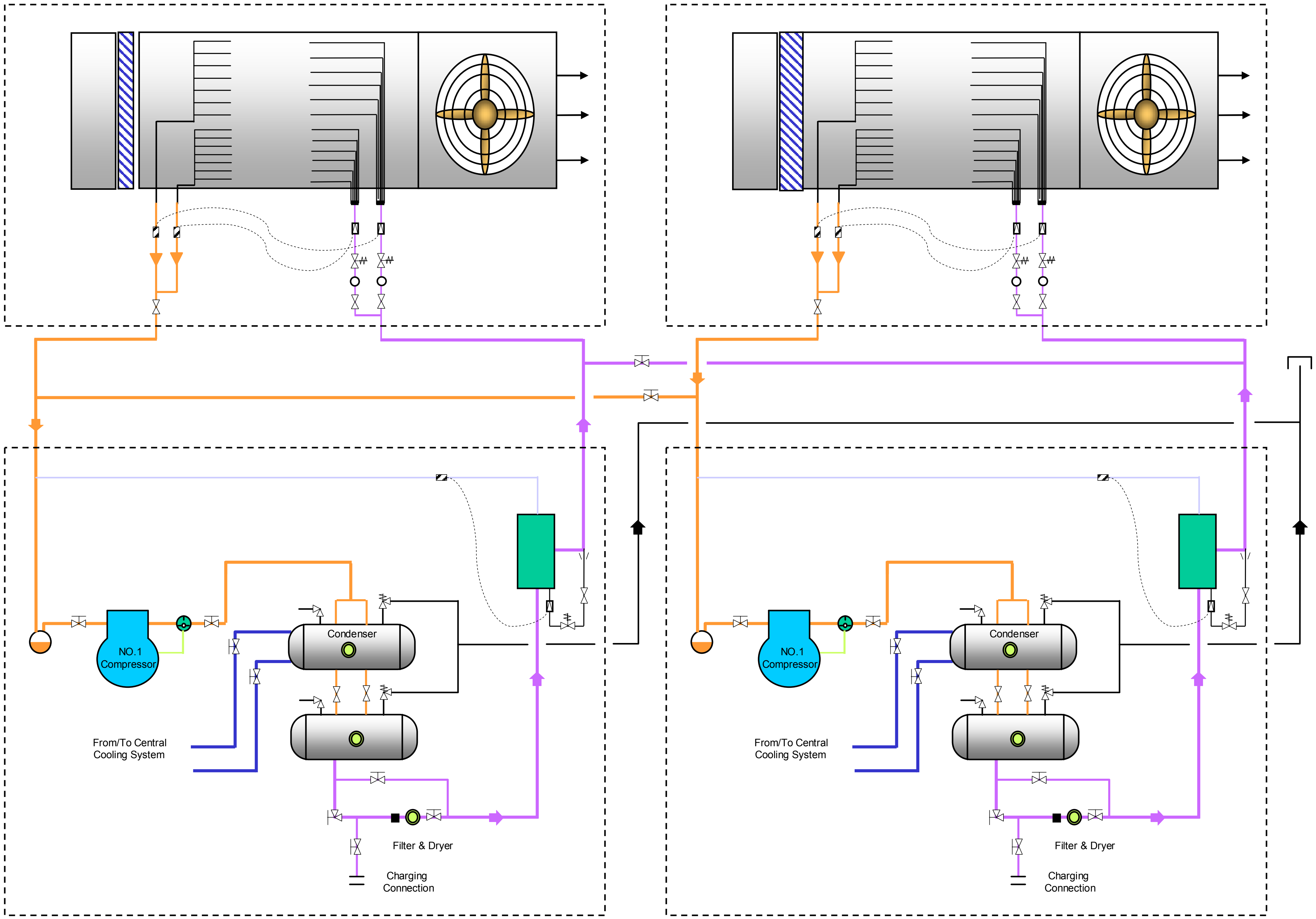
System to Run Checks at Regular Intervals

Lubricating oil levels in the crankcase
Lubricating oil pressure
Moisture indicators
Suction, discharge pressure, and temperature, and any unusual variations are investigated
Check all room temperatures and evaporation coils for any sign of frosting

The following conditions register in the central alarm system:

Power failure
Overcurrent trip
High pressure trip
Oil low pressure trip
Cold room high temperature alarms

Illustration 2.13.2i Accommodation Air Conditioning Plant



2.13.2 Accommodation and Air Conditioning Plant

2.13.2.1 Air-Conditioning Plant

Introduction

The air is supplied to the accommodation room by two identical air handling units located in the Upper Deck. Each unit consists of an electrically driven fan drawing air through the following sections:

Pre-heating coils
Filter
Mixing chamber for fresh and recirculated air
Re-heating coils
Heating coils
Electric heating coils
Evaporator coils
Humidifier nozzles
Water separator
Fan

The air is forced into the distribution trunk, which supplies the accommodation. Air may be drawn into the system either from outside, or from the accommodation via recirculation trunks. With heating or cooling coils in use, the unit is designed to operate on 65% fresh air supply. The ratio of circulating air may be varied manually, using the damper in the inlet trunk. The inlet filters are of the washable mat type, and heating is provided by coils supplied by steam from the 0.8 MPag system.

Cooling is provided by a direct expansion R-404A system. The plant is automatic and consists of two compressor/condenser/dryer units, supplying four evaporator coils, (one high load and one low load evaporator) and two in each of the two separate air handling units in the accommodation. The low load unit is supplied from the same compressor/condenser/dryer as that of supplying the opposite air handling unit high load evaporator.

Under extreme conditions it is possible that one compressor can serve both the high or low capacity air handling units by opening the cross connections on the delivery and return lines. At no time must the cross connection valves be opened while both compressors are in service.

Each compressor/condenser/dryer unit has 70% of the total capacity requirement and, under normal conditions, two compressors would be in use. Direct expansion coils achieve cooling of the air. The coils are fed with refrigerant from the air conditioning compressor as a superheated gas, which is passed through the condenser where it is condensed to a liquid. The liquid R-404A is then fed via filter drier units to the cooling coils where it expands, under the control of the expansion valves, before being returned to the compressor as a gas.

The compressor is fitted with an internal oil pressure activating unloading mechanism, which affords automatic starting and variable capacity control. A high and low pressure cut out switch and low Lubricating oil pressure trip protects the compressor. A crankcase heater and cooler are fitted.

Any leakage of refrigerant gas from the system will result to the system becoming undercharged. The symptoms of system undercharge include low suction and discharge pressure, with the system eventually becoming ineffective.

A side effect of low refrigerant gas charge is an apparent low oil level in the sump. A low charge level will result in excess oil being entrapped in the circulating refrigerant gas, thus the level in the sump will drop. When the system is charged to full capacity, this excess oil will be isolated and returned to the sump. During operation, the level as shown in the condenser level gauge will drop. If the system becomes undercharged, the whole system pipe work should be checked for leakage. If a loss of gas is detected, additional gas can be added through the charging line, after first venting the connection between the gas bottle and the charging connection. The added refrigerant is dried before entering the system. Any trace of moisture in the refrigerant will lead to problems with the thermostatic expansion valve icing up and causing subsequent blockage. Cooling water for the condenser is supplied from the low temperature fresh water cooling system.

Procedure for the Operation of the Air Conditioning System

(1) To Start the Ventilation System

Check if the air filters are clean.
Set the air dampers to the “outside” position.
Start the supply fans.

(2) To Start the Air Conditioning Compressor

a) All stop valves in the refrigerant line should be opened (except for the main valve in the liquid line) and fully sealed to prevent the pressure in the valve reaching the valve gland.
b) Open the compressor discharge valve.
c) The crankcase heater on the compressor that will be used should be switched on three hours prior to starting the compressor.
d) Check the oil level.
e) Check the settings of the compressor safety devices.
f) Start the ancillaries, cooling water pumps etc.
g) Open the valves for the condenser cooling water. Check if there is sufficient flow.
h) Set the capacity regulator to minimum capacity.
i) Open the compressor suction valve slightly. This will prevent excessive pressure reduction in the compressor upon start up, which could cause oil foaming in the crankcase.
j) Start the compressor.
k) Continue opening the suction valve slowly, taking care not to allow liquid into the compressor, and keep the suction pressure above the cut out point.
l) Open the main valve in the liquid line.
m) If the oil in the crankcase foams or a knocking sound is heard, due to droplets of liquid being fed with the suction gas, shut in the suction valve immediately.
n) Increase the setting on the capacity regulator.

(4) Compressor Running Checks

The lubricating oil pressure should be checked at least daily.
The oil level in the crankcase should be checked daily.
The suction and discharge pressure should be checked regularly.
The temperature of oil, suction and discharge should be checked regularly.
A regular check on the motor bearing temperatures should also be kept.
Check on any undue leakage at the shaft seal.
Check that the solenoid valve on the oil return line remains closed for 20-30 minutes after starting, after which check the operation of the oil return line. The pipe should normally be warm.

(5) To Stop the Compressor for Short Periods

a) Reduce the capacity regulator to the minimum setting.
b) Close the condenser liquid outlet valve.
c) Allow the compressor to pump out the system so that the low-level pressure cut- out will work.
d) Close the filter outlet valve.
e) Isolate the compressor motor.
f) Close the compressor suction valve.
g) Close the compressor discharge valve.
h) Close the inlet and outlet valves on the cooling water to the condenser.
i) Switch on the crankcase heater.

(6) To Shut Down the Compressor for a Prolonged Period

If the cooling system is to be shut down for a prolonged period, it is advisable to pump down the system and isolate the refrigerant gas charge in the condenser.

Leaving the system with full refrigerant pressure in the lines increases the tendency to lose charge through the shaft seal.

a) Shut the liquid outlet valve on the condenser.
b) Run the compressor until the low pressure cut-out works.
c) After some time the suction pressure may rise as the evaporators warm up, in which case the compressor should be allowed to pump down again, until the suction pressure remains low. It may be necessary to reduce the setting of the low pressure cut out.
d) Shut the outlet valve from the filter.
e) Shut the compressor suction and discharge valves.
f) Close the inlet and outlet valves on the cooling water to the condenser.
g) The compressor discharge valve should be marked “closed”, and the compressor motor isolated, to prevent possible damage.

(7) Adding Oil to the Compressor

Oil can be added to the compressor while it is running by using an oil pump connected to the oil charging connection or by using the following procedure.

a) Throttle the suction valve until the suction pressure is slightly below the atmospheric level. It will be necessary to reduce the setting of the low pressure cut out.
b) Connect a pipe to the oil charging valve, fill the pipe with oil and insert the free end into a receptacle containing the refrigerator oil.
c) Open the charging valve carefully, allowing atmospheric pressure to force the oil into the crankcase and avoiding ingress of air.
d) Reset the low pressure trip.

2.13.2.2 Package Air-Con for Galley

Specification

No.1 Cooling unit

Maker	HI-PRESS
Cooling capacity	8.6kW
Weight	25kg

No.2 Indoor unit

Maker	SANYO
Type	SPW-U253G56
Power source	220V 60Hz/1phase
Cooling capacity	8.6 kW
Air volume	780 m^3/h
Weight	50 kg

No.3 Outdoor unit

Maker	DANFOSS
Type	HGZ-050
Power source	220V 69Hz/1phase
Cooling capacity	10.9 kW
Air volume	4650 m^3/h
Weight	96 kg
Refrigerant	R-404A

Model	Refrigerant	Low press. side		High press. side	
		Cut in (MPag)	Cut in (MPag)	Cut in (MPag)	Cut in (MPag)
HGZ	R-404A	0.12	0.05	2.4	2.8

Package Air-Con for Galley Diagram

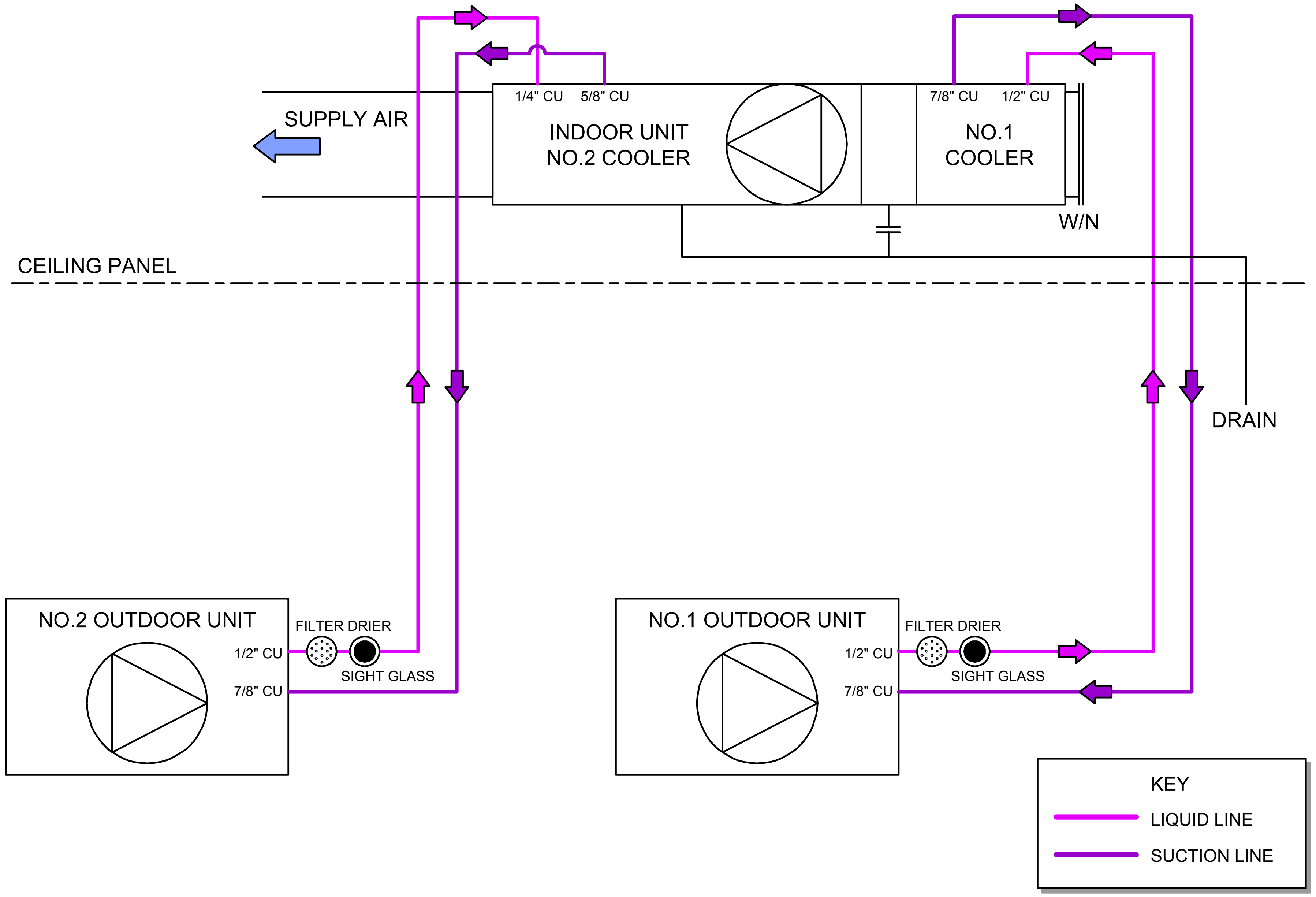
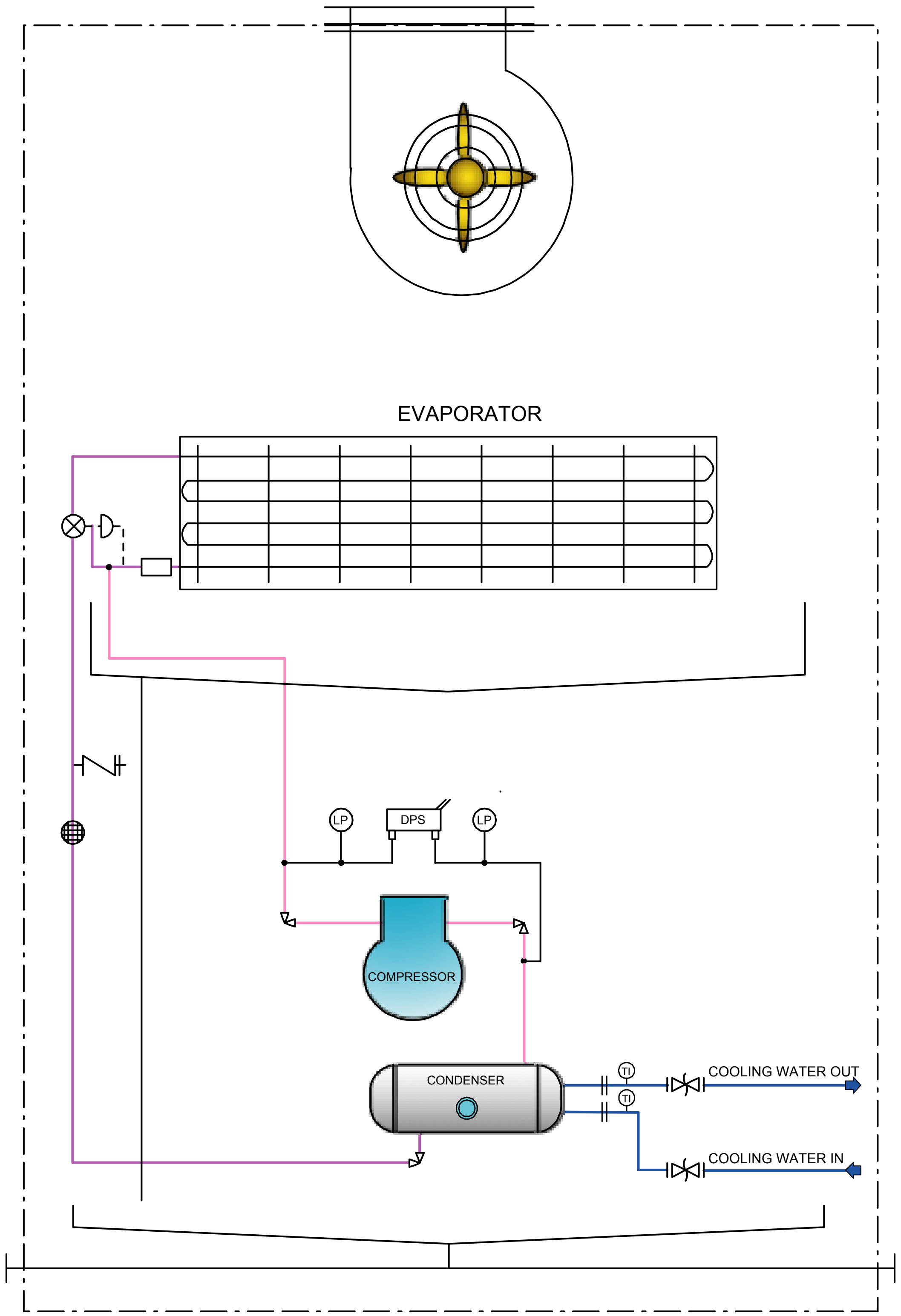
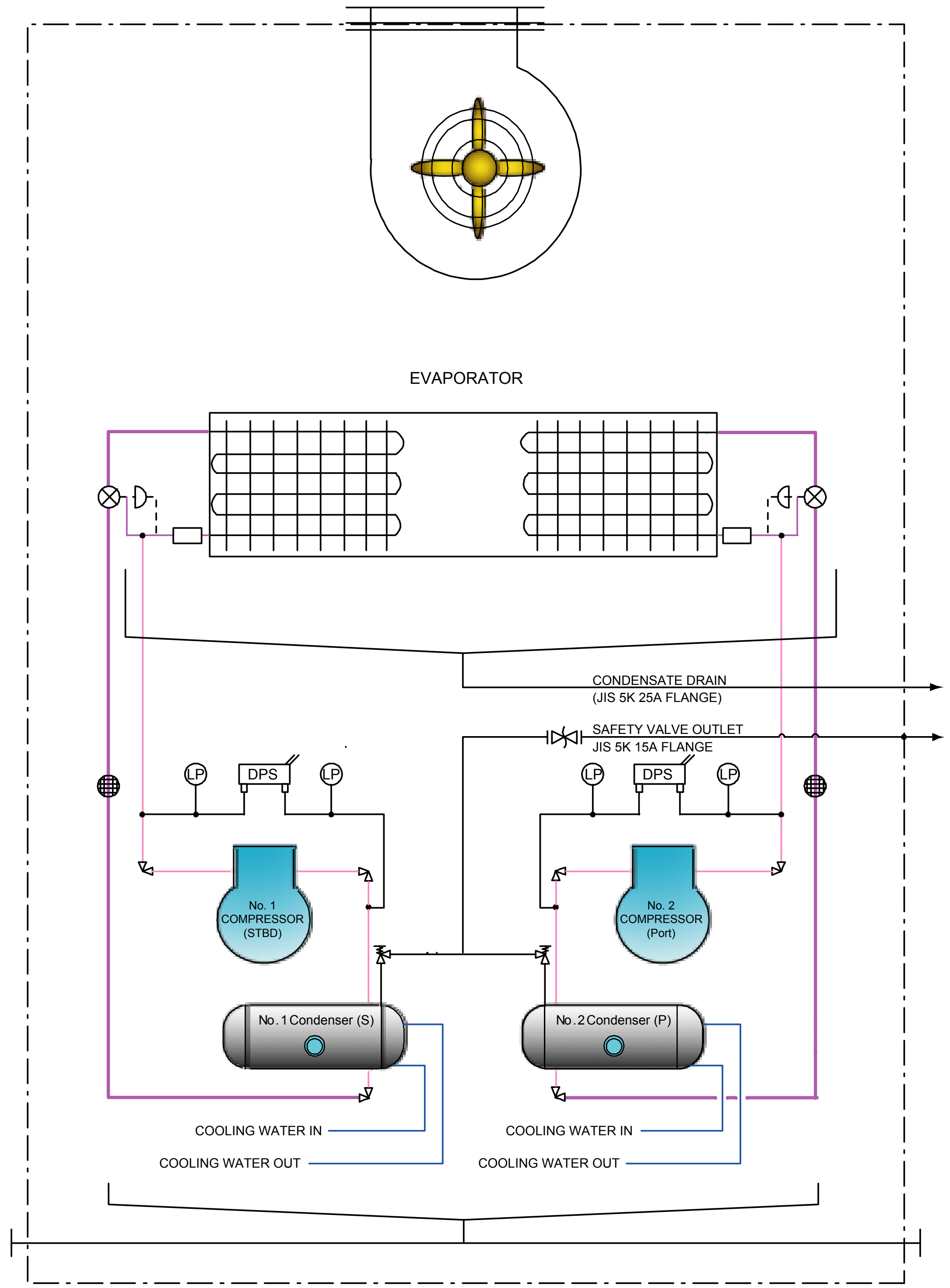


Illustration 2.13.3i Package Air Conditioner

Engine Control Room and No.2 MSBR



Work Shop and No.1 MSBR



2.13.3 Package Air Conditioner

General

Each unit consists of an electrically driven fan drawing air through the following sections:

Mixing chamber for fresh and recirculated air (90%)
Filter
Heating coils
Evaporator coils
Fan

The air is forced into the distribution trunk, which supplies the engine control room. The inlet filters are the washable mat type.

Cooling is provided by a direct expansion R-404A system. The plant is automatic and consists of two compressor, condenser units, supplying evaporator coils, one in each of the two separate air handling units in the engine room. Each compressor and condenser unit has 50% of the total capacity requirement and, under normal conditions, two compressors would be in use, each supplying their own air handling unit. Direct expansion coils achieve cooling of the air. The coils are fed with refrigerant from the air conditioning compressor as a superheated gas, which is passed through the condenser where it is condensed to a liquid. The liquid R-404A is then fed via filter drier units to the cooling coils where it expands, under the control of the expansion valves, before being returned to the compressor as gas.

The compressor is fitted with an internal oil pressure activated unloading mechanism, which affords automatic starting and variable capacity control. A high and low pressure cut out switch and low lubricating oil pressure trip protects the compressor. A crankcase heater and cooler are fitted.

Any leakage of refrigerant gas from the system will result in the system becoming undercharged. The symptoms of system undercharge include low suction and discharge pressure, and an ineffective system.

A side effect of low refrigerant gas charge is an apparent low oil level in the sump. A low charge level will result in excess oil being entrapped in the circulating refrigerant gas, thus the level in the sump will drop. When the system is charged to full capacity, the excess oil will be isolated and returned to the sump. During operation, the level in the condenser level gauge will drop. If the system becomes undercharged, the whole system pipe work should be checked for leakage. If a loss of gas is detected, additional gas can be added through the charging line, after first venting the connection between the gas bottle and the charging connection. The added refrigerant is dried before entering the system. Any trace of moisture in the refrigerant will lead to problems with the thermostatic expansion valve icing up and causing subsequent blockage. The cooling water for the condenser is supplied from the low temperature fresh water cooling system.

Engine Control Room

(1) Model : MP-G7 HF3
Capacity : 22,000 kcal/hr
Supply air volume : 60 m^3/min

(2) Compressors
Maker : CENTURY CORPORATION
No. of sets : 1
Model : TAN4590Z
Oil Type : ESTER OIL
Refrigerant : R-404A

(3) Procedure for the Operation of the Air Conditioning System

The air conditioning system is designed to run with one compressor on each air handling unit. On borderline temperature areas, and during maintenance of one of the compressors, the system can be crossed over, allowing one compressor to supply both air handling units.

Before opening the crossover valves, to prevent over charging the system in use, make sure that the shut down system is fully pumped down. Also pump down the running unit before separating the two systems by closing the crossover valves.

(4) To Start the Ventilation System

a) Check if the air filters are clean.
b) Set the air dampers to the outside position.
c) Start the supply fans.

Work Shop

Comprising a fan, compressor, refrigerant circuit, filters and controls, these are all self-contained and are air cooled.

(1) Model : MP-G15 HF3
Capacity : 45,000 kcal/hr
Supply air volume : 120 m^3/min

(2) Compressors
Maker : CENTURY CORPORATION
No. of sets : 2
Model : TAN4590Z
Oil Type : ISO VG32 or equivalent
Refrigerant : R-404A

Switch board Room

Comprising a fan, compressor, refrigerant circuit, filters and controls these are all self-contained and are air cooled.

No.1 Switch board room

(1) Model : MP-G15 HF3
Capacity : 45,000 Kcal/hr
Supply air volume : 120 m^3/min

(2) Compressors
Maker : CENTURY CORPORATION
No. of sets : 2
Model : TAN4590Z
Oil Type : ISO VG32 or equivalent
Refrigerant : R-404A

No 2 Switch board room

(1) Model : MP-G10 HF3
Capacity : 30,000 Kcal/hr
Supply air volume : 88 m^3/min

(2) Compressors
Maker : CENTURY CORPORATION
No. of sets : 1
Model : TAN4612Z
Oil Type : ESTER OIL
Refrigerant : R-404A

Procedure for the Operation

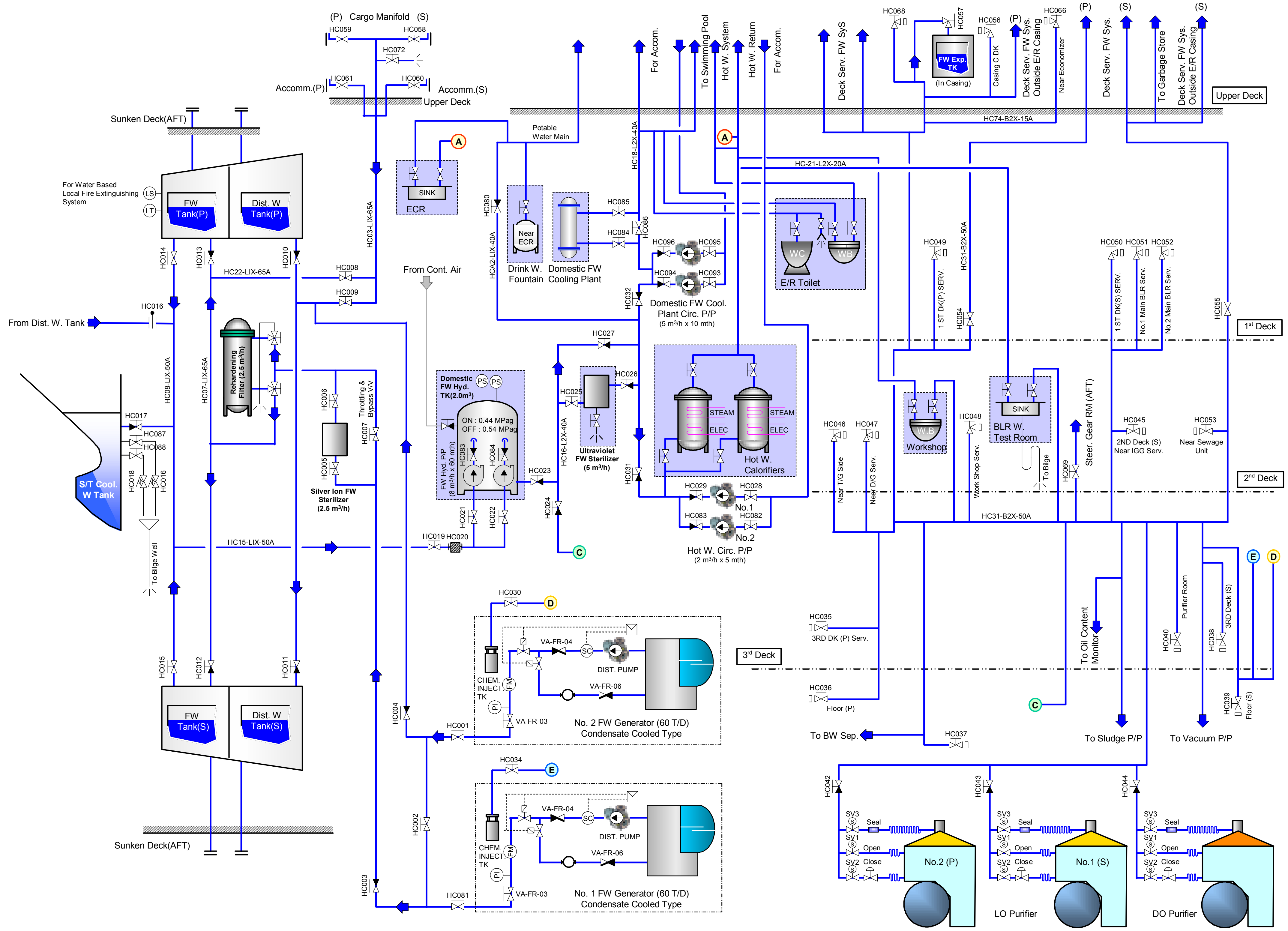
(1) Starting

a) Open the condenser refrigerant inlet and outlet valves.
b) Make sure that the air filter is clean.
c) Turn on the power switch at least six hours beforehand.
d) Start the fan.
e) Start the compressor by switching on the cooling ON/OFF selection switch.

(2) Shutting Down

a) Close the condenser refrigerant outlet valve.
b) Allow the compressor to shut down on the low suction pressure trip.
c) Stop the compressor.
d) Close the compressor stop valves on the suction and discharge lines.
e) Switch off the cooling ON/OFF selection switch.

Illustration 2.14.1i Fresh Water General Service System



2.14 Fresh Water General Service Systems

2.14.1 Fresh Water General Service System

Introduction

Fresh water for domestic use, other than that used for drinking, is stored in a fresh water storage tanks of 246 m^3 designated as the fresh water tank and supplies fresh water general services throughout the vessel. The other tank for domestic purposes is the drinking water tank with 253.7 m^3 of water. Each tank can supplement the other system via using locked valves. Both tanks are normally filled from the fresh water generators.

Water produced by the fresh water generators is piped directly to the water tanks. The fresh water tanks are filled from a shore supply with the bunker connections at the cargo manifold midships.

Water is supplied to the fresh water system by two pumps, which pressure the hydrophone tank with a 2 m^3 capacity. The system supplies water at a rate of 8 m^3/h at 0.54 MPag. One of the pumps will be on duty with the other pump on automatic stand-by. Water can be sourced direct from the hydrophone tank, supplies outlets in the engine room, accommodation, and deck. Fresh water is also supplied to the domestic fresh water cooler before passing into the accommodation areas. Fresh water is branched off before the cooler, passing to the calorifier, where it is heated for the domestic hot water system. Two calorifiers are a thermostatically controlled vertical storage and heating vessel, of 0.2 m^3 capacity, utilizing steam or electricity to provide heat. The electric heater is reserved for use when the steam plant is shut down or during a refit. Fresh water is heated to 70°C and is then circulated around the ship by the hot water circulating pump. By continually circulating the hot water around the ship, valuable water is saved by not having to run as much water off in order to get hot water at the outlet. Both the steam and electrical supplies are thermostatically controlled.

The fresh water system supplies the following:

- Sanitary system
- Cooled fresh water for accommodation cold water services, calorifier and accommodation hot water services
- LO and DO purifier operating water systems
- Swimming pool
- Deck service
- Sludge pump
- Steering gear room
- Vacuum pump
- Fresh water cooling system header tanks
- Bilge water separator
- Garbage storage

Preparation for the Operation of the Domestic Fresh Water System

Set up the valves as shown

Position	Description	Valve
Open	FW Tank Outlet Valve	HC014 or HC015
Closed	Hydrophone Discharge to FW System	HC023
Open	Master Valve to Hot Water System	HC031 or HC032
Open	Outlet from Calorifier	
Open	Inlet to Hot Water Circulating Pump	HC028 or HC082
Open	Outlet from Hot Water Circulating Pump	HC029 or HC083
Open	FW to Accommodation	HC026

(1) Start one FW supply pump.

(2) Fill the hydrophone tank to about 75% capacity.

(3) Stop the pump.

(4) Slightly open the air inlet valve to the tank until the operating pressure is reached.

(5) Close the air supply.

(6) Repeat steps (2)~(5) until the tank is at the operating pressure, with the water level at about 75% full.

(7) Switch one hydrophone pump to automatic operation.

(8) Open the hydrophone tank outlet valve HC023 slowly, until the system pressures.

(9) Start one hot water circulating pump.

(10) Vent air from the calorifier.

(11) Start the electric heater for the calorifier.

(12) Supply steam to the calorifier when steam is available.

(13) Shut down the electric heater.

2.14.2 Distilled Water Filling Service System

Introduction

Distilled water is stored in two distilled water storage tanks of 253.7 m^3 capacity each. They are normally filled directly from the fresh water generators, with a shore bunkering manifold port and starboard, forward of the accommodation block and FW filling on manifold.

The distilled water system serves the following:

- Feed water make- up for the boilers
- Emergency feed for boiler feed pumps via valve (FD016)
- Spill return from condensate drain pump system

The system supplies valve gland sealing to the following:

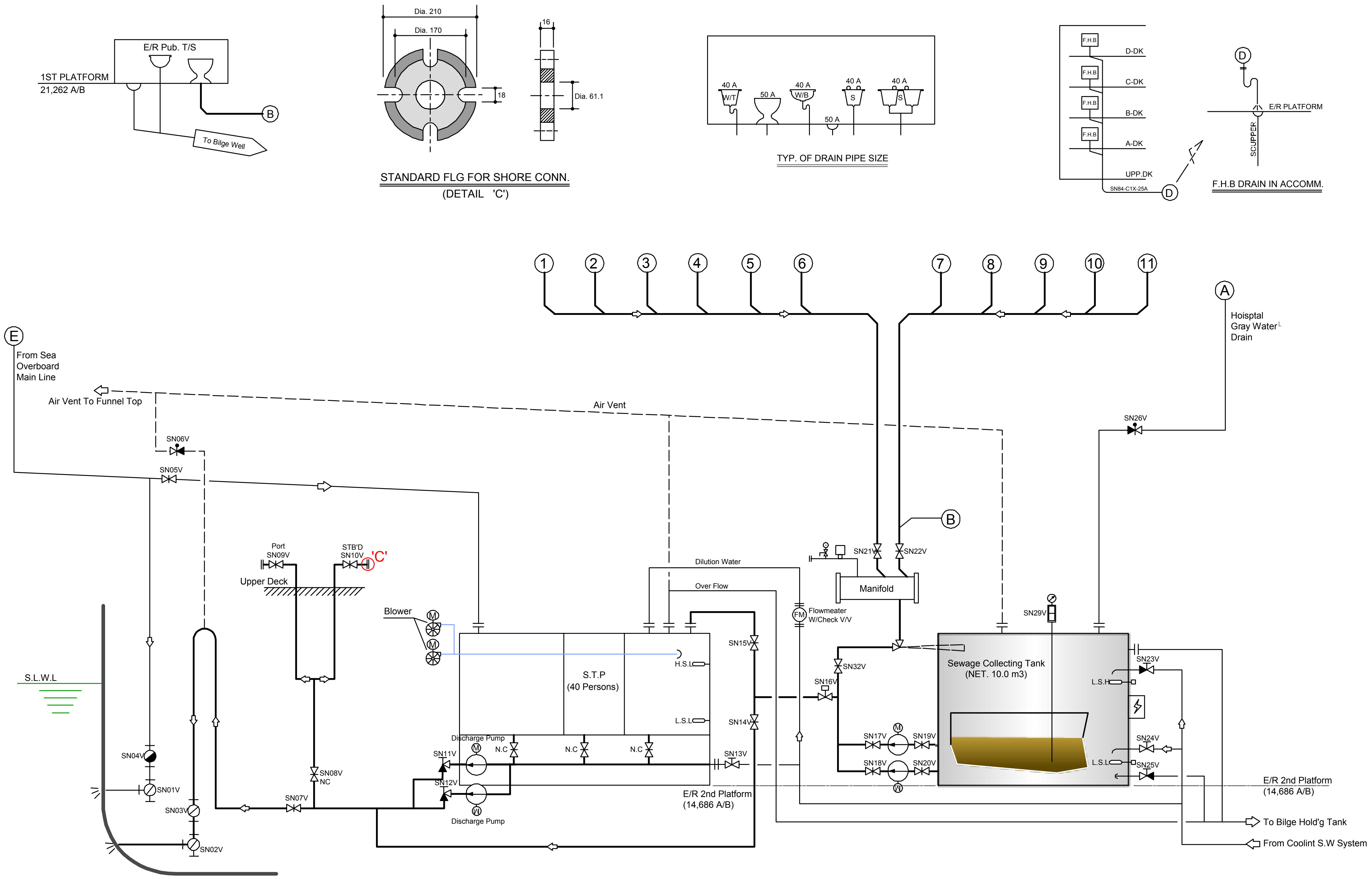
- Main condenser steam dump inlet
- Atmospheric condenser steam dump inlet
- Outlet stop valve of No.1 dump steam external desuperheater
- Outlet stop valve of No.1 dump steam external desuperheater
- Main turbine gland steam spill bypass to main condenser
- Main turbine gland steam spill outlet to main condenser
- Main turbine gland steam spill outlet
- HP exhaust steam dump control valve bypass
- HP exhaust steam dump control valve outlet
- No.1 generating turbine exhaust steam outlet to main condenser
- No.1 generating turbine exhaust steam outlet to atmospheric condenser
- No.2 generating turbine exhaust steam outlet to main condenser
- No.2 generating turbine exhaust steam outlet to atmospheric condenser
- HP exhaust steam dump to main condenser
- HP exhaust steam dump to atmospheric condenser

It is possible to run down water from the fresh water tank in an emergency into the distilled water line via valve CD074 and spectacle flange HC016. This valve is normally kept locked. A spectacle blank fitted before this valve ensures isolation and must be rotated in order to run one tank into the other.

Control and Alarm Settings

DIST W TK(S) LVL H/L	5.48-2.51	m
DIST W TK(P) LVL H/L	5.48-2.51	m
FW TK(P) LVL H/L	5.59-2.77	m
FW TK(S) LVL H/L	5.59-2.77	m
1 FW GEN. DIST W. SAL. HIGH	4	ppm
2 FW GEN. DIST W. SAL. HIGH	4	ppm

Illustration 2.14.3i Sanitary Discharge System



2.14.3 Sanitary Discharge System

General Description

The main functions of the Evac collecting unit are controlled via the electric control panel. Following functions are described:

- Vacuum generation for vacuum toilets and interface valves
- Holding and discharge operation
- Alarms, indications and connections to the monitoring system

Vacuum generation

The vacuum is generated by ejected pump M1 or M2 (depending on selector switch SO3 position) by circulating water through the ejector.

(1) Automatic vacuum generation

The vacuum switch S11 controls the level of the vacuum piping. It is set to start pumping at - 40 kPag and stop at – 55 kPag.

Note !
The low level switch S13 does not stop the pumps in the "Automatic vacuum generation" mode. Therefore in normal operation conditions, the water level in the tank has to be above the low level switch.

a) The control switch S01 (pump motor M1) or control switch S02 (pump motor M2) has to be in "Auto"mode.
b) The selector switch S03 is used to select operation as follow:

P1 DISCH. :	P1 is selected to use discharging (P2 is not in use)
P1 VAC. :	P1 is selected to use vacuum generation (P2 is not in use)
NORMAL :	P1 is select to use vacuum generation and P2 is selected to discharging use.
P2 DISCH.:	P2 is selected to use discharging (P1 is not use)
P2 VAC. :	P2 is selected to use vacuum generation (P1 is not in use)

(2) Manual vacuum generation

In the "Manual vacuum generation" mode, the vacuum switch is not use. The generation of the vacuum has to be controlled via the vacuum gauge.
The control switch S01 of the pump motor M1, or the control switch S02 of the pump motor M2 has to be switched to the MAN position.

Discharge operation

The discharging can be done either with pump M1 or pump M2, depending on the position of select switch S03.

- Evac collecting unit can discharge automatically either as TIMER or LEVEL controlled by selector switch S04.

Level controlled discharge operation

The discharge starts when the liquid level has reached the high level switch S12, and continues down to the low level switch S13.

- The selector switch S03 to be switched to position (M1 or M2) depending on which pump shall discharge.
- The control switches of the pumps motor, S01 and S02, has to be switched to AUTO position.
- The control switch S04 for discharge mode must be switched to "LEVEL" position.

The discharge stops when the discharge mode switches from the S04 to the "0" position. Although LEVEL controlled discharging is selected, the discharging is also controlled by external discharging interruption. If a discharge interruption is received, the discharging will stop.

Timer controlled discharge operation

The timer controlled operation is carried out with the timer K05T. Discharging time is adjustable, and is pre-set to 15 seconds. When the discharge starts, the selected pump also starts pumping. After a pre-set time, the discharge will stop and a timed pause will start. The duration of the pause between discharging is also adjustable, pre-set to 15 minutes.

a) The selector switch S03 can be switched to position (M1 or M2), depending on which pump shall discharge.
b) The control switches of the pumps motor, S01 and S02, have to be switched to AUTO position.
c) The control switch S04 for discharge mode must be switched to "TIMER" position.

Although timer-discharging is selected, the discharging is also controlled by:

- Low level switch S13 :
  The discharging stops if the level in the collecting tank sinks under the low level switch S13.
- High Level Switch S12 :
  If the level in the tank raises up to the high level switch S12 the discharging starts and stops as soon as the level sinks under the high level S12 switch.
- External discharge interruption :
  If the discharge interruption is received, the discharging stops.

Manually controlled discharge operation

Manually controlled discharging has always been strictly controlled in order not to cause overflow, discharging to non-permitted area or damage to the pump!

a) The control switch S01 or S02 of the pumps motor M1 or M2 are to be switched MAN-position.
b) The control switch for discharging mode S04 is to be switched to LEVEL-position.

The discharging will continue down to the low level switch S13.

By-passing the low level switch

The tank could be emptying completely by-passing the low level S13 switch. When the level meets the low level switch S13, an indication lamp starts to lit and discharging stops. In order to continue discharging the push button S05 for the low level by-pass must remain in down position.
The level has to be strictly controlled in order to prevent the pumps from running.

Note !
For the collecting unit to work in normal operation after emptying the tank, it must be filled above the low level S13 switch before starting the plant.

Other Functions

The other collecting unit functions can be observed from the control panel.

Following indications are shown:

a) Voltage connected	green
b) Ejector pump M1 running	green
c) Discharge pump M2 running	green
d) Discharging	green
e) Motors M1 or M2 overload	red
f) Under Low level	amber
g) Above high level	amber
h) High level failure	red
i) Vacuum failure	red

"TEST" through turning the control switch S06, checks the condition of the lamps.

Alarms

Following alarms can be taken from the terminal blocks to the control panel:

a) Unit group alarm, which consist of motor M1 or M2 overload or vacuum failure (if pumps run more than 15 minutes without interruption).
b) High level alarm (if the water level is more than 60s above the high level switch S12).

Reason for installing alarms must be recognized Reset the alarm by pushing "ALARM RESET" button S06

The discharged clarified and disinfected waste water is allowed to have the maximum values as shown in the following to meet the requirements of U.S coast guard as well as IMCO:

Coil count	:	Less than 200 per 100 mL
B.O.D	:	Less than 50 mg/litre
Suspended solids	:	Less than 50 mg/litre

Note !
For operating and maintenance procedure, please refer to the manufacturer's manual.

2.15 E/R General Piping Diagram

Illustration 2.15.1i Piping Diagram for Boiler Sealing system

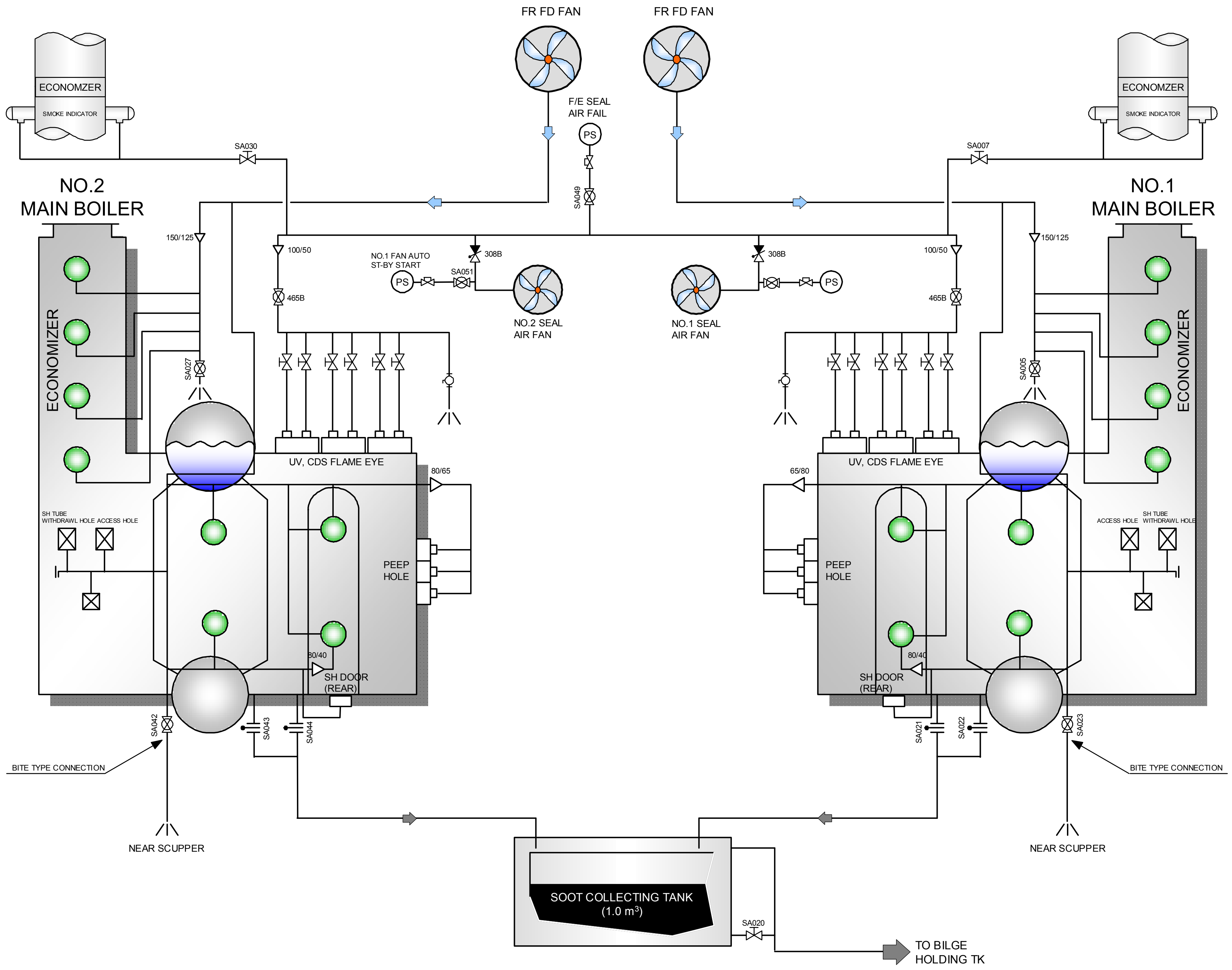


Illustration 2.15.2i Piping Diagram for Waste Steam System

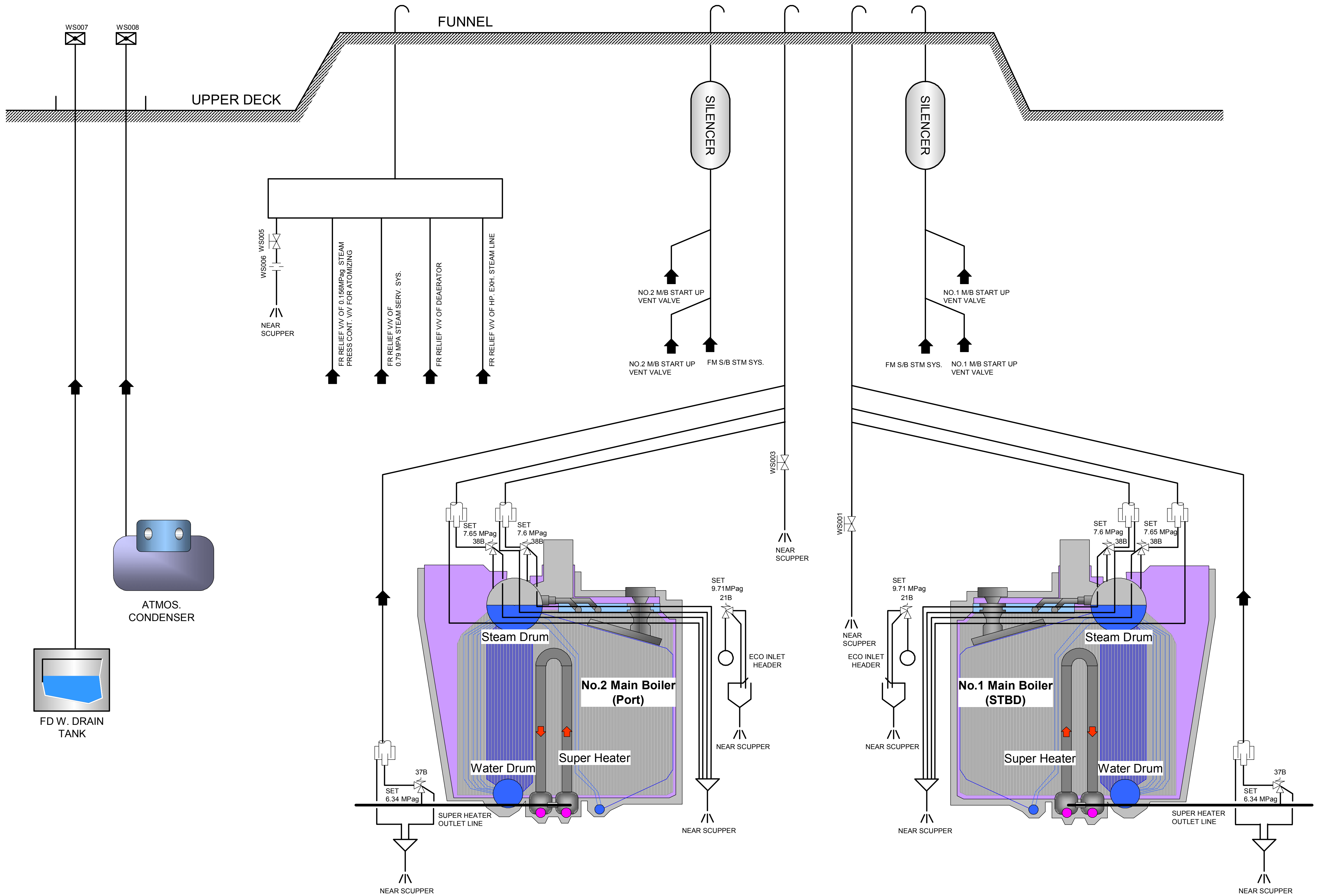


Illustration 2.15.3i Piping Diagram for LO Drain System

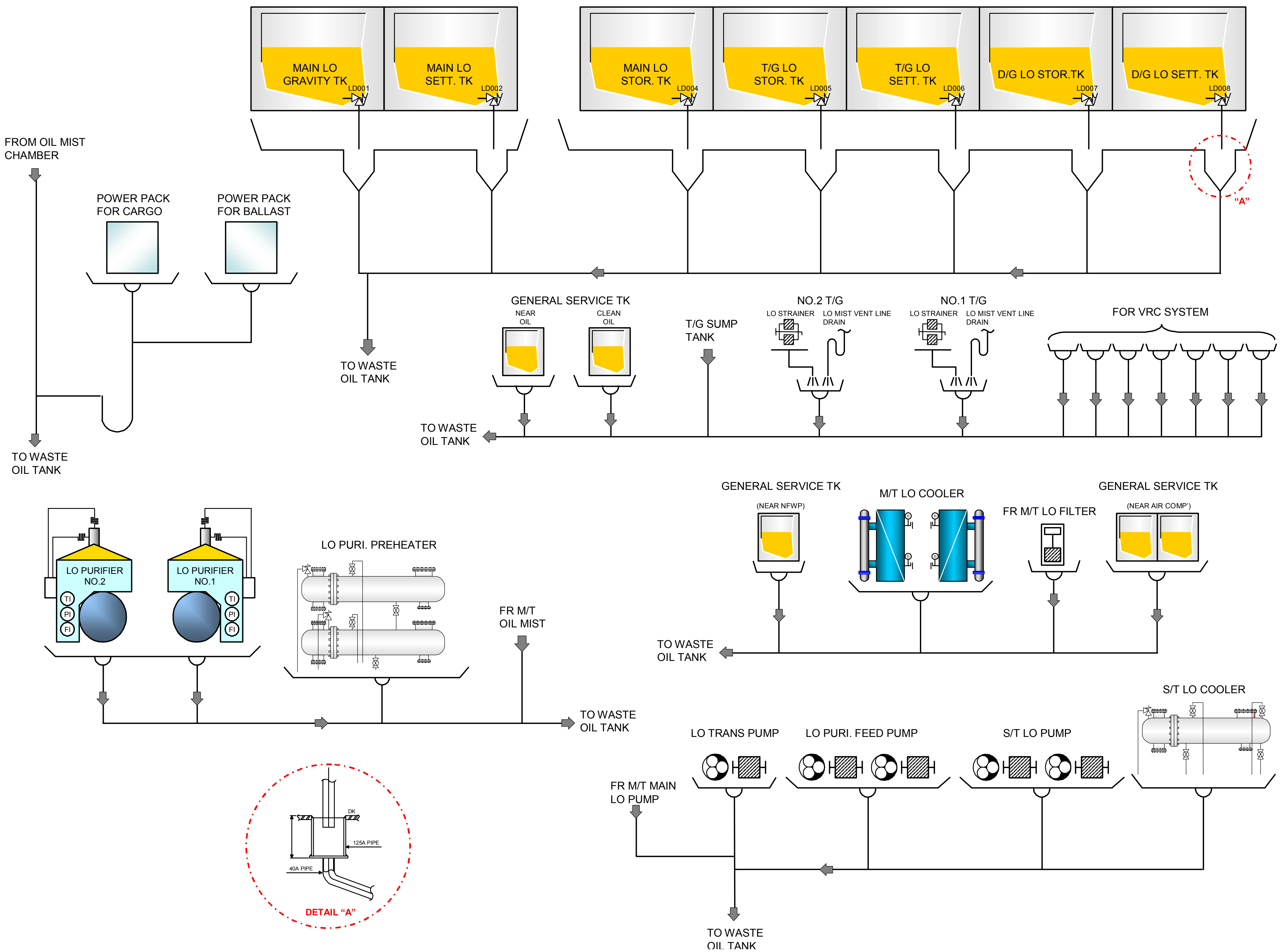


Illustration 2.15.4i Piping Diagram for FO Drain System

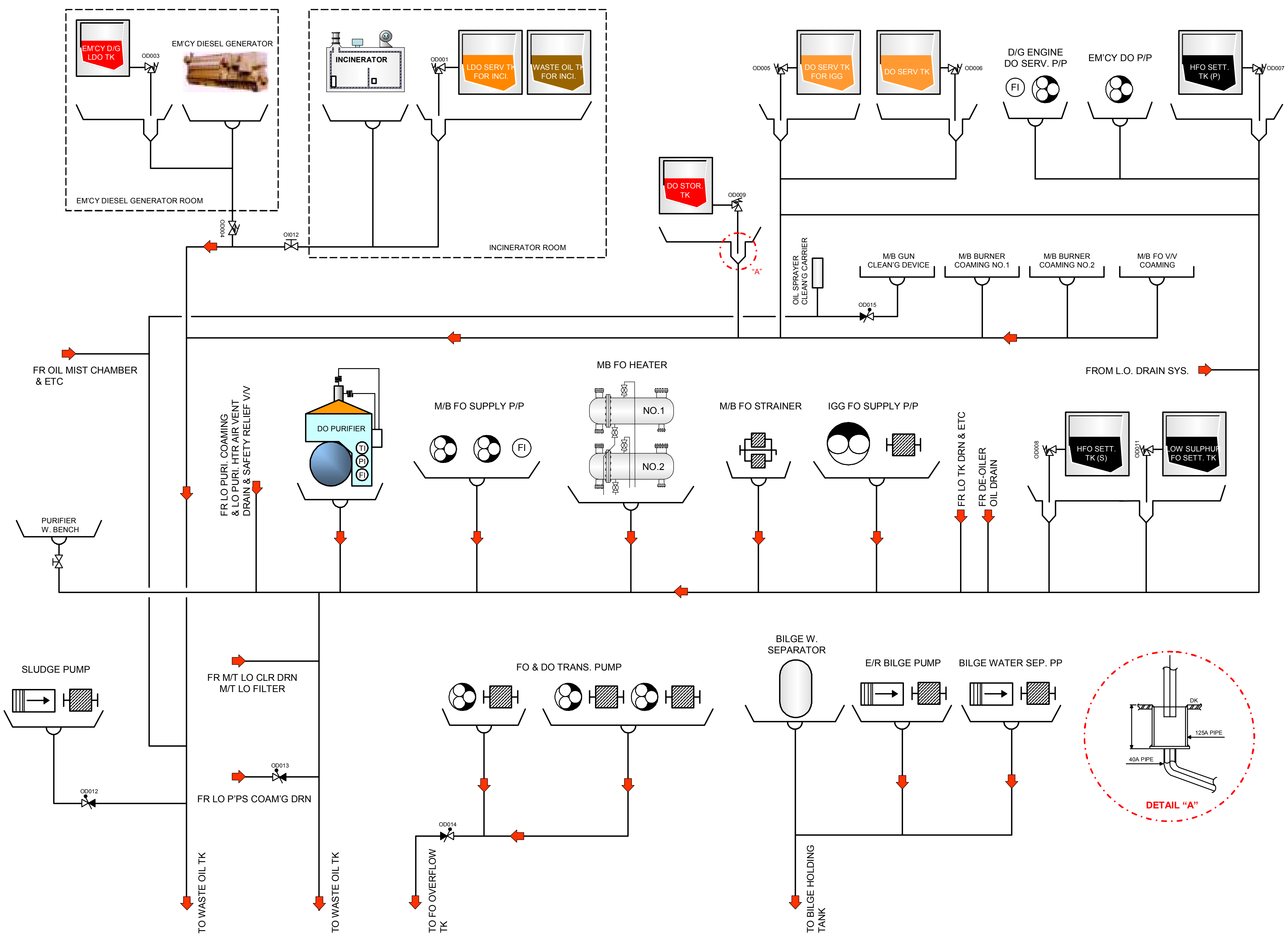
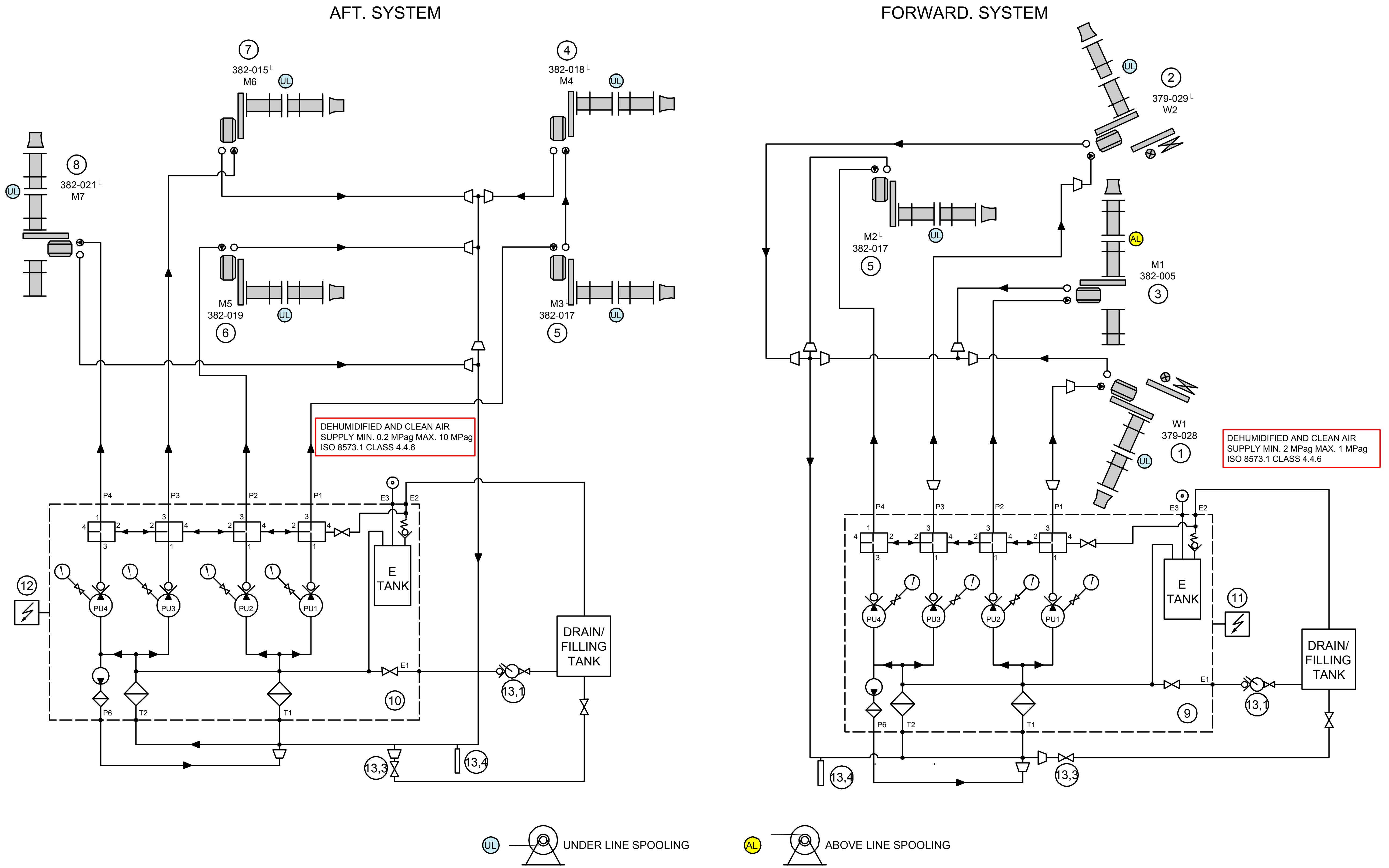


Illustration 2.16i Hydraulic Power System for Deck Machinery



2.16 Hydraulic Power System for Deck Machinery

General

Windlass

Maker	Rolls-Royce
Type	BFMC41.102
Sets	2
Capacity	49.4 tons

Mooring winch

Maker	Rolls-Royce
Type	WMC41030
Sets	7
Capacity	30 tons

Hydraulic oil
Check that the oil is clean and also if the right type and viscosity is used.

Air
Problems like noise in the system, reduced hoisting speed and power of the winches are often caused by the air in the system.
Air should be vented through air plugs often especially before the winches are used.

Expansion tank
This should always be filled to 2/3 of the height or to the sight glass if it is mounted.

Lubrication
The hydraulic system oil lubricates the moving parts in the hydraulic motors, pumps and valves. However, on most of the winches there will be some greasing points on the mechanical part and these should be sufficiently lubricated. Check also the oil level in gears and chain cases.

Bolts
Bolts on covers, flanges and other connections have to be tightened at all times to avoid leakage. Special attention should be drawn to new plants.

Alignment
At times it may be necessary to check the alignment of pumps and winches. Even if pumps and winches are carefully aligned when installed they can be misaligned later. When found misaligned (or to check misalignment) on fasten foundation bolts and turn the winch (pump) in order to correct it to turn freely. Be aware that misalignment can cause the equipment to break down.

Change over valves
These have to be fully opened/closed.
Partly opened/closed change over valves have slowed winch speed and power.
Check also if the change over valves are in the right position to lead the oil to the required winch.

Safety valves
These are normally adjusted from the factory. If necessary, however, to readjust the valve, please read the instructions on safety valve.

Before Starting
If the above are followed, the procedure before starting should be simple:

a) Before starting the pumps, be sure that control levers on all winches are in “stop” position.
b) Check the oil level in the expansion tank.
c) See item “**Air**”
d) During winter, the pumps should be started before the winches are used so that the hydraulic oil can be self-heated.
e) It is also important to follow the instructions regarding wires. All wheels, shackles and other moving parts have to be sufficiently lubricated.

! Note
A careful inspection during first mounting/installation period can prevent future breakdowns and expenses.

Part 3 : Integrated Automation System (IAS)

Part 3
Integrated Automation System (IAS)

Illustration 3.1.1a IAS Overview

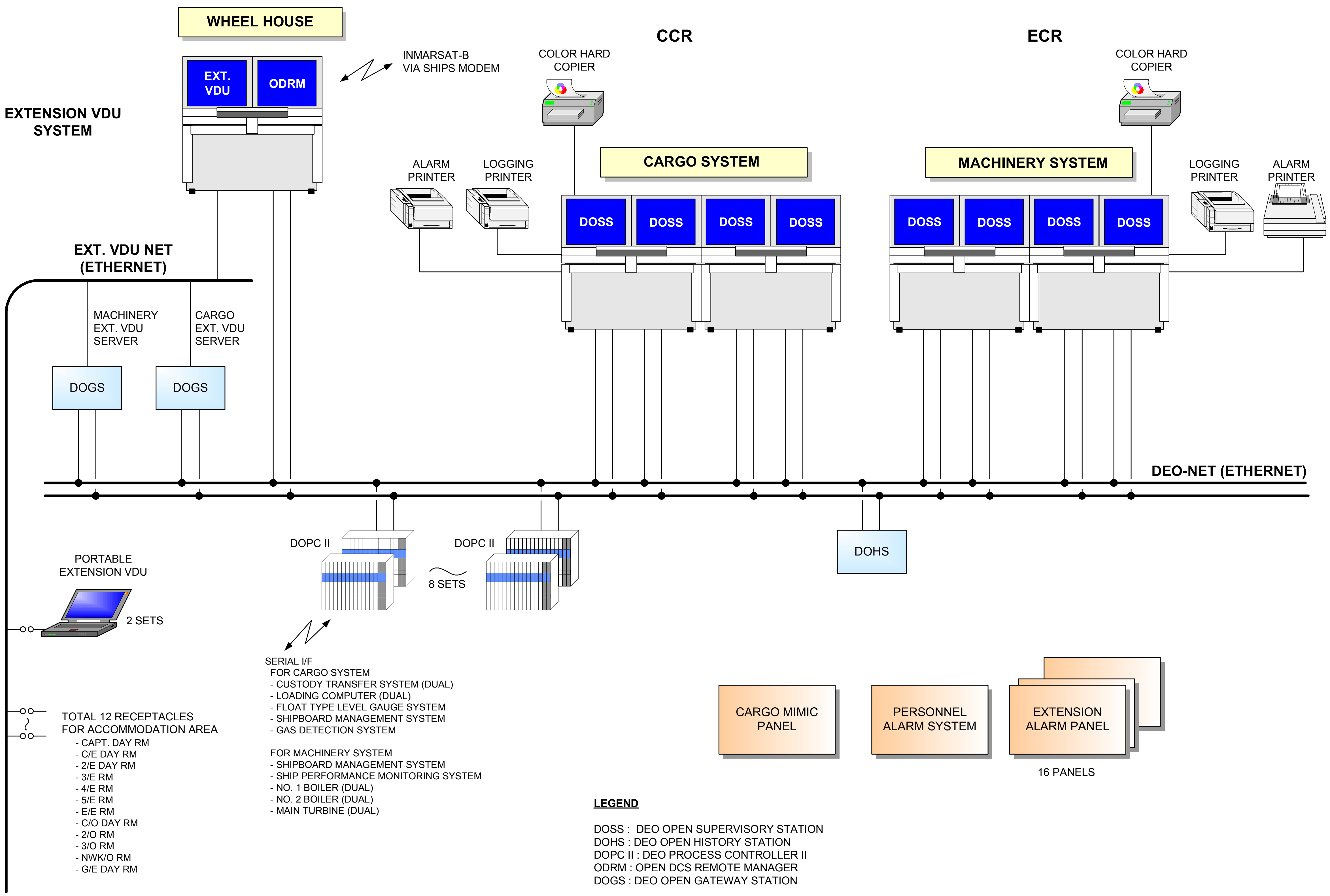


Illustration 3.1.1b IAS Overview

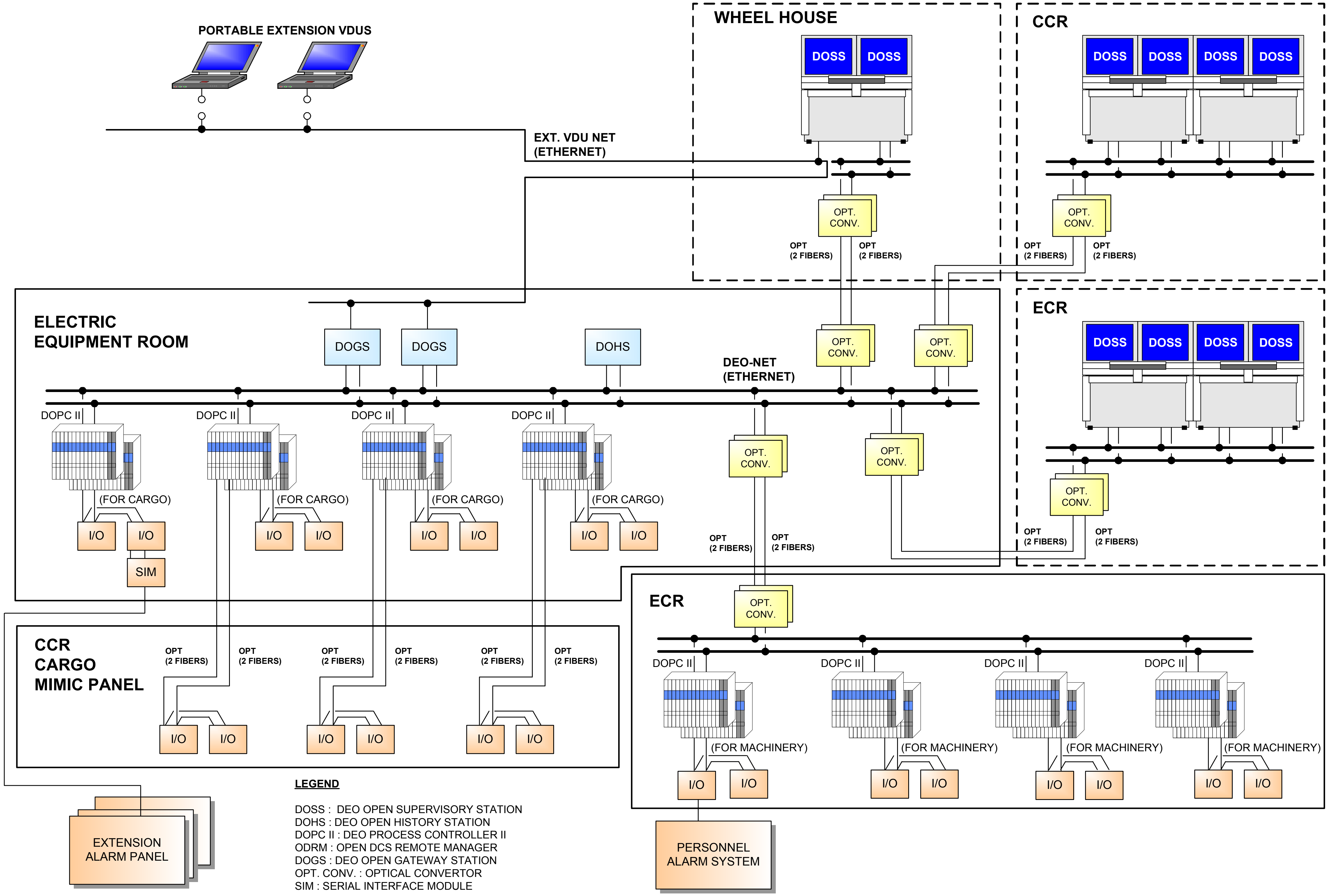
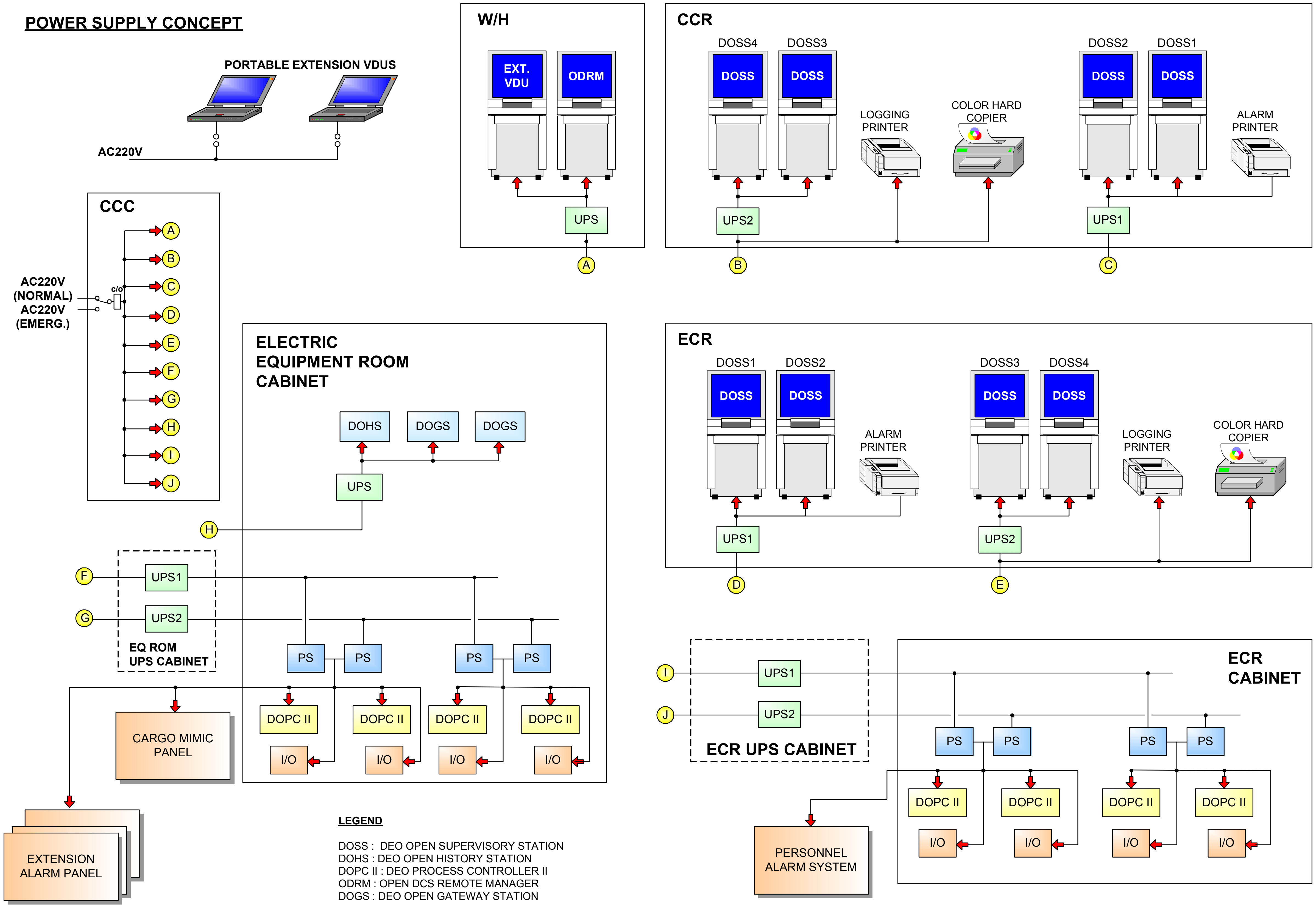


Illustration 3.1.1c IAS Overview



LEGEND

DOSS : DEO OPEN SUPERVISORY STATION
DOHS : DEO OPEN HISTORY STATION
DOPC II : DEO PROCESS CONTROLLER II
ODRM : OPEN DCS REMOTE MANAGER
DOGS : DEO OPEN GATEWAY STATION

Part 3 : Integrated Automation System (IAS)

3.1 General

The ship's Integrated Automation System (IAS) has been designed, programmed, and installed by Yamatake Industrial Systems.

Two entirely separate systems have been provided within the IAS for cargo/ballast operations (referred to the Cargo System) and machinery/electric generation plant operations (referred to the Machinery System). Other, independent control systems are interfaced either with the Cargo or Machinery Systems.

The IAS has been designed to ease and logical for the operator. Most of functions are automatically run, but, at any time, the operator can be intervened.

The grouping of the alarms allows easy access for identification, action, and alarm handling.

As even a momentary interruption of electrical power supply (220V AC) to the IAS could cause the failure of the IAS, a Uninterruptible Power Supply (UPS) system is installed for uninterrupted power supply to the designated IAS operator station.

Extension VDU System

The extension VDU system is used in plant monitoring, not in plant operation. The extension VDU also does not require the use of alarms in its operation.

There are two kinds of display for plant monitoring as follows.

- Alarm summary display:
  Applies the both the Cargo and Machinery Systems
  A simplified alarm summary display designed for this system is provided, indicating 100 points of the latest alarms recorded for each of the Cargo and Machinery Systems.

- Graphic display:
  Applies the both the Cargo and Machinery Systems
  Provides graphic displays designed for these systems.
  Plant monitoring display only.

An extension VDU network with receptacles for the portable VDU monitor is supplied to monitor the local status at the following locations:

- Captain's Day Room
- Chief Engineer's Day room
- 2/E Day Room
- 3/E Room
- 4/E Room
- 5/E Room
- E/E Room
- C/O Day Room
- 2/O Room
- 3/O Room
- NWK/O Room
- Gas/E Room

Portable and Extension VDU System

This VDU system is only for monitoring, not operations. Both the cargo and machinery can be monitored anywhere, but only 4 users can concurrently connected.

Cargo System

This system is used in the control and monitoring of the cargo and ballast auxiliaries and valves. In addition, automatic sequence control logic programs are provided for the cargo and ballast operations. Displays available include composed of overviews, operational graphics, monitoring graphics, operational guidance graphics and alarm displays.

The emergency shutdown system (ESDS), cargo tank protection system (except the cargo tank filling valve close function due to the cargo tank level very high), and machinery trip and safety systems are totally operating independently of the IAS. Alarms for these systems are sent to the IAS.

The cargo system signal from the dangerous zone inputs information through Intrinsic Safety barrier(I.S.). The IAS circuit between the dangerous zone and safety zone separate into Highway coupler module to maintain safety circuit condition. The equipment, which is relative to the I.S., supplis the power from I.S. transformer.

The following independent systems are interfaced with the cargo system for date gathering, calculation and monitoring purposes:

- Custody Transfer System
- Loading Computer
- Float Type Level Gauge System
- Shipboard Management System
- Gas Detection System

Common
A. Shipboard Management System
B. VDR

Machinery System

This system is capable of controlling and monitoring the main propulsion plant and Engine Room auxiliaries, and the electric generating plant system.

In addition, the system is capable of controlling and monitoring specified control valves, e.g. superheated steam temp., main turbine lubricating oil, the cooling water, etc. However, auxiliary pump Standby/Auto selection can also be carried out through this system.

The following independent systems are interfaced with the Machinery System:

- Ship Performance Monitoring System
- No.1 Boiler and Common Part
- No.2 Boiler
- Main Turbine
- Voyage data recorder
- Shipboard Management System

Common
A. Ship Board Management System
B. VDR

Printers

Each cargo and machinery system has the following printers in each CCR and ECR.

- Alarm printer 1set
- Logging printer 1set

The alarm printer prints out alarm history with time information form the ship's clock.
The logging printer provides data logging function by fixed time and operator's demand. Fixed time logging is initiated by the ship's time.

Color Hard Copier

This color hard copier is used for copying VDU displays.
Two sets of Color Hard Copiers are furnished in the CCR and ECR.
One is for the Cargo System and the other for the Machinery System.

3.2 IAS Overview

Maker : Yamatake Industrial System

General

As implemented on this ship, the IAS system controls and monitors almost all systems and equipments on board. The functions of the IAS are as follows:

System monitoring
System operation
Alarm handling, summary and acceptance
Data logging and trending
Data interface to other system
Control of the extension alarm system
Operation planning and control
Control of the extension VDU system

Marine-DEO

Marine-DEO is a product name of the IAS(Industrial Automation System), This section describes the following each component specification of Marine-DEO.

DOSS	:	DEO Open Supervisory Station
DOHS	:	DEO Open History Station
DOGS	:	DEO Open Gateway Station
ODRM	:	Open DCS Remote Manager
DOPC II	:	DEO Process Controller II

DOSS(DEO Supervisory Station)

DOSS is a human-machine interface of Marine-DEO that runs on Windows 2000 operating system. The DOSS has the following features.

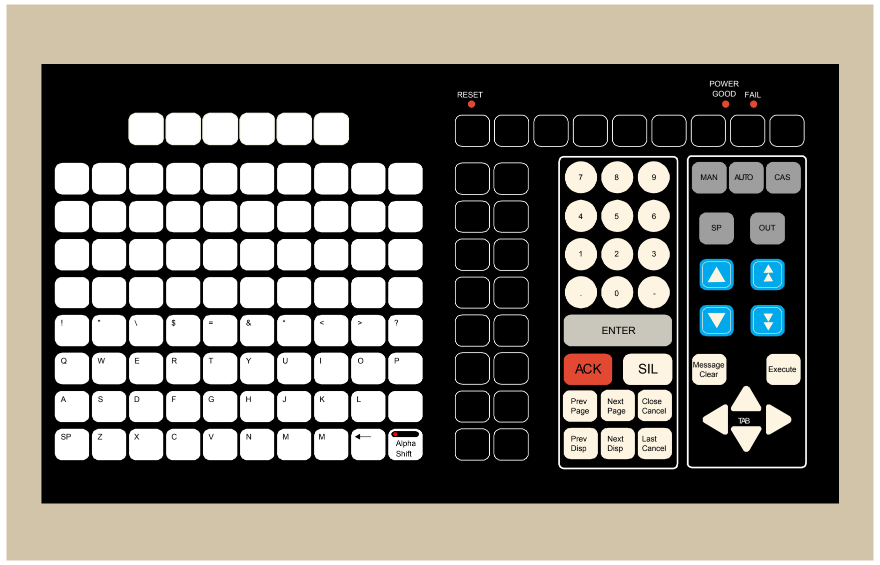
Display call-up toolbar
Operational face plate facility
One line alarm indication
Touchscreen in addition to trackball
High resolution display (1280 X 1024)

It is fully integrated with Marine-DEO and can be a client node for DOPC, DOHS for LNGC monitoring control.

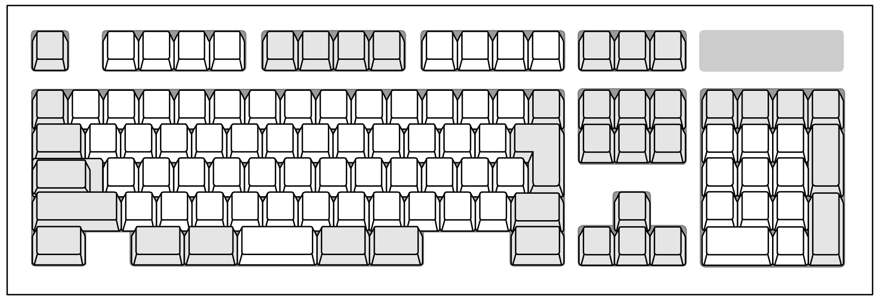
The DOSS has two type of keyboard.

Operation keyboard
Engineering keyboard

The Engineering keyboard is used for the software modification and installation only. The keyboard is furnished on the console with cover. The following figures indicate the layout of keyboard.



Layout of Operation Keyboard



Layout of Engineering Keyboard

DOHS(DEO Open History Station)

DOHS is a historian and provides histories data for DOSS.

Vessel data collection and historian;

Collect process data at periodic basis.
Collect various events.
- Process Alarm
- Sequence Event
- Message
- Operator Change
- System Alarm
- System Status

Query and retrieve events by various condition.
Archive data into backup media.

Reliability
Adoption disk mirroring

H/W Specification

CPU	:	Intel Pentium III 850MHz
RAM	:	256MB
HDD	:	18GB

DOGS(DEO Open Gateway Station

DOGS is a gateway between the DEO-NET and the Extension VDU.

ODRM(Open DCS Remote Manager)

ODRM is a facility which realize remote maintenance from land service center via satellite communication.

DOPC II(DEO Process Controller II)

DOPC II is a multi-function controller employing control loops, logic functions, sequence control, and I/O processing.
- Built-in control / calculation algorithms
- Sequence control implemented by CL (Control Language)
- Distributed I/O for space saving
- Remote I/O capability by fiber optic connection
- Peer to peer communication with other DOPC IIs over the DEO-NET using the tag name basis
- Memory back-up by flash ROM

DOPC II consists of ;
- DOCM(DOPC Control Module)
  It is a the main module of the DOPC II consisting of the control modules and the communication interface modules.
- Distributed I/O
  The I/O modules are mounted on DIN rail.

DOCM(DOPC Control Module)

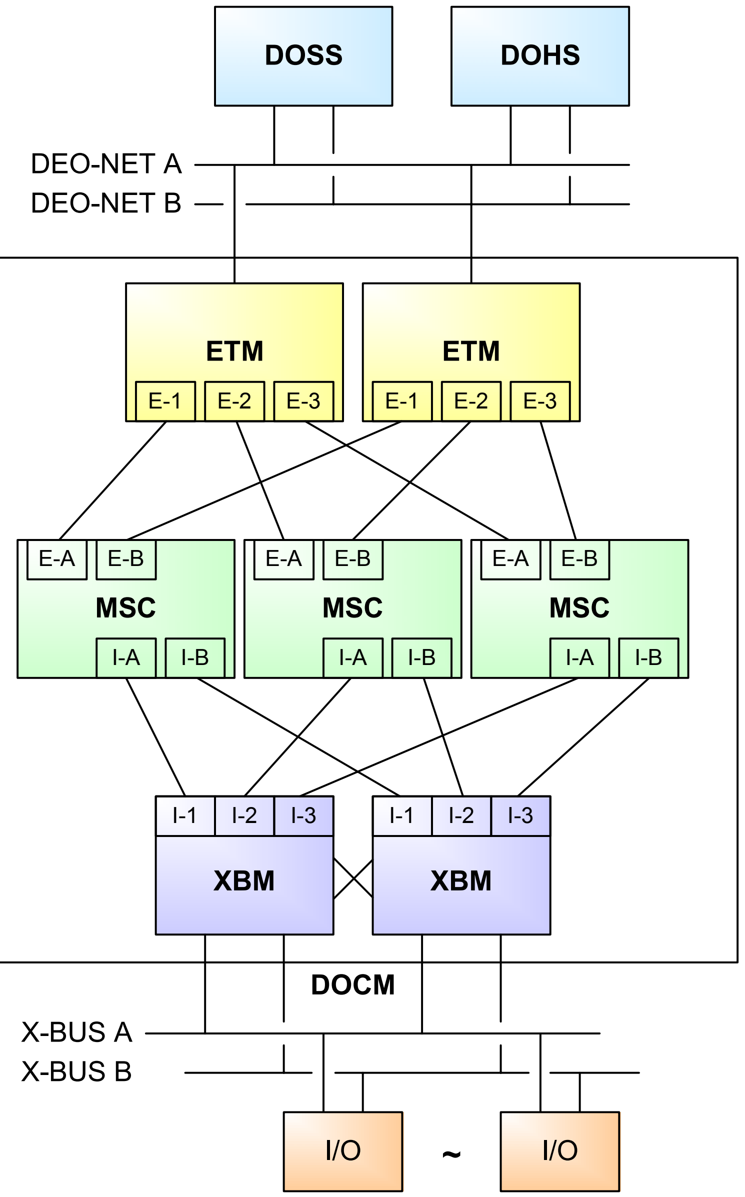
DOCM Configuration shows the DOCM system. The DOCM is composed of the following modules.

Control Module(MSC)

Ethernet Module(ETM)

X-BUS Module(XBM)

Three sets of control module (MSC) have redundant configuration, and execute same processing synchronised each other. The ethernet module (ETM) and the X-BUS module (XBM) compare outputs of three (3) MSCs, and get data by “logic of majority”, i.e., 2 out of 3. Even though one of MSC outputs incorrect data, the remaining two (2) data are correct and used for the control and monitoring.



DOCM Configuration

3.3 IAS Function Operation

Time Management

The IAS operates with two time data. One is the marine DEO's standard time, which could be GMT and the other is the ship's time supplied from the ship's chronometer. The ship's time is used for alarm summary displays, alarm printing and report printing. Standard time is applied to trend data and fast alarm printing.

Alarm Management

The IAS provides some kinds of alarms as follows.

1) Process Alarm
   Input from ship process by analog and digital signals.
   Temperature High, Level Low, Pressure High, etc.

   The alarms are indicated on the Alarm Summary Display within 2 seconds after receiving the signals on analog or digital input modules.

Alarm Print out

The alarm printers of the IAS are located as follows.

1) Cargo system – 1set in CCR
2) Machinery system – 1set in ECR

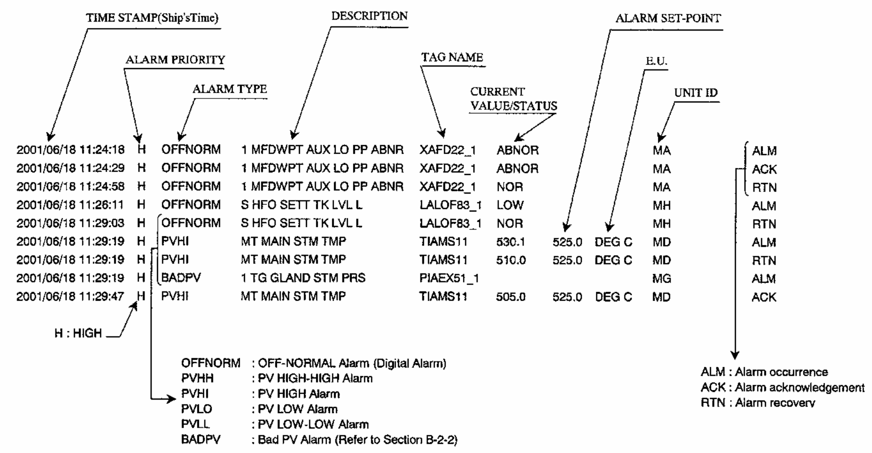
The historical alarm information are printed out on the alarm printer with reference time. For the process alarm, the alarm printout provides the following events.

---- Alarm occurrence
---- Alarm acknowledgement
---- Alarm recovery

The major printout item is as follows.

---- "ALM", "ACK", "RTN"
---- DATE/Time : YYYY/MM/DD XX:XX:XX (HH:MM:SS)
---- TAG name
---- Description

The "ALM" is printed in red.
In addition to the above, the system status changes including system abnormal are printed out on the alarm printer.



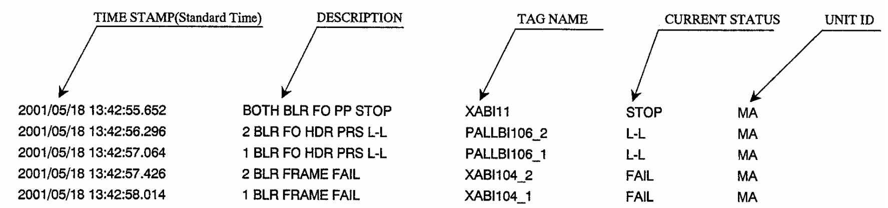
Example of Alarm Print-out

Fast Alarm Function

The fast alarm function is a high speed scanning function for finding out a trip cause. The fast alarms are recorded on the hard disk of DOSS automatically. Operator can display and print the recorded the fast alarms.
If a equipment comes to trip, the procedure for finding out the trip cause as follows.

1) The representative trip alarm of this equipment is reported on the alarm summary display and the alarm printer.
2) The fast alarms are indicated on the dedicated display and printed on the logging printer with operator's request.
3) The fast alarms are indicated and printed the order of its occurrence time.
   Operator can find out the trip cause for that equipment.

To realize the Fast Alarm Function, The IAS applies specialized digital I/O modules, i.e. DISOE, Digital Input Sequence of Event.
The DISOE provides high-resolution scanning within 20ms.



Example of Fast Alarm Print-out

The available quantity of line of the fast alarm display is as follows.
25 lines/display
Max. 2000 lines

Data Logging

The logging printers of IAS are located as follows.

1) Cargo system – 1 set in CCR
2) Machinery system – 1 set in ECR

The IAS provides data logging function in accordance with following specification.

1) Fixed time Report
   This report is printed out automatically in accordance with the selected time interval. (Based on Ship's Time)
2) Demand Report
   This report is printed out by the operator's request. The format of "Demand Report" is same as "Fixed Time Report".

The re-report function is available until next log is activated.

Setting of the logging interval, the demand request and the re-reporting request are done from "System Operation Display"

Extension Alarm System

All alarms detected by the IAS are extended to extension alarm panels located in officer's / engineer's cabins and public spaces by the extension alarm system. The alarms are grouped to the extension alarm groups and the group alarm status is annunciated by the extension alarm panels. The alarm annunciation by the extension alarm panels is done by one audible buzzer and annunciation indicators corresponded to extension alarm groups.

The extension alarm groups are shown on the following tables.

Cargo system

- Emergency shutdown
- Gas detection
- Essential
- Non essential
- Cargo IAS abnormal
- Fire

Machinery system

- Boiler trouble
- M/T Trip
- M/T Auto power reduction
- M/T abnormal
- Generator abnormal
- Gas detection in E/R
- Essential alarm
- Non essential alarm
- Fire alarm
- Personnel alarm
- Mach. IAS system abnormal
- Bilge

- E/R call from E/R

Duty Engineer/Officer Selector

One set of the duty engineer /officer selector by lighting the push button for each cargo and machinery systems are furnished on the CCR and the ECR console as follows. When one of the button is lit, that indicates the UMS mode.

For the cargo system:

C/O	2/O	3/O	NWK/O	G/E

For the machinery system

C/E	2/E	3/E	4/E	5/E	E/E

Personnel Alarm System

The following lamps and push buttons are supplied for the personnel alarm system.

- Start/Stop buttons with buzzer on master panel furnished on ECR console : 1 set
- Start/Stop push buttons on engine room entrance : 1 set
- Reset push buttons in engine room : 9 sets

"System ON" Lamp on W/H extension alarm panel.

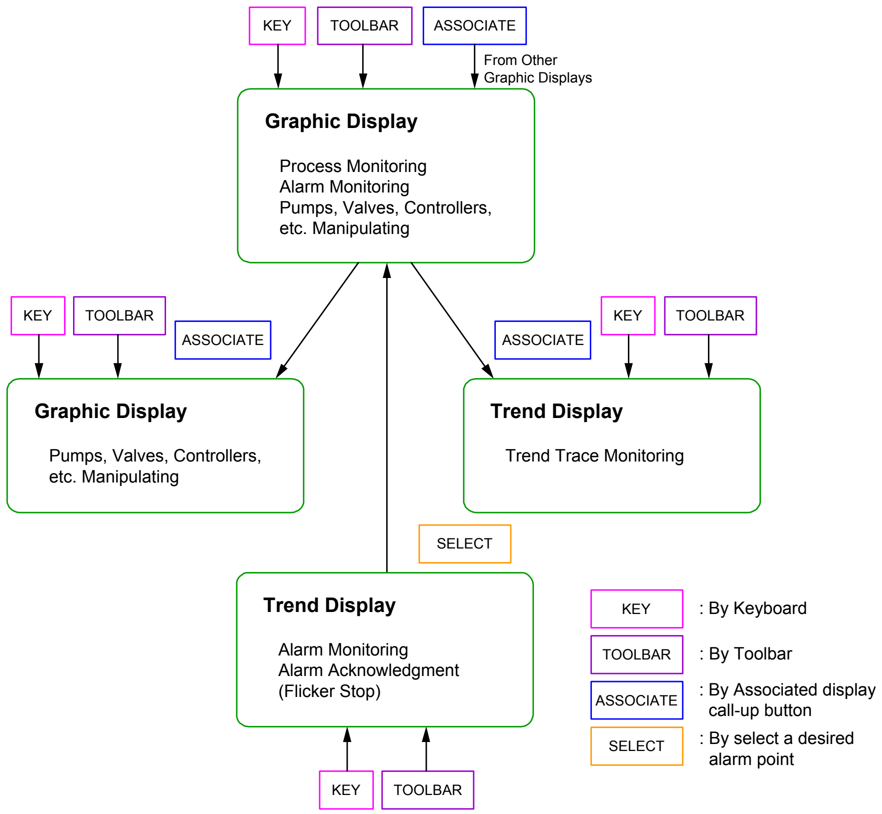
The Personnel Alarm System's first setting time when activate the system is 27 min. After setting time, the system occur pre-warning to E/R column light. Then can activate the second setting time which is set 3 min.

Display Function Assignment

The DOSS provides the following major displays.

Graphic Display
Group Display
Trend Display
Alarm Summary Display

The Graphic Displays take the initiative in operation basically.
The function assignment and the relationship among displays are as follows.



3.4 IAS Mimics

NO.	DISPLAY TITLE	ASSOCIATED DISPLAY CODE							
1	STEAM DUSTRIBUTION SYSTEM	G001	G131	G136	M07	M10	M09	-	-
2	MAIN TURBINE STEAM SYSTEM	G011	G041	M25	M07	M10	M21	M20	-
4	STEAM DUMP. SYSTEM	G131	M02	M28	M01	-	M08	-	-
5	BNR ATOMISING SYSTEM	-	-	-	-	-	-	-	-
6	HEATING STEAM SYSTEM	G001	G002	-	-	-	-	-	-
7	CONDENSATE WATER SYSTEM-1	G051	G053	G003	M08	M02	-	-	-
8	COMDENSATE WATER SYSTEM-2	G151	G152	G206	G207	M01	M07	M09	-
9	BOILER FEED WATER SYSTEM	G141	G145	M07	M10	M01	M08	-	-
10	BOILER AUX. SYSTEM	G121	G128	M15	M29	-	M01	M09	-
11	WATER COOLING SYSTEM	G216	-	-	-	-	-	-	-
14	FRESH WATER SYSTEM	-	-	-	-	-	-	-	-
15	M/B FUEL SYPPLY SYSTEM	G071	G075	M29	-	-	-	M16	M40
16	FO FILL, TRANS & PURI. SYSTEM	G224	G225	G226	G227	G228	G229	G230	M15
18	INCINERATOR FO SERVICE SYSTEM	-	-	-	-	-	-	-	-
19	LO FILL, TRANS & PURI. SYSTEM	G231	G232	-	M21	-	-	-	-
20	M/T BEARING CONDITION	G043	-	M02	M21	-	-	-	-
21	MAIN TURBINE & STERN TUBE LO SYS.	G041	G048	-	M02	M20	-	-	-
22	STEERING GEAR SYSTEM	-	-	-	-	-	-	-	-
23	COMPRESSED AIR SYSTEM	G201	G202	M34	M35	M36	-	-	-
24	BILGE SYSTEM	-	-	-	-	-	-	-	-
25	M/T OVERVIEW	G011	G013	M02	-	-	-	-	-
26	M/T SHUT DOWN/PRE-ALARM	M25	-	M07	M29	-	M30	M09	-
27	M/T AUTO POWER REDUCTION	-	M07	M30	M10	M09	-	-	-
28	M/B ACC SYSTEM OVERVIEW	G061	G064	M29	-	M09	-	-	-
29	M/B BMS SYSTEM OVERVIEW	G083	G093	M15	-	M01	M09	-	-
30	BLR TRIP/PRE ALARM	M15	M29	-	M10	M09	-	-	-
31	MAIN POWER DISTRIBUTION	M33	M34	M35	-	M32	M36	-	-
32	POWER DISTRIBUTION CONT	G195	M33	M34	M35	M36	M31	-	-
33	NO.1 TURBINE GENERATOR	G161	G164	M07	M10	M01	M32	M11	-

NAME	TITLE	ASSOCIATED GRAPHIC							
34	NO.2 TURBINE GENERATOR	G171	G174	M35	M31	M32	M23	M11	-
35	DIESEL GENERATOR	G181	G183	M33	M34	M31	M32	M23	M11
36	EM'CY DIESEL GENERATOR	G191	M33	M34	M35	M31	M32	M23	-
37	E/R VENT FAN	G236	G237	G238	-	-	-	-	-
38	REFRIGERATION	G221	G222	-	-	-	-	-	-
40	MOTOR RUNNING HOUR 1	M40_1	M40_2	M40_3	M40_4	M40_5	-	-	-
40_1	MOTOR RUNNING HOUR 2	M40	M40_2	M40_3	M40_4	M40_5	-	-	-
40_2	MOTOR RUNNING HOUR 3	M40	M40_1	M40_3	M40_4	M40_5	-	-	-
40_3	MOTOR RUNNING HOUR 4	M40	M40_1	M40_2	M40_4	M40_5	-	-	-
40_4	MOTOR RUNNING HOUR 5	M40	M40_1	M40_2	M40_3	M40_5	-	-	-
40_5	MOTOR RUNNING HOUR 6	M40	M40_1	M40_2	M40_3	M40_4	-	-	-
42	REPOSE GROUP	-	-	-	-	-	-	-	-
43	LOG SET	-	-	-	-	-	-	-	-
44	MACH OVERVIEW	-	-	-	-	-	-	-	-
45	WINDING TEMP	-	-	-	-	-	-	-	-

Part 4 : Main Boiler Control System

Part 4
Main Boiler Control System

Part 4 : Main Boiler Control System

4.1 Main Boiler

4.1.1 Performance Data

Boiler Type **MB-4E-NS**
Oil Firing

LOAD			100% NORMAL	MAX.	75%	50%	25%
EVAPOURATION	SH STEAM	kg/h	53,600	61,000	40,200	26,800	13,400
	DSH STEAM	kg/h	1,000	2,000	1,000	1,000	1,000
	TOTAL	kg/h	54,600	63,000	41,200	27,800	14,400
STEAM PRESS.	DRUM	MPag	6.61	6.81	6.37	6.18	6.07
	SH OUTLET	MPag	6.03	6.03	6.03	6.03	6.03
FEED WATER STEAM TEMP.	ECO INLET	°C	138.5	138.5	138.5	138.5	138.5
	SH INLET	°C	283	284.9	280.4	278.6	277.4
	SH OUTLET	°C	515	515	515	500.4	469.9
	DSH OUTLET	°C	288.5	293.1	288.5	288.5	288.5
EFFICIENCY	(HHV BASE)	%	88.5	88.4	88.4	87.9	86.2
CALORIFIC VALUE	HHV	kcal/kg	10,280	10,280	10,280	10,280	10,280
	LHV	kcal/kg	9,713	9,713	9,713	9,713	9,713
FUEL CONSUMPTION		kg/h	3,962	4,561	2,987	1,995	1071
EXCESS AIR RATE		%	10	10	12.5	19.2	36
O_2 RATE		%	1.9	1.9	2.3	3.4	5.6
COMBUSTION AIR FLOW		kg/h	60,679	69,862	46,794	33,110	19,263
FLUE GAS FLOW		kg/h	64,641	7,4423	49,781	35,105	20,280
ECO OUTLET GAS TEMP.		°C	171	174	165	160	154
AIR TEMP.	FDF OUTLET	°C	38	38	38	38	38
	SAH OUTLET	°C	120	120	120	120	120
TOTAL DRAFT LOSS		kPag	3.57	4.74	2.12	1.05	0.35

Main Boiler for
Boiler Type **MB-4E-NS**
Gas Firing
N_2 : 0 Vol% **CH4 : 100 Vol%**

LOAD			100% NORMAL	MAX.	75%	50%	25%
EVAPOURATION	SH STEAM	kg/h	53,600	61,000	40,200	26,800	13,400
	DSH STEAM	kg/h	1,000	2,000	1,000	1,000	1,000
	TOTAL	kg/h	54,600	63,000	41,200	27,800	14,400
STEAM PRESS.	DRUM	MPag	6.61	6.81	6.37	6.18	6.07
	SH OUTLET	MPag	6.03	6.03	6.03	6.03	6.03
FEED WATER STEAM TEMP.	ECO INLET	°C	138.5	138.5	138.5	138.5	138.5
	SH INLET	°C	283	284.9	280.4	278.6	277.4
	SH OUTLET	°C	515	515	515	515	506.8
	DSH OUTLET	°C	288.5	293.1	288.5	288.5	288.5
EFFICIENCY	(HHV BASE)	%	84.0	83.9	84	83.6	82
CALORIFIC VALUE	HHV	kcal/kg	13,270	13,270	13,270	13,270	13,270
	LHV	kcal/kg	11,964	11,964	11,964	11,964	11,964
FUEL GAS CONSUMPTION		kg/h	3,251	3,745	2,450	1,654	858
EXCESS AIR RATE		%	10	10	12.5	19.2	36
O_2 RATE		%	1.9	1.9	2.3	3.4	5.6
COMBUSTION AIR FLOW		kg/h	62,336	71,805	48,039	34,367	20,336
FLUE GAS FLOW		kg/h	65,587	75,550	50,488	36,021	21,193
ECO OUTLET GAS TEMP.		°C	173	178	166	159	153
AIR TEMP.	FDF OUTLET	°C	38	38	38	38	38
	SAH OUTLET	°C	120	120	120	120	120
TOTAL DRAFT LOSS		KPag	3.68	4.87	2.18	1.11	0.38

Boiler Water Content and Water Content Curves

Water Content at Filled Up State by Cold Water (Hydrostatic Test)

	VOLUME(m^3)	WEIGHT(kg)	REMARKS
BOILER TUBE	9.83	9,830	COLD WATER g = 1,000 kg/m^3
BOILER HEADER	0.67	670	COLD WATER g = 1,000 kg/m^3
WATER DRUM	4.16	4,160	COLD WATER g = 1,000 kg/m^3
WATER CHAMBER OF STEAM DRUM	4.63	4,630	COLD WATER g = 1,000 kg/m^3
STEAM CHAMBER OF STEAM DRUM	4.97	4,970	COLD WATER g = 1,000 kg/m^3
SATURATED STEAM PIPE	0.13	130	COLD WATER g = 1,000 kg/m^3
SUPERHEATER	2.12	2,120	COLD WATER g = 1,000 kg/m^3
CONTROL DESUPERHEATER	0.51	510	COLD WATER g = 1,000 kg/m^3
DESUPERHEATER INLET PIPE	0.05	50	COLD WATER g = 1,000 kg/m^3
DESUPERHEATER	0.07	70	COLD WATER g = 1,000 kg/m^3
ECONOMIZER	2.97	2,970	COLD WATER g = 1,000 kg/m^3
TOTAL	30.11	30,110	

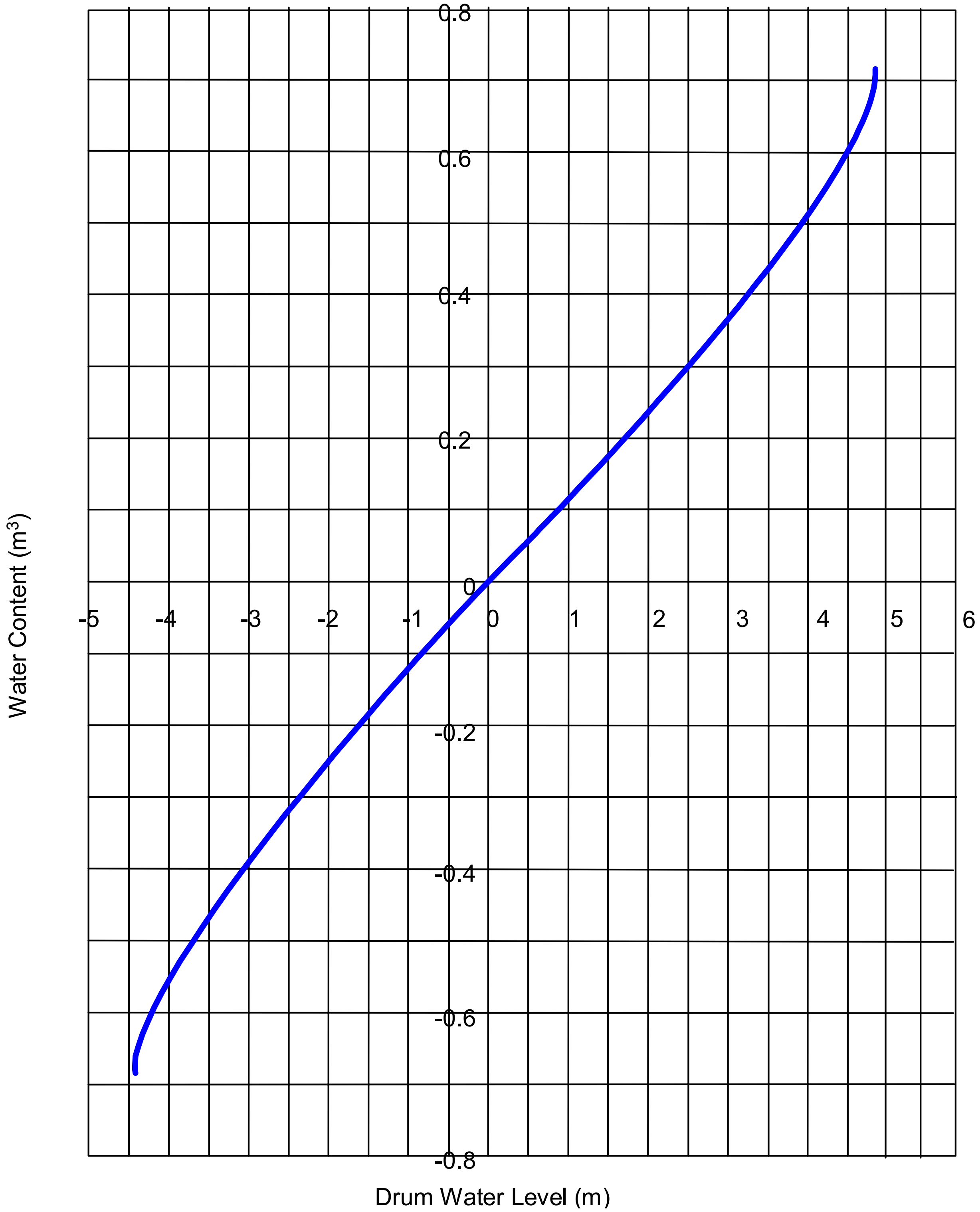
Water Content at Normal Water Level by Cold Water (Before Boiler Ignition)

	VOLUME(m^3)	WEIGHT(kg)	REMARKS
BOILER TUBE	9.83	9,830	COLD WATER g = 1,000 kg/m^3
BOILER HEADER	0.67	670	COLD WATER g = 1,000 kg/m^3
WATER DRUM	4.16	4,160	COLD WATER g = 1,000 kg/m^3
WATER CHAMBER OF STEAM DRUM	4.63	4,630	COLD WATER g = 1,000 kg/m^3
STEAM CHAMBER OF STEAM DRUM	-	-	-
SATURATED STEAM PIPE	-	-	-
SUPERHEATER	-	-	-
CONTROL DESUPERHEATER	-	-	-
DESUPERHEATER INLET PIPE	-	-	-
DESUPERHEATER	-	-	-
ECONOMIZER	2.97	2,970	COLD WATER g = 1,000 kg/m^3
TOTAL	22.26	22,260	-

Water Content at Boiler Operation

	VOLUME(m^3)	WEIGHT(kg)	REMARKS
BOILER TUBE	9.83	7,323	SAT. WATER g = 745 kg/m^3
BOILER HEADER	0.67	499	SAT. WATER g = 745 kg/m^3
WATER DRUM	4.16	3,099	SAT. WATER g = 745 kg/m^3
WATER CHAMBER OF STEAM DRUM	4.63	3,449	SAT. WATER g = 745 kg/m^3
STEAM CHAMBER OF STEAM DRUM	-	-	-
SATURATED STEAM PIPE	-	-	-
SUPERHEATER	-	-	-
CONTROL DESUPERHEATER	-	-	-
DESUPERHEATER INLET PIPE	-	-	-
DESUPERHEATER	-	-	-
ECONOMIZER	2.97	2,213	Comp. Water g = 930 kg/m^3
TOTAL	22.26	16,583	-

Drum Water Level and Water Content



Steam, Air & Electric Consumption

Air Consumption (per boiler)

EQUIPMENT NAME	SUPPLY AIR	CONSUMPTION	OPERATING CONDITION
ACC (ACTUATOR)	0.9 MPag	120 Nl/min	CONTINUOUS
FWR. (ACTUATOR)	0.9 MPag	50 Nl/min	CONTINUOUS
BURNER FLAME EYE SEALING	750 mmAq	150 x 6 = 900 Nl/min	CONTINUOUS
SOOT BLOWER SCAVENGING	550 mmAq	78 x 8 = 624 Nl/min	CONTINUOUS
SOOT BLOWER SEALING	550 mmAq	220 x 8 =1,760 Nl/min	CONTINUOUS

Steam Consumption (per boiler)

EQUIPMENT NAME	SUPPLY STEAM	CONSUMPTION	OPERATING CONDITION
SOOT BLOWER	6.03 MPag	110 Nl/min	CONTINUOUS
BURNER	0.79 MPag	375 Nl/min	CONTINUOUS
STEAM AIR HEATER	0.23 MPag	2700 Nl/min	CONTINUOUS

Electric Consumption (per ship)

EQUIPMENT NAME	ELECTRIC POWER	CONSUMPTION	OPERATING CONDITION
BOILER CONTROL PANEL	220V	30A	CONTINUOUS
FORCED DRAFT FAN	440V	524A (HIGH) 240A (LOW)	CONTINUOUS
FUEL OIL PUMP	440V	38A	CONTINUOUS

Alarm & Trip List

NO.	DESCRIPTION	SET POINT			TIMER
		ALARM	TRIP	NOR	
157B	DRUM LEVEL HIGH-HIGH	-	+ 240 mm	± 0 mm	0 sec
157B	DRUM LEVEL VERY HIGH FW MOTOR VALVE CLOSE	+220 mm	-	± 0 mm	10 sec
157B	DRUM LEVEL VERY HIGH TURBINE TRIP	+220mm	-	± 0 mm	10 sec
157B	DRUM LEVEL VERY HIGH TURBINE AUTO SLOW DOWN	+180 mm	-	± 0 mm	10 sec
157B	DRUM LEVEL HIGH	+130 mm	-	± 0 mm	10 sec
157B	DRUM LEVEL LOW	-130 mm	-	± 0 mm	10 sec
157B	DRUM LEVEL LOW-LOW TURBINE AUTO SLOW DOWN	-180 mm	-	± 0 mm	10 sec
157B	DRUM LEVEL EX-LOW	-	-240 mm	-	0 sec
158B	DRUM LEVEL EX-LOW	-	-240 mm	-	0 sec
-	DRUM PRUSSURE HIGH	7.50 MPag	-	-	4 sec
-	DRUM PRESSURE LOW	5.10 MPag	-	-	4 sec
-	FEED WATER PRESS LOW	7.65 MPag	-	-	10 sec
-	FEED WATER SALINITY HIGH	10 ppm	-	0 ppm	10 sec
-	SUPERHEATER STEAM PRESS HIGH	6.25 MPag	-	6.03 MPag	4 sec
-	SUPERHEATER STEAM PRESS LOW	5.30 MPag	-	6.03 MPag	4 sec
126B	SUPERHEATER STEAM TEMP HIGH-HIGH	-	530°C	515°C	0 sec
146B	SUPERHEATER STEAM TEMP HIGH	525°C	-	515°C	10 sec
-	DSH STEAM PRESS HIGH	6.25 MPag	-	5.19 ~ 6.03 MPag	4 sec
-	DSH STEAM TEMP HIGH	400 °C	-	285 ~ 400 °C	10 sec

NO.	DESCRIPTION	SET POINT			TIMER
		ALARM	TRIP	NOR	
229B	FLAME FAILURE	ONE OF TWO	-	-	2 sec
229B	FLAME FAILURE	-	TWO OF TWO	-	2 sec
-	FO HEADER PRESS LOW	0.15 MPag	-	1.6-2.0 MPag	4 sec
259B	FO HEADER PRESS LOW-LOW	-	0.10 MPag	1.6-2.0 MPag	0 sec
-	FO HEADER TEMP. HIGH	RW#1 50	-	-	10 sec
-	FO HEADER TEMP. LOW	RW#1 150	-	-	10 sec
234B	FO HEADER TEMP. LOW-LOW	-	RW#1 200	-	0 sec
-	ATM. STEAM PRESS LOW	0.40 MPag	-	1.0-1.6 MPag	4 sec
243B	ATM. STEAM PRESS LOW-LOW	-	0.30 MPag	1.0-1.6 MPag	0 sec
205B	GAS HEADER PRESS HIGH-HIGH	-	75 kPag	-	0 sec
-	GAS HEADER PRESS HIGH	70 kPag	-	-	4 sec
-	GAS HEADER PRESS LOW	1 kPag	-	-	4 sec
-	GAS HEADER PRESS LOW-LOW	-	0.7 kPag	-	0 sec
-	GAS HEADER TEMP HIGH	80°C	-	30°C	10 sec
-	GAS HEADER TEMP LOW	15°C	-	30°C	10 sec
234B	GAS HEADER TEMP LOW-LOW	-	5°C	30°C	0 sec
-	PURGE N_2 PRESS LOW	0.05 MPag	-	100 kPag	4 sec
288B	SOOT BLOWER STEAM PRESS LOW	4.0 MPag	-	-	4 sec
276B	EXH GAS SMOKE HIGH	4 deg	-	1~3 deg	10 sec
277B	O_2 CONTENT LOW	1%	-	-	10 sec
246B	FD FAN VIBRATION HIGH	6.0 mm/s	-	-	4 sec
-	FD FAN TRIP	-	STOP	-	0 sec
-	FO HEATER OUTLET TEMP HIGH	RW#1 45	-	-	10 sec

NO.	DESCRIPTION	SET POINT			TIMER
		ALARM	TRIP	NOR	
-	FO HEATER OUTLET TEMP LOW	RW#1 145	-	-	10 sec
-	FO HEATER OUTLET STRAINER PRESS LOSS HIGH	0.02 MPag	-	-	4 sec
250B	FO PUMP OUTLET PRESS LOW AUTO- CHANGE	1.0 MPag	-	-	4 sec
349B	SEAL AIR FAN OUTLET PRESS LOW FAN AUTO-CHANGE	4.50 kPag	-	-	4 sec
-	ECO OUTLET GAS TEMP HIGH	-	250 °C	160~190°C	10 sec
397B	CONTROL AIR PRESS LOW	-	0.4 MPag	-	0 sec

Boiler Valve List

Valve No.	Name of Valve	Valve No.	Name of Valve	Valve No.	Name of Valve	Valve No.	Name of Valve	Valve No.	Name of Valve
1B	Main feed line stop check valve	43B	R.W.L.I. shut-off valve	77B	Superheater inlet & outlet header drain valve	210B	Atomizing steam press. gauge shut-off valve	255B	Purge steam piston valve
3B	ECON. Inlet valve	44B	R.W.L.I. shut-off valve	78B	Superheater inlet & outlet header drain valve	211B	Gas cut off butterfly valve	256B	Purge steam stop check valve
4B	Main feed stop check valve	45B	Water level shut-off valve	79B	Remote hot starting piston valve	212B	Gas line N_2 purge piston valve	268B	SAH steam inlet valve
5B	ECON. Drain valve	46B	Drum level safety system shut-off valve	121B	Superheater steam press. gauge shut-off valve	213B	Burner N_2 purge piston valve	273B	F.O. shut-off valve
6B	ECON. Drain valve	47B	Drum level safety system shut-off valve	130B	Steam temp. control valve	214B	Gas inlet cut off butterfly valve	284B	Soot blower steam inlet piston valve
7B	ECON. Air vent valve	48B	Drum press. gauge shut-off valve	131B	Control DESUPHTR. Inlet valve	215B	F.O. pump press. control valve	285B	Soot blower drain piston valve
8B	ECON. Air vent valve	49B	Drum air vent valve	132B	Control DESUPHTR. Outlet valve	218B	Gas header vent piston valve	294B	SAH air vent valve
11B	Aux. feed line stop check valve	50B	Drum air vent valve	134B	CDSH bypass orifice needle valve	220B	F.O. control valve	466B	DESUPHTR. Outlet bypass valve
12B	Aux. feed stop check valve	61B	Surface blow check valve	135B	Control DESUPHTR. Drain valve	221B	F.O. recirculation piston valve	467B	Flame eye seal air drain valve
13B	Feed water line interconnecting valve	62B	Surface blow valve	136B	Control DESUPHTR. Drain valve	222B	Boiler F.O. cut off piston valve	468B	Root valve for flame eye seal air
15B	Chemical feed check valve	64B	Bottom blow check valve	137B	Control DESUPHTR. leak test valve	223B	F.O. burner piston valve	-	-
16B	Chemical feed stop valve	65B	Bottom blow off valve	138B	Control DESUPHTR. leak test valve	225B	F.O. burner piston valve	-	-
20B	Feed water motor valve	66B	Bottom header blow off valve	141B	DESUPHTR. Inlet check valve	144B	DESUPHTR. Inlet bypass valve	-	-
21B	ECON. Relief valve	69B	Water wall header drain valve	142B	DESUPHTR. Leak test valve	146B	DESUPHTR. Outlet check valve	-	-
26B	Feed water control valve	70B	Boiler main steam warming valve	143B	DESUPHTR. Leak test valve	188B	Smothering steam inlet shut-off valve	-	-
28B	Main feed water press. gauge with root valve	71B	Boiler main steam stop check valve	189B	F.O. recirculation needle valve	226B	Atomizing steam control valve	-	-
37B	Superheater safety valve	72B	Superheater intermediated header drain valve	195B	F.O. temp. control valve	232B	F.O. min. keep press. valve	-	-
38B	Drum safety valve	73B	Superheater outlet starting valve	207B	Gas line vent piston valve	244B	Atomizing steam inlet piston valve	-	-
41B	F.W.R. shut-off valve	74B	Superheater outlet starting needle valve	208B	Gas control valve	253B	Purge steam stop needle valve	-	-
42B	F.W.R. shut-off valve	76B	Superheater intermediated header drain valve	209B	Atomizing steam inlet check valve	254B	Purge steam 3-way piston valve	-	-

4.1.2 Main Boiler Operation

4.1.2.1 Preparing for Service

Before starting the boiler, check the following items.

Boiler

(1) Be sure the fire sides are clean and the furnace refractory is in good condition.

(2) Be certain that no oil or gas have accumulated in the furnace bottom or in the burner wind box. Wipe all oil spills and remove any combustible material from burner area.

(3) Check the boiler to make sure all repair work has been completed, all tools have been removed etc. The hand hole fittings and manhole covers should be properly installed. All access doors and casing panels should have been replaced and properly secured.

(4) Check the safety valves to make sure the gag was removed, the lifting levers replaced and the easing gear not fouled. Make sure the hand easing gear and safety valves are free and clear. The hand gear for lifting safety valves should be thoroughly examined and operated so that this can be done without lifting the safety valves.

(5) Check the water level gauge shut-off valves, make sure they are open.

(6) Open the drum air vent valve

(7) Open the superheater outlet starting valve.

(8) Open the superheater header drain valves.

(9) Open the boiler pressure gauge shut-off valves, check the pipe lines up to the gauges and make sure that all the valves for the gauges are open.

(10) Check and make sure blow-off valves and water wall header drain valves are closed.

(11) Bring the water level to normal water level in the steam drum as instructed below and check the feed water line at the same time.

(a) If the boiler is full of water (See instructions on “Care of Boilers Out of Service”), then drain the boiler water until the water level is at the bottom of the water gauge. Bring the level to about 100 mm, through the auxiliary feed line. Then bring up the Normal Water Level, through the main feed line.

(b) If the boiler is empty, then fill it with water until the level is displayed on the water gauge, through auxiliary feed line. Raise to Normal Water Level, through the main feed line. This practice serves to check that both auxiliary and main feed lines are ready for service. Use condensate for filling the boiler, preferably from the deaerator in service if possible. Compound the boiler as per instruction from a boiler water consultant.

Superheater

(1) Drain both superheater headers before lighting a fire. Scale in superheater tubes is usually soluble in water. By draining the superheater, such soluble matter which has gone into the solution is removed from the tubes. If the water remains, then it will quickly evaporate and the soluble material is re-deposited in the tubes.

(2) Open the starting valve on the superheater outlet line. The superheater is protected by the starting valve to maintain a flow of cooling steam to pass through the tubes during lighting up, securing and stand-by periods. The vent must be open while the boiler is being fired and normal steam flow should not exist. If at any time the superheater overheats from the furnace, the vent valve must be opened immediately. The valves in the superheater vent line should be opened fully until pressure of at least 0.7 MPag has been reached. If a thermometer is fitted in the steam line between the superheater outlet flange and the superheater protection line, a valve in the protection line can be throttled after a pressure of 0.7 MPag has been reached.

(3) The header drain valves should be left cracked open to make sure no condensation collects in the headers. Close the drain valves as soon as the superheater tubes and headers are thoroughly warmed up. At no time should a large volume of steam be permitted to blow from the drains while the boiler is being fired.

Economizer

Be sure the economizer is full of water. While filling the boiler with water open the vent and bleed off all air. Then close the valve when water appears.

Uptakes

Close all access doors that have been removed for repairs or cleaning. Be sure that uptakes are clear for firing and that no one is working in the stack area.

Burners

(1) Check fuel oil strainers and the entire fuel oil system to make sure that everything is in good condition.

(2) Inspect the burner air casing to make sure no oil has dripped around the burners this will crate a fire hazard. If there are drip pans, then make sure that their connecting pipe is clean.

(3) Make sure the air slide doors are clean and functioning properly.

(4) Check whether the burners or atomizer housing tube parts have been replaced and if the positions of the sprayer plate is correct. This setting is very important. (Refer to the section on “Oil Burners”)

(5) Do not use fuel gas to light up a fire. After lighting up, change to gas firing. Check the entire fuel gas system according to schedule, and make sure everything is in good condition.

Steam Air Heater

(1) Check whether the supply for steam air heater is correct.

(2) Make sure to drain the trap operation and avoid water hammer by drain.

4.1.2.2 Starting a Boiler from Dead Ship Conditions
(Boiler cold start, in case the other boiler is not used)

[Refer to “Boiler Start-up Procedure – 1”]

1. When starting a boiler in dead ship conditions (neither shore power nor shore steam is available), use diesel oil until enough steam has been raised to heat the bunker fuel.

2. Start the emergency diesel generator and energize the EM’CY switchboard. Energize the main switch board using the power feed back system.

3. The following equipment will be started for starting Diesel Generator Engine ;
   - D/G starting air compressor for charging D/G starting air reservoir
   - D/G D.O service pump
   - Service air compressor
   - D/G L.O. priming pump
   - Main cooling S.W. pump
   - Central cooling F.W. pump

4. Start Diesel Generator Engine

5. Following equipments will be started in service condition for main boiler starting.
   - Two(2) sets of Service Air Compressors
   - One(1) set of Main Boiler Forced Draft Fan
   - One(1) set of Main Boiler Seal Air Fan
   - One(1) set of Main Boiler Fuel Oil Pump
   - EM'CY Feed Water Pump

6. Fill the boiler with distillate water from a Dist.W. tanks. The feed water drain tank should be filled with condensate water before securing the boilers to provide the water for starting. It is advisable to fill the boiler up to 50~80 mm above the normal water level to provide additional storage until the main feed pump starts.

7. Prepare the boiler for service according to '4.1.2.1 preparing for service'

8. When using diesel oil on the burner, make sure it has designated oil pressure for proper atomization.

9. Open the following valves before lighting up;
   (1) Control desuperheater drain valves
   (2) Steam temperature control valve

10. Start the forced draft fan and confirm complete purgation in the furnace.

11. Operate the steam air heater simultaneously with the forced draft fan.

12. Light on a burner with atomizing air. The fuel oil pressure should be at 0.29 MPag (combustion rate is abt. 400 kg/h).

Note !

1. The combustion rate should be used as a guide for start-up and should be controlled appropriately so that the pressure raising curve can be followed. To prevent damage to superheater tubes, do not increase the combustion rate excessively.

2. When it takes time to raise pressure, the starting valve should be operated (throttled) so that the combustion rate will follow the pressure raising curve.

4.1.2.3 Lighting Up and Raising Pressure

[Refer to " Boiler Start-up Procedure – 1"]

1. Check the water level in the steam drum. When water level is lined up properly on the water level gauge, open the drain valve, the water level will drop. When the drain valve close, water level returns to original level.

2. Light up the burner following the instructions outlined in the burner section and burner instruction book. Adjust the fuel oil pressure and forced draft pressure to establish a full steady flame with ignition close to the atomizer. The fuel oil must be completely burned. It is important that no unburned oil is sprayed into the furnace and that no heavy smoke is produced. Frequently observe the smoke indicator and the burner flame, especially after making any changes in firing rate or in forced draft pressure.

3. When steam pressure is up to 0.1 MPag, close the drum air vent valve. In case the steam spurts severely, crack open the superheater header and the control desuperheater drain valve. The superheater outlet starting valve must be left open until the boiler is put on the line.

4. If it will be completely drained, close the superheater header drain valves, the starting valve outlet drain valves, and the control desuperheater drain valves.

5. Take plenty of time bringing the boiler to working pressure to avoid overheating the superheater elements or damaging the brickwork. Firing should be less than 380 kg/h until the pressure of 0.15 MPag has been reached. Then fire the boiler at a rate that will raise the steam pressure in according to the pressure raising curve. It takes at least 2~3 hours to raise steam pressure to about 0.15 MPag. Do not raise steam pressure too quickly. Turn the burner on/off if necessary.

6. After reaching a drum pressure of 0.2 MPag, warm up the auxiliary steam lines. Line up steam to the settling tank coils. Line up feed pump and have it ready for service when needed. The starting valve must be left open until the boiler's load has been cut.

7. When the steam pressure is about 0.3-0.4 MPag below the normal operating pressure, check the safety valves with the easing gear. Lift the disc well off the seat to give a strong blow and release the lifting lever quickly to reseat the valves sharply.

8. As soon as the fuel oil in the settling tank is warm enough to pump, prepare to change from diesel fuel to bunker fuel. Line up steam on the fuel oil heaters.

9. When steam pressure is up to 1.0~1.5 MPag, start warming-up the feed water pump, the main generator and the other machineries.

10. After a drum pressure 1.5 MPag has been reached, change atomizing fluid from air to steam. Change bunker to heavy oil and continue raising pressure at 0.45 MPag of fuel oil pressure.

11. Start the feed pump, as early as possible.

12. When the boiler pressure reaches operating pressure, open the valves and cut the boiler on load. Close the superheater outlet starting valve. Make sure all other drain valves, vent valves and bypass valves are closed. At this point carefully observe the water level in the boiler. If automatic water regulation needs to be used, make sure regulators are working properly

13. When steam pressure reaches 4.5 MPag, start the generator turbine.

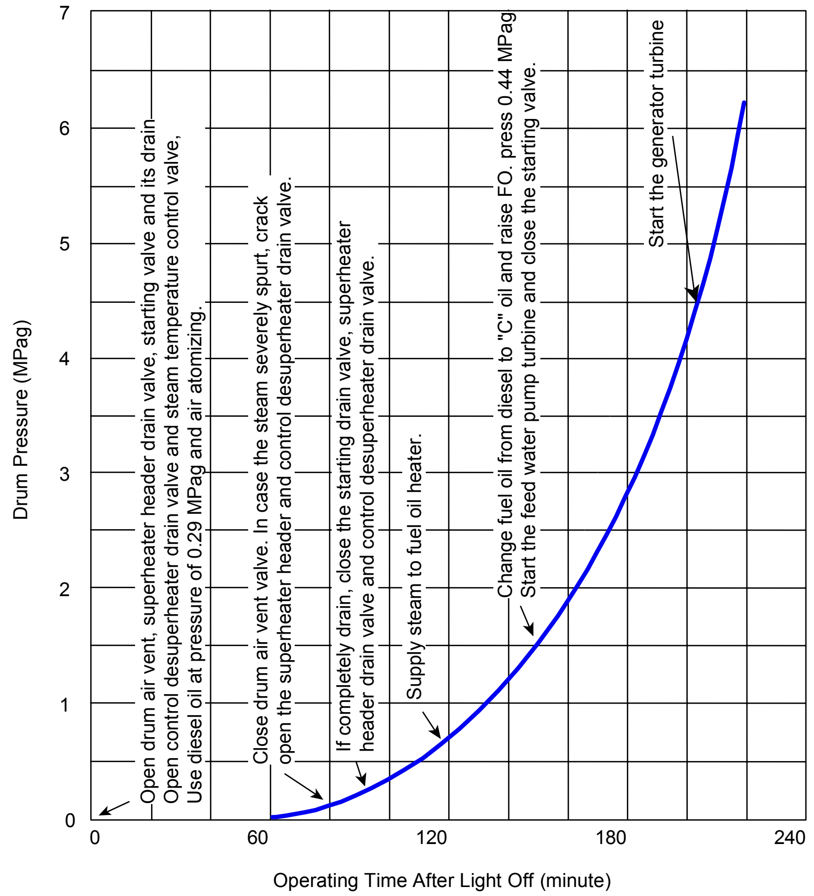
14. When the generator is up to speed and capable of carrying a load, switch over and secure the diesel generator.

15. It may steam forming in the tubes causing a water hammer since the economizer is installed. In this case, run enough feed water to lower the economizer temperature. Blow down the boiler if necessary to keep the water level in the gauges in sight. Never open the water wall header drain valves unless the burners are secured.

Boiler Start-up Procedure-1
Cold Start
(In case the other boiler is not used)

Note !

The combustion rate should be used as a guide for start-up and should be controlled appropriately to follow the pressure raising curve.



Operating procedure for each boiler condition is as following;

(1) Boiler Cold Start (In case the other boiler is normal used)

[Refer to "Boiler Start-up Procedure – 2"]

a) Prepare the boiler for service as outlined under the normal starting procedure.
b) Start the forced draft fan, ventilate the furnace thoroughly before lighting up.
c) Circulate bunker fuel through the fuel oil heaters and pipes until oil at the proper temperature is available in the manifold.
d) Open the following valves before lighting up.
   i) Drum air vent valve
   ii) Superheater header drain valves
   iii) Starting valves
   iv) Starting valve outlet drain valves
   v) Control desuperheater drain valves
   vi) Steam temperature control valve
e) Light up the burner at 0.3 MPag of fuel oil pressure (Combustion rate is 250 kg/h).
f) When steam pressure is up to 0.1 MPag, close the drum air vent valve. If the steam severely spurts, crack open the superheater header and the control desuperheater drain valve. The superheater outlet header vent valve must be left open until the boiler is put on the line.
g) If completely drained, then close the superheater header drain valves, the starting valve outlet drain valves and the control desuperheater drain valves.
h) Raise the steam pressure according to pressure raising curve.
i) Drain and warm up the connecting pipes to the main and auxiliary steam lines. It is essential that the connecting steam piping is clear of all water and warmed up to the approximate operating temperature before cutting the boiler on the load.
j) When the steam pressure is about 0.3~0.4 MPag below normal operating pressures, check the safety valves with the easing gear. Lift the disc well off the seat to give a strong blow and release the lifting lever quickly to reseat the valves sharply.
k) When the boiler pressure reaches operating pressure, open the valves cutting the boiler on load. Close the superheater outlet starting valve. Make sure all other drain valves, vent valves and bypass valves are closed. At this point carefully observe the water level in the boiler. If automatic water regulation needs to be used, then make sure regulators are working properly.

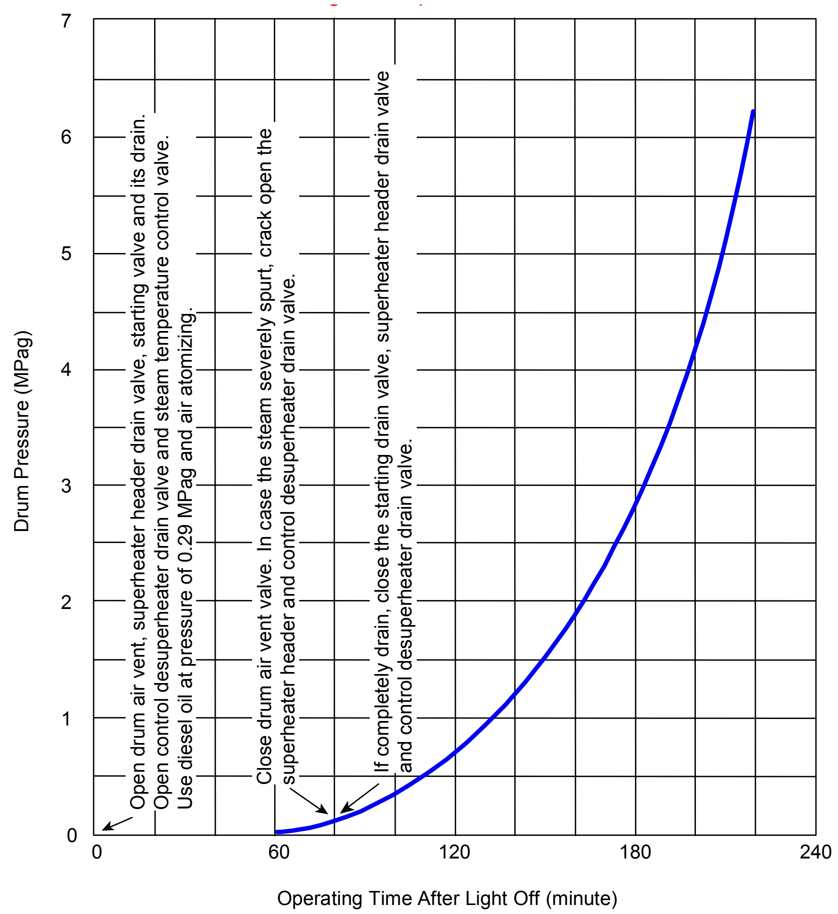
Note !

1. The combustion rate should be used as a guide for start-up and should be controlled appropriately to follow the pressure raising curve. To prevent damage to superheater tubes, do not increase the combustion rate excessively.
2. When it takes time to raise pressure, the starting valve should be operated (throttled) so that the combustion rate will follow the pressure raising curve.
3. During a two-boiler operation, make sure to keep the starting valve open until the boiler under pressure takes on load.

Boiler Start-up Procedure-2
Cold Start
(In case the other boiler is normal used)

Note !

1. The combustion rate should be used as a guide for start-up and should be controlled appropriately to follow the pressure raising curve.
2. During a two-boiler operation, keep the starting valve open until the boiler pressure lowers.



(2) Boiler Hot Start (In case the other boiler is not used)

[Refer to "Boiler Start-up Procedure – 3"]

a) Check the water level in the steam drum. When the water level gauge is lined up properly, the water level will drop when the drain valve is opened. The water level will return to its original level when the drain valve closes.
b) Start the forced draft fan, open the damper and the burner air slide door and ventilate the furnace thoroughly for at least one minute before lighting up.
c) Operate the steam air heater simultaneously with the forced draft fan.
d) Circulate fuel oil through the fuel oil heaters and the burner manifold. A re-circulating valve on the manifold and a re-circulating line to the service pump suction is provided for this purpose. Bypass the fuel oil meter until it's ready to light up.
e) When the fuel oil in the burner manifolds at the correct temperature, insert an atomizer with a light-up sprayer plate in the burner. Close the air registers of the other burners.
f) Reduce the forced draft pressure at the burners to 0.1~0.2 kPag. Close the re-circulating valve and see that the proper fuel oil pressure is available in the burner manifold.
g) Set the following valves before lighting up;
   i) Air vent valve fitted on the steam drum : Full close
   ii) Drain valves of the superheater headers, drain valves on the starting valve outlet, drain valves of the control desuperheater, steam temperature control valve : Full open
   iii) Starting valves on the superheater outlet : Half open
h) Supply steam to the fuel oil heater.
i) Light up the burner following the instructions outlined in the burner section and the burner instruction book. Adjust the fuel oil pressure and forced draft pressure to establish a full steady flame with ignition close to the atomizer. The fuel oil must be completely burned. It is important that no unburned oil is sprayed into the furnace and no heavy smoke is produced. Frequently observe the smoke indicator and the burner flame, especially after making any changes in the firing rate or in the forced draft pressure.
j) Line up the desuperheated steam to each machinery. The starting valve must be left open until the superheater is stable.
k) Take plenty of time to bring the boiler to working pressure to avoid overheating the superheater elements or damaging the brickwork. Firing rate should be less than 380 kg/h.
l) Raise the steam pressure according to pressure raising curve.
m) Confirm complete drainage condition.
n) Close the superheater header drain valves, starting valve outlet drain valves and the control desuperheater drain valves.
o) Close the valve on the steam pressure gauge and bleed the steam gauge line to make sure it is clear. Allow the line to cool for a few minutes before opening the pressure gauge valve. See whether the gauge will respond immediately when the valve is opens.
p) Check the water level again by opening the water gauge drain, the water level drops immediately when the drain valve opens, and returns to the original level as the valve closes.
q) After drum pressure reaches 1.5 MPag, change atomizing fluid from air

to steam. Continue to raise pressure at 0.45 MPag of fuel oil pressure according to normal conditions.

r) Start the feed pump as early as possible. After starting the feed pump, close the starting valve.

s) After reaching 4.5 MPag of steam pressure, start the generator turbine.

Note !

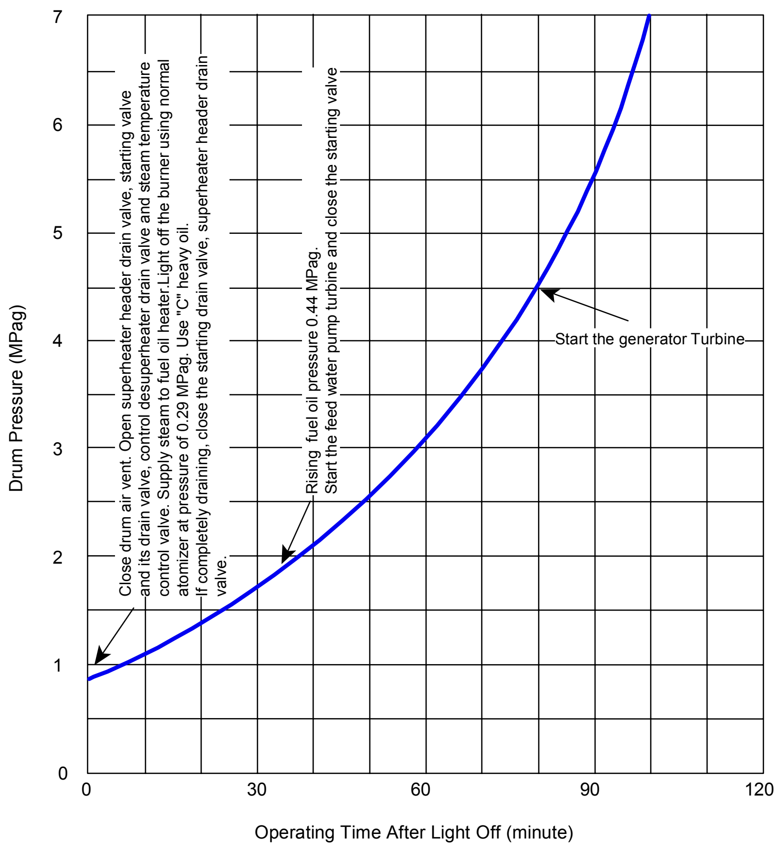
1. Combustion rate should be used as a guide for start-up and should be controlled appropriately to follow the pressure raising curve. To prevent any damage to the superheater tubes, do not increase the combustion rate excessively.

2. Take time to raise the pressure, the starting valve should be operated (throttled) so that the combustion rate will follow the pressure raising curve.

Boiler Start-up Procedure-3
Hot Start
(In case the other boiler is not used.)

Note !

The combustion rate should be used as a guide for start-up and should be controlled appropriately to follow the pressure raising curve.



(3) Boiler Hot Start (In case the other boiler is normal used)

[Refer to "Boiler Start-up Procedure – 4"]

a) Start the forced draft fan, ventilate the furnace thoroughly before lighting up.

b) Circulate bunker fuel through the fuel oil heaters and pipes until oil at the proper temperature is available in the manifold.

c) Open the following valves before lighting up.

Full close	Steam drain air vent valve
Full open	Drain valve of superheater
	Drain valve on starting
	Outlet, drain valves of control
	De-superheater steam temp. control valve

d) Light up the burner following the instructions outlined in the burner section and the burner instructional book. Adjust the fuel oil pressure and forced draft pressure to establish a full steady flame with ignition close to the atomizer. The fuel oil must be completely burned out. It is important that no unburned oil is sprayed into the furnace and no heavy smoke is produced. Frequently observe the smoke indicator and the burner flame, especially after making any changes in the firing rate or in the forced draft pressure.

e) Line up the desuperheated steam to each machinery. The starting valve must be left open until stable steam enters superheater.

f) Take plenty of time in bringing the boiler to working pressure to avoid overheating the superheater elements or damaging the brickwork. Firing rate should be less than 250 kg/h.

g) If drained completely of condensate, close the superheater header drain valves, starting valve outlet drain valves and control desuperheater drain valves.

h) Steam pressure should rise according to the pressure raising curve.

i) When the steam pressure is about 0.03~0.04 MPag below normal operating pressure, check the safety valves with the easing gear. Lift the disc well off the seat to give a strong blow and release the lifting lever quickly to reseat the valves sharply.

j) When the boiler pressure reaches operating pressure, open the valves cutting the boiler on load. Close the superheater outlet starting valve. Make sure all other drain valves, vent valves and bypass valves are closed. At this point carefully observe the water level in the boiler. If the automatic water regulation needs to be used, make sure regulators are working properly.

k) Set up the burner with the proper sprayer plates for the services required. Light up as necessary.

Note !

1. The combustion rate should be used as a guide for start-up and should be controlled appropriately to follow the pressure raising curve. To prevent damage to superheater tubes, do not increase the combustion rate excessively.

2. When it takes time to raise pressure, the starting valve should be operated (throttled) so that the combustion rate will follow the pressure raising curve.

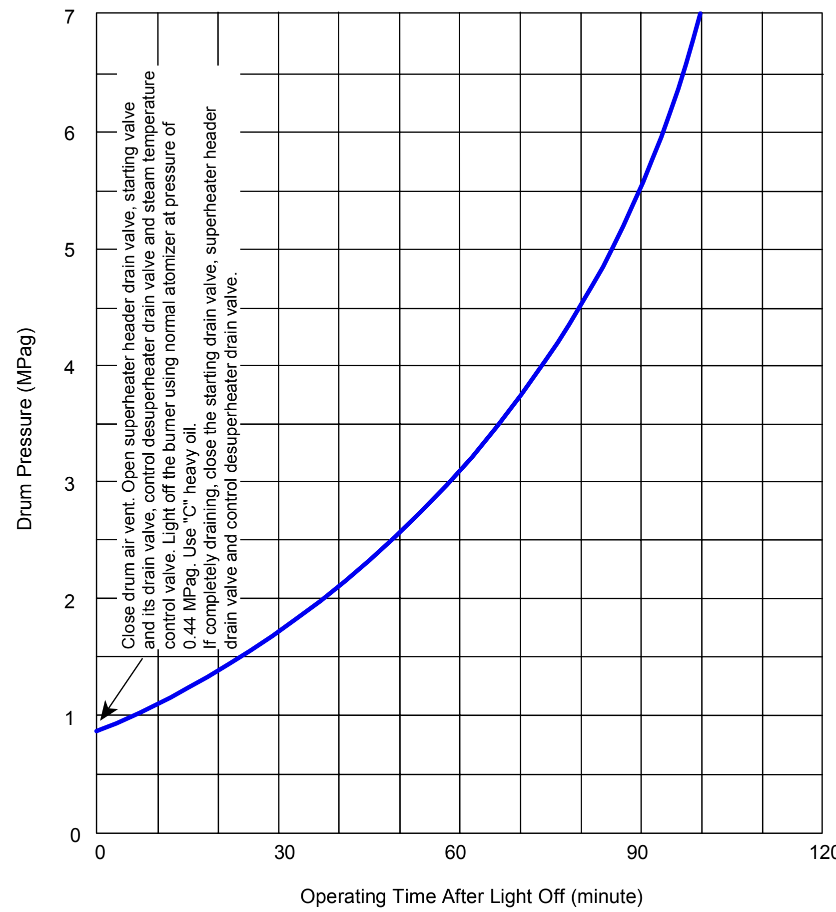
3. During a two-boiler operation, make sure the starting valve is open until the rising boiler pressure takes on load.

Boiler Start-up Procedure-4
Hot Start
(In case the other boiler is normal used.)

Note !

1. The combustion rate should be used as a guide for start-up and should be controlled appropriately to follow the pressure raising curve.

2. During a two-boiler operation, keep the starting valve open until the boiler pressure starts rising. As long as there is no steam consumer on line, the starting valves must remain open.



4.1.2.4 Securing a Boiler

1. Operate the soot blowers under optimal conditions. It is recommended to use the soot blowers are used before boiler load drops to 50%.

2. Secure the burners one at a time.

3. Keep the forced draft fan running a few moments after securing burners, maintaining a forced draft pressure of at least 0.25 kPag until all combustible vapour are cleared from the furnace. Then close all air registers, secure the fan, and close the forced draft fan vane.

4. In case the boiler is in stand-by condition, light up a burner occasionally to hold the steam pressure within 0.4~0.7 MPag below normal operating pressure. Always remember to open the starting valve before lighting a burner.

5. When the unit is cooled;

(1) Before securing the feed stops, raise the water level 70~120 mm above normal as the boiler cools. Keep water level at about 50 mm above the lower end of water gauge.

(2) Secure the main auxiliary and superheater outlet stop valve as soon as the boiler stops steaming.

(3) Before securing the steam stop valves, open the superheater vent valve, throttle to avoid dropping the pressure too rapidly.

(4) When the steam pressure has dropped to 0.1 MPag, open the drains on the superheater headers and the desuperheater drain.

(5) When the steam pressure is down to atmospheric, open the steam drum vent.

4.1.2.5 Cutting in Another Boiler

In addition to a thorough knowledge of the boiler structure and piping system, close attention and good judgment are need to safely operate the boilers. The careless handling of valves can lead to serious accidents, causing damage to valves, piping, machinery etc. If the piping systems are improperly drained, further damage can occur. The boilers should be operated in strict compliance with these instructions.

1. When a boiler (STBD boiler) is steaming and the other (PORT boiler) is going to be cut-in, slowly bring the steam pressure in the port boiler up to the pressure in the STBD boiler. At the same time, warm up the piping on the port boiler. Assume that the valve E is fully opened, and a generator is running and the desuperheated steam is supplied through the valve N.

2. Fire the port boiler and raise the pressure gradually in the procedure described in “Raising Pressure” while warming-up the pipes. This is necessary in combined operation to send the steam. This warming-up should be done 30 minutes prior to the cutting-in to save time for drainage.

3. Keep the water level at normal after lighting up. When water level rises and pressure rises, blow down the boiler water, if necessary. The feed water system should be lined up for use and combustion control should be performed by manual control.

4. When the steam in the port boiler is nearly the same pressure as that in the STBD boiler, open the inlet and outlet drain valves of the superheater header and thoroughly drain the header.

5. First, cut in the desuperheated steam line (auxiliary steam line) as follows; Inform the operators of the auxiliary machinery (for which auxiliary steam is being supplied) to open the drain valves on the steam pipe of each machine. Then gradually equalize the steam pressure of both boilers.

(1) Slightly open the non-return valve L.

(2) Open the drain valve W and drain the desuperheater thoroughly.

(3) Close the non-return valve L.

(4) Slightly open the valve N.

(5) Drain the desuperheater outlet line completely.

(6) Slowly open the valve N after the non-return valve L is slightly opened again.

(7) Slowly open the non-return valve L.

(8) Tightly close the drain valve W.

Now that desuperheated steam line (auxiliary steam line) has been cut-in, close the starting valve U tightly.

Note !
The starting valve should be opened until the boiler steam is placed on the line.

6. Connect the main steam line as follows. Inform the operators of generator to cut-in the generator line and open the drain valve before the generator inlet steam valve.

(1) Open the drain valve X.

(2) Slightly open the non-return valve S and drain the steam line completely.

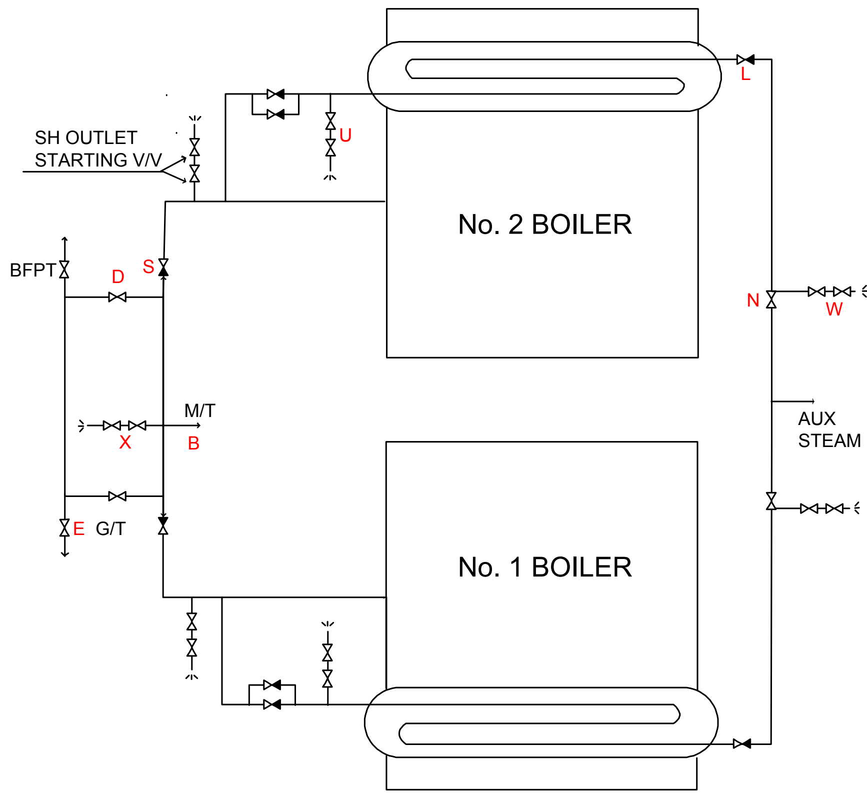
(3) Slowly open the non-return valve S.

(4) Close the drain valve X.

Pay special attention to paid on the opening of the valve “E” and “D” to prevent the accumulated condensate from entering into the generator turbine and the main feed water turbine.

7. In principle all valves of the boilers in service should be fully opened or fully closed. Carefully check whether there are no leaks and that all vent and drain valves are tightly closed. This directly influences the fuel oil consumption.

Steam Line Diagram



4.1.2.6 One-Boiler Operation

When an unexpected problem occurs and it becomes necessary to run the ship with only one boiler, follow these instructiuon.

1. Allowable Maximum Continuous Evaporation for One-boiler Operation

   Allowable maximum continuous evaporation is 63.0 t/h. Whether the maximum continuous evaporation is reached or not, it should be judged by the burner oil pressure of the ACC oil flow meter. At the maximum continuous evaporation, oil pressure is 1.57 MPag while oil flow is about 4.551 kg/h with three burners in use.

2. One Boiler Operation at Maximum Evaporation

   (1) Pay attention to the condition of combustion and adjust the airflow properly. The fan should operate in near maximum load. Take additional caution so that smoke is not emitted during load change.

   (2) Change boiler load as slowly as possible.

   (3) When cleaning burner tips, reduce boiler load beforehand. When only one burner is in service, the boiler's maximum evaporation is 21 t/h, so reduce the boiler load below this load before cleaning burner tips. If the boiler load is not reduced, the steam pressure decreases.

   (4) Pay attention to the increase in steam temperature. If steam temperature is 515°C or higher with STC control valve fully opened, reduce the boiler load.

3. Boiler Out of Operation

   (1) Completely isolate the boiler out of operation from the boiler in operation. Particularly when making repairs, check the main steam stop valve, the feed water valve, the ACC steam pressure detecting foot valve, the auxiliary steam desuperheater steam outlet valve drain valve, the chemical dosing valve, and other lines which are connected to the other boiler.

   (2) When the boiler will be shut down for a long time, the boiler should be preserved by the wet lay-up method.

4.2 Main Boiler Control System

This system makes automation of oil and gas burner. If an abnormality occurs during operation, the system issues an alarm. If the abnormal condition is such that operation cannot continue, the system immediately shuts off the fuel for the main boiler and stops the boiler.

Note !

This manual describes an outline on the remote operation of the boiler.
An operator must be fully acquainted with the operation of the main boiler, main boiler auxiliaries, oil and gas burner and the boiler automatic control system and its associated equipment. All the equipment must be maintained in good working condition.

Outline of Functions

This system consists of the following functions.

(1) BMS (Burner Management System)
Each burner is controlled automatically or manually by the BMS. It also includes a safety system.

(2) ACC (Automatic Combustion Control)
The fuel (oil or gas) and combustion air are controlled automatically by the ACC.

(3) SDC (Steam Dump Control)
Excess steam is controlled automatically by the SDC.

(4) STC (Steam Temperature Control)
Superheated steam temperature is controlled automatically by the STC.

(5) FWC (Feed Water Control)
Steam drum water level is controlled automatically by the FWC.

Outline of the Control Panel

(1) Boiler Control Panel (BCP)
The boiler control panel is installed in the engine control room and contains the ABC and the BMS controller, relay units and system power supply units.

a) Switching on the Power Supply
Switch on the following power switches on BCP Power Panel;

No. 1 Boiler AC220V Source	MCB11A
No. 1 Boiler DC24V Source	MCB12A
No. 2 Boiler AC220V Source	MCB11B
No. 2 Boiler DC24V Source	MCB12B

b) Trip Reset Operation
Operate the Acknowledge switch on Boiler Gauge Board (BGB) and confirm that the interlock lamp is off.

(2) Boiler Gauge Board (BGB)
The boiler gauge board is installed at the main boiler's side (near the burner) and contains monitoring instruments (direct pressure type), graphic operation panel and relay units necessary for machine-side operation of the oil and gas burner.

a) Switching on the Power Supply
Switch on the following power switches on the BGB and confirm the operation of indicating lamps with a lamp test switch.

No. 1 Boiler Solenoid Valve Source	MCB24A
No. 1 Boiler Detector Source	MCB23A
No. 2 Boiler Solenoid Valve Source	MCB24B
No. 2 Boiler Detector Source	MCB23B

b) Boiler Graphic Operation Panel
The boiler graphic operation panel is used to perform operation and monitor the ABC and BMS necessary for machine-side operation of the oil and gas burner and the selection of the control position. This panel is also used for machine side operation and the ABC when its controller(CPU) can not be used. The following operations can be done.

ABC (AUTO/MANUAL)
Atomizing press. control.
Steam temp. control.
Feed water flow control
Air flow control.
Fuel oil control.
Gas flow control.
Selection of Control Position
ABC Emergency Operation

c) Emergency Operation Panel
This panel is used to start/shut-off the FO burner when the BMS controller(CPU) cannot be used. The controller (CPU) is dual, if ether CPU-1 or CPU-2 be normal, automatically operation will be able to maintain.

(3) Boiler Operation Panel (BOP)
The boiler operation panel is a sub-control station installed in the engine control console that provides with operation and monitoring functions necessary for remote manual/automatic operation of the burner. The panel is used to perform the following operations.

a) To change Boiler control position
After the initial start of the boiler is completed on the boiler gauge board, change the control position from the BGB to the ECR and make operation and monitoring necessary for remote operation of the oil and gas burner.

b) Gas Supply Operation
Perform supply and shut-off operation of fuel gas from the master gas valve to the boiler gas burner.

Master Gas V/V Open or Close Operation (MANUAL)
Master N_2 Purge Start Operation (MANUAL)
Boiler Gas V/V Open or Close Operation (MANUAL)
Boiler Gas Header N_2 Purge Start Operation (MANUAL)

4.3 Burner Management System

The BMS makes the remote operation of three (3) LNG/FO combination burners installed on the boiler roof. A dual programmable controller used in the control section of the BMS enables sequential operation of LNG/FO combination burner and burner piston valves interlocking with the boiler protective system. The ABC and a centralized monitoring system have been adopted to display sequence flow and interlocking operation on the graphic operating panel.
In an emergency, the fuel master valve is shut off to protect the boiler.

Control Position

(1) BGB Position
This is an operation mode at the boiler side. In this mode, operations of LNG/FO combination burner (priority given to BGB position operation) and selection of control position can be made except operation of master gas supply and boiler gas supply.

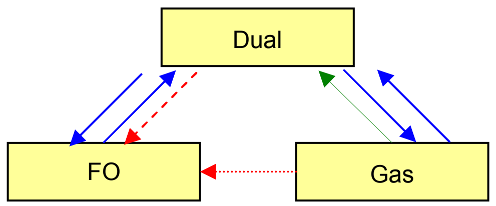
(2) ECR Position
This is an operation mode at engine control room console.
In this mode, all remote operations of LNG/FO combination burner can be made.

Selection of the Operation Mode

(1) Selection of control position
Select either the BGB or ECR control position by operating the control position selection switch on the boiler gauge board graphic panel.
Only the BGB position can be selected at the initial burner start when the burner is out of operation or an in interlock-bypass mode. If either FO burner or GAS burner is operating and the operating mode is not in erlock-bypass mode, the ECR position can be selected.

(2) Selection of FO/Dual/Gas Fuel Mode

a) FO/Dual/Gas fuel mode can be selected with the fuel mode switch on ECR graphic operation panel when the BMS' auto mode is selected.
However, the fuel mode cannot be changed directly from FO to Gas or Gas to FO.



In operation in the fuel mode PB, it is necessary to establish the interlock conditions of item c).
When the ACC is in Full Auto position, these conditions are automatically set by commands for BMS.

Fuel mode switch order

FO "Boost Up"

FO " Back Up"

b) Fuel mode can also be changed with the FO burner ON/OFF PB switch or GAS burner ON/OFF PB switch. In this operation, the interlock conditions in item c) are bypassed so an operator must set and confirm the conditions.

c) Sequence interlock
i) Fuel mode change from "FO" to "Dual".
The master gas valve must be open, Gas Ign. Rate Ok from ACC must be established, and GAS CONT. V/V IGN LAMP must be on.
ii) Fuel mode change from "Dual" to "Gas".
The FO EXTINGUISH OK from the ACC must be established.
iii) Fuel mode change from "Gas" to "Dual".
The FO IGN. RATE OK from ACC must be established and FO CONT. V/V IGN. LAMP must be on.
iv) Fuel mode change from "Dual" to "FO"
GAS EXTINGUSH OK from ACC must be established.

(3) Boiler Shut-off

a) Boiler Shut-off
If an abnormal condition arises where the boiler operation cannot be continued, the FO burner valve and Gas burner valve are closed immediately and fuel for the boiler is automatically shut off, thereby tripping the boiler.

Boiler shut-off condition
- Control air pressure L/L
- Drum W. Level H/H
- Drum W. Level L/L
- Black Out
- All Burner Flame Fail
- Manual Trip
- FD Fan Stop
- BMS CPU Abnormal (Both BMS CPU)
- SH Steam Temp H/H
- Economizer outlet gas temp H

b) Boiler FO Shut-off
If an abnormal condition arises where FO burner operation cannot be continued, the FO burner valve is closed immediately and fuel for the boiler is automatically shut off, thereby tripping the FO burner.

Boiler FO shut-off condition
- Boiler Shut-Off Condition (3)-a)
- Atom. Stm Press. L/L
- FO Press. L/L
- FO Temp. L/L
- FO Pump Stop

c) Boiler Gas Shut-off

If an abnormal condition arises where gas burner operation cannot be continued, the master gas valve and boiler gas valve are closed immediately and gas for the burner is automatically shut off, thereby tripping the gas burner.

After that, an N_2 purge of the burner gas line is automatically performed.
Master gas valve shut-off conditions and boiler gas valve shut-off condition are as follows;

Master gas valve shut-off condition

- ESDS Activated
- Both Boiler Trip
- Hood Room Fan Both Stop
- Gas Leak Detect
- BOG Temp. L/L
- Manual Trip (ECR or BGB)
- Fire Detected
- Vapour Header Press. L/L
- BOG Heater Abnormal
- No. 1 and No.2 Boiler Gas Supply Shut-Off Condition

Boiler gas valve shut-off condition

- Gas Press. L/L
- Gas Press. H/H
- Boiler Shut-Off Condition ((3)-a)
- Manual Trip From ECR
- Master Gas Valve Close
- All burner flame fail

(4) Reset of Shut-off

Perform reset of shut-off by the following procedure.

- Investigate the cause of shut-off and restore normal condition.

- After restoring normal condition, push flickering Close PB for the master gas valve, boiler gas valve or FO shut-off valve to cancel shut-off, and reset the alarm circuit with the Lamp Reset PB.

FO Burner Operating Procedure - Cold Start

(1) Start Burner
The initial start of the burner is conducted by starting the Base FO burner in the BGB side.

After the operation position is transferred to the ECR, the restart of the burner may be conducted by remote instruction from the ECR. The start of base FO burner may be conducted in a perfect automation run confirming the start sequence by depressing FO burner on PB.

(2) Selection of Operation Position
This is conducted in accordance with the (BGB Position).

(3) Open of Boiler FO Shut-off Valve
Depressing the boiler FO shut-off valve Open PB causes the valve to open. However, when the boiler remains in shut-off condition, the valve will not open even though the PB is depressed.

Starting the FO burning pump and opening the boiler FO shut-off valve causes in the FO recirculation mode. In this mode, FO circulates along the course of FO burning pump discharge to the FO burning pump suction through the boiler FO header.

(4) Selection of Steam Atomizing and Air Atomizing

a) In case of steam that is not applicable
Steam atomizing is selected when there is a steam source for heating fuel oil at a predetermined temperature and steam is available for atomizing.
In this mode, FO Temp. Low Interlock is actuated and prevents the starting (ignition) sequence from advancing from the furnace purge unless fuel oil is heated at the specified temperature.
In this mode, fuel oil (heavy fuel oil) is used.

b) In case of air that is applicable
Air atomizing is selected when fuel cannot be heated or when steam is not available for atomizing. Open atomizing air supply manual valve, close atomizing steam supply manual valve, and select FO Temp. Bypass mode on the BGB.
In this mode, FO Temp Bypass lamp flickers, indicating that FO Temp. Low Interlock of the starting sequence (ignition) has been bypassed.
In this mode, diesel oil is used.

(5) Start of Base FO Burner
Depressing the base FO burner ON PB, starts the following start sequence and ignites the FO burner. In addition, the definition of symbols used in the sequence is given as follows;

"No"

(1) ↓	: Indicate the serial number of the start sequence.
▭	: Indicate the start and the stop of the sequence.

"Symbol"

◇	: Interlock condition (LSW, ACC signal, etc.)
○	: Manual or automatic operation.
△	: Interlock condition and operation.

"Action"

▭ (solid box)	: Explanation of manual operation.
⬚ (dotted box)	: Explanation of automatic operation.
No symbol	: Explanation of sequence step.

"Indication"
"   " : Indicates BGB operation or indication lamps of graphic panel.

(5) - a) Initial start of Base FO burner
(With other burner off)

Fuel Mode "FO"→ "FO"

No.	Symbol	Action	Indication
(1)		Securing Start condition of boiler (FO burner)	
↓	◇	Boiler FO shut valve open	: FO SHUT V/V "OPEN" lamp on
(2)		Base FO burner start	
↓	○	"ON" PB on	: Base FO burner "ON" lamp flicker
Base FO burner starting sequence start			
(3)		Furnace purge start	
	○	Furnace purge command to ACC	: "FURNACE PURGE" lamp flicker
	△	All burner air reg. fully open	: All burner "AIR REG" lamp on
	○	Base burner atomizing steam valve fully open	: Base burner "ATM STM V/V" lamp on
(4)		Securing furnace purge condition	
↓	◇	Furnace purge condition established signal from ACC	: "FURNACE PURGE" lamp on
(90 sec.)			
↓	△	Hold furnace purge condition for not less than 90 seconds.	<Furnace purge completed>
(5)		Setting up base FO burner ignition	
	○	Base burner ignition condition setting signal to ACC	: FO CONT V/V "IGN. RATE" lamp flicker "IGN AIR" lamp flicker
			: "IGN AIR" lamp flicker
	○	No. 2, No. 3 burner air reg. fully close	: No. 2, No. 3 burner "AIR REG" lamp off
(6)		Securing base burner ignition condition	
	◇	Ignition condition established signal from ACC	: FO CONT. V/V "IGN RATE" lamp on IGN air lamp on
	◇	FO temp normal (or "FO TEMP. BYPASS" selected)	
	◇	FO burning pump running	
	◇	Base burner atomizing steam valve fully open	
	○	FO recirc. valve close	: "FO Rec. V/V" lamp off
(7)		Base burner ignition	
	△	Base burner ignitor insert	: Base burner " IGNIT" lamp flicker
	◇	Confirming ignitor insert position	: Base burner "IGNIT" lamp on
	△	Ignitor spark start	
	○	Base FO burner valve open	: Base burner "FO BNR V/V-1", "FO BNR V/V-2" lamp on
	◇	Detect faulty operation of flame scanner	→ Trip interlock considering flame scanner signal off as correct change to interlock considering flame scanner on as correct.
	◇	Ignition validity term over trip interlock canceling	→ It will be cancelled when ignition is conducted within 5 minutes after burner start.
(8)		Confirmation of burner ignition (FE detection flame within 10 seconds after FO BNR V/V open)	
	◇	Confirmation of on from FE	: Base burner "BASE BNR" lamp on
			: FO CONT. V/V "IGN" Lamp off "IGN AIR" lamp off
			: No.2, No.3 burner "BNR PURGE V/V" lamp on
Base FO burner starting sequence complete			

(5) - b) Increasing number of No.2 or No.3 FO burner
(Start with other FO burner under burning)

Fuel Mode "FO"→ "FO"

No.	Symbol	Action	Indication
(1)		Securing start condition of boiler (FO burner)	
	◇	Base burner under burning	: Base FO burner "ON" lamp on
			: No.2 (No. 3) FO burner "OFF" lamp on
(2)		No.2 (No.3) FO burner start	
	○	"ON" PB on	: No.2 (No.3) FO burner "ON" lamp flicker
		No.2 (No.3) FO burner starting sequence starts	
(3)		No.2 (No.3) FO burner ignition	
	△	No.2 (No.3) burner purge valve fully close	: No.2 (No.3) burner "BNR PURGE V/V" lamp off
	△	No.2 (No.3) burner atomizing steam valve fully open	: No.2 (No.3) burner "ATM STM V/V" lamp on
	△	No.2 (No.3) FO burner valve fully open	: No.2 (No.3) "FO BNR V/V-1", "FO BNR V/V-2" lamp on
	△	No.2 (No.3) burner air reg. fully open	: No.2 (No.3) burner "AIR REG" lamp on
(4)		Confirmation of burner ignition (FE detecting flame within 10 seconds after FO BNR V/V open)	
	◇	Confirmation of on from FE	: No.2 (No.3) burner "No.2 (No.3) BNR" lamp on
		No.2 (No.3) FO burner Starting sequence complete	

(6) Extinguish of No.3 (or No.2 Base) FO Burner
Depressing No.3 (or No.2 Base) FO burner OFF PB, starts the following extinguish sequence to stop the FO burner.

(6) - a) Extinguish of No.3 FO burner
(With other FO burner under burning)

Fuel Mode "FO"→ "FO"

No.	Symbol	Action	Indication
(1)		Securing burner extinguish condition	
	◇	Other burners under burning	
	◇	FO burner manual mode	
(2)		No.3 FO burner extinguish	
	○	"OFF" PB on	: No.3 FO burner "OFF" lamp flicker
		No.3 FO burner extinguish sequence starts	
(3)		No.3 FO burner extinguish	
	○	No.3 FO burner valve close	: No.3 :FO BNR V/V-1", "FO BNR V/V-2" lamp off
	○	No.3 burner purge valve fully open	: No.3 :burner "BNR PURGE V/V" lamp on
			: No.3 burner "No.3 BNR" lamp off
(5 sec.)			
	○	No.3 burner air reg. close	: No.3 burner "AIR REG" lamp off (This process will be cancelled when No.3 gas burner is under operation.)
(10 sec.)			
	○	No.3 FO burner atomizing steam valve close	: No.3 burner "ATM STM V/V" lamp off
		No.3 FO burner extinguish sequence complete	

(6) - b) Extinguish of Base FO burner
(With all other burners inoperative)

Fuel Mode "FO"→ "FO"

No.	Symbol	Action	Indication
(1)		Securing burner extinguish condition	
	◇	All other burners inoperative	
	◇	FO burner manual mode	
(2)		Base FO burner extinguish	
	○	"OFF" PB on	: Base FO burner "OFF" lamp flicker
Base FO burner extinguish sequence starts			
(3)		Base FO burner extinguish	
	○	Base FO burner valve close	: Base "FO BNR V/V-1", "FO BNR V/V-2" lamp off
	○	Base burner atomizing steam valve close	: Base burner "ATM STM V/V" lamp off
			: Base burner "Base BNR" lamp off
	○	FO recirculation valve fully open	: "FO REC V/V" lamp on
(4)		Furnace purge start	
	○	Furnace purge command to ACC	: "FURNACE PURGE" lamp flicker
	△	All burner air reg. fully open	: All burner "AIR REG" lamp on
(5)		Securing furnace purge condition	
	◇	Furnace purge condition established signal from ACC	: "FURNACE PURGE" lamp on
(30 sec.)			
	△	Hold furnace purge condition for not less than 30 sec.	<Furnace purge completed>
(6)		Furnace purge completed	
	○	All burner air reg. close	: All burner "AIR REG" lamp off
			: "FURNACE PURGE" lamp off
Base FO burner extinguish sequence completed			

Gas Burner Operating Procedure

(1) Start of Gas Burner
The start of gas burner may be conducted manually in the BGB and manually or automatically in the ECR. Securing all the conditions of the master gas valve open and boiler gas valve open is required as starting condition of the GAS burner with the FO burner under burning.

(2) Selection of Operation Position
This is conducted in accordance with the BGB Position.

(3) Opening of the Master Gas Valve
Depressing the master gas valve "OPEN" PB causes the valve to open. However, when it remains in the master gas valve shut-off condition, the valve will not open even though the PB is depressed.
("CLOSE" PB lamp flickers.)
If so, the interlock condition should be brought back to the normal state in accordance with boiler gas shut-off. When the master gas valve opens, the master vent valve closes 10 sec. after. This is intended to replace the inside of the piping line from master gas valve to boiler gas valve by BOG and to fill the line with gas.

(4) Opening of Boiler Gas Valve
Depressing the boiler gas valve "OPEN" PB causes the valve to open. However, when it remains in boiler gas valve shut-off condition, the valve will not open even though the PB is depressed.
("CLOSE" PB lamp flickers.)
If so, the interlock condition should be brought back to the normal state in accordance with boiler gas shut-off. When the boiler gas valve opens, the header vent valve closes 5 sec. later. This is intended to replace the inside of the boiler gas header piping line by BOG and to fill the line with gas. Thereafter the boiler will be in gas stand-by state.

(5) Increasing Number of Gas Burner
Depressing base, No.2 or No.3 gas burner "ON" PB causes the gas burner number increasing sequence to start and the gas burner to burn. In this connection, the definition of symbols used in the sequence is identical with that in the start of the FO burner.

(7) - a) Increasing Number of Base (or No.2, No.3) Gas Burner
(With other Gas burner off)

Fuel Mode “FO” → “DUAL”

No.	Symbol	Action	Indication
(1)		Securing start condition of GAS burner	
	◇	Base FO burner under burning	: Base burner “FO ON” lamp on
	◇	Other gas burner inoperative	: No.2 and No.3 “GAS OFF” lamp on
	◇	Master & Boiler gas valve open	: Master gas v/v “OPEN” lamp on
			: BLR gas v/v “OPEN” lamp on
	○	Gas ignition set command to ACC	: Gas Cont V/V “IGN POSIT” lamp flicker
	◇	Gas ignition setting condition established signal from ACC	: Gas Cont V/V “IGN POSIT” lamp on
(2)		Increase number of base gas burner	
↓	○	“ON” PB on	: Base GAS burner “ON” lamp flicker

Base GAS burner number increasing sequence starts

↓

No.	Symbol	Action	Indication
(3)		Base GAS burner ignition	
	○	Base GAS burner valve open	: Base “GAS BNR V/V-1” “GAS BNR V/V-2” lamp on
			: BASE BNR GAS “ON” lamp on
			: FUEL MODE “DUAL” lamp on
			: GAS CONT V/V “IGN POSIT” lamp off

Base gas burner number increasing sequence completed

(7) - b) Increasing Number of No.2, No.3 Gas Burner
(With other gas burner under burning)

Fuel Mode “DUAL” → “DUAL”

No.	Symbol	Action	Indication
(1)		Securing start condition of gas burner	
	◇	No.2 FO burner under burning	: No.2 burner “FO ON” lamp on
	◇	Other gas burner under burning	: Base “GAS ON” lamp on
(2)		Increase number of No.2 gas burner	
↓	○	“ON” PB on	: No.2 GAS burner “ON” lamp flicker

No.2 gas burner number increasing sequence starts

↓

No.	Symbol	Action	Indication
(3)		Gas burner ignition	
	○	No.2 GAS burner valve open	: No.2 “GAS BNR V/V-1” “GAS BNR V/V-2” lamp on
			: No.2 BNR GAS “ON” lamp on

No.2 gas burner number increasing sequence completed

(8) Extinguishing of Gas Burner

Depressing gas burner OFF PB, starts the following extinguish sequence to stop the gas burner. When the gas burner is extinguished, N_2 purge will be automatically conducted.

(8) - a) Extinguish of No.3 (or No.2, Base) Gas Burner

(With FO burner and gas burner in "DUAL" mode, i.e. both under burning, and with other gas burner under burning)

Fuel Mode "DUAL" → "DUAL"

No.	Symbol	Action	Indication
(1)		Securing burner extinguish condition	
	◇	All FO burners under burning	: Base No.2 and No.3 FO burner "ON" lamp on
	◇	Other gas burners under burning	: Base No.2 and No.3 gas burner "ON" lamp on
(2)		No.3 GAS burner extinguish	
	○	"OFF" PB on	: No.3 GAS burner "OFF" lamp flicker
No.3 GAS burner extinguish sequence starts			
(3)		No.3 gas burner extinguish	
	○	No.3 GAS burner valve close	: No.3 "GAS BNR V/V-1" "GAS BNR V/V-2" lamp off
	○	No.3 GAS burner N_2 purge valve fully open	: No.3 gas burner "BNR N_2 V/V" lamp on
(15 sec.)			
	○	No.3 GAS burner N_2 purge complete	: No.3 gas burner "BNR N_2 V/V" lamp off
			: No.3 gas burner "OFF" lamp on
No.3 gas burner extinguish sequence completed			

(8) – b) Extinguish of base (or No.2, No.3) Gas Burner

(With FO burner and gas burner in "DUAL" mode, i.e. both under burning, and with other gas burner under inoperative)

Fuel Mode "DUAL" → "FO"

No.	Symbol	Action	Indication
(1)		Securing burner extinguish condition	
	◇	All FO burners under burning	: Base No.2 and No.3 FO burner "ON" lamp on
	◇	Other gas burners under inoperative	: Base GAS burner "ON" lamp on
(2)		Base GAS burner extinguish	
	○	"OFF" PB on	: Base GAS burner "OFF" lamp flicker
Base gas burner extinguish sequence starts			
(3)		Base gas burner extinguish	
	○	Base GAS burner valve close	: Base "GAS BNR V/V-1" "GAS BNR V/V-2" lamp off
			: Gas Cont V/V "IGN POSIT" lamp on
	○	Base GAS burner N_2 purge valve fully open	: Base GAS burner "BNR N_2 V/V" lamp on
(15 sec.)			
	○	Base GAS burner N_2 purge complete	: Base burner "BNR N_2 V/V" lamp off
			: Base GAS burner "OFF" lamp on
No.3 Gas burner extinguish sequence completed			

(8) - c) Extinguish of No.3 Gas Burner
(With other gas burner in "GAS" mode)

Fuel Mode "GAS" → "GAS"

No.	Symbol	Action	Indication
(1)		Securing burner extinguish condition	
↓	◇	All GAS burners under burning	: Base No.2 and No.3 GAS burner "ON" lamp on
	◇	All FO burners under inoperative	: Base No.2 and No.3 FO burner "OFF" lamp on
(2)		No.3 GAS burner extinguish	
↓	○	"OFF" PB on	: No.3 GAS burner "OFF" lamp flicker
No.3 gas burner extinguish sequence starts			
↓			
(3)		No.3 GAS burner extinguish	
↓	○	No.3 GAS burner valve close	: No.3 "GAS BNR V/V-1" "GAS BNR V/V-2" lamp off
	○	No.3 GAS burner N_2 purge valve fully open	: No.3 GAS burner "BNR N_2 V/V" lamp on
(15 sec.)			
↓	○	No.3 GAS burner N_2 purge complete	: No.3 burner "BNR N_2 V/V" lamp off
			: No.3 GAS burner "OFF" lamp on
	○	No.3 burner air reg. fully close	: No.3 burner "AIR REG" lamp off
No.3 gas burner extinguish sequence completed			

(8) - d) Extinguish of Base Gas Burner
(With other gas or FO burner inoperative in "GAS" mode)

Fuel Mode "GAS" → "FO"

No.	Symbol	Action	Indication
(1)		Securing burner extinguish condition	
↓	◇	Other gas burners under inoperative	: No.2 and No.3 GAS burner "OFF" lamp on
	◇	All FO burners under inoperative	: Base, No.2 and No.3 FO burner "OFF" lamp on
(2)		Base GAS burner extinguish	
↓	○	"OFF" PB on	: Base GAS burner "OFF" lamp flicker
Base GAS burner extinguish sequence starts			
↓			
(3)		Base gas burner extinguish	
↓	○	Base GAS burner valve close	: Base "GAS BNR V/V-1" "GAS BNR V/V-2" lamp off
			: GAS CONT. V/V "IGN POSIT" lamp on
	○	Furnace purge command to ACC	
	△	All air reg. fully open	:"FURNACE PURGE" lamp flicker
	◇	Furnace purge condition established signal from ACC	: "FURNACE PURGE" lamp on
	○	Base GAS burner N_2 purge complete	: Base burner "BNR N_2 V/V" lamp off
(4)		Start N2 purge	
(15 sec.)		Base GAS burner N2 purge completed	: Base burner "BNR N2 V/V" lamp off
(5)		Start Furnace purge	
(30 sec.)	△	Hold furnace purge condition for not less than 30 sec.	: Furnace purge completed
(6)		Furnace purge completed	
↓	○	All burner air reg. close	: All burner "AIR REG" lamp off
			: "FURNACE PURGE" lamp off
			: Base GAS burner "OFF" lamp on
Base Gas burner extinguish sequence completed			

(9) N_2 Purge
Upon closure of the supply valve, each gas line is automatically N_2 purged internally. Also, the master gas line and boiler gas header line can each be manually given a master N_2 purging or boiler N_2 purging if the master gas valve and boiler gas valve are in the closure position.

a) Master N_2 Purge
In the master N_2 purge, the piping from the master gas valve outlet to each boiler gas valve inlet is internally N_2 purged.

- Auto N_2 Purge
  Upon closure of the master gas valve (after confirming with the limit switch of the master gas valve closure), the master vent valve automatically opens and, at same time, the master N_2 purge valve opens for 60 sec. for N_2 purging to the atmospheric vent line.

- Manual N_2 Purge
  When the master gas valve is in the closure position, depressing the master N_2 purge "ON" PB initiates N_2 purging with the same time sequence as Auto N_2 purge above.

b) Gas Header N_2 Purge
In the gas header N_2 purge, the piping from the boiler gas valve outlet to the gas burner valve inlet is internally N_2 purged.

- Auto N_2 Purge
  Upon closure of the boiler gas valve (after confirming with the limit switch of the boiler gas valve closure), the subsequent N_2 purge take place automatically.

  - With FO Burner in Operation
    The burner gas valve in the operation burner opens for 15 sec., while, the header N_2 purge valve simultaneously opens for 35 sec.

  - With All Burners Out of Service and Furnace Purge Conditions Established
    Set the furnace purge conditions : when the purge conditions are established within 15 sec. the furnace is N_2 purged in the same sequence as above. Afterward, furnace purging is performed for another 30 sec.

  - With All Burners Out of Service and Furnace Purge Conditions not Established
    When the furnace purge conditions are not established within 15 sec., the header N_2 purge valve opens for 30 sec. for N_2 purging to the atmospheric vent line.

- Manual N_2 Purge
  When the boiler gas valve is in the closure position, depressing the boiler N_2 purge "ON" PB initiates N_2 purging. In this case, open the header vent valve and at the same time open the header N_2 purge valve 30 sec for purging to the atmospheric vent line.

Note !
Furnace purge conditions are as follows;
a. FD Fan running
b. All burner air reg. open
c. ACC confirms furnace purge air rate

c) Gas Burner N_2 Purge
In the gas burner N_2 purge, the piping from the burner gas valve outlet to the gas burner nozzle is internally N_2 purged.

- Auto N_2 Purge
  Upon closure of the gas burner valve, the subsequent N_2 purging automatically takes place.

  - With FO or other gas burner in operation
    Upon closure of the gas burner, the burner N_2 purge valve opens for 15 sec. for internal N_2 purging of the furnace.

  - With all other burners out of service, FD Fan running, and All burner air reg. open
    At the same time as the gas burner valve is closed, the furnace purge conditions are established and the FD Fan and burner air reg. Opens. The burner N_2 purge valve then opens for 15 sec. for internal N_2 purging of the furnace.
    Afterwards, furnace purging is performed for another 30sec. In case the FD Fan stops, the sequence mentioned in the above item Gas Header N_2 Purge takes place.

Automatic Operation

Starting Base FO burner and selecting burner control mode "AUTO" in ECR allow the burner to be automatically operated in accordance with the fuel mode.

(10) - (1) FO Burner Number Control (Fuel mode "FO")
In case of burner control "AUTO", No.2 and No.3 FO burner makes automatic start/stop in accordance with the instruction of number increasing/decreasing from ACC In this connection, the number increasing/decreasing sequence are as follows.

(10) - (1) - a) Burner Number Increasing Sequence

Fuel Mode "FO" → "FO"

No.	Symbol	Action	Indication
(1)		Securing burner number increasing condition	
	◇	Base burner under burning	: Base FO burner "ON" lamp on
	◇	Burner control mode "AUTO" selected	: "BNR AUTO" lamp on
(2)		Increasing number of No.2 FO burner	
	○	No.2 burner increasing signal from ACC	: No.2 FO burner "ON" lamp flicker
No.2 FO burner increasing sequence starts			
(3)		No.2 FO burner ignition	
	△	No.2 burner purge valve fully close	: No.2 burner "BNR PURGE V/V" lamp off
	△	No.2 burner atomizing steam valve fully open	: No.2 burner "ATM STM V/V" lamp on
	△	No.2 FO burner valve fully open	: No.2 "FO BNR V/V-1" "FO BNR V/V-2" lamp on
	△	No.2 burner air reg. fully open	: No.2 burner "AIR REG" lamp on
(4)		Confirmation of burner ignition (FE detecting flame within 10 seconds after FO BNR V/V open)	
	◇	Confirmation of on from FE	: No.2 burner "No.2 BNR" lamp on
No.2 FO burner increasing sequence completed			

(10) - (1) - b) Burner Number Decreasing Sequence

Fuel Mode "FO" → "FO"

No.	Symbol	Action	Indication
(1)		Securing burner number decreasing condition	
	◇	All FO burner under burning	: Base No.2, No.3 burner "ON" lamp on
	◇	Burner control mode "AUTO" selected	: "BNR AUTO" lamp on
(2)		Decreasing number of No.3 FO burner	
	○	No.3 burner Decreasing signal from ACC	: No.3 FO burner "OFF" lamp flicker
No.3 FO burner decreasing sequence starts			
(3)		No.3 FO burner extinguish	
	○	No.3 FO burner valve close	: No.3 "FO BNR V/V-1" "FO BNR V/V-2" lamp off
	○	No.3 burner purge valve fully open	: No.3 burner "BNR PURBE V/V" lamp on
			: No.3 burner "No.3 BNR" lamp off
(10 sec.)			
	○	No.3 burner air reg. close	: No.3 burner "AIR REG" lamp off (This process will be cancelled when No.3 gas burner is under operation)
(20 sec.)			
	○	No.3 FO burner atomizing steam valve close	: No.3 burner "ATM STM V/V" lamp off
No.3 FO burner decreasing sequence completed			

(10) - (2) Dual Burner Number Control (Fuel mode "DUAL")

In case of burner control "AUTO", No.2 and No.3 FO burner and No.2 and No.3 gas burner makes automatic start/stop in accordance with the instruction of the number increasing/decreasing from ACC. In this connection, the number increasing/decreasing sequence are as follows.

(10) - (2) - a) Burner Number Increasing Sequence

Fuel Mode "DUAL" → "DUAL"

No.	Symbol	Action	Indication
(1)		Securing burner number increasing condition	
	◇	Base FO burner under burning	: Base FO burner "ON" lamp on
	◇	Base gas burner under burning	: Base gas burner "ON" lamp on
	◇	Burner control mode "AUTO" selected	: "BNR AUTO" lamp on
(2)		Increasing number of No.2 FO/Gas burner	
	○	No.2 burner increasing signal from ACC	: No.2 FO burner "ON" lamp flicker : No.2 Gas burner "ON" lamp flicker
		No.2 FO/Gas burner increasing sequence starts	
(3)		No.2 FO burner ignition	
	△	No.2 burner purge valve fully close	: No.2 burner "BNR PURGE V/V" lamp off
	△	No.2 burner atomizing steam valve fully open	: No.2 burner "ATM STM V/V" lamp on
	△	No.2 FO burner valve fully open	: No.2 "FO BNR V/V-1" "FO BNR V/V-2" lamp on
	△	No.2 burner air reg. fully open	: No.2 burner "AIR REG" lamp on
(4)		Confirmation of burner ignition (FE detecting flame within 10 seconds after FO BNR V/V open)	
	◇	Confirmation of on from FE	: No.2 burner "No.2 BNR" lamp on
(5)		No.2 Gas burner ignition	
	○	No.2 Gas burner valve open	: No.2 "GAS BNR V/V-1" "GAS BNR V/V-2" lamp on : No.2 BNR GAS "ON" lamp on
		No.2 FO burner increasing sequence completed	

(10) - (2) - b) Burner Number Decreasing Sequence

Fuel Mode "DUAL" → "DUAL"

No.	Symbol	Action	Indication
(1)		Securing burner number decreasing condition	
	◇	All FO burner under burning	: Base No.2, No.3 FO burner "ON" lamp on
	◇	All gas burner under burning	: Base No.2, No.3 Gas burner "ON" lamp on
	◇	Burner control mode "AUTO" selected	: "BNR AUTO" lamp on
(2)		Decreasing number of No.3 FO/Gas burner	
	○	No.3 burner decreasing signal from ACC	: No.3 FO burner "OFF" lamp flicker : No.3 Gas burner "OFF" lamp flicker
		No.3 FO/Gas burner decreasing sequence starts	
(3)		No.3 FO/Gas burner extinguish	
	○	No.3 FO burner valve fully close	: No.3 "FO BNR V/V-1" "FO BNR V/V-2" lamp off
	○	No.3 burner purge valve fully open	: No.3 burner "BNR PURBE V/V" lamp on
	○	No.3 Gas burner valve fully close	: No.3 "GAS BNR V/V-1" "GAS BNR V/V-2" lamp off
	○	No.3 burner N_2 purge valve fully open	: No.3 burner "BNR N_2 PURBE V/V" lamp on
(15sec.)		No.3 burner atomizing steam valve Fully close	: No.3 burner "ATM STM V/V" lamp off No.3 FO burner "OFF" lamp on
(4)		No.3 Gas burner auto N_2 purge complete	
	○	No.3 burner N_2 purge valve fully close	: No.3 burner "BNR N_2 V/V" lamp off : No.3 Gas burner "OFF" lamp on
	○	No.3 burner air reg. fully close	: No.3 burner "AIR REG" lamp off
(5)		No.3 FO burner purge completed	
		No.3 FO/Gas burner decreasing sequence complete	

(10) - (3) Gas Burner Number Control (Fuel mode "GAS")

In case of burner control "AUTO", No.3 Gas burner makes automatic stop in accordance with the instruction of the number decreasing from ACC. In this connection, the number decreasing sequence are as follows.

(10) - (3) - a) Burner Number Decreasing Sequence

Fuel Mode "GAS" → "GAS"

No.	Symbol	Action	Indication
(1)		Securing burner number decreasing condition	
	◇	All FO burner under inoperative	: Base No.2, No.3 FO burner "OFF" lamp on
	◇	All gas burner under burning	: Base, No.2, No.3 Gas burner "ON" lamp on
↓	◇	Burner control mode "AUTO" selected	: "BNR AUTO" lamp on
(2)		Decreasing number of No.3 Gas burner	
↓	○	No.3 burner decreasing signal from ACC	: No.3 GAS burner "OFF" lamp flicker
No.3 GAS burner decreasing sequence start ↓			
(3)		No.3 GAS burner extinguish	
	○	No.3 GAS burner valve fully close	: No.3 "GAS BNR V/V-1" "GAS BNR V/V-2" lamp off
↓	○	No.3 burner N_2 purge valve fully open	: No.3 burner "BNR N_2 V/V" lamp on
(15sec.) ↓			
(4)		No.3 Gas burner auto N_2 purge complete	
	○	No.3 burner N_2 purge valve fully close	: No.3 burner "BNR N_2 V/V" lamp off
			: No.3 GAS burner "OFF" lamp on
↓		No.3 burner air reg. fully close	: No.3 burner "AIR REG" lamp off
No.3 GAS burner decreasing sequence complete			

Note !

The Fuel Mode "GAS" can be selected from 2 burners' burning conditions of 3 burners. When only one burner is burning, the FO back-up operation is activated automatically. Also, 3 burners burning is required in the "GAS" mode, the FO back-up operation is activated to automatically increase the No.3 burner.

(10) - (4) FO Back-up

In the burner control "AUTO" and the fuel mode "GAS", the "FO Back-Up" order from ACC, ECR or IAS for the FO burner(s), equivalent to the Gas burner(s) running, automatically starts with their increased number. The fuel mode changes from "GAS" to "DUAL". In this connection, the "FO Back-Up" sequence is shown as follows.

Fuel Mode "GAS" → "DUAL"

No.	Symbol	Action	Indication
(1)		Securing "FO Back-Up" Operation	
	◇	All GAS burner under burning	: Base No.2, No.3 Gas burner "ON" lamp on
	◇	Burner control mode "AUTO" selected	: "BNR AUTO" lamp on
↓	◇	Fuel mode "GAS"	: Fuel Mode "GAS" lamp on
(2)		"FO Back-Up" ordered	
↓	○	"FO Back-Up " order from ACC or other system	: Fuel Mode "DUAL" lamp flicker
FO Back-Up sequence starts ↓			
(3)		Securing FO burner number increasing condition	
	○	FO ignition setting order to ACC	: FO Cont. V/V "IGN RATE" lamp flicker
↓	◇	FO ignition setting OK from ACC	: FO Cont. V/V "IGN RATE" lamp on
(4)		Increasing number of FO burner	
	○	Each FO burner valve open	: Each burner "FO BNR V/V" lamp on
↓			: Fuel Mode "DUAL" lamp on
FO Back-Up sequence completed			

Note !

The FO BACK-UP conditions are as follows;
- M/T manoeuvring mode
- Vapour header press low
- Both low duty compressor stop
- No.2 burner auto decreasing

How ever, in both low duty stop conditions, the No.3 burner is decreased before FO back-up.

(10) - (5) FO Boost-up Operation

In the burner control "AUTO" with the fuel mode "GAS" and "DUAL", the master gas valve shut-off condition (Gas Trip) automatically turns the fuel mode "FO"

Fuel mode	Master gas valve Shut-off condition	Fuel mode
"DUAL"	·······→	"FO"
"GAS"	——→	"FO"

(10) - (5) - a) FO "Boost-Up" in the fuel mode "GAS"

The FO "Boost-up" in the fuel mode "GAS" causes the FO burner(s), equivalent to the GAS burner(s) running, to automatically start while the Master Gas valve is shut-off . The FO burner runs alone.

Fuel Mode "GAS" → "FO"

No.	Symbol	Action	Indication
(1)		Securing "FO Boost-Up" Operation	
	◇	All Gas burner under burning	: Base No.2, No.3 Gas burner "ON" lamp on
	◇	Burner control mode "AUTO" selected	: "BNR AUTO" lamp on
	◇	Fuel mode "GAS"	: Fuel Mode "GAS" lamp on
(2)		"FO Boost-Up" ordered	
	○	Master gas shut-off condition	: Base, No.2, No.3 Gas burner "OFF" lamp flicker : "MASTER GAS V/V" lamp flicker : "MASTER GAS V/V", "CLOSE" lamp flicker
		(15 sec.)	
	○	Boiler gas valve close	: "BLR GAS V/V" lamp off
	○	Gas burner valve fully close	: All "GAS BNR V/V-1", "GAS BNR V/V-2" lamp off
		FO Boost-Up sequence starts	
(3)		FO burner ignition	
	○	Each FO burner valve open	: Each burner "FO BNR V/V" lamp on : Fuel Mode "FO" lamp on
		FO Boost-Up sequence complete	
		Master, Gas Header and burner auto N_2 purge sequence starts	

Note !

FO BOOST-UP conditions are as follows.

- ESDS active
- Hood room fan both stop
- Gas leak detected
- BOG temp L/L
- Manual trip(ECR or BGB)
- Fire detected
- Vapour header pressure L/L
- BOG heater abnormal
- Both boiler gas valve trip

How ever, If ESDS is the activated condition, the No.3 burner is decreased before FO boost-up.

(10) - (5) - b) FO "Boost-Up" in the fuel mode "DUAL"

The FO "Boost-Up" in the fuel mode "DUAL" shut off the Master Gas valve and causes the FO burner to run alone.

Fuel Mode "DUAL" → "FO"

No.	Symbol	Action	Indication
(1)		Securing "FO Boost-Up" Operation	
	◇	All Gas burner under burning	: Base No.2, No.3 Gas burner "ON" lamp on
	◇	All FO burner under burning	: Base No.2, No.3 FO burner "ON" lamp on
	◇	Burner control mode "Auto" selected	: "BNR AUTO" lamp on
	◇	Fuel mode "DUAL"	: Fuel mode "DUAL" lamp on
(2)		"FO Boost-Up" ordered	
	○	Master gas shut-off condition	: Base, No.2, No.3 Gas burner "OFF" lamp flicker : "MASTER GAS V/V" lamp flicker : "MASTER GAS V/V", "CLOSE" lamp flicker
		(15 sec.)	
	○	Boiler gas valve close	: "BLR GAS V/V" lamp off
	○	Gas burner valve fully close	: All "GAS BNR V/V-1", "GAS BNR V/V-2" lamp off
		Master, Gas Header and burner auto N_2 purge sequence starts	

(11) Hot Start Valve

The hot start piston valve open/close order from ACC causes BMS to automatically close or open the hot start piston valve. At the same time, the BGB and BOP indicator lamp is turned on/off.

(12) 1 Fan 2 Boilers Operation

This is an operation with 1 FD Fan(high speed) for 2 boiler when No.1 FD fan or No.2 FD fan is in trip condition.
The operation procedure is as follows. (◇ shows an interlock condition.) This mode can only be selected in BGB operation.

- FD Fan for No.2 boiler (for example) is trips. And boiler trips.
- ◇ Set high speed condition for No.1 boiler FD Fan. The indication lamp of the graphic panel "NO.1 FD FAN HIGH" lights when this signal is inputted to BMS
- ◇ Open common air dumper slowly. The indication lamp of the graphic panel "COMMON DAMPER OPEN" lights when this signal is inputted to BMS.
- ◇ Select "No.2 Boiler by 1 fan 2 boilers select switch on BGB. The indication lamp of the graphic panel "1 FAN 2 BOILER MODE" flickers and "NO.2 BOILER USE" lights when this signal is inputted to BMS.
- Reset the boiler trip condition
- Open No.2 boiler FO shut-off valve
- Start Base FO burner

(13) Flame Monitoring System

Each burner is equipped with 2 sets of flame scanner which is combined type
(UV & IR).

1) Interlock
- Flame Eye Trip
When two (2) flame scanners detect loss of flame during operation of the burner, the burner is tripped by the "BNR FAIL".

- Flame Eye Alarm
When one (1) flame scanner detects loss of flame during operation of the burner, the alarm "FL1 or FL2 FAIL" is issued.

- Detection of Malfunction
When either flame scanner detects flame with FO burner V/V and Gas burner V/V in close position, "Fl1 or FL2 FAIL" alarm is issued and the burner is tripped because of flame scanner malfunction.

2) Burner Re-start
Restore the boiler to normal in accordance with (4) reset of shut-off and re-start FO burner in accordance with (5)-a).

(14) Emergency Operation

Operation in failure of BMS CPUs (both CPUs)

When both BMS CPUs fail. The FO burner operation bypassing BMS CPU can be made by operating "EMERGENCY OPERATION SWITCH" on BGB. (◇ shows an interlock condition.)

Start the FO burner.
- ◇ Start the FD Fan.
- Start the FO Pump
- ◇ Fully open the FD Fan inlet vane and perform furnace purge.
  * Perform the furnace purge for 3 minutes or more with the FD Fan inlet vane and all burner air reg. fully opened.
- ◇ Put FO Shut-V/V Switch on the OPEN position
- Adjust the FD fan inlet vane and FO flow control valve to the specified opening angle.
- ◇ Put the base burner IGNITOR SWITCH on the INSERT position. Put the base burner V/V SWITCH on OPEN position after turning on the ignitor switch.
  * The time for ignition is 15 seconds at maximum.
- If FO the burner is not ignited through the above steps, repeat the procedure from the third step.

Extinguish the FO burner
- Put base, No.2 or No.3 FO burner V/V SWITCH to CLOSE position.

Note !

1. Perform a furnace purge.

2. In this mode, the following FO SHUT-OFF conditions are actuated. Other FO SHUT-OFF conditions are bypassed, so the operator must directly confirm and operate them.
   - FD Fan Stop
   - Steam Drum Water Level L-L
   - Black Out
   - Flame Fail
   - Manual Trip

3. The gas burner cannot be operated in the EMERGENCY MODE.

(15) FO Temp. Bypass Operation

Use Diesel Oil use instead of Fuel Oil.

When heating steam of fuel is not prepared, FO burner operation bypassing the interlock of FO Temp. Low can be made by operating the "FO Temp bypass Switch" on the BGB.

(16) Flame Eye Bypass Operation

Maintaining of Flame Scanner is carried out in the burner operation.

When this happens, the burner operation bypassing the interlock of FLAME FAIL can be made by operating the "F/E BYPASS SWITCH" on the BGB.

(17) Portable Operation

The portable igniter is used in the operation.

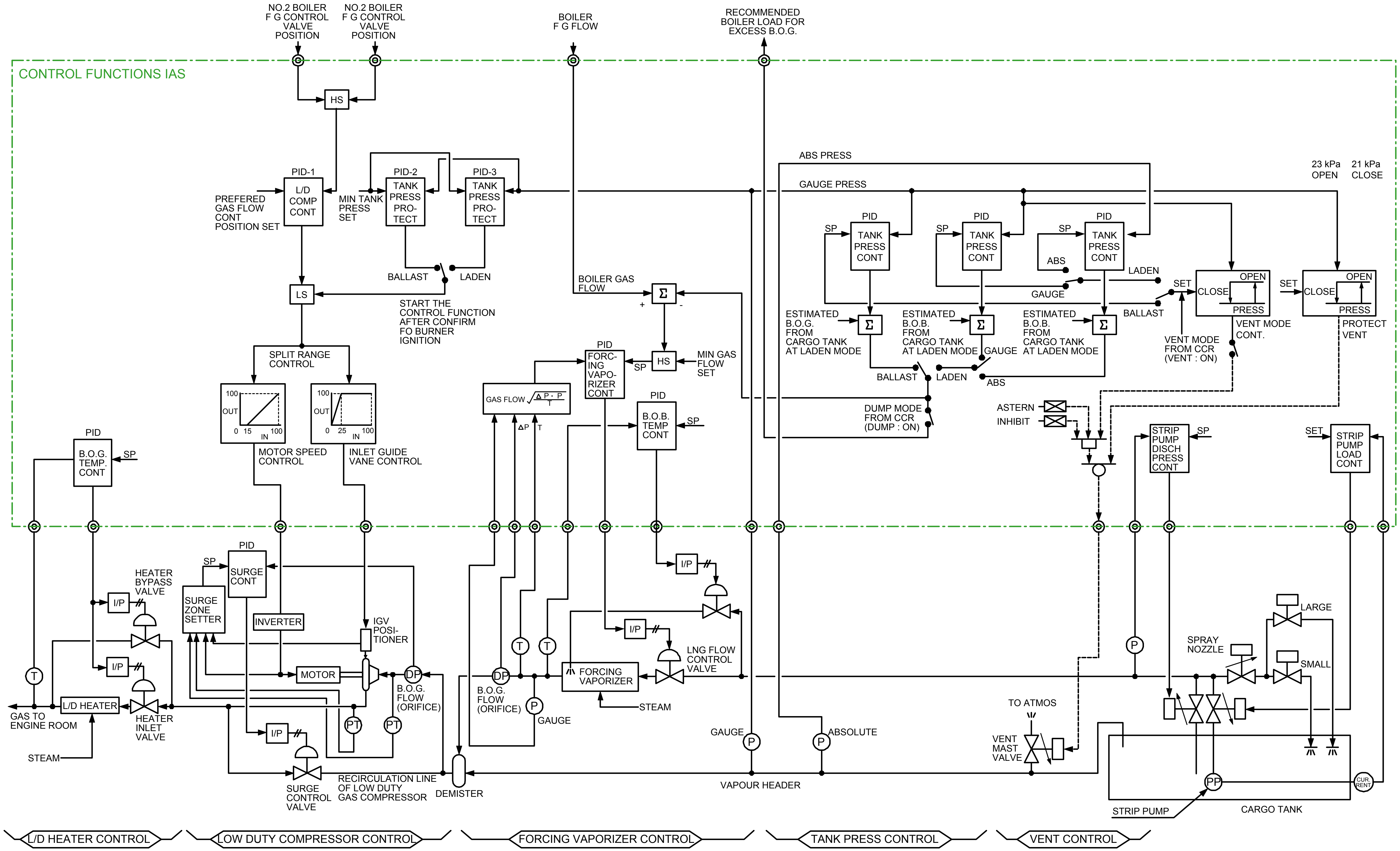
When the boiler starts initially the No.2 or No.3 FO burner, the portable igniter is used for the following procedure;

1) Insert the portable igniter to use the burner.
2) After confirming lamp flickering(slowly flicker at 1 sec.) in the igniter lamp on the boiler graphic operation panel, push the FO burner "ON" switch.
3) The burner ignition sequence starts.
4) Take out the portable igniter after the FO burner firing(quickly at 0.1 sec.).

Also, increasing No.3 FO burner orNo.2 FO burner without the base FO burner is possible by using the portable igniter.

1) Insert the portable igniter to increase the burner.
2) After confiming lamp flickering(slowly flicker at 1 sec.)in the igniter lamp on the boiler graphic operation panel, push the FO burner "ON" switch to increase the burner.
3) The burner increasing sequence starts.
4) Take out the portable igniter after the FO burner increases(quick flicker at 0.1 sec.).

Illustration 4.4i Gas Management System



4.4 Gas Management System (GMS)

General Description

Heat transfer to the liquid cargo from the insulation spaces and the cargo tanks cause the liquid to boil and vapour to form. This is termed the cargo tank boil-off and it must be removed to maintain equilibrium within the tanks at the designed operating pressure. The volume of boil-off also increased during passage due to the energy dissipated by the agitation of the cargo caused by the ship's motion.

Gas is normally taken from the vapour header, is compressed using the LD compressor(s) and heated in the LD heater before being delivered to the boilers.

Control System

The gas management system is integrated into the IAS. It covers:

LD compressor control
Tank pressure control
Vent control
Forcing vaporizer control

The GMS controls the LD compressor control system to maintain gas flow to the boilers. When the tank's pressure falls to a set point, the LD compressor automatically maintains a pressure above the set point. The tank's pressure control system generates the amount of gas to maintain the tank's pressure at the set point by matching the fuel gas requirement from the boilers with the available gas in the tanks. If fuel mode is gas only, and the boiler's requirement exceeds the gas output in the tanks, the forcing vaporizer is used. In dual fuel mode, the shortage is addressed by using additional fuel oil. Any tank over-pressure is controlled by the vent control or the steam dump control system, depending on the boiler's demand.

LD Compressor Control

The LD compressor's capacity control depends on the boiler fuel gas control valve position and the vapour header pressure. The compressor capacity is controlled by split range control adjustment of inlet guide vanes position and motor speed.

There are three PID controllers within the LD compressor control system :

PID "1" (XICLD70) : set point is the boiler fuel gas valve position
PID "2" (PICGH11BLS, PICGH11LDS) : set point is cargo tank pressure

PID 2 & 3 are available for ballast and laden mode, respectively, in dual fuel mode. Outputs are selected automatically from the GMS.

Cargo Tank Pressure Control by Forcing Vapouriser

The system monitors the vapour header pressure in absolute and gauge mode and controls. The operator must first select the correct voyage mode in which the controllers operate on the IAS as follows:

Mode Condition	**Voyage** Mode	**Pressure Sensor** Selection	**Cargo Tank Pressure** Control mode
1	Laden	Absolute	Absolute control for Laden
2	Laden	Gauge	Gauge control for Laden
3	Ballast	Gauge	Gauge control for Ballast

The sensors calculate the appropriate data that controllers can use in their operation.

Two controllers provide control, one each for laden and ballast voyage. The output controls the forcing vaporizer to maintain the flow to the boiler.

Vent Mast Control
Vent control valve CG106 is controlled from the IAS and has four control levels.

Cargo tank protection vent
Manual vent inhibit
Vent control at "Vent Mode"
Manual vent

In the cargo tank protection vent mode, the vent control valve CG106 opens to full flow (100% capacity) when a pressure on the vapour header exceeds the set value of 23 kPag. The valve stays in this mode until the pressure registered on the vapour header drops below 21 kPag, at which point the valve closes. In the cargo tank protection vent mode, the manual vent inhibit and the vent control at vent mode are disabled. Manual operation of the vent valve is not available.

In the manual vent inhibit mode, the vent valve stays close while the engine telegraph is astern or, if in the wheelhouse, the vent inhibit order is in operation. The manual operation of the vent mast valve is not available. The cargo tank protection vent mode overrides the manual vent inhibit mode.

In the vent control at vent mode, the IAS controls the opening of the vent control valve CG106, according to the vapour header pressure while BOG is routed to the engine room for burning in the boilers. In this mode, the manual operation of the vent control valve is not available.

The manual vent mode (inching control), is to be operated during pre-dry docking and post dry-dock voyage. The operator manually sets the opening (position %) of the vent control valve from the operator's screen on the IAS.

Low Duty Heater

The outlet temperature of the BOG through the low duty heater is monitored via the IAS, with the temperature of the outlet from the heater being regulated by the heater inlet valve and the heater bypass valve. Manual operation of the control valves is not available when control comes from the IAS.

Under low duty heater trip conditions, the IAS automatically closes the heater inlet valve and opens the bypass valve. Both valves are locked in this mode until the trip condition is recovered. The boiler controller receives a signal from the IAS of the heater trip and orders a change over to FO (FO boost up order).

Forcing Vapouriser

During ballast or laden voyages, cargo tank pressure in the fuel gas mode can be maintained by the forcing vaporizer control. Two PID controllers are provided for the ballast or laden voyage.

The IAS controls stripping /spray pump load by motor current, inlet valve and large spray nozzle to feed a constant flow to the forcing vaporizer.

The cargo tank's temperature is controlled by the small spray nozzle'.

The IAS monitors the BOG's flow rate and outlet temperature from the forcing vaporizer and accordingly sets the control valves on the forcing vaporizer.

There are three modes in which the forcing vaporizer operates:

Manual mode
Cascade mode
Program-Man mode

In manual mode, the control parameters are set locally by the operator for the BOG's flow and temperature.

4.5 Automatic Boiler Control System

System Configuration

The control section has two programmable dual CPU controllers, one for each boiler, that constitute an independent system for each boiler.
The control valve and output section of the drive unit are provided with a back-up unit so that in case of failure by a controller, back-up operation (emergency manual operation) can be made, bypassing it.

Note !

1. The control system is for one boiler, while control systems for two boilers are provided.

2. The following control loops are common to two boilers controlled by No.1 boiler controller. When failure of No.1 boiler controller, No.2 boiler controller automatically backs up.
   - Steam Dump Control Loop
   - FO Pump Discharge Press. Control Loop

3. Emergency manual operation (BACK-UP UNIT)
   The control valve and output section of the drive unit is provided with a back-up unit in case of failure by the controller.
   A manual operation bypassing the controller can be made by selecting the ABC mode "EMERGENCY" on the BGB.

*** ACC : AUTOMATIC COMBUSTION CONTROL**
ACC controls fuel flow (FO flow + Gas flow) and combustion air flow to maintain the superheater outlet steam at a preset pressure in response to boiler load changes.

1. MST/Master Control Loop

The master control loop compares and computes (set point control) a pre-set master set pressure (Master SP) with the actual boiler superheater steam pressure (PV). Its outputs are the results of computing the sub-control loop as boiler load signal ("master signal") to equalize both pressures quickly.

(1) Two-Master System
The two master system with a master controller for each boiler is adopted. The active master signal is automatically selected depending on the operating condition of boilers. (Master signal is output from the active master controller.)

The priority in the active master controller

1. Boiler Auto Run
2. Auto Steaming Up
3. No.1 Boiler

Selected by "BMS"

(2) Master A/M Station ("BOP" only)

a) Boiler Bias Operation
Both boilers are operating in "ACC AUTO" mode with "BIAS" to produce a master signal distribution.

b) Master Set Point
The master set pressure (MASTER SP) of the superheater outlet steam pressure is set manually. This master set point is given an initial value of 6.03 MPag when electric power is on.
The set point of steam dump control (DUMP SP) is set to MASTER SP + 0.1 MPag.

* MASTER SP Auto Set Down :
In the following modes, the master set point is lowered automatically by 0.1 MPag to 5.93 MPag.

Manoeuvring Mode
M/T Stop or Trip

2. SDC/Steam Dump Control Loop

This is a system that dumps excess steam from the boiler to the main condenser.

(1) Steam Dump Control
When the boiler load is below the turn-down range of the burners or when it changes quickly, the steam dump control valve dumps the momentarily generated steam and quickly stabilizes boiler operation.
A pre-set steam dump set pressure (DUMP SP) and superheater outlet steam pressure (PV) are compared and computed (set point control). The steam dump control valve is controlled to equalize both pressures quickly.

(2) Excess BOG Control (Excess BOG Dump Mode)
This is a controller that operates when the dump mode is selected in the cargo control system and the BOG consumption in the boiler is lower than "RECOMMENDED BOILER LOAD" an output the cargo control system. The steam equivalent to excess BOG is automatically dumped.

(3) Dump A/M Station
Auto/Man Station is provided to both BOP and BGB operation panels.

3. FO/Fuel Oil Control Loop

The master signal (SP) from the master control loop and the actual FO flow (FO flow is calculated by multiplying FO burning pressure by the number of burners : PV) are compared and computed (cascade control). The FO flow (FO flow control valve) is controlled to quickly equalize both.

(1) Priority Control of Gas Flow
When the gas flow control is in "AUTO" mode, priority is always given to gas flow over FO flow to meet boiler load (master signal).

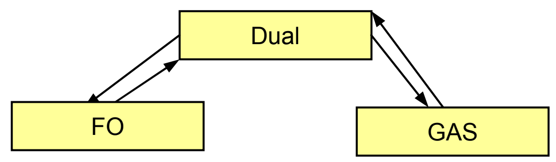
* Conditions for releasing the minimum fuel oil flow :
- Gas control valve is fully open or manually operated.
- BMS issues FO boost-up order.

(2) Coordinate Control with BMS
The following controls are performed automatically in coordination with BMS.

a) Initial light-off of the FO burner

b) Automatic burner increasing and decreasing control in "FO" mode and "DUAL" mode.

c) Automatic change-over of the fuel mode
The FO flow is automatically controlled in accordance with the fuel mode change-over order from BMS.



d) FO Back-up Control
The Fuel mode is changed from "GAS" to "DUAL" to supply fuel oil equivalent to the shortage made by BOG firing.

e) FO Boost-up Control
When the master gas valve shut-off function is activated, the fuel mode is changed from "GAS" or "DUAL" to "FO". The FO flow is equivalent to the BOG flow supplied to meet the boiler load made by fuel oil firing.

f) A/M Station
BOP and BGB operation panel are provided with Auto/Man Station of the follow-up type.

4. ATM/Atomizing Pressure Control Loop

The required atomizing pressure (SP) is determined by the fuel's (FO or DO) actual atomizing pressure (PV) that is compared and computed. The atomizing flow (atomizing pressure control valve) is controlled to equalize both pressures quickly.

(1) A/M Station
BOP and BGB operation panel are provided with Auto/Man Station of the follow-up type.

5. Gas/Gas Flow Control Loop

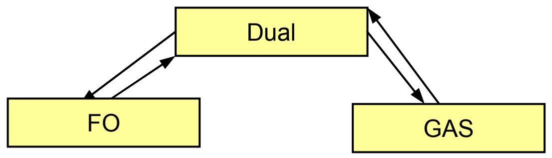
The master signal (SP) from the master control loop and actual BOG flow (Gas flow is calculated by computing temperature and pressure as the value of BOG burning pressure multiplied by the number of burners: PV) are compared and computed (cascade control). The BOG flow (gas flow control valve) is controlled to quickly equalize both.

(1) Control of BOG Flow
Control of BOG flow is made by controlling the LD compressor (controlled by the shipyard system), with the gas flow control valve kept at a constant opening.

(2) Free Flow Control
BOG firing is made at the pressure of vapour header, with LD compressor stopped. BOG flow is controlled only by gas flow control valve.

(3) Coordinate Control with BMS
The following controls are performed automatically in coordination with BMS.

a) Automatic burner decreasing control in “GAS” mode.
b) Automatic burner increasing and decreasing control in “DUAL” mode.
c) Automatic change-over of fuel mode.
Gas flow is automatically controlled in accordance with the fuel mode change-over order from BMS.



d) FO Boost-up Control
When the master gas valve shut-off function is activated, the BOG supply is maintained until the fuel mode is changed from the “GAS” mode to the “FO” mode or from “DUAL” mode to “FO” mode.
e) A/M Station
BOP and BGB operation panel are provided with Auto/Man Station of the follow-up type.

6. Air/Air Flow Control Loop

The required burner draft loss (SP) switch is determined by the sum of FO flow and gas flow. The actual burner draft loss (wind box-furnace draft : PV) are compared and computed (cascade control). Combustion air (FD Fan inlet vane) is controlled to quickly equalize both.
The feed-forward control by the master signal is adopted to improve control in response to boiler load change.
Moreover, excess air adjuster is provided to enable manual correction of combustion air in response to changes in firing conditions.

(1) O_2 Trim Control
Feed-back control by O_2 concentration in the boiler outlet exhaust gas is adopted.
The design of the O_2 concentration (SP) is determined by the boiler load. The actual O_2 concentration (PV) is compared and computed (cascade control) and the “EXCESS AIR RATIO” is automatically corrected.

(2) Fuel/Air Ratio Adjuster
BOP and BGB operation panels are provided with a ratio adjuster.
The Fuel/Air ratio (excess air ratio) can be adjusted manually regardless of BOP and BGB control positions.

(3) Auto/Man Station
BOP and BGB operation panels are provided with Auto/Man station of follow up type.

*** FWC : FEED WATER FLOW CONTROL**

1. FWC/Feed Water Flow Control Loop

A pre-set drum water level (SP) and actual steam drum level (PV) are compared and computed (set point control). Feed water flow (Feed water flow control valve) is controlled to equalize both levels quickly.
The feed-forward control by the boiler steam flow and feed water flow is adopted to improve control in response to boiler load changes. (three-element type control system)

(1) “VARIABLE” or “FIX” Mode
The operator can select the setting point “VARIABLE” or “FIX” mode.

(2) A/M Station
BOP and BGB operation panels are provided with Auto/Man Station of the follow-up type.

*** STC : STEAM TEMPERATURE CONTOL**

1. STC/Steam Temperature Control Loop

A pre-set STC set temperature (SP) and actual superheater outlet steam temperature (PV) are compared and computed (set point control). Steam flow (steam temperature control valve) circulating through the internal control desuperheater in the water drum is controlled to quickly equalize both temperatures.
Feed-forward control by the superheater 5 pass inlet steam temperature is adopted to improved control in response to boiler load changes. (two-element type control system)

(1) A/M Station
BOP and BGB operation panel are provided with Auto/Man Station of the follow-up type.

*** FOP : FO PUMP DISCHARGE PRESS. CONTROL**
(FO RECIRCULATION CONTROL)

1. FOP/FO Pump Discharge Press. Control Loop

A pre-set FO pump discharge pressure (SP) and actual pressure (PV) are compared and computed (set point control). FO pump recirculation flow (FO Recirc. Flow control valve) is controlled to quickly equalize both pressures.

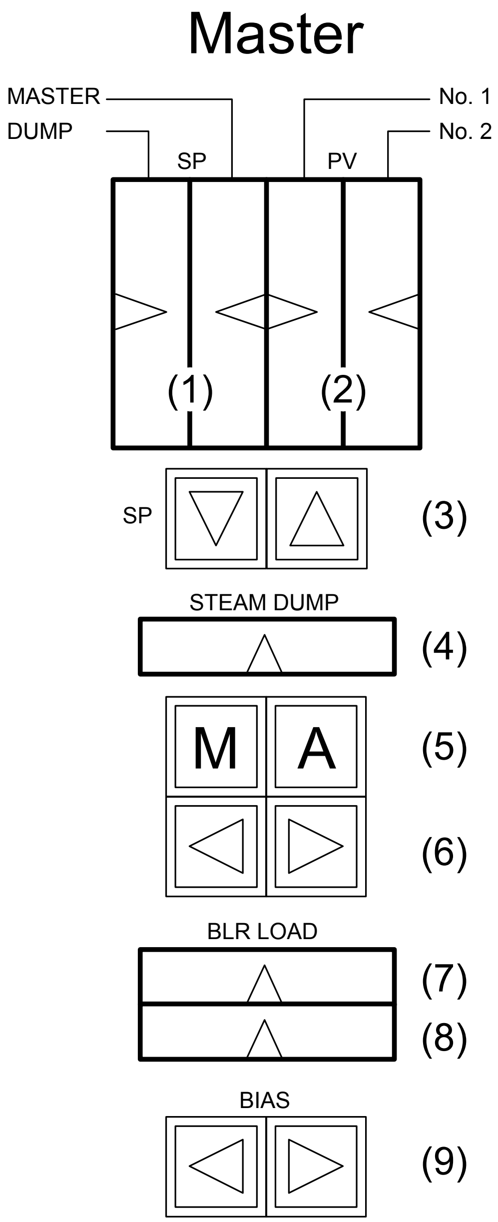
(1) A/M Station
BOP and BGB operation panel are provided with Auto/Man Station of the follow-up type.

(2) Set Point Station
The FO pump discharge pressure can be set manually. This set point can be returned to its original value through the reset switch.

Operating Function of Auto/Manual Station

(1) Master Station

The master station indicates the status of the master control loop and transfer it to Auto/Manual.

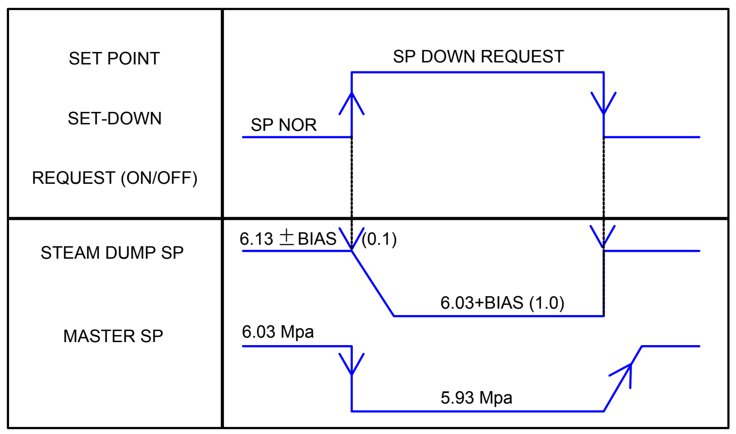


PB : Push Button switch
PB/L : PB with indication Lamp
(1) Set Point Indicator (:SP)
Left : Dump set pressure (Master SP + 0.1 MPag)
Right : Master set pressure
(2) Indicator (Process Value : PV)
Left : No. 1 Boiler
Right : No. 2 Boiler
(3) SP Raise & Lower PB
Master SP is manually set. (BOP only)
(4) Steam Dump Indicator
Indicate output signal to IAS
(5) Steam Dump Auto/Man Selector PB/L
Select Auto/Man for Steam Dump control
(6) Increase/Decrease switch of Steam Dump manual operation
(7) Boiler Load Indicator
(8) Boiler Bias Indication
(9) Bias setting PB

Note !
Master SP is set-down when M/T is operated in a manoeuvring condition.
Refer to the following table;

Master SP : 6.03 → 5.93 MPag
Dump SP : 6.13 → 6.03 MPag

ACC Master Set Point Set-Down



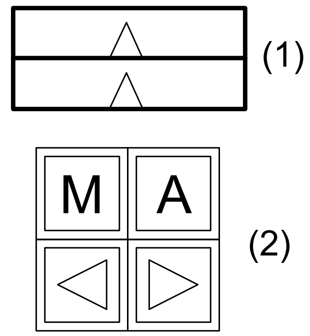
► Control Position

BGB ECR : Operation is done regardless of ABC control position.

(2) FO Flow Station

This station indicates the status of FO Flow Control Loop and transfer it to Auto/Manual.

a) "FO FLOW" Auto/Manual Station
This station transfers Auto/Manual of the FO Control V/V.



(1) Indicator
Upper : FO burning pressure (PV)
(Green) 0~3.0 MPag
Lower : Output signal for FO control V/V
(Red) 0~100%
(2) Auto/Manual Station
Auto/Manual Station transfers the control mode of FO control V/V to Auto/Manual and indicates its status.
In Manual mode, FO control V/V is manually operated.

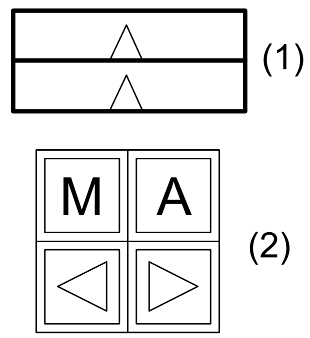
► Control Position

BGB ECR : Operation is done at the ABC control position.

(3) Gas Flow Station

This station indicates the status of the FO Gas Control Loop and transfer it to Auto/Manual.

a) "GAS FLOW" Auto/Manual Station
This station transfers Auto/Manual mode of the Gas Control V/V.



(1) Indicator
Upper : Gas Burning pressure (PV)
(Green) 0~100 kPag
Lower : Output signal for Gas Control V/V
(Red) 0~100%
(2) Auto/Manual Station
Auto/Manual Station transfers control mode of Gas Control V/V to Auto/Manual and indicates its status.
In Manual mode, Gas Control V/V is manually operated.

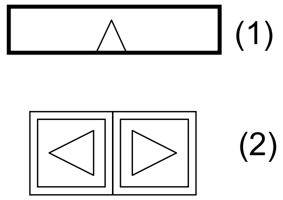
► Control Position

BGB ECR : Operation is done at the ABC control position.

(4) Air Flow Station

This station indicates the status of the Air Gas Control Loop and transfer it to Auto/Manual.

a) Fuel/Air Ratio Adjuster
Fuel/Air ratio is set.

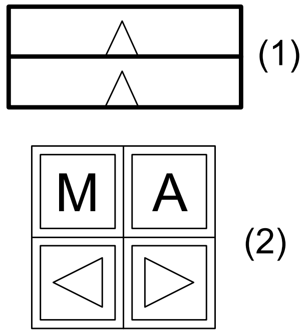


(1) Indicator
Fuel/Air Ratio
0.5 ~ 1.0 ~ 1.5 %
(2) Increase & Decrease PB
Fuel/Air Ratio is set
1.0 : Standard fuel/air ratio
(Standard air rate)
1.0 → 1.5 : Increases fuel/air ratio
(Increase combustion air above standard rate.)
0.5 ← 1.0 : Decreases fuel/air ratio
(Decrease combustion air above standard rate.)

► Control Position

BGB ECR : Operation is done at the ABC control position.

b) "AIR FLOW" Auto/Manual Station
This station transfers the Auto/Manual mode of the FD Fan inlet vane control drive unit.



(1) Indicator
Upper : Burner Draft Loss (PV)
(Green) 0~5.0 kPag
Lower : Output signal for FD Fan inlet vane control drive unit
(Red) 0~100%
(2) Auto/Manual Station
Auto/Manual Station transfers control mode of FD Fan inlet vane control drive to the Auto or Manual and indicates its status.
In Manual mode, FD Fan inlet vane control drive unit is manually operated.

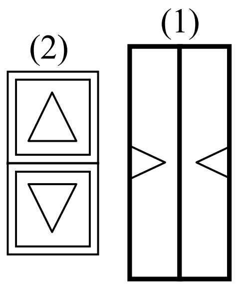
► Control Position

BGB ECR : Operation is done at the ABC control position.

(5) FWC Flow Station

This station indicates the status of the FWC Control Loop and transfer it to Auto/Manual.

a) Drum Level Set Station
This station sets SETPOINT of FWC Control Loop.

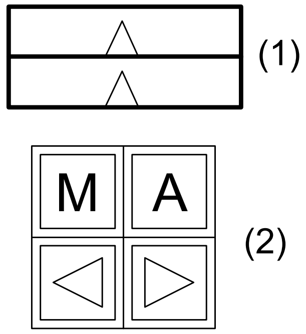


(1) Indicator
Left (No. 1 Boiler) : Set Point (SP)
Right (No. 2 Boiler) : Set Point (SP)
-300 ~ 0 ~ +300 mm
Right (No. 2 Boiler) : Drum Water Level (PV)
Left (No. 1 Boiler) : Drum Water Level (PV)
-300 ~ 0 ~ +300 mm
(2) Raise & Lower Switch
This switch is used to set the Drum Level SP in Fix mode.

► Control Position

BGB ECR : Operation is done at the ABC control position.

b) "FWC" Flow Auto/Manual Station
This station transfers the Auto/Manual of the FWC Control V/V.



(1) Indicator
Upper : Feed Water Flow (PV)
(Green) 0~56 T/H
Lower : Output signal for FW Control V/V
(Red) 0~100%
(2) Auto/Manual Station
This station transfers the control mode of the FW control V/V to Auto/Manual and indicates its status.
In Manual mode, the FW Control V/V is manually operated.

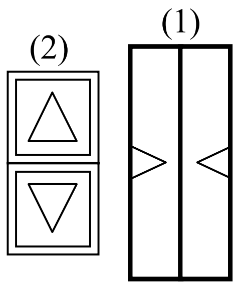
► Control Position

BGB ECR : Operation is done at ABC control position.

(6) STC Station

This station indicates the status of the STC Control Loop and transfer it to Auto/Manual.

a) STC Set Station
This station sets SETPOINT of STC Control Loop.



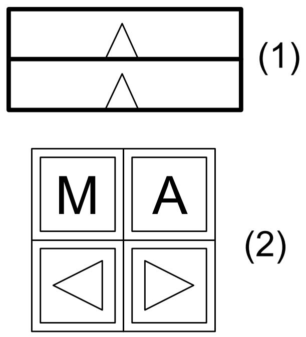
(1) Indicator
- Left (No. 1 Boiler) : Set Point (SP)
- Right (No. 2 Boiler) : Set Point (SP)
  0 ~ 600˚C
- Right (No. 2 Boiler) : Steam temp (PV)
- Left (No. 1 Boiler) : Steam temp (PV)
  0 ~ 600˚C

(2) Raise and Lower Switch
This switch is used to set the Steam Temp SP.

► Control Position

BGB ECR : Operation is done at the ABC control position.

b) "STC" Auto/Manual Station
This station transfers the Auto/Manual of the STC Control V/V.



(1) Indicator
- Upper : Steam Flow (PV)
  (Green) 0~56 T/H
- Lower : Output signal for steam temp control V/V
  (Red) 0~100%

(2) Auto/Manual Station
This station transfers the control mode of the steam control V/V to Auto/Manual and indicates its status.
In Manual mode, the steam temp control V/V is manually operated.

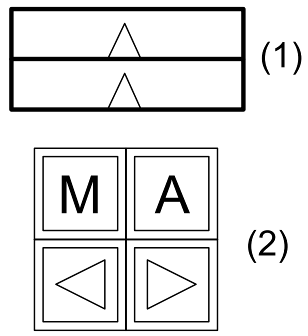
► Control Position

BGB ECR : Operation is done at the ABC control position.

(7) ATM Press Station

This station indicates status of the Atomize Press Control Loop and transfers it to Auto/Manual.

a) "ATM" Auto/Manual Station
This station transfers the Auto/Manual of the ATM Press. Control V/V.



(1) Indicator
- Upper : Atomize pressure (PV)
  (Green) 0 ~ 1.5 MPag
- Lower : Output signal for Atomize Press. Control V/V
  (Red) 0 ~ 100%

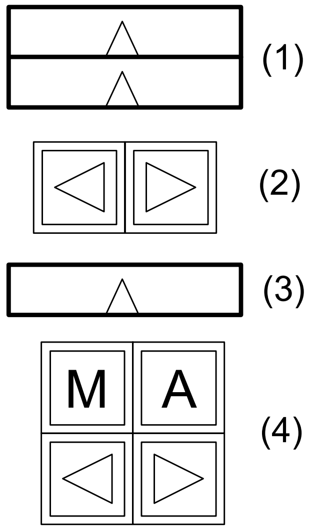
(2) Auto/Manual Station
The Auto/Manual Station transfers the control mode of the Atomize Control V/V to the Auto/Manual and indicates its status. In Manual mode, the Atomize Control V/V is manually operated.

► Control Position

BGB ECR : Operation is done at the ABC control position.

(8) FO Recalculation Control Station

a) "FO REC" Auto/Manual Station
This station indicates the FO Rec. Control Loop and transfers the Auto/Manual of the FO Rec. (FO Pump Discharge Press. Control) control V/V.



(1) Indicator
Upper : FO recirculation set press (SP)
(Green) 0 ~ 4.0 MPag
Lower : FO recirculation press value (PV)
(Red) 0 ~ 100%
(2) Increase/Decrease switch for SP
The set press of FO recirculation can be changed by this switch.
(3) Indicator
Indication of output signal for FO Rec. Control V/V.
(4) Auto/Man Station
This station transfers the control mode of the FO Rec. Control V/V to Auto/Manual and indicates its status.
In Manual mode, the FO Rec. Control V/V is manually operated.

► Control Position

BGB ECR : Operation is done at the ABC control position.

4.6 BMS and ACC Logic Diagram

4.6.1 Burner Management System Logic Diagram

BMS LOGIC SYMBOLS

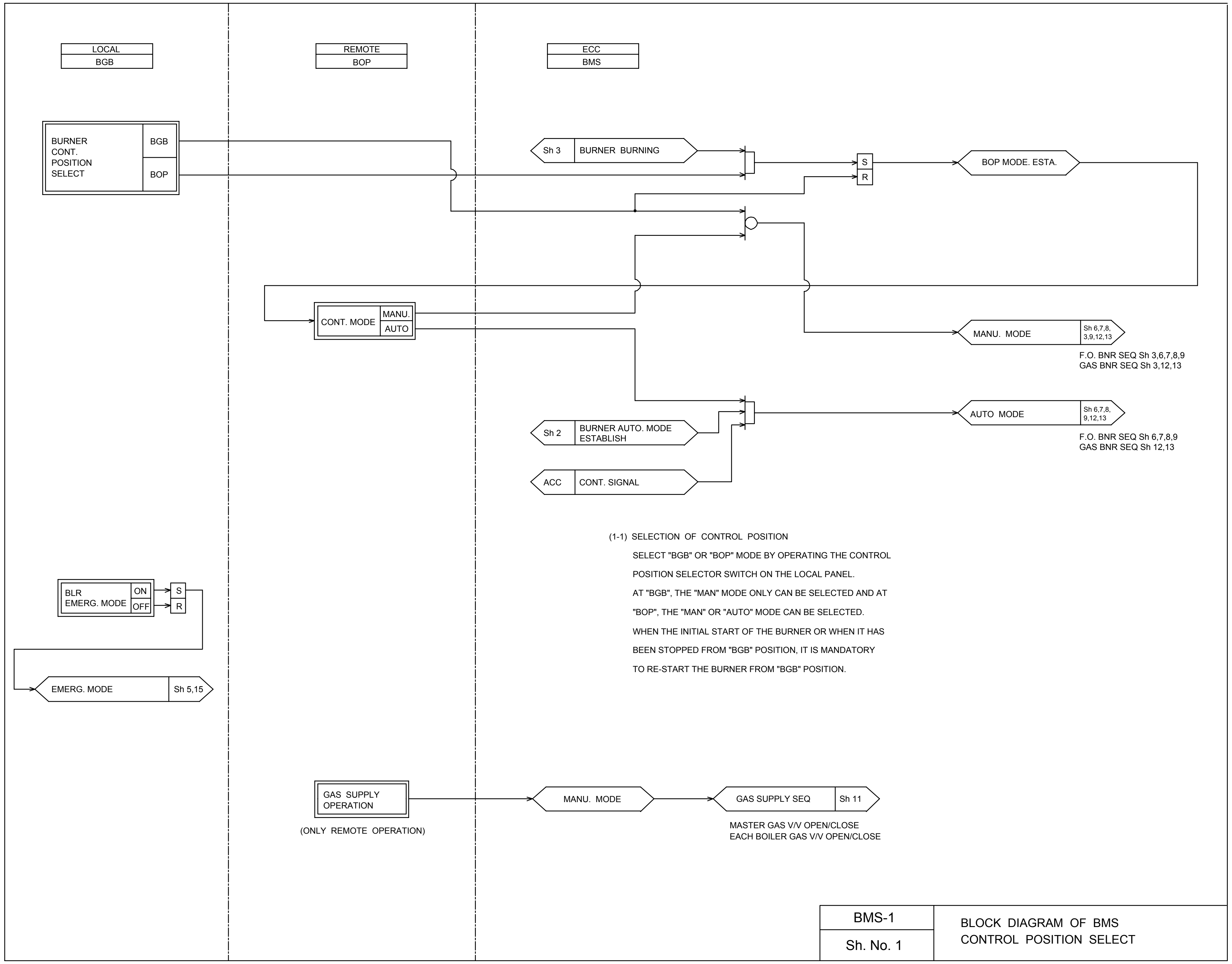
NO.	DESCRIPTION	SYMBOLS	REMARKS
1	OR-GATE		
2	AND-GATE		
3	INVERTER		IN OUT
4	ON DELAY TIMER (SOFT)	# SET TIME (sec.)	IN T OUT
5	OFF DELAY TIMER (SOFT)	# SET TIME (sec.)	IN T OUT
6	FLIP-FLOP	S R S: SET R: RESET	S R OUT
7	CROSS CONNECTION		
8	MANUAL OPERATION		
9	AUTO OPERATION		
10	SEQUENCE SIGNAL		
11	CONDITIONAL STEP		
12			
13	ALARM LAMP FLICKER	RL	ON
14	MONITOR SWITCH	M. S.	
15	LIMIT SWITCH	L. S.	
16			
17	AUTOMATIC COMBUSTION CONTROL	ACC	
18	BURNER MANAGEMENT SYSTEM	BMS	
19	BOILER GAUGE BOARD	BGB	LOCAL

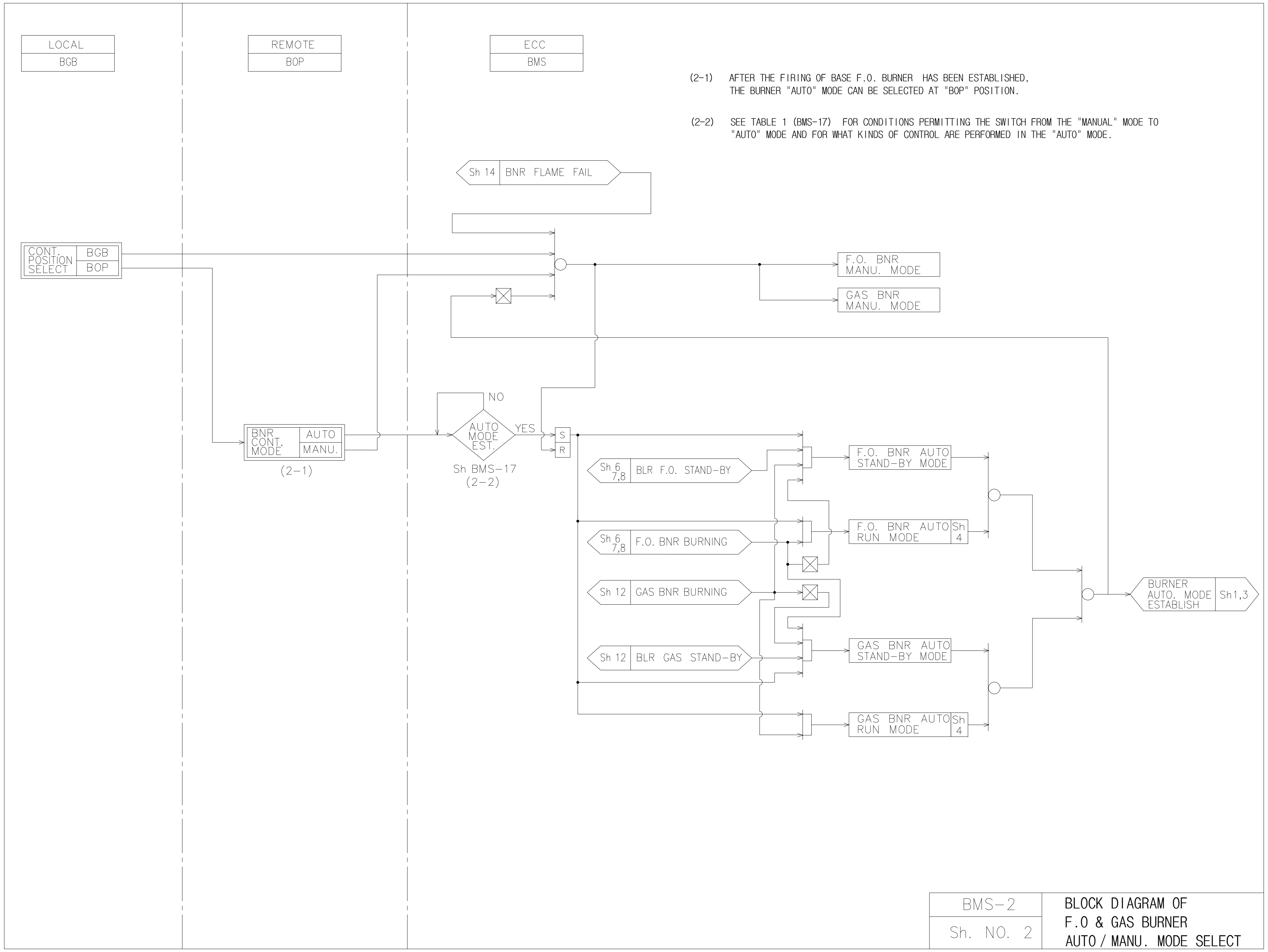
BMS MAN-AUTO CHANGE

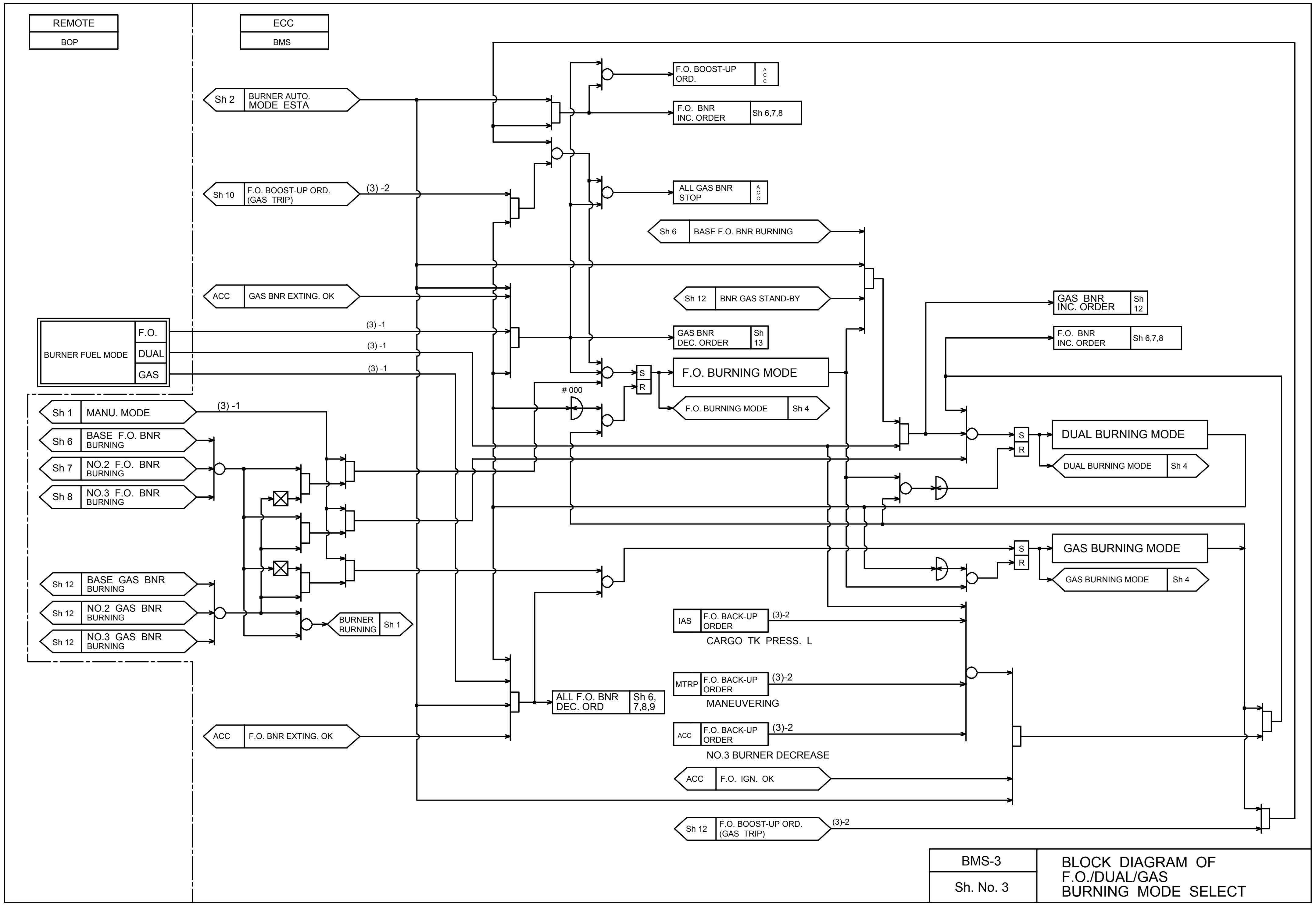
CASE NO.	BURNER	FUEL F.O.	FUEL GAS	FUEL MODE	"BMS MODE MAN-AUTO" OK or NOT	DESCRIPTION OF BMS AUTO. CONTROL	BURNER CONTROL MODE AT FUEL TRIP *4: F.O. TRIP	BURNER CONTROL MODE AT FUEL TRIP *4: GAS TRIP	OPERATE OF "FUEL MODE" SW AT BMS AUTO.: F.O./DUAL/GAS
1	BASE	O	X	F.O. ONLY	OK	*1 NO.2 F.O. -> ON (CASE 2)	BLR TRIP AUTO->MAN	CONTINUE (AUTO)	F.O. -> DUAL (TO CASE 7) *6
	NO.2	X	X						
	NO.3	X	X						
2	BASE	O	X			*1 NO.2 F.O. -> OFF (CASE 1) NO.3 F.O. -> ON (CASE 3)	BLR TRIP AUTO->MAN	CONTINUE (AUTO)	F.O. -> DUAL (TO CASE 8) *6
	NO.2	O	X						
	NO.3	X	X						
3	BASE	O	X			*1 NO.3 F.O. -> OFF (CASE 2)	BLR TRIP AUTO->MAN	CONTINUE (AUTO)	F.O. -> DUAL (TO CASE 9) *6
	NO.2	O	X						
	NO.3	O	X						
4	BASE	X	O	GAS ONLY	NOT (MAN)	-	CONTINUE (MAN)	CONTINUE (MAN)	NOT OPERATE BMS MAN
	NO.2	X	X						
	NO.3	X	X						
5	BASE	X	O		OK	*2 GAS -> DUAL (CASE 8) *3 GAS -> F.O. (CASE 2) *1 NO.2 GAS -> OFF (CASE 7) (BACK-UP ORDER FROM ACC)	CONTINUE (AUTO)	*3 CONTINUE (TO CASE 2)	GAS -> DUAL (TO CASE 8) *5
	NO.2	X	O						
	NO.3	X	X						
6	BASE	X	O			GAS -> DUAL (CASE 9) *3 GAS -> F.O. (CASE 3) *1 NO.3 GAS -> OFF (CASE 5)	CONTINUE (AUTO)	*3 CONTINUE (TO CASE 3)	GAS -> DUAL (TO CASE 9) *5
	NO.2	X	O						
	NO.3	X	O						
7	BASE	O	O	DUAL	OK	*1 NO.2 DUAL -> ON *3 DUAL -> F.O. (CASE 1)	AUTO->MAN (TO CASE 4)	CONTINUE (TO CASE 1)	DUAL -> F.O. (CASE 1)
	NO.2	X	X						
	NO.3	X	X						
8	BASE	O	O			*1 NO.2 DUAL -> OFF (CASE 7) *1 NO.3 DUAL -> ON (CASE 8) *3 DUAL -> F.O. (CASE 2)	AUTO->MAN (TO CASE 5)	CONTINUE (TO CASE 2)	DUAL -> F.O. (CASE 2)
	NO.2	O	O						
	NO.3	X	X						
9	BASE	O	O			*1 NO.3 DUAL -> OFF (CASE 8) *3 DUAL -> F.O. (CASE 3)	CONTINUE (AUTO) (TO CASE 6)	CONTINUE (TO CASE 3)	DUAL *8 F.O. (CASE 3) GAS (CASE 6) *7
	NO.2	O	O						
	NO.3	O	O						
-	BASE	-	-	F.O. DUAL GAS	NOT (MAN)	ALL COMBINATIONS EXCEPT CASE 1 ~ CASE 9	CONTINUE (MAN)	CONTINUE (MAN)	NOT OPERATE BMS MAN
	NO.2	-	-						
	NO.3	-	-						

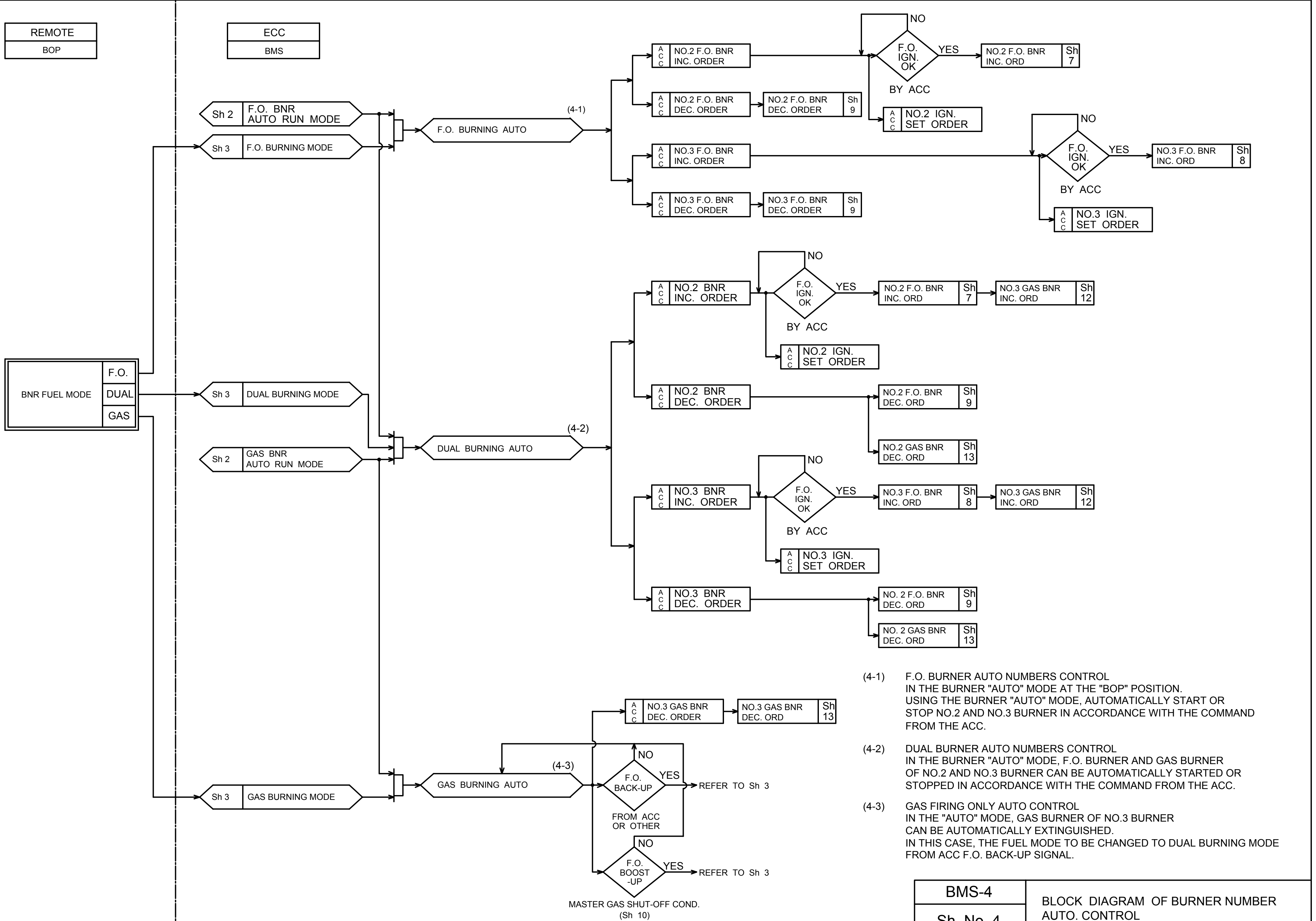
* 1 ; BURNER AUTO NUMBERS CONTROL
* 2 ; F.O. BACK-UP CONTROL (FROM ACC SIGNAL)
* 3 ; F.O. BOOST-UP CONTROL (BY GAS TRIP)
* 4 ; IN CASE OF BOTH FUEL TRIP CONDITION, BLR IS MADE "TRIP" & BMS IS SET TO "MAN"
* 5 ; IGN. F.O. RATE HAS BEEN ESTABLISHED
* 6 ; IGN. GAS RATE HAS BEEN ESTABLISHED
* 7 ; F.O. EXTINGUISH HAS BEEN ESTABLISHED AND NOT * 2
* MAN ; BMS CONTROL MODE "MAN"
* AUTO ; BMS CONTROL MODE "AUTO"
* 8 ; GAS EXTINGUISH HAS BEEN ESTABLISHED

MAN-AUTO. CHANGE & AUTO. CONTROLS OF BMS


LOCAL
BGB
REMOTE
BOP
ECC
BMS
BURNER CONT. POSITION SELECT
BGB
BOP
Sh 3
BURNER BURNING
S
R
BOP MODE. ESTA.
CONT. MODE
MANU.
AUTO
MANU. MODE
Sh 6,7,8, 3,9,12,13
F.O. BNR SEQ Sh 3,6,7,8,9
GAS BNR SEQ Sh 3,12,13
Sh 2
BURNER AUTO. MODE ESTABLISH
AUTO MODE
Sh 6,7,8, 9,12,13
F.O. BNR SEQ Sh 6,7,8,9
GAS BNR SEQ Sh 12,13
ACC
CONT. SIGNAL
(1-1) SELECTION OF CONTROL POSITION
SELECT "BGB" OR "BOP" MODE BY OPERATING THE CONTROL
POSITION SELECTOR SWITCH ON THE LOCAL PANEL.
AT "BGB", THE "MAN" MODE ONLY CAN BE SELECTED AND AT
"BOP", THE "MAN" OR "AUTO" MODE CAN BE SELECTED.
WHEN THE INITIAL START OF THE BURNER OR WHEN IT HAS
BEEN STOPPED FROM "BGB" POSITION, IT IS MANDATORY
TO RE-START THE BURNER FROM "BGB" POSITION.
BLR EMERG. MODE
ON
OFF
S
R
EMERG. MODE
Sh 5,15
GAS SUPPLY OPERATION
(ONLY REMOTE OPERATION)
MANU. MODE
GAS SUPPLY SEQ
Sh 11
MASTER GAS V/V OPEN/CLOSE
EACH BOILER GAS V/V OPEN/CLOSE
BMS-1
Sh. No. 1
BLOCK DIAGRAM OF BMS
CONTROL POSITION SELECT


LOCAL
BGB
REMOTE
BOP
ECC
BMS
(2-1) AFTER THE FIRING OF BASE F.O. BURNER HAS BEEN ESTABLISHED. THE BURNER "AUTO" MODE CAN BE SELECTED AT "BOP" POSITION.
(2-2) SEE TABLE 1 (BMS-17) FOR CONDITIONS PERMITTING THE SWITCH FROM THE "MANUAL" MODE TO "AUTO" MODE AND FOR WHAT KINDS OF CONTROL ARE PERFORMED IN THE "AUTO" MODE.
Sh 14 BNR FLAME FAIL
CONT. POSITION SELECT
BGB
BOP
F.O. BNR MANU. MODE
GAS BNR MANU. MODE
NO
BNR CONT. MODE
AUTO
MANU.
(2-1)
AUTO MODE EST.
YES
Sh BMS-17
(2-2)
S
R
Sh 6 7,8 BLR F.O. STAND-BY
Sh 6 7,8 F.O. BNR BURNING
Sh 12 GAS BNR BURNING
Sh 12 BLR GAS STAND-BY
F.O. BNR AUTO STAND-BY MODE
F.O. BNR AUTO RUN MODE
Sh 4
GAS BNR AUTO STAND-BY MODE
GAS BNR AUTO RUN MODE
Sh 4
BURNER AUTO. MODE ESTABLISH
Sh1,3
BMS-2
Sh. NO. 2
BLOCK DIAGRAM OF F.O & GAS BURNER AUTO / MANU. MODE SELECT


REMOTE
BOP
ECC
BMS
Sh 2 BURNER AUTO. MODE ESTA
Sh 10 F.O. BOOST-UP ORD. (GAS TRIP)
ACC GAS BNR EXTING. OK
BURNER FUEL MODE
F.O.
DUAL
GAS
Sh 1 MANU. MODE
Sh 6 BASE F.O. BNR BURNING
Sh 7 NO.2 F.O. BNR BURNING
Sh 8 NO.3 F.O. BNR BURNING
Sh 12 BASE GAS BNR BURNING
Sh 12 NO.2 GAS BNR BURNING
Sh 12 NO.3 GAS BNR BURNING
BURNER BURNING Sh 1
ACC F.O. BNR EXTING. OK
F.O. BOOST-UP ORD.
F.O. BNR INC. ORDER Sh 6,7,8
ALL GAS BNR STOP
Sh 6 BASE F.O. BNR BURNING
Sh 12 BNR GAS STAND-BY
GAS BNR DEC. ORDER Sh 13
F.O. BURNING MODE
F.O. BURNING MODE Sh 4
000
GAS BNR INC. ORDER Sh 12
F.O. BNR INC. ORDER Sh 6,7,8
DUAL BURNING MODE
DUAL BURNING MODE Sh 4
GAS BURNING MODE
GAS BURNING MODE Sh 4
IAS F.O. BACK-UP ORDER
CARGO TK PRESS. L
MTRP F.O. BACK-UP ORDER
MANEUVERING
ACC F.O. BACK-UP ORDER
NO.3 BURNER DECREASE
ACC F.O. IGN. OK
Sh 12 F.O. BOOST-UP ORD. (GAS TRIP)
ALL F.O. BNR DEC. ORD Sh 6, 7,8,9
BMS-3
Sh. No. 3
BLOCK DIAGRAM OF F.O./DUAL/GAS BURNING MODE SELECT

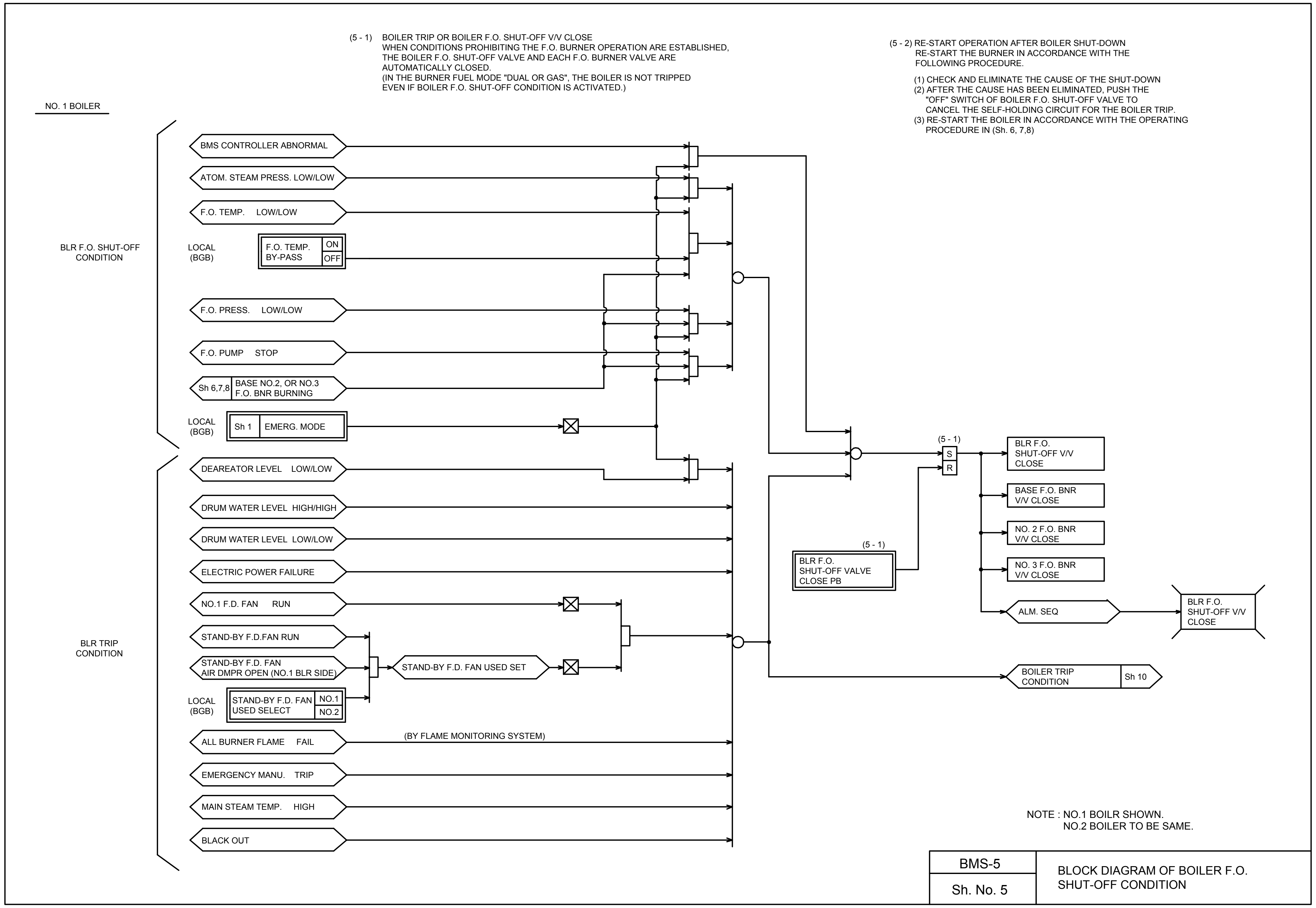


(4-1) F.O. BURNER AUTO NUMBERS CONTROL
IN THE BURNER "AUTO" MODE AT THE "BOP" POSITION.
USING THE BURNER "AUTO" MODE, AUTOMATICALLY START OR STOP NO.2 AND NO.3 BURNER IN ACCORDANCE WITH THE COMMAND FROM THE ACC.

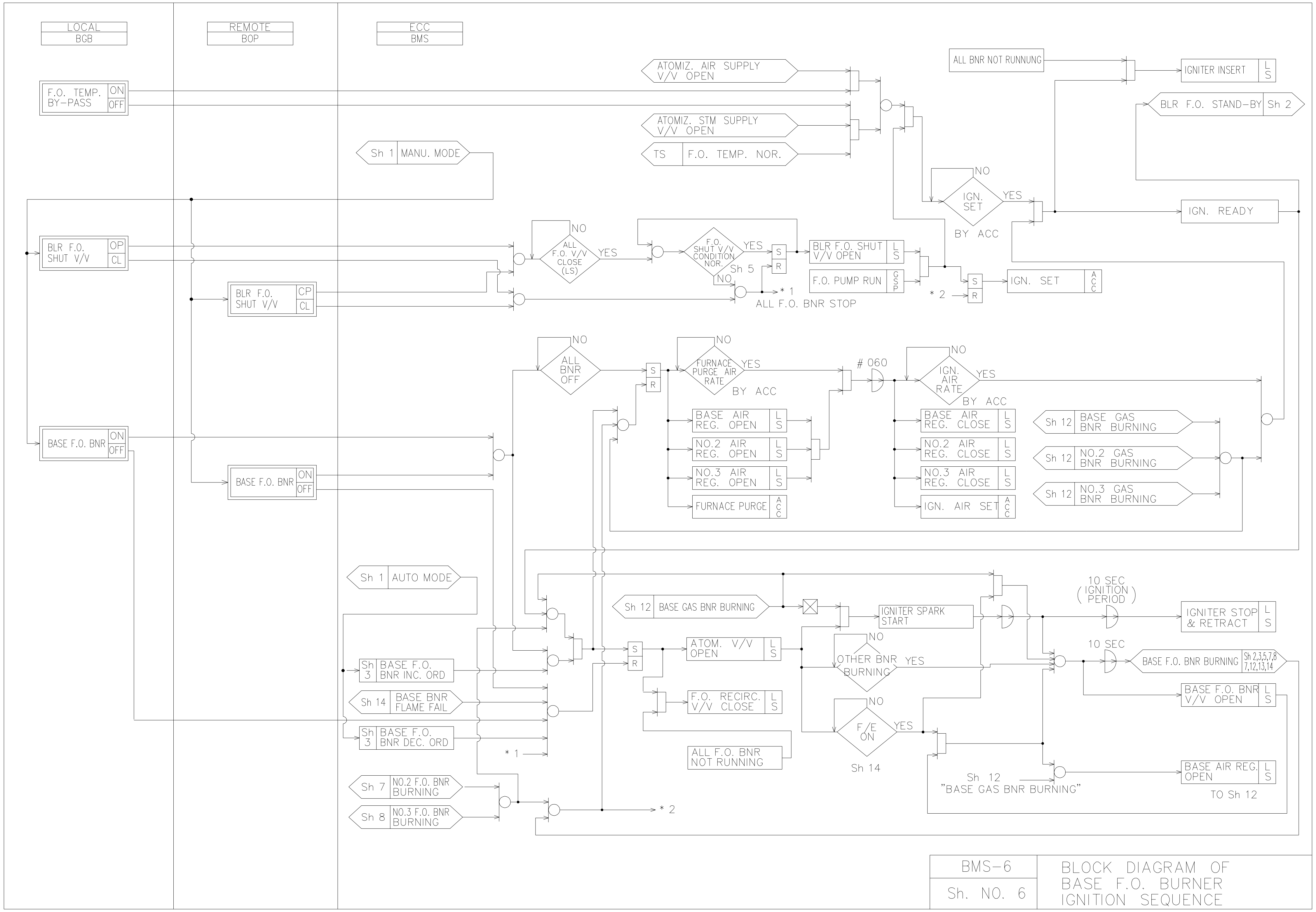
(4-2) DUAL BURNER AUTO NUMBERS CONTROL
IN THE BURNER "AUTO" MODE, F.O. BURNER AND GAS BURNER OF NO.2 AND NO.3 BURNER CAN BE AUTOMATICALLY STARTED OR STOPPED IN ACCORDANCE WITH THE COMMAND FROM THE ACC.

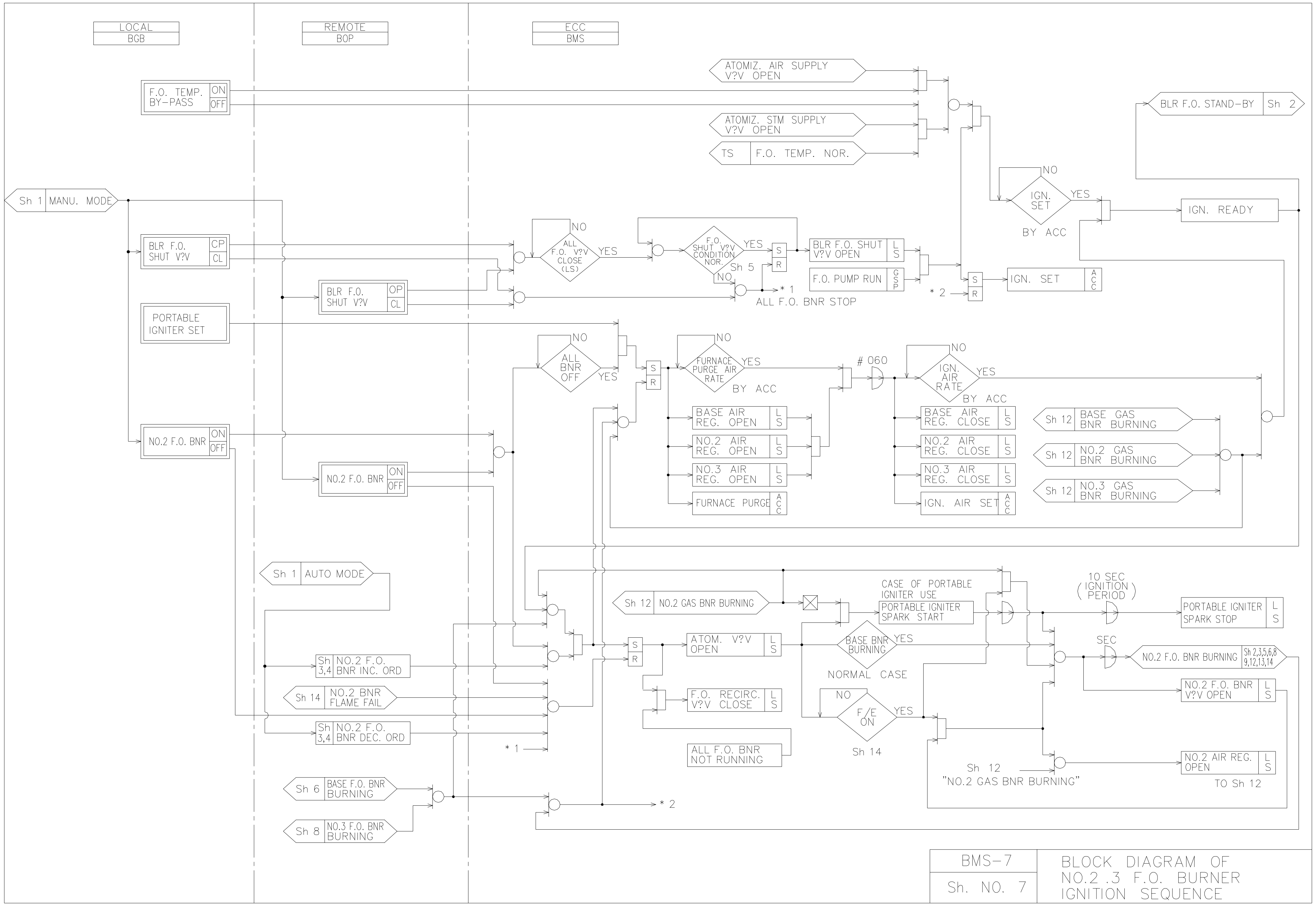
(4-3) GAS FIRING ONLY AUTO CONTROL
IN THE "AUTO" MODE, GAS BURNER OF NO.3 BURNER CAN BE AUTOMATICALLY EXTINGUISHED.
IN THIS CASE, THE FUEL MODE TO BE CHANGED TO DUAL BURNING MODE FROM ACC F.O. BACK-UP SIGNAL.

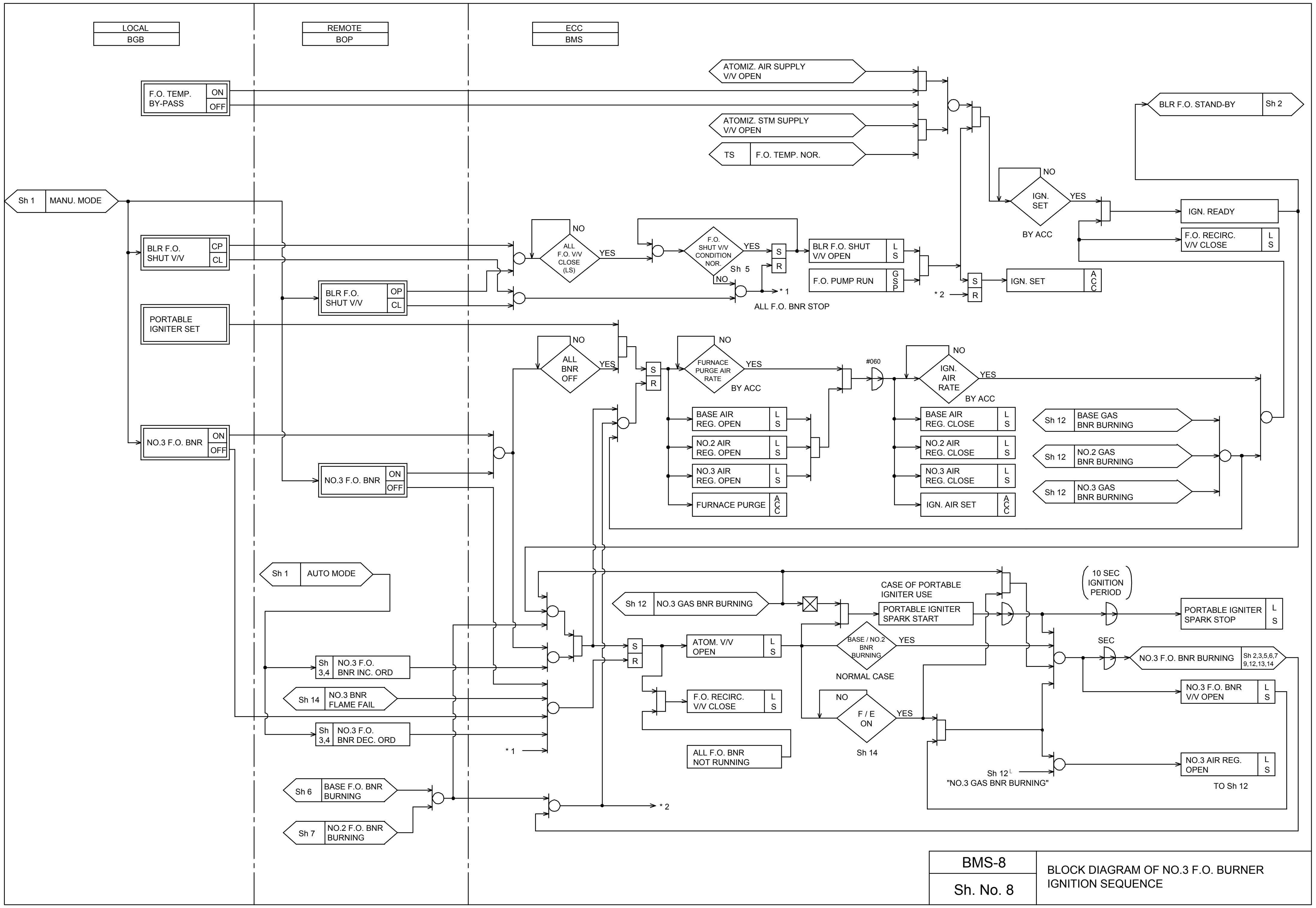
BMS-4	BLOCK DIAGRAM OF BURNER NUMBER AUTO. CONTROL
Sh. No. 4	

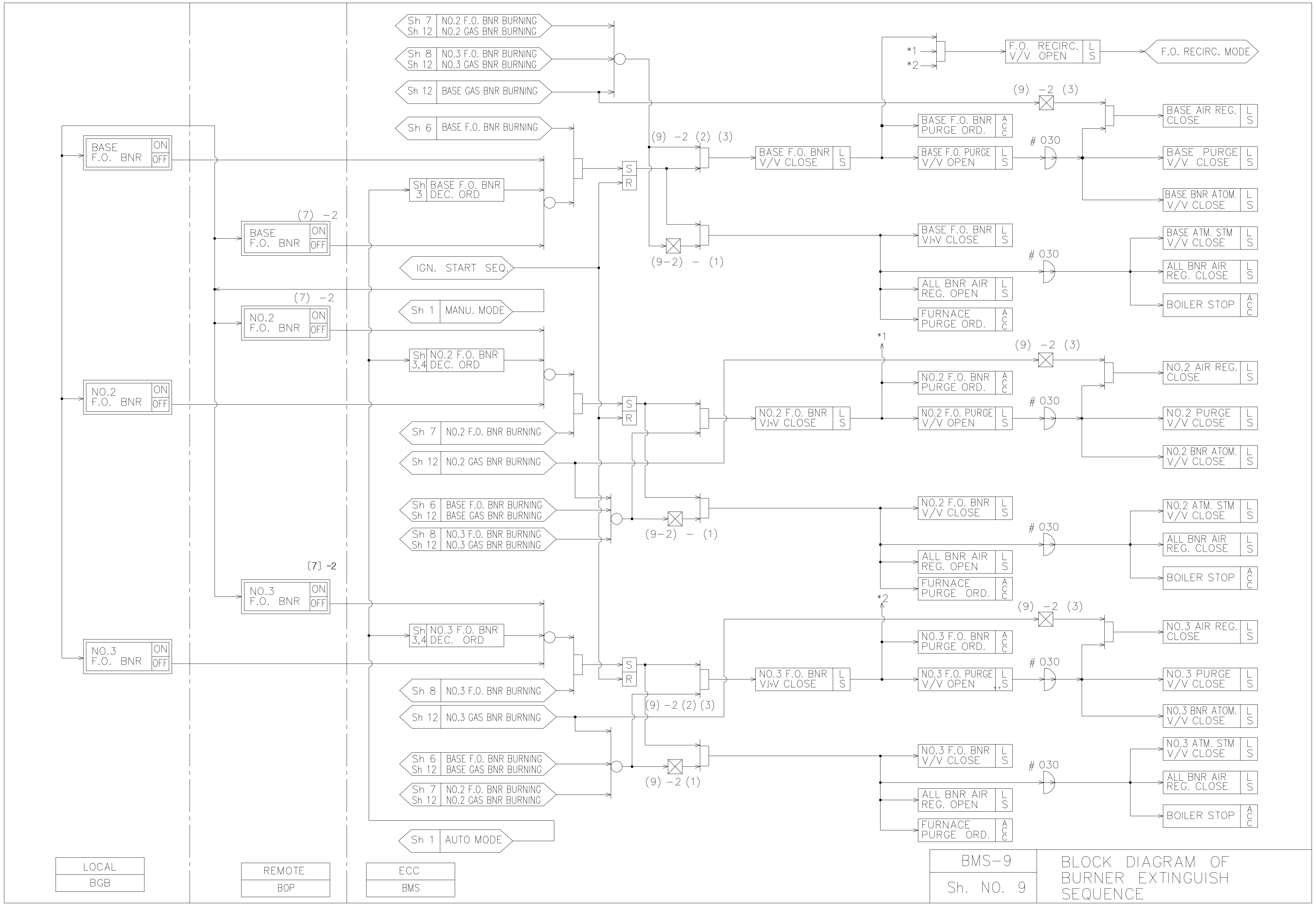


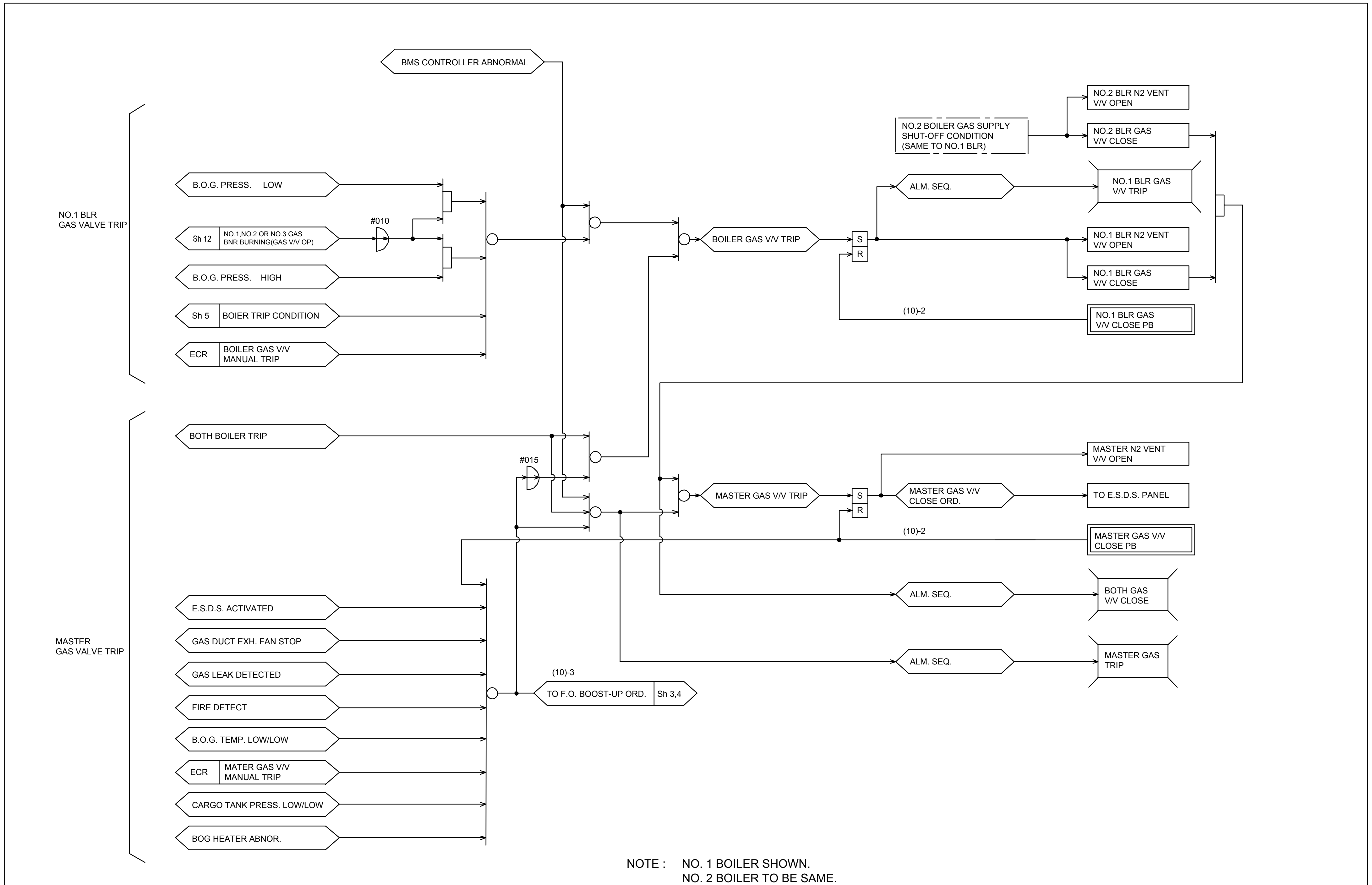
(5 - 1) BOILER TRIP OR BOILER F.O. SHUT-OFF V/V CLOSE
WHEN CONDITIONS PROHIBITING THE F.O. BURNER OPERATION ARE ESTABLISHED, THE BOILER F.O. SHUT-OFF VALVE AND EACH F.O. BURNER VALVE ARE AUTOMATICALLY CLOSED.
(IN THE BURNER FUEL MODE "DUAL OR GAS", THE BOILER IS NOT TRIPPED EVEN IF BOILER F.O. SHUT-OFF CONDITION IS ACTIVATED.)
(5 - 2) RE-START OPERATION AFTER BOILER SHUT-DOWN
RE-START THE BURNER IN ACCORDANCE WITH THE FOLLOWING PROCEDURE.
(1) CHECK AND ELIMINATE THE CAUSE OF THE SHUT-DOWN
(2) AFTER THE CAUSE HAS BEEN ELIMINATED, PUSH THE "OFF" SWITCH OF BOILER F.O. SHUT-OFF VALVE TO CANCEL THE SELF-HOLDING CIRCUIT FOR THE BOILER TRIP.
(3) RE-START THE BOILER IN ACCORDANCE WITH THE OPERATING PROCEDURE IN (Sh. 6, 7,8)
NO. 1 BOILER
BLR F.O. SHUT-OFF CONDITION
BMS CONTROLLER ABNORMAL
ATOM. STEAM PRESS. LOW/LOW
F.O. TEMP. LOW/LOW
LOCAL (BGB)
F.O. TEMP. BY-PASS
ON
OFF
F.O. PRESS. LOW/LOW
F.O. PUMP STOP
Sh 6,7,8
BASE NO.2, OR NO.3 F.O. BNR BURNING
LOCAL (BGB)
Sh 1
EMERG. MODE
BLR TRIP CONDITION
DEAREATOR LEVEL LOW/LOW
DRUM WATER LEVEL HIGH/HIGH
DRUM WATER LEVEL LOW/LOW
ELECTRIC POWER FAILURE
NO.1 F.D. FAN RUN
STAND-BY F.D.FAN RUN
STAND-BY F.D. FAN AIR DMPR OPEN (NO.1 BLR SIDE)
STAND-BY F.D. FAN USED SET
LOCAL (BGB)
STAND-BY F.D. FAN USED SELECT
NO.1
NO.2
(BY FLAME MONITORING SYSTEM)
ALL BURNER FLAME FAIL
EMERGENCY MANU. TRIP
MAIN STEAM TEMP. HIGH
BLACK OUT
(5 - 1)
S
R
BLR F.O. SHUT-OFF V/V CLOSE
BASE F.O. BNR V/V CLOSE
NO. 2 F.O. BNR V/V CLOSE
NO. 3 F.O. BNR V/V CLOSE
ALM. SEQ
BLR F.O. SHUT-OFF V/V CLOSE
(5 - 1)
BLR F.O. SHUT-OFF VALVE CLOSE PB
BOILER TRIP CONDITION
Sh 10
NOTE : NO.1 BOILR SHOWN.
NO.2 BOILER TO BE SAME.
BMS-5
Sh. No. 5
BLOCK DIAGRAM OF BOILER F.O. SHUT-OFF CONDITION


LOCAL BGB
REMOTE BOP
ECC BMS
F.O. TEMP. BY-PASS ON OFF
ATOMIZ. AIR SUPPLY V/V OPEN
ATOMIZ. STM SUPPLY V/V OPEN
TS F.O. TEMP. NOR.
Sh 1 MANU. MODE
ALL BNR NOT RUNNUNG
IGNITER INSERT L S
BLR F.O. STAND-BY Sh 2
IGN. SET
BY ACC
IGN. READY
BLR F.O. SHUT V/V OP CL
ALL F.O. V/V CLOSE (LS)
F.O. SHUT V/V CONDITION NOR.
Sh 5
BLR F.O. SHUT V/V OPEN L S
F.O. PUMP RUN G S P
IGN. SET A C C
ALL F.O. BNR STOP
BLR F.O. SHUT V/V CP CL
ALL BNR OFF
FURNACE PURGE AIR RATE
BY ACC
060
IGN. AIR RATE
BASE AIR REG. OPEN L S
NO.2 AIR REG. OPEN L S
NO.3 AIR REG. OPEN L S
FURNACE PURGE A C C
BASE AIR REG. CLOSE L S
NO.2 AIR REG. CLOSE L S
NO.3 AIR REG. CLOSE L S
IGN. AIR SET A C C
Sh 12 BASE GAS BNR BURNING
Sh 12 NO.2 GAS BNR BURNING
Sh 12 NO.3 GAS BNR BURNING
BASE F.O. BNR ON OFF
Sh 1 AUTO MODE
Sh 12 BASE GAS BNR BURNING
IGNITER SPARK START
10 SEC (IGNITION PERIOD)
IGNITER STOP & RETRACT L S
ATOM. V/V OPEN L S
OTHER BNR BURNING
10 SEC
BASE F.O. BNR BURNING Sh 2,3,5,7,8 7,12,13,14
BASE F.O. BNR V/V OPEN L S
Sh 3 BASE F.O. BNR INC. ORD
Sh 14 BASE BNR FLAME FAIL
Sh 3 BASE F.O. BNR DEC. ORD
F.O. RECIRC. V/V CLOSE L S
F/E ON
Sh 14
ALL F.O. BNR NOT RUNNING
Sh 12 "BASE GAS BNR BURNING"
BASE AIR REG. OPEN L S
TO Sh 12
Sh 7 NO.2 F.O. BNR BURNING
Sh 8 NO.3 F.O. BNR BURNING
YES
NO
S R
* 1
* 2
BMS-6
Sh. NO. 6
BLOCK DIAGRAM OF BASE F.O. BURNER IGNITION SEQUENCE

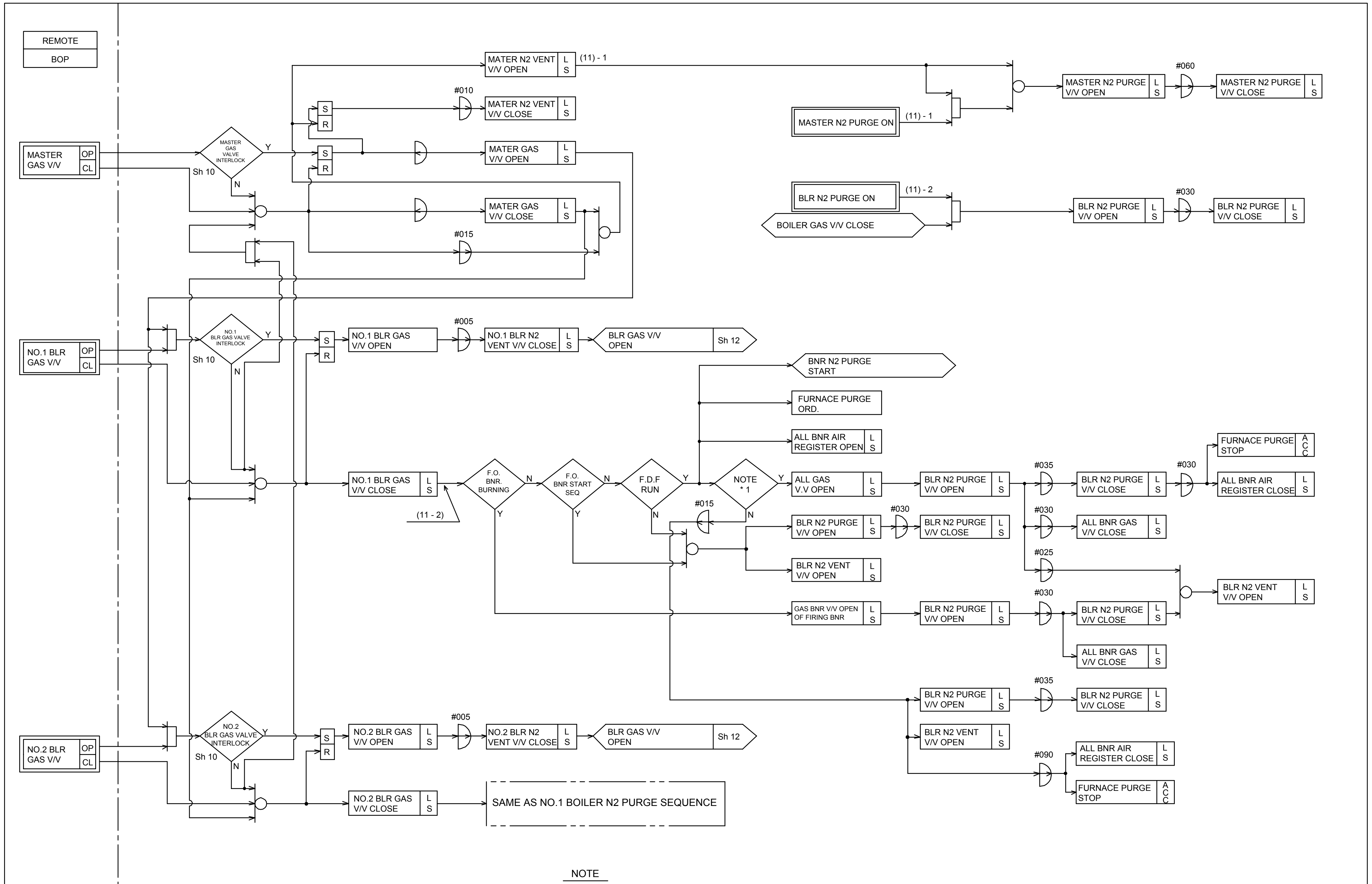

LOCAL BGB
REMOTE BOP
ECC BMS
ATOMIZ. AIR SUPPLY V?V OPEN
F.O. TEMP. BY-PASS ON OFF
ATOMIZ. STM SUPPLY V?V OPEN
TS F.O. TEMP. NOR.
BLR F.O. STAND-BY Sh 2
Sh 1 MANU. MODE
IGN. SET BY ACC
IGN. READY
BLR F.O. SHUT V?V CP CL
ALL F.O. V?V CLOSE (LS)
F.O. SHUT V?V CONDITION NOR. Sh 5
BLR F.O. SHUT V?V OPEN
F.O. PUMP RUN
IGN. SET
ALL F.O. BNR STOP
BLR F.O. SHUT V?V OP CL
PORTABLE IGNITER SET
ALL BNR OFF
FURNACE PURGE AIR RATE BY ACC
060
IGN. AIR RATE BY ACC
BASE AIR REG. OPEN
NO.2 AIR REG. OPEN
NO.3 AIR REG. OPEN
FURNACE PURGE
BASE AIR REG. CLOSE
NO.2 AIR REG. CLOSE
NO.3 AIR REG. CLOSE
IGN. AIR SET
Sh 12 BASE GAS BNR BURNING
Sh 12 NO.2 GAS BNR BURNING
Sh 12 NO.3 GAS BNR BURNING
NO.2 F.O. BNR ON OFF
Sh 1 AUTO MODE
Sh 12 NO.2 GAS BNR BURNING
CASE OF PORTABLE IGNITER USE
PORTABLE IGNITER SPARK START
10 SEC (IGNITION PERIOD)
PORTABLE IGNITER SPARK STOP
ATOM. V?V OPEN
BASE BNR BURNING
NORMAL CASE
SEC
NO.2 F.O. BNR BURNING Sh 2,3,5,6,8 9,12,13,14
NO.2 F.O. BNR V?V OPEN
Sh 3,4 NO.2 F.O. BNR INC. ORD
Sh 14 NO.2 BNR FLAME FAIL
F.O. RECIRC. V?V CLOSE
F/E ON Sh 14
Sh 3,4 NO.2 F.O. BNR DEC. ORD
ALL F.O. BNR NOT RUNNING
Sh 12 "NO.2 GAS BNR BURNING"
NO.2 AIR REG. OPEN
TO Sh 12
Sh 6 BASE F.O. BNR BURNING
Sh 8 NO.3 F.O. BNR BURNING
BMS-7
Sh. NO. 7
BLOCK DIAGRAM OF NO.2 .3 F.O. BURNER IGNITION SEQUENCE


LOCAL
BGB
REMOTE
BOP
ECC
BMS
ATOMIZ. AIR SUPPLY V/V OPEN
F.O. TEMP. BY-PASS
ON
OFF
ATOMIZ. STM SUPPLY V/V OPEN
TS
F.O. TEMP. NOR.
BLR F.O. STAND-BY
Sh 2
NO
IGN. SET
YES
BY ACC
IGN. READY
Sh 1
MANU. MODE
BLR F.O. SHUT V/V
CP
CL
ALL F.O. V/V CLOSE (LS)
F.O. SHUT V/V CONDITION NOR.
Sh 5
BLR F.O. SHUT V/V OPEN
F.O. PUMP RUN
F.O. RECIRC. V/V CLOSE
IGN. SET
ALL F.O. BNR STOP
BLR F.O. SHUT V/V
OP
CL
PORTABLE IGNITER SET
ALL BNR OFF
FURNACE PURGE AIR RATE
#060
IGN. AIR RATE
BASE AIR REG. OPEN
NO.2 AIR REG. OPEN
NO.3 AIR REG. OPEN
FURNACE PURGE
BASE AIR REG. CLOSE
NO.2 AIR REG. CLOSE
NO.3 AIR REG. CLOSE
IGN. AIR SET
Sh 12
BASE GAS BNR BURNING
NO.2 GAS BNR BURNING
NO.3 GAS BNR BURNING
NO.3 F.O. BNR
Sh 1
AUTO MODE
10 SEC IGNITION PERIOD
CASE OF PORTABLE IGNITER USE
NO.3 GAS BNR BURNING
PORTABLE IGNITER SPARK START
PORTABLE IGNITER SPARK STOP
ATOM. V/V OPEN
BASE / NO.2 BNR BURNING
NORMAL CASE
SEC
NO.3 F.O. BNR BURNING
Sh 2,3,5,6,7 9,12,13,14
Sh 3,4
NO.3 F.O. BNR INC. ORD
Sh 14
NO.3 BNR FLAME FAIL
NO.3 F.O. BNR DEC. ORD
F/E ON
NO.3 F.O. BNR V/V OPEN
NO.3 AIR REG. OPEN
TO Sh 12
ALL F.O. BNR NOT RUNNING
Sh 12
"NO.3 GAS BNR BURNING"
Sh 6
BASE F.O. BNR BURNING
Sh 7
NO.2 F.O. BNR BURNING
BMS-8
Sh. No. 8
BLOCK DIAGRAM OF NO.3 F.O. BURNER IGNITION SEQUENCE

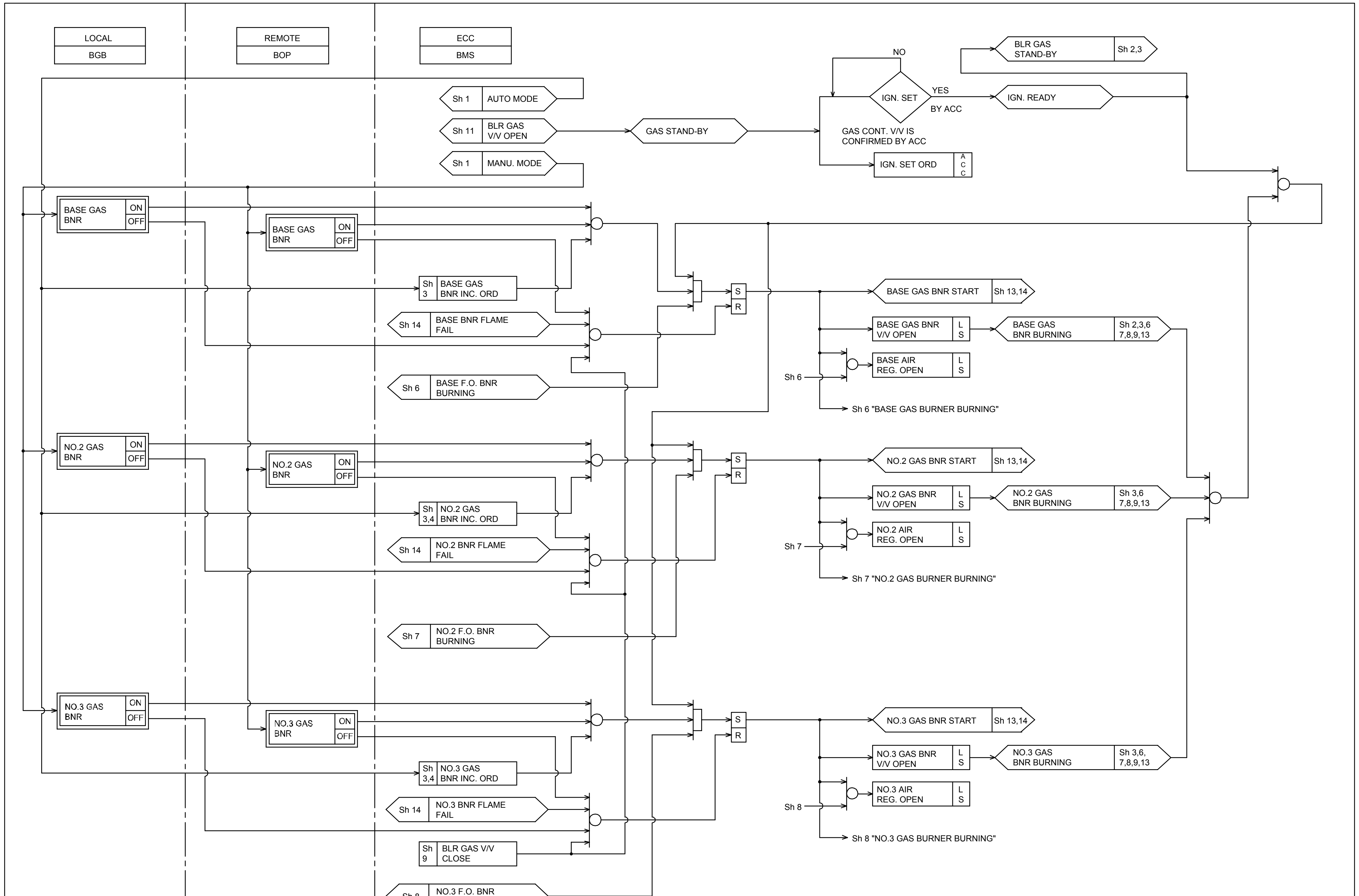

LOCAL
BGB
REMOTE
BOP
ECC
BMS
BASE F.O. BNR ON OFF
NO.2 F.O. BNR ON OFF
NO.3 F.O. BNR ON OFF
Sh 7 NO.2 F.O. BNR BURNING
Sh 12 NO.2 GAS BNR BURNING
Sh 8 NO.3 F.O. BNR BURNING
Sh 12 NO.3 GAS BNR BURNING
Sh 12 BASE GAS BNR BURNING
Sh 6 BASE F.O. BNR BURNING
Sh 3 BASE F.O. BNR DEC. ORD
IGN. START SEQ.
Sh 1 MANU. MODE
Sh 3,4 NO.2 F.O. BNR DEC. ORD
Sh 3,4 NO.3 F.O. BNR DEC. ORD
Sh 1 AUTO MODE
BASE F.O. BNR V/V CLOSE
NO.2 F.O. BNR V/V CLOSE
NO.3 F.O. BNR V/V CLOSE
F.O. RECIRC. V/V OPEN
F.O. RECIRC. MODE
BASE F.O. BNR PURGE ORD.
BASE F.O. PURGE V/V OPEN
BASE AIR REG. CLOSE
BASE PURGE V/V CLOSE
BASE BNR ATOM. V/V CLOSE
BASE ATM. STM V/V CLOSE
ALL BNR AIR REG. CLOSE
BOILER STOP
ALL BNR AIR REG. OPEN
FURNACE PURGE ORD.
NO.2 F.O. BNR PURGE ORD.
NO.2 F.O. PURGE V/V OPEN
NO.2 AIR REG. CLOSE
NO.2 PURGE V/V CLOSE
NO.2 BNR ATOM. V/V CLOSE
NO.2 ATM. STM V/V CLOSE
NO.3 F.O. BNR PURGE ORD.
NO.3 F.O. PURGE V/V OPEN
NO.3 AIR REG. CLOSE
NO.3 PURGE V/V CLOSE
NO.3 BNR ATOM. V/V CLOSE
NO.3 ATM. STM V/V CLOSE
030
(9) -2 (2) (3)
(9-2) - (1)
BMS-9
Sh. NO. 9
BLOCK DIAGRAM OF BURNER EXTINGUISH SEQUENCE



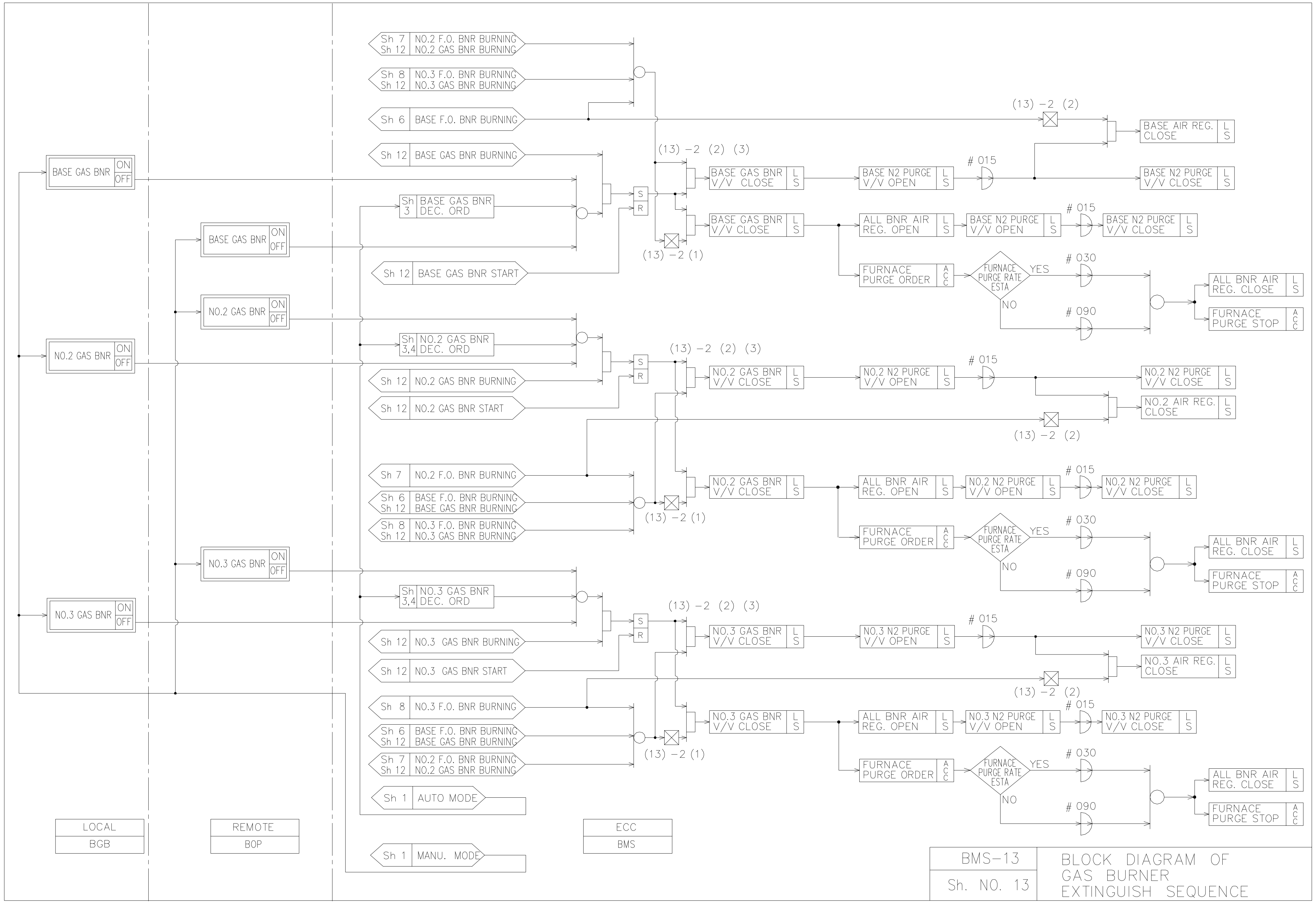
BMS-10	BLOCK DIAGRAM OF MASTER GAS & BOILER GAS SUPPLY SHUT-OFF CONDITION
Sh. No. 10	

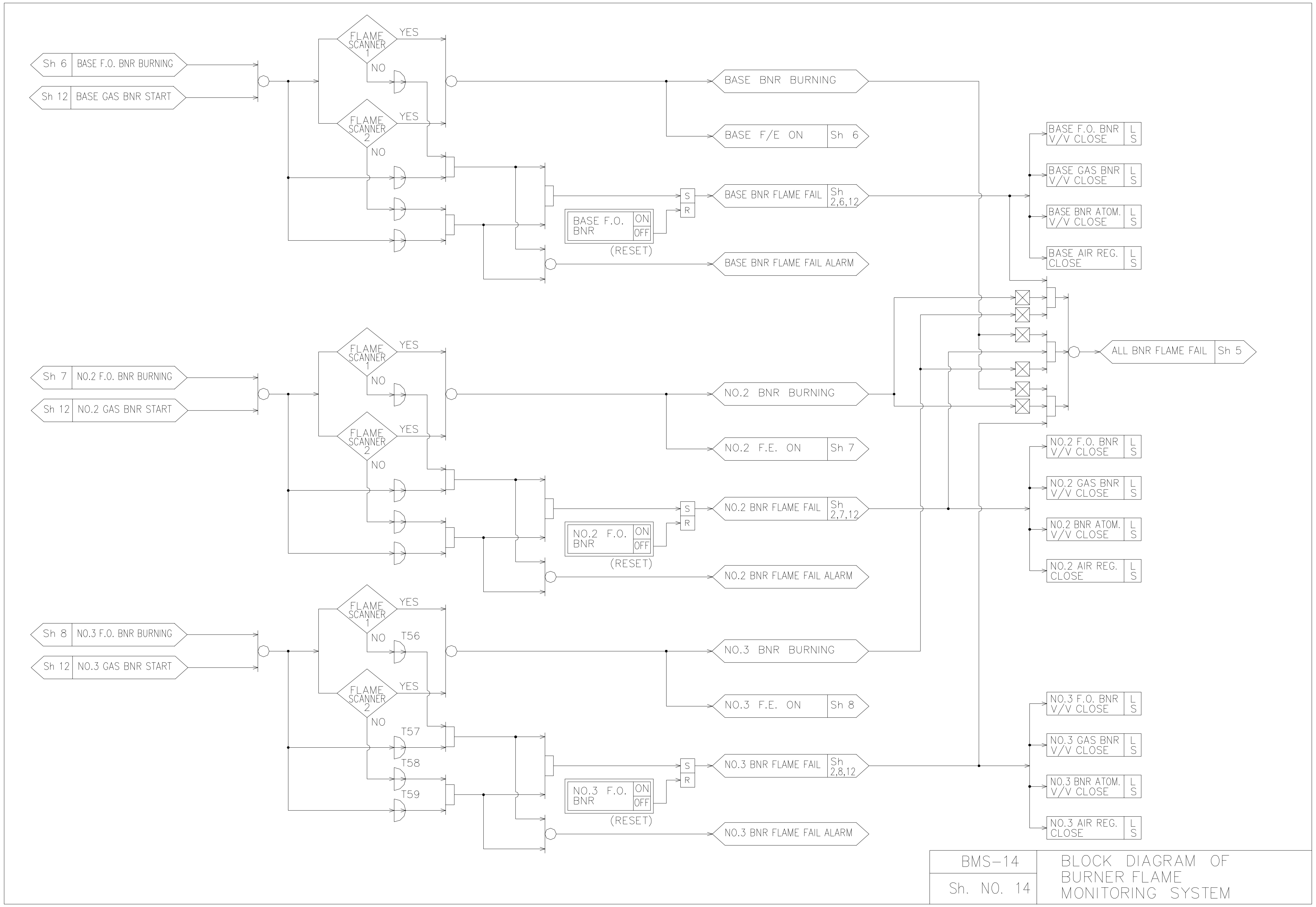


BMS-11	BLOCK DIAGRAM OF MASTER & BOILER GAS V/V OPEN / CLOSE SEQUENCE
Sh No. 11	

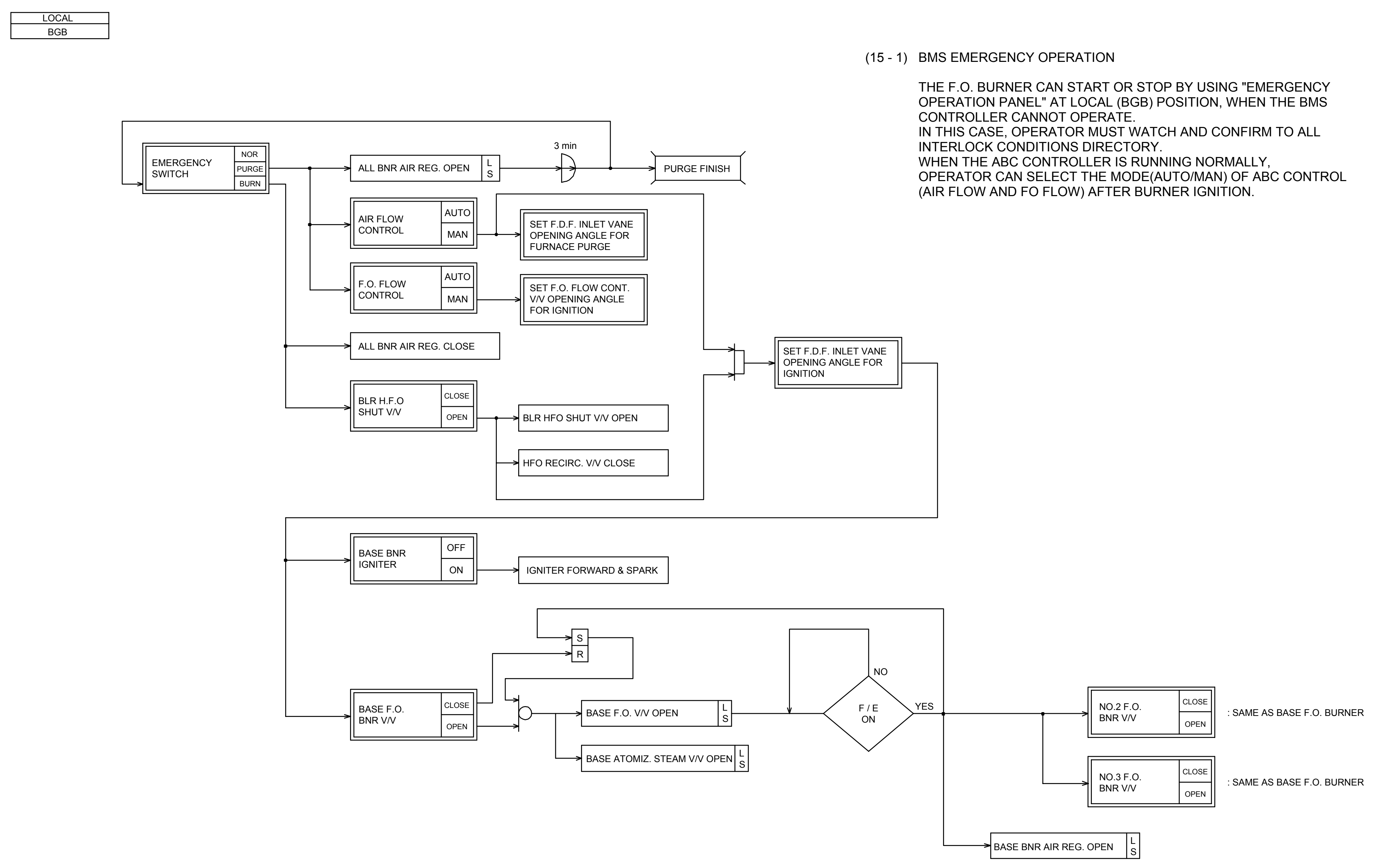


BNS-12	BLOCK DIAGRAM OF GAS BURNER IGNITION SEQUENCE
Sh. No. 12	


BMS-13
Sh. NO. 13
BLOCK DIAGRAM OF GAS BURNER EXTINGUISH SEQUENCE
LOCAL BGB
REMOTE BOP
ECC BMS
BASE GAS BNR ON OFF
NO.2 GAS BNR ON OFF
NO.3 GAS BNR ON OFF
Sh 7 NO.2 F.O. BNR BURNING
Sh 12 NO.2 GAS BNR BURNING
Sh 8 NO.3 F.O. BNR BURNING
Sh 12 NO.3 GAS BNR BURNING
Sh 6 BASE F.O. BNR BURNING
Sh 12 BASE GAS BNR BURNING
Sh 3 BASE GAS BNR DEC. ORD
Sh 12 BASE GAS BNR START
Sh 3,4 NO.2 GAS BNR DEC. ORD
Sh 12 NO.2 GAS BNR START
Sh 3,4 NO.3 GAS BNR DEC. ORD
Sh 12 NO.3 GAS BNR START
Sh 1 AUTO MODE
Sh 1 MANU. MODE
BASE GAS BNR V/V CLOSE
BASE N2 PURGE V/V OPEN
BASE N2 PURGE V/V CLOSE
BASE AIR REG. CLOSE
ALL BNR AIR REG. OPEN
ALL BNR AIR REG. CLOSE
FURNACE PURGE ORDER
FURNACE PURGE RATE ESTA
FURNACE PURGE STOP
YES
NO
NO.2 GAS BNR V/V CLOSE
NO.2 N2 PURGE V/V OPEN
NO.2 N2 PURGE V/V CLOSE
NO.2 AIR REG. CLOSE
NO.3 GAS BNR V/V CLOSE
NO.3 N2 PURGE V/V OPEN
NO.3 N2 PURGE V/V CLOSE
NO.3 AIR REG. CLOSE
(13) -2 (2) (3)
(13) -2 (2)
(13) -2 (1)
015
030
090
S
R
L S
A C



Sh 6 BASE F.O. BNR BURNING
Sh 12 BASE GAS BNR START
FLAME SCANNER 1
FLAME SCANNER 2
YES
NO
BASE BNR BURNING
BASE F/E ON Sh 6
BASE BNR FLAME FAIL Sh 2,6,12
BASE F.O. BNR ON OFF
(RESET)
BASE BNR FLAME FAIL ALARM
BASE F.O. BNR V/V CLOSE L S
BASE GAS BNR V/V CLOSE L S
BASE BNR ATOM. V/V CLOSE L S
BASE AIR REG. CLOSE L S
ALL BNR FLAME FAIL Sh 5
Sh 7 NO.2 F.O. BNR BURNING
Sh 12 NO.2 GAS BNR START
NO.2 BNR BURNING
NO.2 F.E. ON Sh 7
NO.2 BNR FLAME FAIL Sh 2,7,12
NO.2 F.O. BNR ON OFF
NO.2 BNR FLAME FAIL ALARM
NO.2 F.O. BNR V/V CLOSE L S
NO.2 GAS BNR V/V CLOSE L S
NO.2 BNR ATOM. V/V CLOSE L S
NO.2 AIR REG. CLOSE L S
Sh 8 NO.3 F.O. BNR BURNING
Sh 12 NO.3 GAS BNR START
T56
T57
T58
T59
NO.3 BNR BURNING
NO.3 F.E. ON Sh 8
NO.3 BNR FLAME FAIL Sh 2,8,12
NO.3 F.O. BNR ON OFF
NO.3 BNR FLAME FAIL ALARM
NO.3 F.O. BNR V/V CLOSE L S
NO.3 GAS BNR V/V CLOSE L S
NO.3 BNR ATOM. V/V CLOSE L S
NO.3 AIR REG. CLOSE L S
BMS-14
Sh. NO. 14
BLOCK DIAGRAM OF BURNER FLAME MONITORING SYSTEM

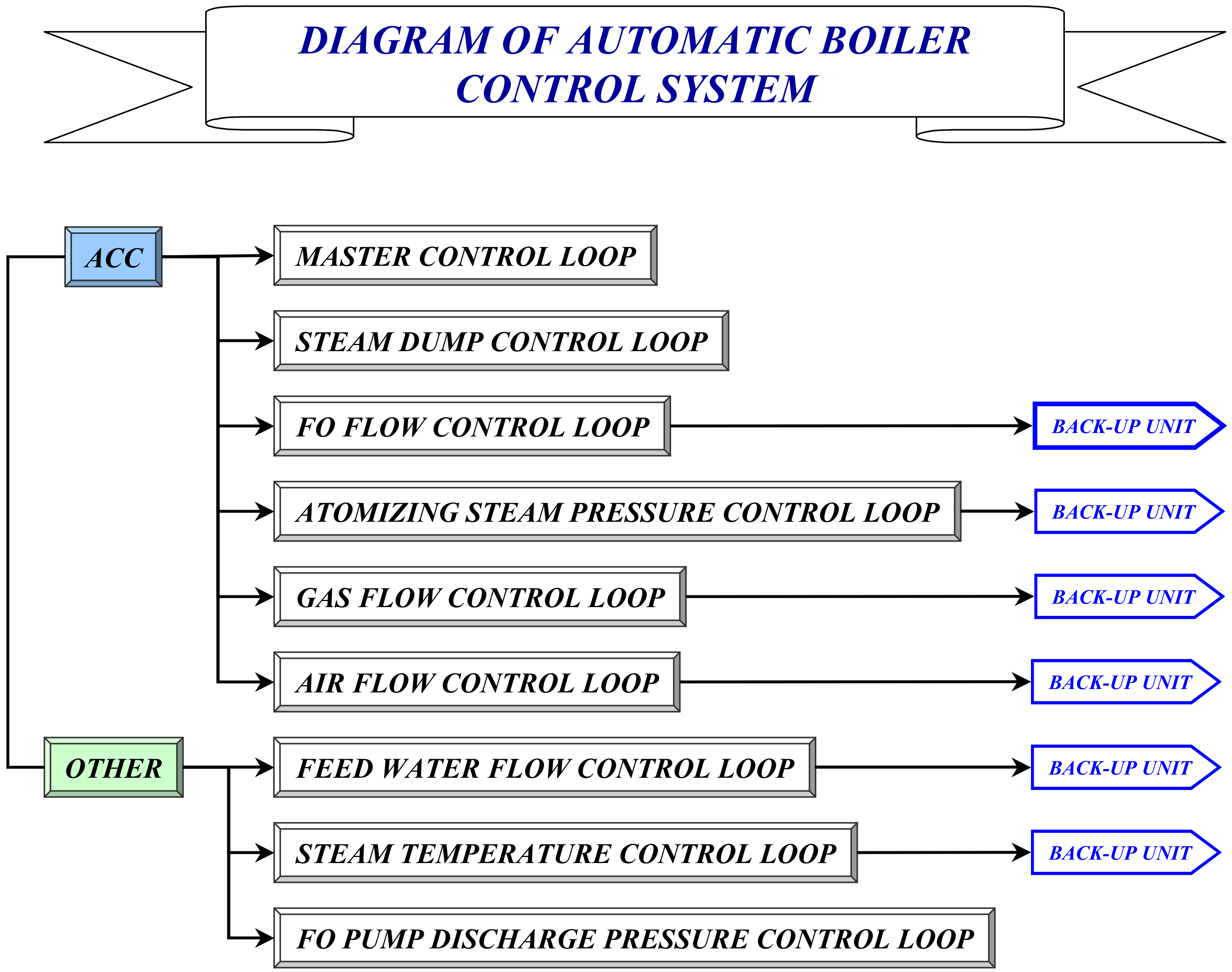


(15 - 1) BMS EMERGENCY OPERATION

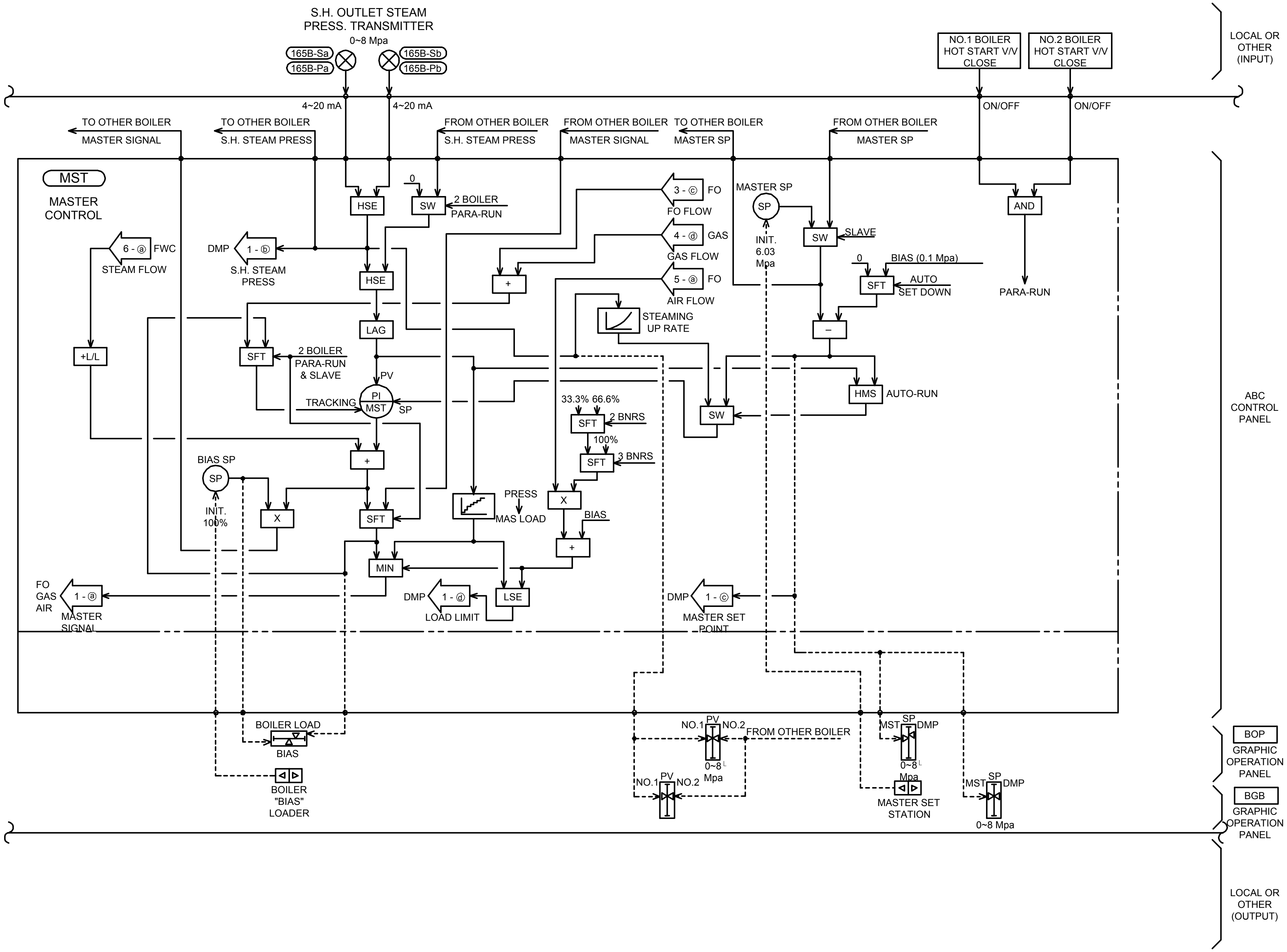
THE F.O. BURNER CAN START OR STOP BY USING "EMERGENCY OPERATION PANEL" AT LOCAL (BGB) POSITION, WHEN THE BMS CONTROLLER CANNOT OPERATE.
IN THIS CASE, OPERATOR MUST WATCH AND CONFIRM TO ALL INTERLOCK CONDITIONS DIRECTORY.
WHEN THE ABC CONTROLLER IS RUNNING NORMALLY, OPERATOR CAN SELECT THE MODE(AUTO/MAN) OF ABC CONTROL (AIR FLOW AND FO FLOW) AFTER BURNER IGNITION.

BMS-15	BLOCK DIAGRAM OF BMS EMERGENCY MODE
Sh. No. 15	

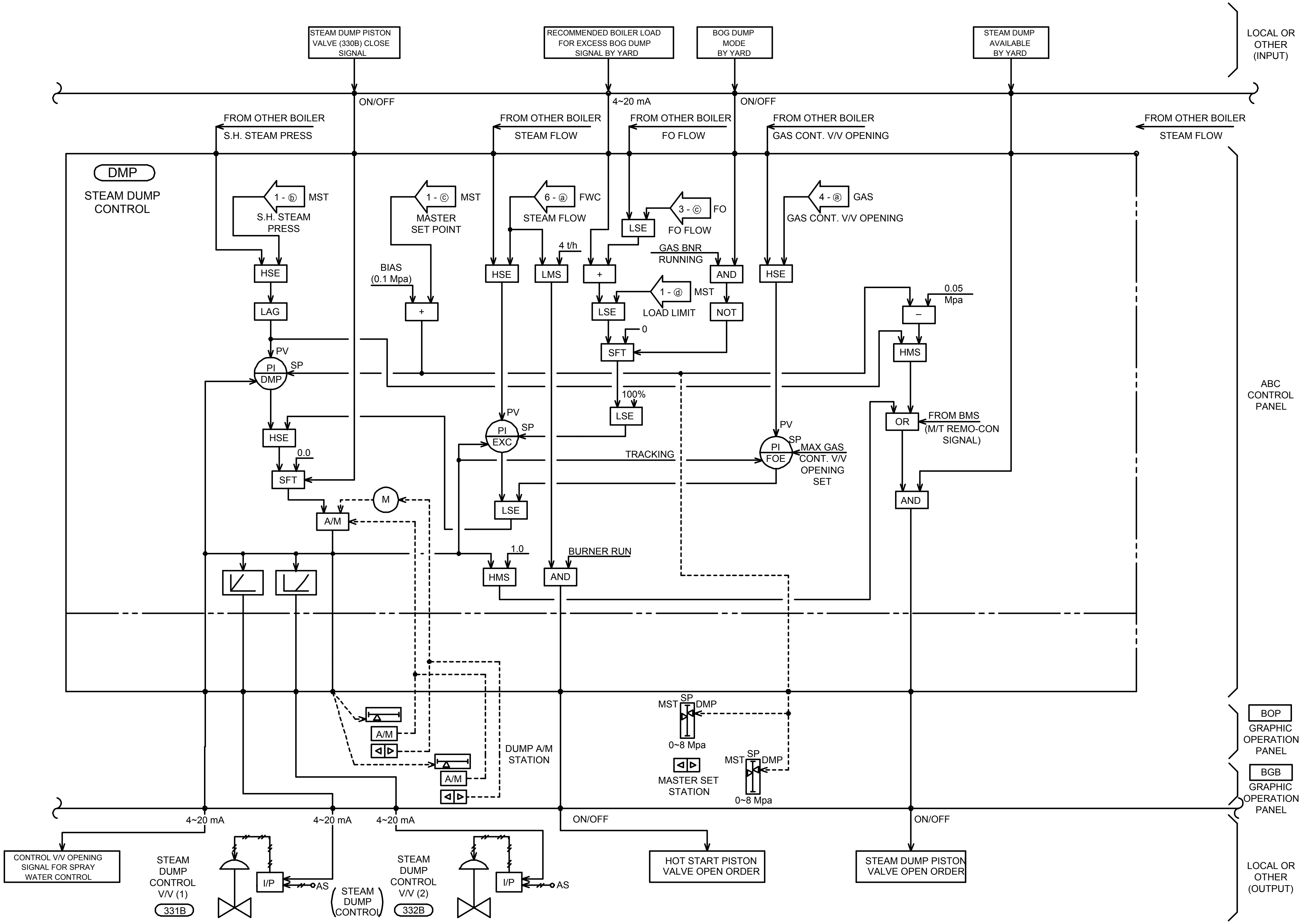
4.6.2 Automatic Boiler Control System Diagram



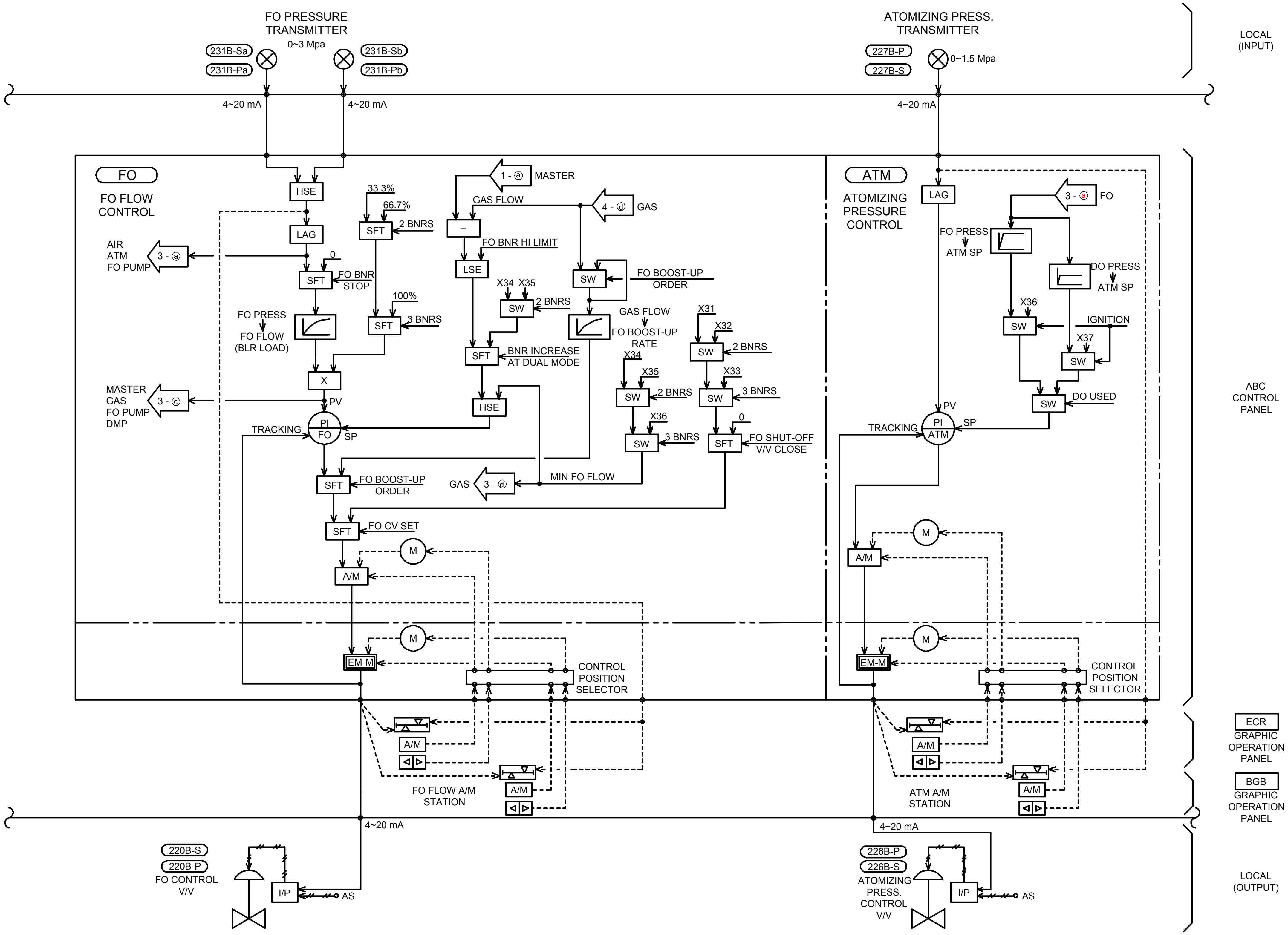
Master Control



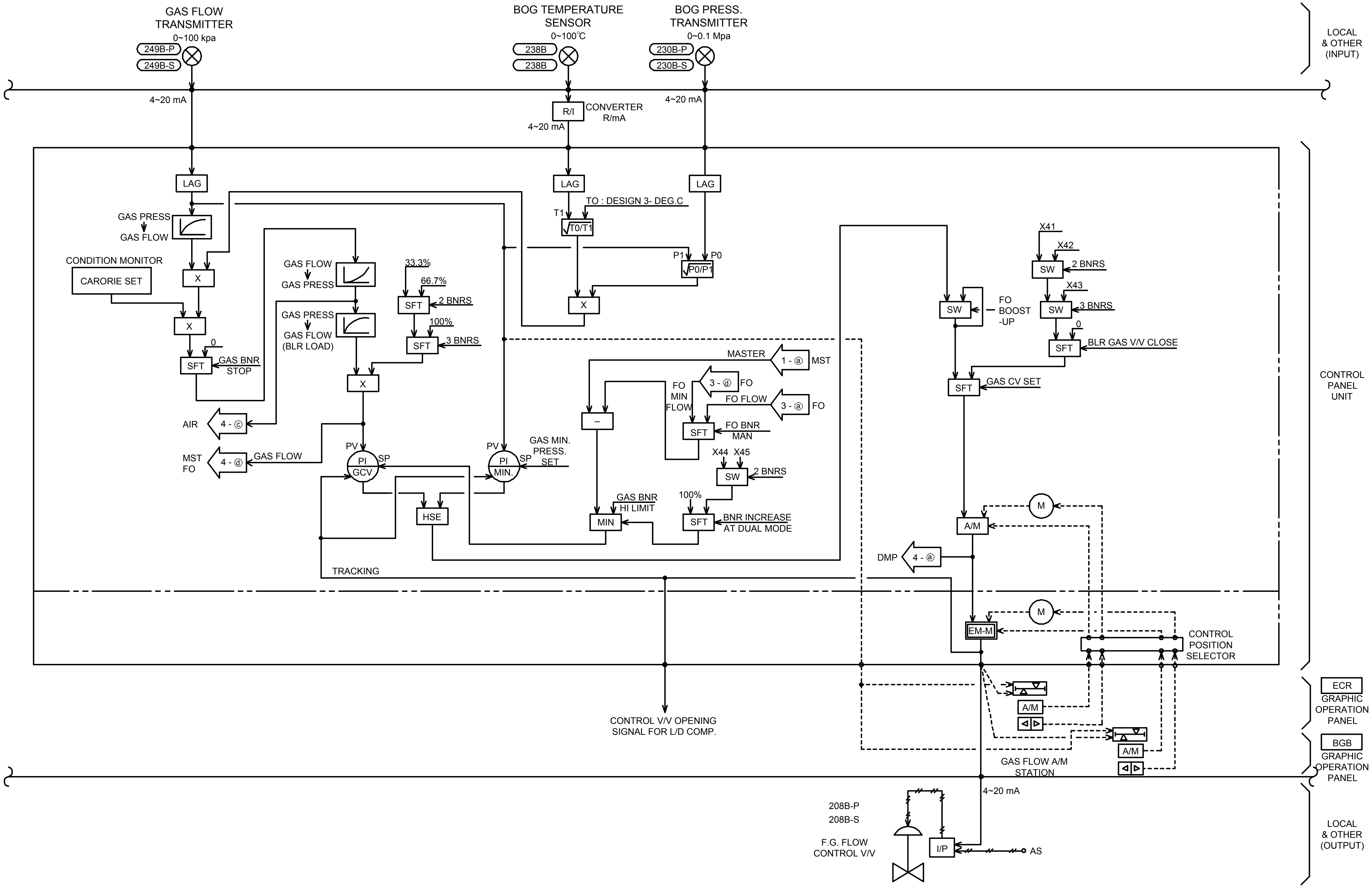
Steam Dump Control



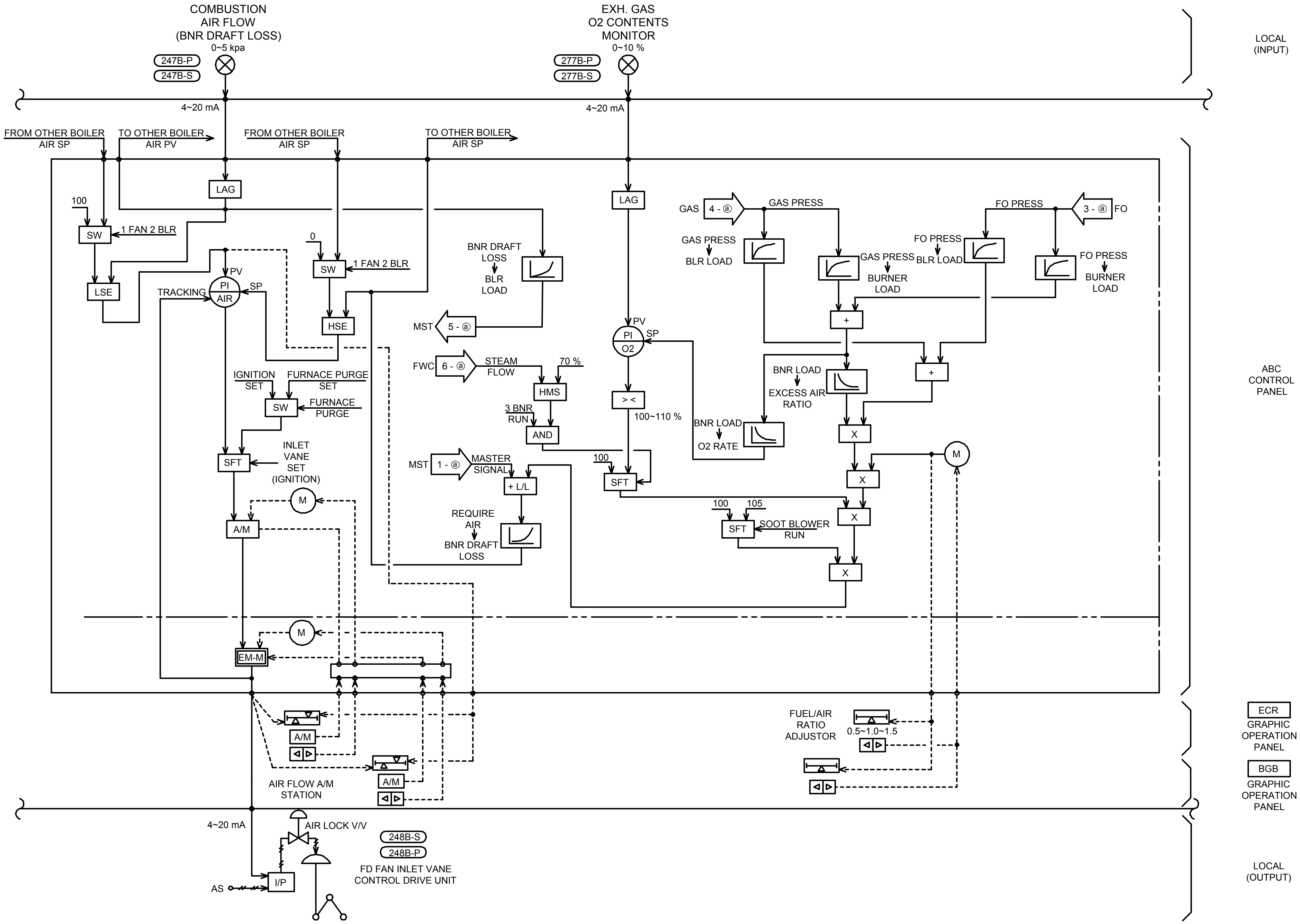
FO Flow Control



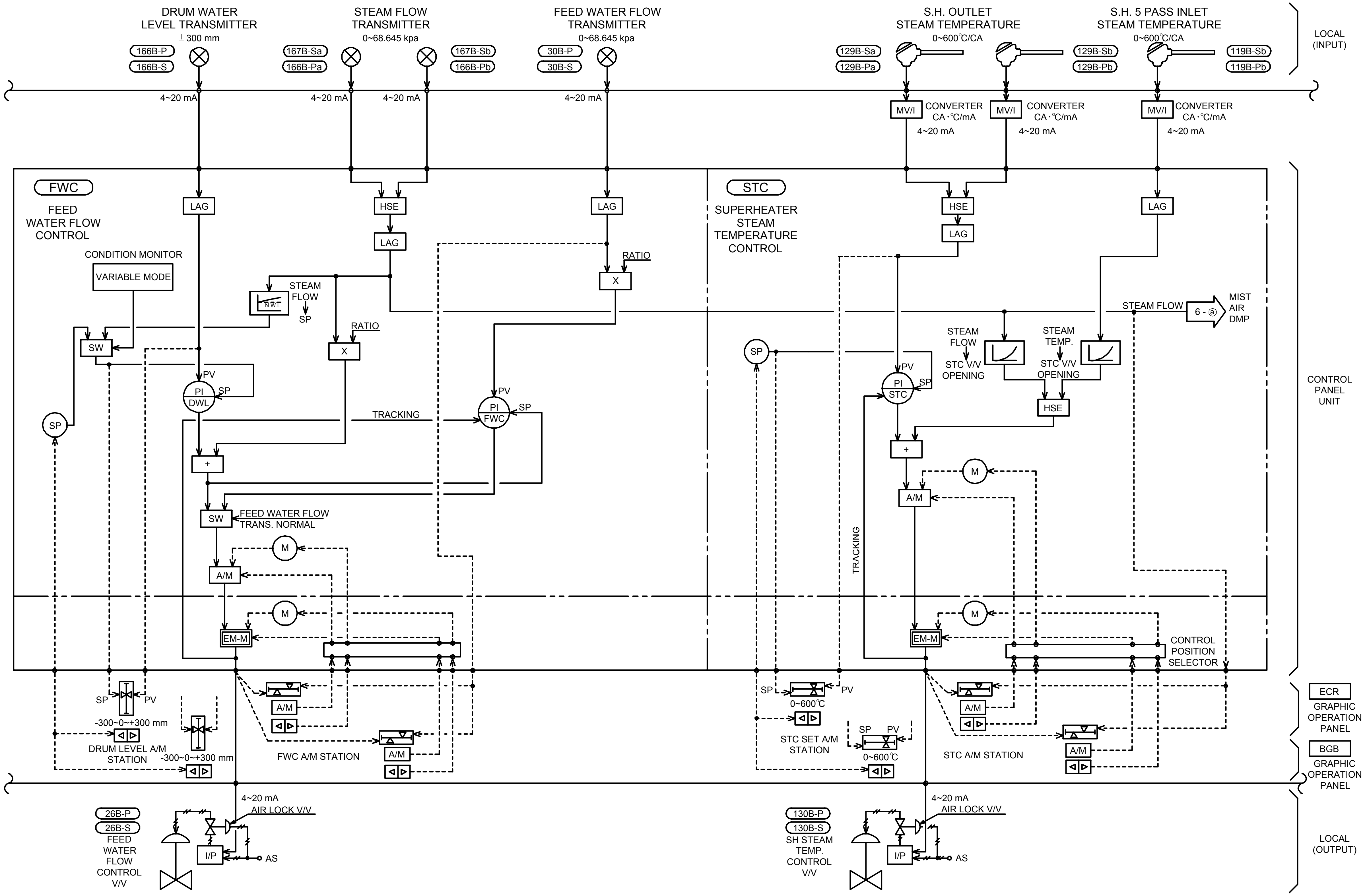
F.G. Flow Control



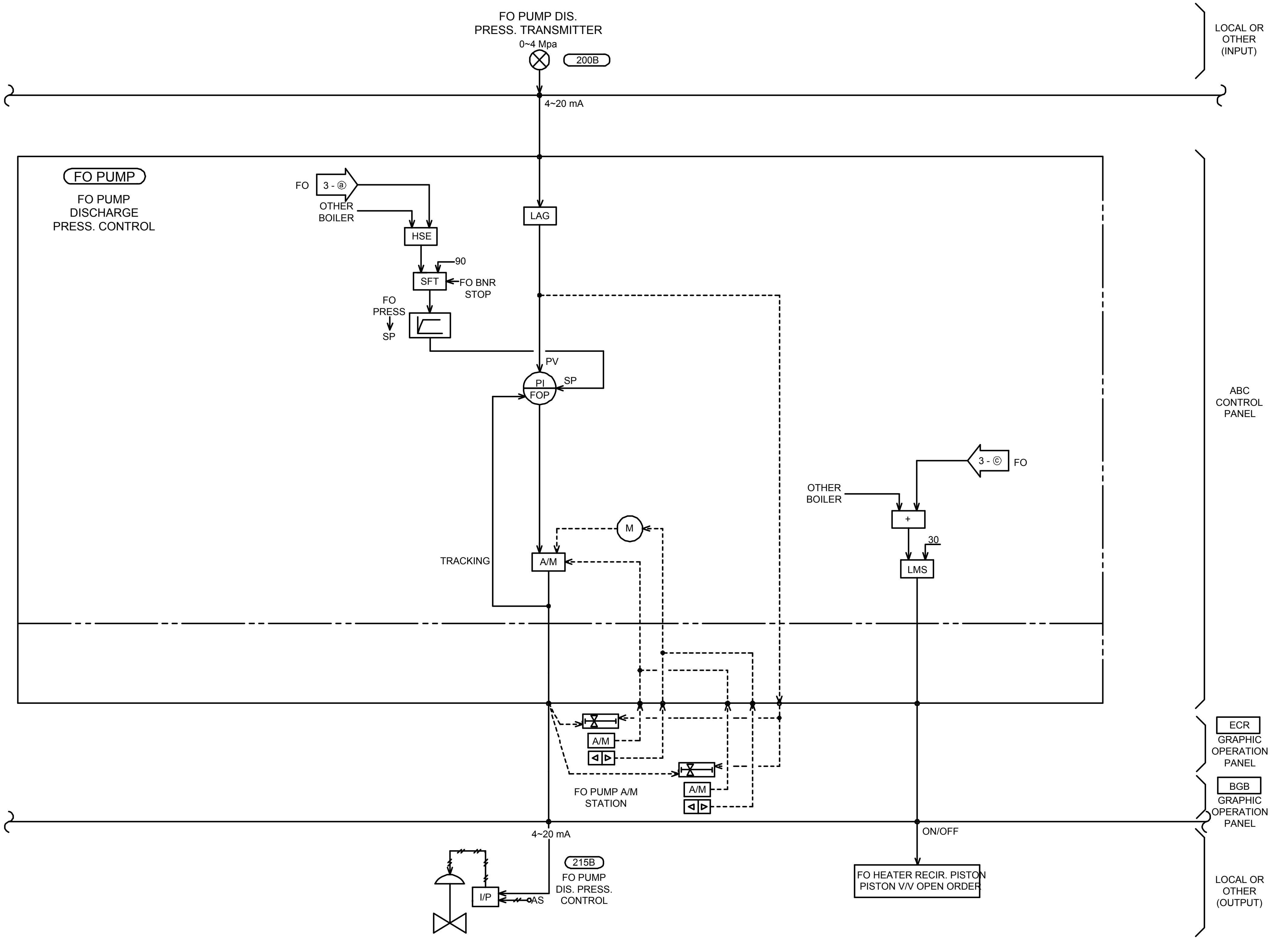
Air Flow Control



Feed Water Flow Control & S.H. Steam Temp. Control

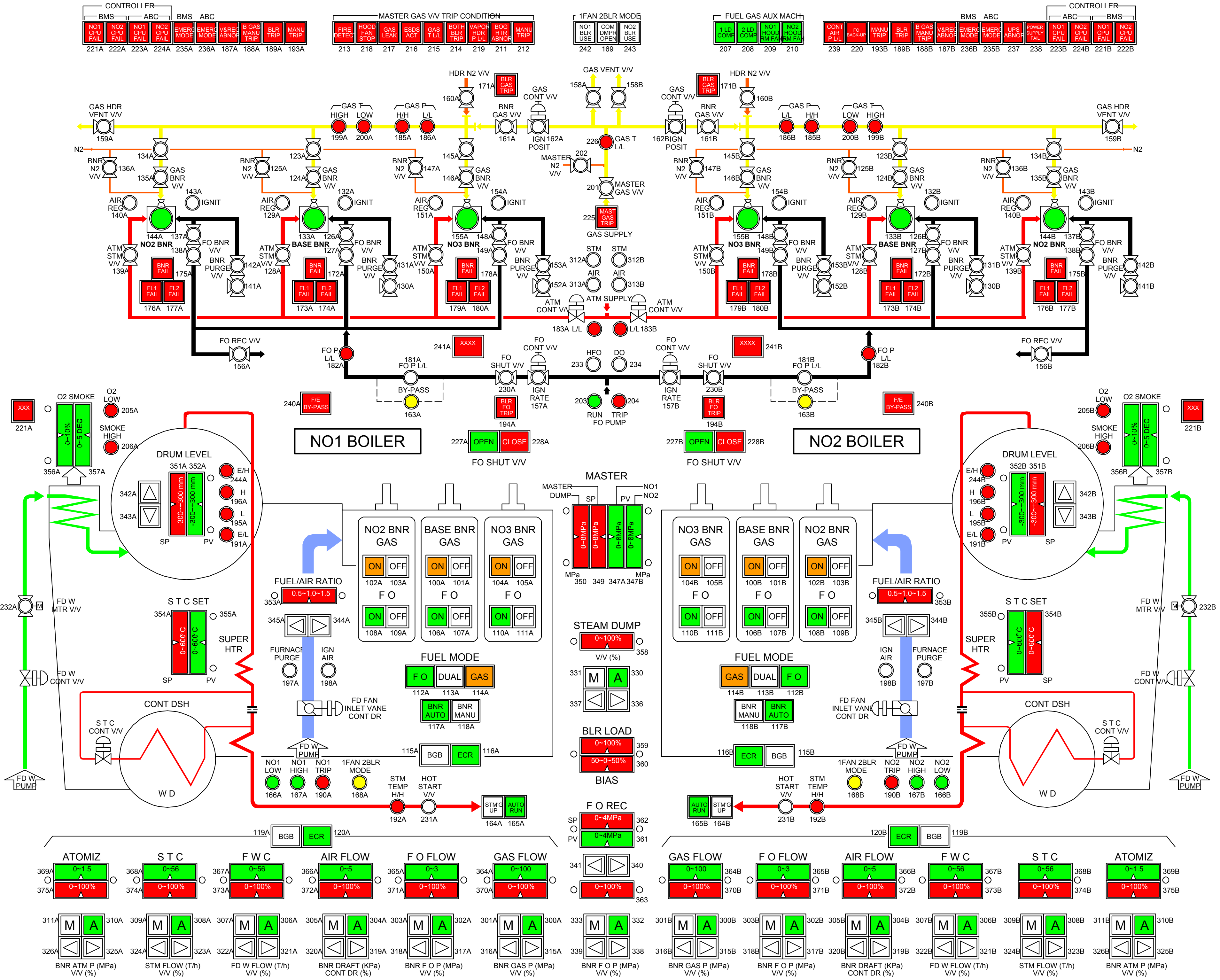


FO Pump Discharge Pressure Control



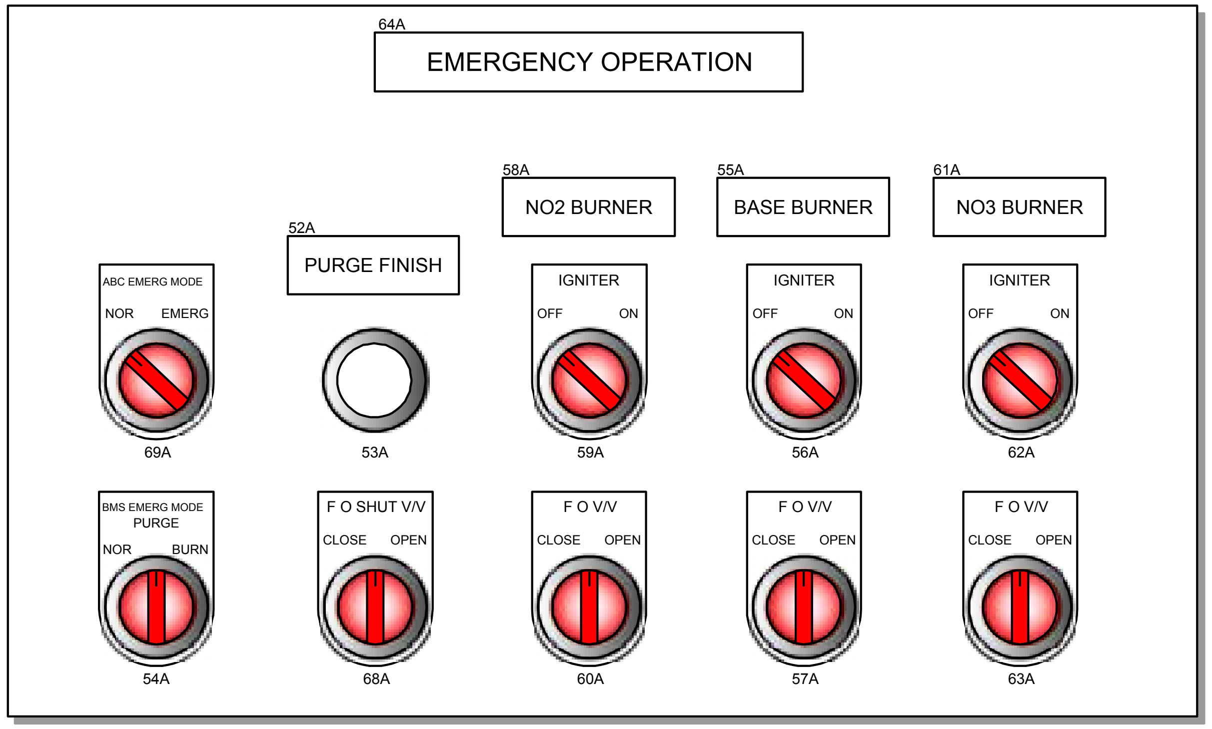
4.7 BLR Control Panel Drawing

Boiler Gauge Board Graphic Panel

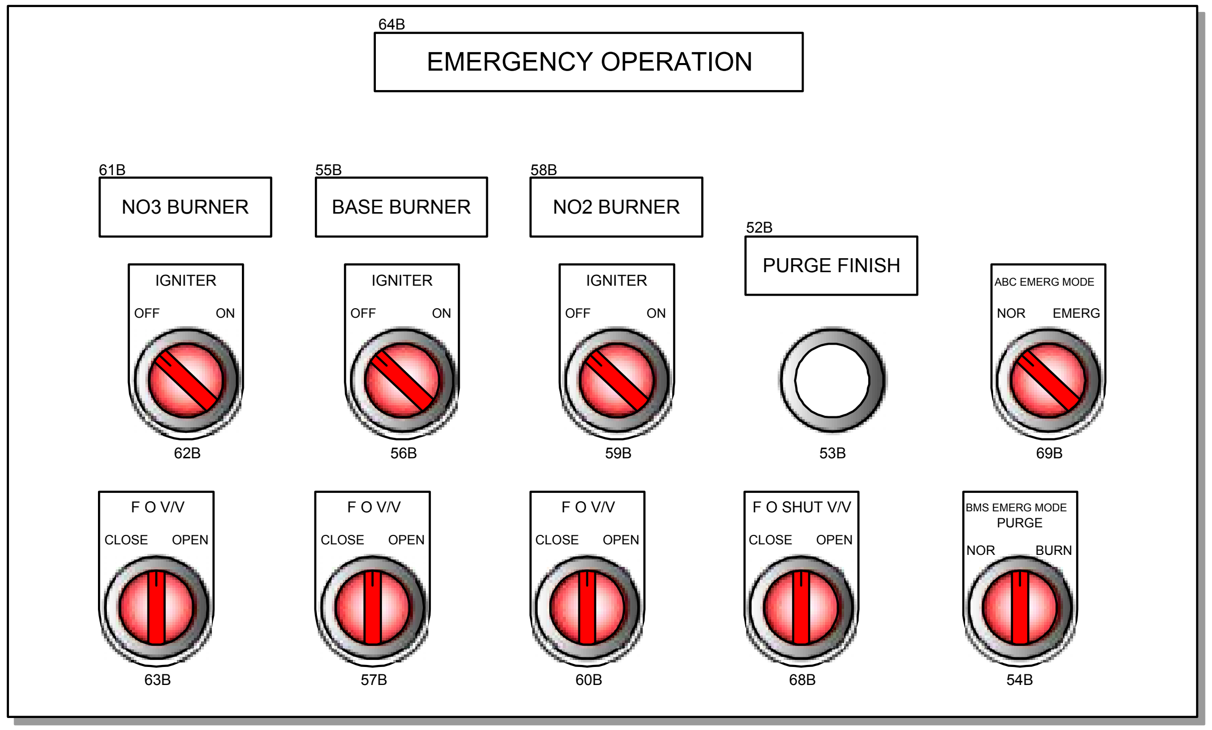


Boiler Gauge Board Emergency Control Panel

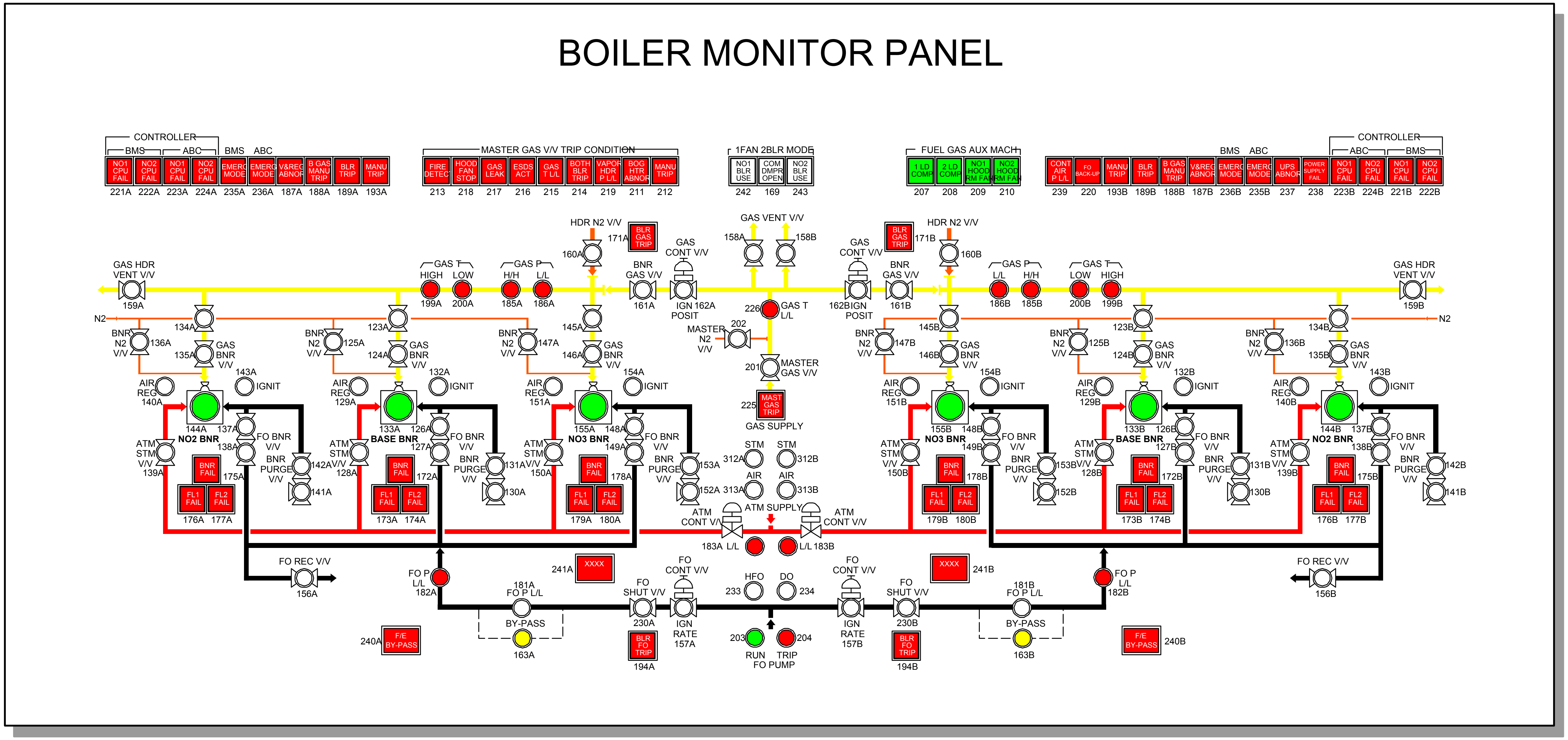
NO1 BOILER



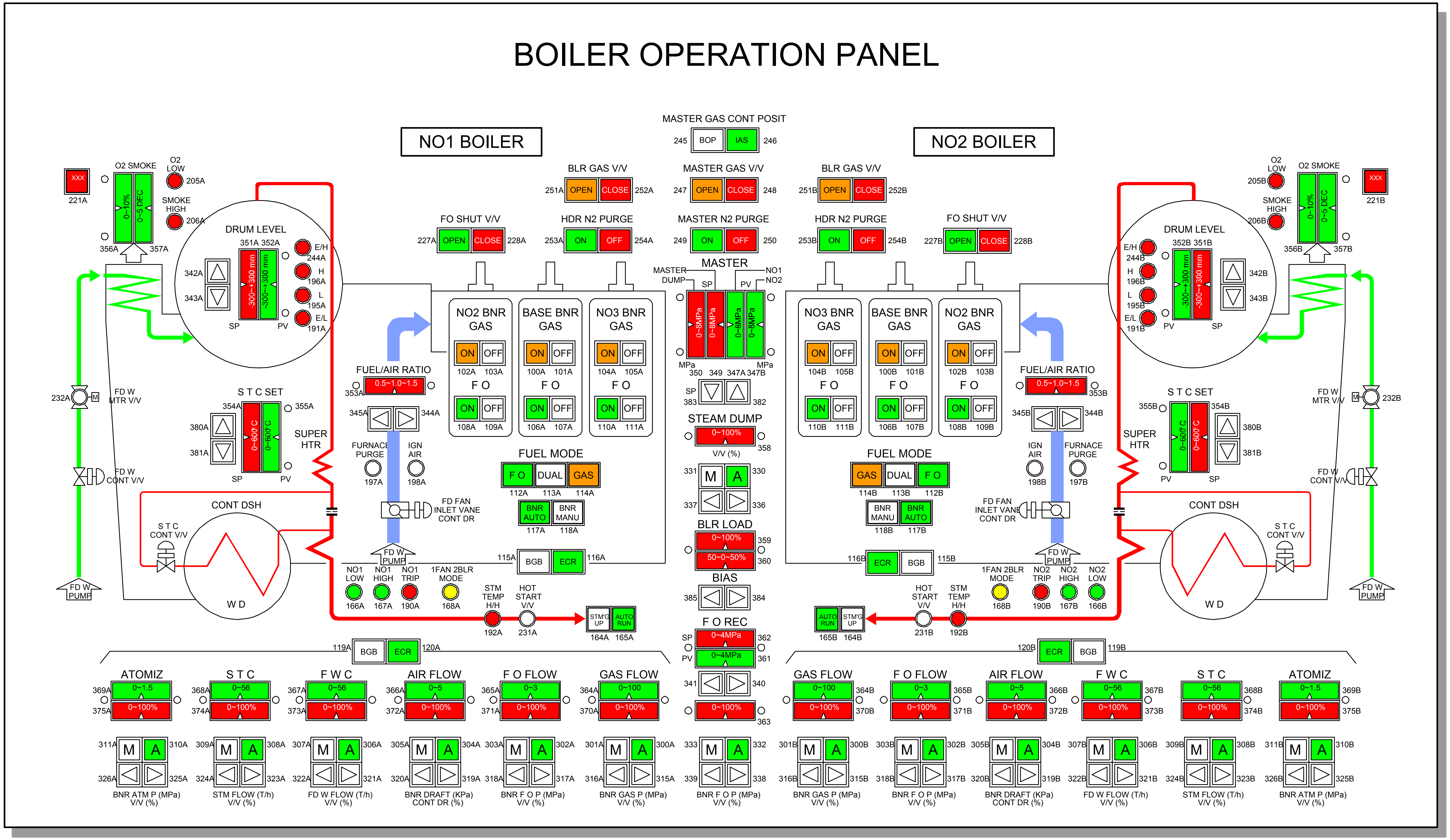
NO2 BOILER



Boiler Monitor Panel of ECR



Boiler Operation Panel of ECR



Part 5 : Main Turbine System

Part 5
Main Turbine System

Part 5 : Main Turbine System

5.1 Main Turbine

Main Particulars :

Type : KAWASAKI UA-360 Cross compound, impulse, double reduction geared marine turbine.

			MCR	NCR
Output		PS	36,000	32,400
Revolution	HP Turbine	rpm	4,962	4,793
	LP Turbine	rpm	3,275	3,163
	Propeller	rpm	88	85
Steam Pressure (at maneuv. valve inlet)			5.88 MPag	
Steam Temperature (at manoeuv. valve inlet)			510°C	
Condenser vacuum (at normal & maximum output with 27°C sea water inlet temperature)			722 mmHg (-96.3 kPag) at cond. top	
Astern max. torque			80% of the MCR ahead torque at main shaft revolution of 50% rpm of MCR rpm	
Astern allowable max. continuous rpm			70% of the MCR ahead rpm not exceed more than two (2) hours	
Ahead rotating direction			Clockwise looking from after	
Main shaft speed at torsional vibration			28.56 rpm & 58.47 rpm	
Critical speed of turbine rotor (converting into main shaft)			HP Turbine	abt. 63.0 rpm
			LP Turbine	117.9 rpm

Turbine : One (1) Unit

		HP Turbine	LP Turbine
No. of stages		10	8 (Ahead) 2 (Astern)
Main steam inlet nominal dia.		175 mm x 2	175 mm (Astern)
Cross-under pipe nominal dia.		420 mm	-
Bleeding pipe nominal dia.	HP	65 mm at HP turbine 5th stage	
	IP	200 mm at cross over pipe	
	LP	300 mm at LP turbine 3rd stage	

Manoeuvring Valve : One (1) Unit

Type					Single lid diffuser type
Valve	Dia.	throttle/pilot		mm	185 / 80
	Lift	ahead/astern		mm	71 / 45
Oil Cylinder	Piston dia.			mm	600
	Stoke	ahead/astern		mm	160 / 100
	Oil Pressure			MPag Kgf/cm^{2}G	0.29 3.0

Reduction Gear : One (1) Unit

Type : Tandem articulated, double reduction, double helical type

Item		P.C.D. mm	No. of teeth
1st red. pinion	HP	291.0	36
	LP	396.1	49
1st red. gear	HP	2,626.9	325
	LP	2,360.2	292
2nd red. pinion	HP	658.2	57
	LP	658.2	57
Main gear	-	4,110.7	356
Effective face width (at P.C.D.)	1st. Red.	HP 510 mm / LP 510 mm	
	2nd Red.	1,168 mm	

Main Condenser : One (1) Unit

Type			Reheating, surface type
Vacuum		mmHg (kPag)	722 (-96.3)
Cooling surface		m^2	3,300
Quantity of condensed steam		kg/h	83,600
Cooling water inlet temperature		°C	27
Quantity of cooling water		m^3/h	19,000
Number of flow		-	1
Velocity of cooling water		m/s	1.88
Distance between tube sheets		mm	5,000
Cooling tubes	Dia. / Thickness	mm	19.0/0.7
	Length	mm	5,079
	Number	-	11,057

Vacuum Pump : Two (2) Units

Type			Water sealed, rotary type
Pump	Capacity	m^3/h	12.7 (21°C dry air)
	Suction vacuum	mmHg (kPag)	730 (-97.7)
	Revolution	rpm	880
Motor	Output	kW	30
	Voltage	V	AC 440
Cooler	Cooling surface	m^2	6.5
	Cooling water quantity.	m^3/h	20.4
	Tube dia. / thickness	mm	12 / 0.5
	Tube length	mm	1,502
	No. of tubes	-	120

Gland condenser : One (1) Unit

Type		Horizontal, shell & tube
Cooling area	m^2	25
Cooling water	-	Condensate water
Cooling water inlet / outlet temp.	°C	32.5/35.8
Cooling water quantity	m^3/h	81.8
Cooling tube dia. / thickness	mm	16.0 / 1.0

Gland Exhaust Fan : One(1) Unit

Type	Motor driven centrifugal	
Capacity	m^3/min. / kPag(mmAq)	7 / -2.94(-300)
Motor	kW / rpm	3.7 / 1,800

Lub. Oil Pump : One (1) Unit

Type	Main turbine driven gear pump	
Capacity	m^3/h	210
Discharge press.	MPag(kf/cm^{2}g)	0.39/(4.0)

Alarming and Tripping Point

Item		Unit	Normal	Alarm	Trip
Main condenser vacuum		mmHg	722	600±60	300±30
Packing steam press.		kPag (kgf/cm^{2}G)	9.8~19.6 (0.1~0.2)	H 49±5(0.5±0.05) L 5±1(0.05±0.01)	-
Control oil press.		MPag (kgf/cm^{2}G)	0.29~0.39 (3.0~4.0)	0.245±0.0098 (2.5±0.1)	0.196±0.0098 (2.0±0.1)
Brg. supply oil press.		MPag (kgf/cm^{2}G)	0.098~0.147 (1.0~1.5)	0.069±0.007 (0.7±0.07)	0.049±0.005 (0.5±0.05)
Gear supply oil press.		MPag (kgf/cm^{2}G)	0.098~0.147 (1.0~1.5)	0.069±0.007 (0.7±0.07)	-
Brg. & gear supply oil temp.		°C	set 45	50±1	-
Brg. temp.	HP & LP Turbine	°C	45~70	75±1	-
	HP & LP Turbine Thrust		45~70	75±1	
	HP 1st red. pinion		45~70	75±1	
	LP 1st red. pinion		45~70	75±1	
	HP 1st red. gear		45~70	75±1	
	LP 1st red. gear		45~70	75±1	
	HP 2nd red. pinion		45~70	75±1	
	LP 2nd red. pinion		45~70	75±1	
	Main gear		45~50	55±1	
	Main thrust		45~50	55±1	
	Main thrust pad		45~ab. 90	100±1	
Over speed (Main shaft)		rpm	MCR 88	-	HP / LP 101.2 +0 -2.6
Rotor axial displacement	HP Turbine	mm	0.2	0.5±0.05 *1) (on gauge)	1.0±0.05*1) (on gauge)
	LP Turbine		0.2	0.5±0.05 *1) (on gauge)	1.0±0.05*1) (on gauge)
Rotor vibration	HP Turbine	μm (p-p)	-	100±5	130±5
	LP Turbine		-	150±5	180±5
Main reduction gear vibration excessive		mm/s	-	7	18
Condenser water level		mm	NWL *2)	H +250±10 L -110±10	H +500±10
Main steam press. (at M.V. inlet)		MPag (kgf/cm^{2}G)	5.88 (60)	High 6.18(63) Low 5.59(57)	-
Main steam temperature (at M.V. inlet)		°C	510	High 525	-
Ast. steam chamber temp.		°C	30~50	350 *3)	-
LP turbine exhaust chamber temp. Dump steam system interlock	°C	33	150*4)	-	
	Main cond. Sea water outlet temp. high	°C	29.3	Set value 70	
	Main cond. Vacuum low	kPag (mmHg)	-96.3 (722)	Set value -80±8(600±60)	

*1 Mark : Including clearance.
*2 Mark : 400 mm from hot well bottom.
*3 Mark : at astern guardian valve close, and delay timer abt. 4H
*4 Mark : at manoeuvring valve astern side open

5.1.1 Manufacturing Specifications

General

The main propulsion unit is a Kawasaki UA type cross compound turbine with double reduction gear. This unit consists of one high pressure turbine, one low pressure turbine including astern elements, main condenser, manoeuvring valve unit, and reduction gear.
Steam from the manoeuvring valve enters the high pressure turbine through the nozzles.
Only the manoeuvring valve unit controls the steam.
The astern turbine is designed to develop no less than 80% of the maximum ahead torque at 50% of the maximum ahead rpm. It can operate astern at 70% of the maximum ahead rpm for two hours without overheating the ahead elements.
The high pressure turbine bearing bracket is mounted on a common bed frame and supports the high pressure turbine. The low pressure turbine is mounted on the bracket which is composed of a part of the main condenser shell. The bracket is designed to support the total weight of the condenser and the low pressure turbine at working condition.
The thermal expansion of the turbines is allowed in any direction without affecting the alignment of the rotors.
Connections are provided to allow either high pressure turbine or low pressure turbine to run independently for emergencies. This is accomplished by an emergency steam supply from the desuperheated steam line to the low pressure turbine or an emergency exhaust connection from the cross over pipe to the low pressure turbine exhaust casing.
The turbine glands are steam sealed, and the seal is spring backed labyrinth type.
The motor driven turning gear is fitted on the reduction gear casing.

Main Turbine

(1) High pressure turbine
The high pressure turbine is a impulse type.
The casing is a single casing type and divided into two halves along at horizontal centerline. It is provided with a steam bleeding connection on the lower half.
The casing is supported by the pedestals on common bed frame at both ends.
The turbine thrust bearing is a Michell type and that is located at forward end of the turbine. An axial displacement indicator and a vibration meter sensor are fitted on the thrust bearing end of the rotor.

(2) Low pressure turbine and astern turbine
The astern turbine is located at the exhaust end of the low pressure turbine, and has two curtis stages.
The low pressure turbine casing is single casing type that has a welded steel plate and cast steel. The astern turbine casing is separated from the low pressure turbine casing and is arranged in such a way as to protect it from excessive heat when the astern turbine is operating.
Stellite pieces are brazed on the last two stage blades of the low pressure turbine in order to prevent wet steam from damaging.
The turbine thrust bearing is a Michell type and is located at the forward end of the turbine. An axial displacement indicator and a vibration meter sensor are fitted at the thrust bearing end of the rotor.

(3) Manoeuvring valve
The manoeuvring valve consists of an ahead throttle valve, an astern throttle valve, and a hydraulic cylinder which are mounted on the same girder of HP turbine.
Throttle valves are actuated by the hydraulic cylinder.
The mechanical gear is used for using the throttle valves during emergencies, especially when the hydraulic system fails.

Main Reduction Gear

The main reduction gear is a tandem of the double reduction type.
The torque generated by HP and LP turbines is transmitted to 1st reduction gears through flexible couplings, then, to 2nd reduction gears through quill shafts and gear couplings.

(1) Reduction gear casing
Reduction gear casing is welded steel divided into the upper and lower casing by a horizontal plane.
Main thrust bearing is installed at the fore side of the lower casing.
On the upper casing, peep holes are provided to allow for checking lubrication on the meshing surface and contact marks.

(2) Reduction gears
Each reduction gear is modified in a volute shape tooth profile.
Pinions are integral with the shaft. Gears consist of the forged steel rim and a shaft welded with steel plate spokes.

(3) Flexible coupling
Both HP and LP flexible couplings are made of two coupling sleeves of internal gears and a coupling shaft of external gear.
This permits thermal expansion, and eccentricity of turbine rotor and 1st reduction pinion.

(4) Quill shaft and gear coupling
Quill shaft is installed inside of hollow shafts at the 1st reduction gear and the 2nd reduction pinion. Its fore-side is connected to the 1st reduction gear shaft by a flange coupling while the after-side is connected to the 2nd reduction pinion by a flange coupling through gear coupling.

(5) Bearings
All bearings are divided into upper and lower shells. Bearing metals are made of white metal cast on the back metal of steel plates.
Thermometers for bearing are attached at each cover or casing.

(6) Main thrust bearing
The main thrust bearing is a the tilting pad-type, integrated with the fore-side of lower gear casing and lubricated by the oil led from main lube oil system.
The adjuster which adjusts bearing temperature at the initial stage is attached on the top of the bearing.
The main thrust bearing block shall be fitted using liners on the machine frame of the ship

(7) Turning gear
The turning gear installed on the after-side of the HP 1st reduction upper casing is a planetary gear type.
Tuning motor is installed on the top of the planetary gear unit. It takes about 6 minutes to turn the main shaft full circle..
The boss at the shaft end of turning motor should be turned with a handle.
There is an interlock device between the turning gear and the manoeuvring valves.

(8) Direct driven lub. oil pump (Main oil pump)
The lub. oil pump consists of a pair of double helical gears. It discharges lub. oil from the suction pipe to the delivery pipe at ahead revolution but does not discharge to the delivery pipe by recirculation at ast. revolution.

Main Condenser

The main condenser is installed in an athwart ship position and is supported on the package frame by its own bracket. The main condenser is of straight tube, reheating, surface cooling type arranged for single pass of circulating water. It is provided with an air cooling section and condensate hotwell. The tubes are expanded into the tube plate at both ends.
An expansion joint is provided on the shell.
The water boxes have adequate openings for inspection.
The water boxes' inside surface is lined with approximately 3 mm thick neoprene.
All connections of the shell are provided with baffles to protect the tubes from damage.
Generator turbine exhaust steam line, steam dump line and auxiliary exhaust spill line are connected to the main condenser.
Protection steel plates are provided to protect condenser tube plate from corroding.

Vacuum Pump

Two (2) vacuum pumps (one is stand-by) serves the main condenser. The vacuum pump is a horizontal water ring type. Vacuum pump, motor, water chamber and fresh water cooler are mounted on the common bed frame.

Lub. Oil Pump

The main turbine is provided with one main turbine direct driven lube. Oil pump and two auxiliary motor driven oil pumps.
One motor driven lube. oil pump starts and stops automatically under the following condition.

Auto stop condition

Above 90% of M.C.R. revolution
And
Above MV lift corresponding to above revolution
And
Pump outlet press. above 0.363 MPag

Auto start condition

Under 87% of M.C.R. revolution
And
Under MV lift corresponding to above revolution
And
Pump outlet press. above 0.343 MPag

Safety Device

The oil relay mechanism shuts off the throttle valve when one of the following emergency cases occur;

(1)	Over speed	115% of ahead full
(2)	Lub. oil low-low pressure	about 49 kPag
(3)	Control oil low pressure	about 196 kPag
(4)	Main condenser low-low vacuum	about 300 mmHg
(5)	Main condenser hot well level high-high	NWL + 500 mm
(6)	HP turbine rotor position excessive displacement	about 1.0 mm
(7)	LP turbine rotor position excessive displacement	about 1.0 mm
(8)	HP turbine excessive vibration	about 130 micron
(9)	LP turbine excessive vibration	about 180 micron
(10)	Main reduction bearing excessive vibration	about 18 mm/s
(11)	Main boiler steam drum very high level	+ 220 mm
(12)	Two boilers trip	Trip
(13)	Manual trip	Trip
(14)	Turning gear engaged	Engage
(15)	Emergency manoeuvring handle not in neutral position	
(16)	Auto spinning over-speed	

Signal for items (11), (12) and (13) are supplied by the shipbuilder.
In addition to safety devices above, an emergency hand trip is provided to shut the throttle valves in case of emergency.
When the turning gear is engaged and the emergency manual manoeuvring handle is not at neutral position, interlocking devices are provided to prevent the main turbine from starting. These devices for emergency trips and interlocking are designed to be not reset automatically after recovery, and to be reset by pushing reset button for a few seconds.

Remote Control System

The main turbine remote control system is designed to control the propeller shaft revolution or the manoeuvring valve lift by operating the telegraph lever installed on the bridge control console and the ECR console.
The main turbine remote control system is designed to control the manoeuvring valve lift by operating the "Direct Control Switches" installed on the ECR and Machine side.
The following table shows the control operation from each manoeuvring position and method.

M/P	Manoeuvring method (MV)		Speed/MV control method	Safety system/ Interlock
W/H	Lever	Automatic control by Telegraph transmitter (Micro computer-servo motor)	Corresponding to the electrical signal of telegraph transmitter, the micro computer calculates to drive the servo motor actuating the control valve	-Manual trip -Auto. trip -Auto. slow down -BLR interlock -Rough sea cont. (Overspeed prevention)
ECR	Lever	Automatic control by telegraph receiver (Micro computer-servo motor	Corresponding to the electrical signal of telegraph receiver, the micro computer calculates to drive the servo motor actuating the control valve	-Manual trip -Auto. trip -Auto. slow down -BLR interlock -Rough sea cont. (Overspeed prevention)
	Direct Control	Manual control by INC/DEC control switch. (Electric-servomotor)	Control signal of INC/DEC control switch. is amplified to drive servo motor actuating the cont. valve.	Manual trip Auto. trip
M/S	Direct Control	Manual control by Inc/Dec control switch (Electric servo motor)	Contact signal of Inc/Dec control switch is amplified to drive servo motor actuating the control valve.	Manual trip Auto. trip
	Mech. Handle	Manoeuvring valve is Operated by mechanical handle.	Operator directly controls Manoeuvring valve by Operating mechanical handle	The remote control system makes auto trip of control oil for servo motor, while the handle is not in neutral position, so that the remote control system cannot affect the handle operation.

Abbreviation

- M/P : Manoeuvring Position
- W/H : W/H bridge control console
- ECR : Engine Control room
- M/S : Machine Side

Main Turbine Valve List

Valve No.	Name of Valve	Valve No.	Name of Valve	Valve No.	Name of Valve	Valve No.	Name of Valve
T-3	Astern guardian valve	T-49	Rec. bypass valve	T-64C	H.P. bleeder pressure root	T-86A	Control oil press. (Remote)
T-11	Stop valve for aux. system	T-51	Manoeuv. Valve drain	T-66	L.P. bleeder pressure	T-86B	Control oil press. (Local)
T-13	Warming steam supply	T-52	H.P. steam chest drain	T-66A	L.P. bleeder pressure switch	T-86C	Control oil press. (Local)
T-14	Warming steam supply	T-53	H.P. turbine 2nd stage drain	T-67	L.P. bleeder pressure	T-87	Main turbine driven L.O. pump suction press.
T-15	H.P bleeder valve	T-54	H.P. bleeder drain	T-68	Condenser vacuum (Local)	T-88	Main turbine driven L.O. pump delivery press.
T-16	I.P bleeder valve	T-55	H.P. casing drain	T-68A	Condenser vacuum (Remote)	T-89	Main turbine driven L.O. pump delivery air vent
T-17	L.P bleeder valve	T-56	Spray water for steam dump	T-68B	Condenser L.L. vacuum trip	T-90	Main turbine driven L.O. pump delivery air vent
T-24	Before make-up valve	T-57	Spray water for astern operation.	T-68C	Condenser vacuum for vacuum pump start	T-105	Inlet chamber air vent
T-25	After make-up valve	T-58	H.P. bleeder drain	T-68D	Condenser vacuum for dump steam	T-105A	Inlet chamber air vent
T-26	Make-up valve bypass valve	T-59	Before H.P. bleed drain trap	T-69	After H.P. 1st stage pressure	T-106	Outlet chamber air vent
T-27	Before spill valve	T-60	After H.P. bleed drain trap	T-69A	After H.P. 1st stage pressure test	T-106A	Outlet chamber air vent
T-28	After spill valve	T-61	Main steam pressure	T-71	Packing steam reservoir pressure	T-108	Inlet chamber drain
T-29	Spill bypass valve	T-61A	Remote control program interlock	T-71A	Packing steam controller	T-109	Outlet chamber drain
T-41A	Vacuum breaker	T-61B	Main steam pressure test	T-72	Main steam drain	T-141	Lube. Oil supply pipe drain (Normally close)
T-41B	Vacuum breaker	T-61C	Main steam pressure root	T-72A	Main steam drain	T-142	Gas vent pipe drain (Normally close)
T-42	Main condenser level control	T-62	Ahead steam chest pressure	T-81	Lube. Oil supply press. (Local)	T-143	Main thrust oil flow regulate
T-43	Cond. Water recirculation	T-62A	Ahead steam chest pressure test	T-81A	Lube. Oil supply press. (Remote)	T-144	Gear supply pipe drain (Normally close)
T-44	Before level control valve	T-63	Astern steam pressure	T-82	Gear oil supply press. (Local)	T-145	L.O. temp. control
T-45	After level control valve	T-63A	Astern steam pressure test	T-82A	Gear oil supply press. (Remote)	T-302	Packing steam make-up valve
T-46	Level control bypass valve	T-64	H.P. bleeder pressure	T-83	Lube. oil L.L. press. trip	T-303	Packing steam spill valve
T-47	Before rec. valve	T-64A	H.P. bleeder pressure switch	T-85	Operating oil press.	SV-1	Sentinel valve for exhaust casing
T-48	After rec. valve	T-64B	H.P. bleeder pressure test	T-86	Control oil press.	-	-

5.1.2 Main Turbine Operations

5.1.2.1 Preparing for Start-up

Confirmation

1) Confirm that the steam source (Main steam, Auxiliary steam, etc.), the air source, and the electrical source are operational.
2) Confirm that all gauges and meters are normal.
3) Check the emergency manual handle of the manoeuvring valve with the main steam valve at shut-off condition.
4) Make sure the manoeuvring lever is at "stop". Check the switches of bleeder valves, drain valves etc. on the control console at the engine stop condition.
5) Confirm the water level of the main condenser hot well.
6) Confirm the working level of the LO by the LO tank level gauge.

Preparation

1) Put the electric source to the control console and open up the air source to each control installation.
2) Check the indication lamp of each valve by pressing the lamp test button on the control console.
3) Check each control valve by the indication lamps.
4) Set the operation switch "auto" for the drain valves, the astern guardian valve, bleeder valves and spray water valves.
5) Check the manual-handle position of the control valves.
   a) Open position :
      Astern guardian valve, drain valves, packing steam make-up valve.
   b) Close position :
      Packing steam spill valve, bleeder valves, main condenser Recirc. Valve.
   c) Locking position with stopper:
      Spray water valve for steam dump, spray water valve for ast. operation.
      Check the bypass valves of the control valves are closed.
   d) Check and record the axial position of rotors at cold condition.

Start – up of Condensate System

1) Open the necessary valves in the main S.W. circulation system.
2) Start the main S.W. circulating pump.
3) Open the air vent valves on the water boxes of the main condenser to eliminating the air bubbles in the system.
4) Fill the main condenser hot well with fresh water up to the normal working level.
5) Operate the level controller for the condenser hot well.
6) Open the suction valves for condensate pumps.
7) Open all valves in pressure balancing and gland sealing line for condensate pump.
8) Start the condensate pump.
9) Open the delivery valves for condensate pumps.
10) Confirm that the hot well level is controlled properly by the level controller and that the condensate line has pressure.

Start-up of the Lube Oil System

1) Confirm the level of lube oil in the sump tank.
2) Check the oil temperature. If it is below 30°C, preheat oil to minimum 30°C.
3) Open necessary valves and cocks in the lube oil system.
4) Operate the lube oil temperature control valve.
5) Start the Aux. LO pump.
6) Close the air vent in the system to eliminate air bubbles.
7) Open the cooling water valves for lube oil coolers.
8) Check the oil pressure and oil flow in all sight glasses.
9) Recheck the level in the sump tank.
10) Check the overflow of the gravity tank.
11) Confirm the oil pressure of pump delivery, bearings and gears.

Function Check for the Manoeuvring Device

1) After confirming that the main steam valve is fully shut-off, reset the main turbine by pushing the reset-button until the reset lamp lights up.
2) Operate the manoeuvring valve hydraulically by the manoeuvring lever in order to check the manoeuvring device function.
3) After resetting, push the trip-button to confirm the normal operation of the trip.
   After this, reseting is not necessary so leave it in the trip condition.

Warming-up System (refer to Fig. Main Turbine Warming-up System)

The warming-up system using superheated steam(main steam) in addition to the conventional warming-up system using de-superheated steam is provided to improve the warming-up efficiency of the main turbine.
In this system, superheated steam(main steam) is supplied into the main turbine by bypassing the manoeuvring valve while the turning device is kept operating.
If an excessive amount of warming-up steam flows into the main turbine, the turbine is to be rotated, so that the turning gear is damaged. Therefore, pressure reducing valve (V50) is provided by bypassing main steam stop valves(V1, V2) in order to prevent supply of such excessive amount of warming-up steam, which can keep warming-up steam pressure constant while closing the main steam stop valves(V1, V2) in addition, the system is equipped with safety devices which would automatically stop supply of warming-up steam to the turbine when any conditions such as warming-up steam pressure, temperature, and shaft revolution exceed the set values.

Warming-up :

The warming-up of the main turbine and the main steam pipe is important for the following reasons.
1) Clean steam without drain should be introduced to the main turbine from the main steam pipe.
2) While at anchor and on a berth, the main turbine should be ready for starting at any time by keeping the main turbine warmed condition.
3) After departure, the main turbine should be free from any abnormal vibration trouble.

Before starting the main turbine, the main turbine is required to be sufficiently warmed-up by the following procedure in accordance with the turbine condition.

Warming-up Procedure(M/T) by Desuperheated Steam
(refer to Fig. Main Turbine Warming-up System)

Warming-up for main turbine by using the de-superheated steam should be carried out in such case that the turbine is going to be in service again after dry docking, long anchoring, etc. at which the H.P. turbine casing inside temp. is abt. 50°C and below.

(1) Preparation for warming-up
   1) Confirm that manoeuvring valve is in trip condition and main steam stop valves (V1, V2) are being closed.
   2) Confirm that all drain valves are being opened.
   3) Engage the clutch of turning gear by lever.
   4) Start turning motor to ahead side, and confirm that turbine rotor is being rotated.

! Caution
Never turn on turning motor switch while the handle for hand-turning is inserted into motor shaft end.

! Caution
If the electric current of the turning motor is oscillating between abnormally high and low values during turning, stop the turning motor and disengage the clutch of turning gear to prevent the turning gear from damage due to driving of the propeller by extreme tidal current.

   5) Supply packing steam by opening stop valve on auxiliary steam line and both inlet & outlet stop valves for packing steam control valve. Shut off its bypass valve.
   6) Start gland exhaust fan either before supplying packing steam or immediately after.
   7) Supply cooling water to vacuum pumps.
   8) Check level in water separator for vacuum pumps.
   9) Open suction valve and its bypass valve for vacuum pump suction.

10) Start vacuum pump. When condenser vacuum reaches 300mmHg (-40kPag), close the suction valve leaving the bypass valve open and keep condenser vacuum in the range of 250mmHg ~ 300mmHg (–33.3~40.0kPag) for half and hour

(2) Warming-up by de-superhaeated steam

1) Open drain valves of a strainer on de-superheated stem line.
2) Open warming-up steam valve for turbine on de-superheated steam line by manual.

! Caution

If the electric current of the turning motor is reduced during warming-up, stop opening operation of the warming-up steam valve for turbines and close it, immediately.

3) Warm-up turbines until H.P. turbine casing inside temp. becomes approx. 80~100°C of higher
4) Shut off the warming-up steam valve for turbines.
5) Open the suction valve for vacuum pump, and close its bypass valve.
6) Confirm that condenser vacuum to be 722mmHg (-96.3kPag) or higher

Warming-up Procedure(Main steam pipe & M/T) by Superheated Steam (refer to Fig. Main Turbine Warming-up System)

This step should be carried out in order to keep main turbine in warmed condition during loading/unloading and/or during anchoring off shore on the usual voyage so that the turbine can be ready for start-up all the time.

(1) Pre-condition

1) Packing steam is being supplied.
2) Gland exhaust fan is being operated.
3) Main condenser vacuum is in normal condition
4) Turning gear is being engaged and operated in ahead side.
5) Drain valves(air-cylinder type, 5 sets) are being opened.
6) All interlock items for warm-up are in normal condition.

! Caution

If the H.P. turbine casing inside temp. is still being over 250°C, it is prohibited to supply the warm-up steam into the H.P. turbine in order to protect the turbine from cool-down caused by waterdrops which is condensed from the steam in the casing.

! Caution

If the electric current of the turning motor is oscillating between abnormally high and low values during turning, stop the turning motor and disengage the clutch of turning gear to prevent the turning gear from damage due to driving of the propeller by extreme tidal current.

(2) Warming-up for main steam pipe

1) Confirm that the manoeuvring valve is in trip condition, and the main steam stop valves(V1, V2) are being closed.
2) Confirm that the bypass valves(V5, V9) of the main steam stop valves are being closed.
3) Confirm that the H.P. turbine steam chest inlet valve(T-152), the needle valve(T-153), and the piston valve(T-151) are being closed.
4) Confirm that main steam temp. at the main boiler outlet is abt. 350°C and above, and set the pressure of pressure reducing valve(V3) abt. 0.49MPag.
5) Open the drain valves(T-72, T-72A) of main turbine inlet.
6) Open the drain valves(V6, V7, V10, V11) of the bypass valves.
7) Slightly open the bypass valves(V4, V8) of the main steam stop valves. After blowing off drain from the drain valves(V6, V7, V10, V11) gradually open the bypass valves(V5, V9) of the main stop valves.
8) Close the drain valves(V6, V7, V10, V11)
9) Warm-up the main steam pipe ;
   a) Gradually increase the set pressure of pressure reducing valve(V3) up to abt. 1.47MPag
   b) Slightly open the drain valves(T-72, T72A) after completion of the warm-up, which is ;
      - Colour of drain steam from the drain valves(T-72, T-72A) will be changed to transparent from white.
      - The main turbine inlet steam temp. becomes abt. 280°C and above.

(3) Warming-up for main turbine

1) Confirm that the manoeuvring valve is in trip condition and the main steam stop valves(V1, V2) are being closed
2) Gradually open the needle valve(T-153) for warm-up pipe up to the full opening.
   Confirm that the indication lamp of the warm-up valve open signal on the main control console turns on and the warm-up start/reset lamp flickers.
3) Push the warm-up start/reset push button on the main control console.
   Confirm that the piston valve(T-151) is fully opened.
4) Gradually open the H.P. turbine steam chest inlet valve(T152) up to the full opening. (The warming-up of the main turbine starts)

! Caution

If any abnormal noise and vibration is noticed, stop opening operation of the H.P. turbine steam chest inlet valve(T-152), and check the cause carefully.

! Caution

If the electric current of the turning motor is oscillating between abnormally high and low values during turning, stop the turning motor and disengage the clutch of turning gear to prevent the turning gear from damage due to driving of the propeller by extreme tidal current.

5) Confirm that the H.P. turbine casing inside temp. becomes abt. 180°C above.
   a) In case that the H.P. turbine casing inside temp. is descended during the warm-up, stop the warm-up operation and check the cause.
   b) In case that the H.P. turbine casing inside temp. becomes lower to abt. 180°C and below, increase the super heated steam temp. of the main boiler until the H.P. turbine casing inside temp. returns to abt. 180°C and above.

! Caution

Do not touch the surface of heated parts as follows without protective gloves.

- Turbine casing and lagging
- Manoeuvring valves and lagging
- Steam and drain pipes and valves

(4) Warming-up finish

When the stand-by for departure is close at hand, the following operation shall be carried out.

1) Close the all drain valves except the air cylinder type drain valves(5 sets).
2) Close the steam chest inlet valve(T-152).
3) Close the needle valve(T-153).
   Confirm that the piston valve(T-151) shall be fully closed automatically.
4) Gradually increase the set pressure of the pressure reducing valve(V3) up to abt. 5.88MPag.
5) Open the main stop valves(V1, V2).
6) Close the bypass valves(V4, V5, V8, V9)of the main steam stop valves.
7) Before the try-engine, the following to be confirmed.
   a) Confirm that the main turbine inlet steam temp. is abt. 280°C and above
      If the steam temp. is lower than 280°C, open the drain valves(T-72, T-72A) and increase the main turbine inlet steam temp. up to 280°C and above in order to prevent the drain generation in the main steam pipe.
   b) Confirm that the H.P. turbine casing inside temp. is abt. 180°C and above.
      If the H.P. turbine casing inside temp. dose not rise up to abt. 180°C because of the malfunction of the warm-up system, spinning shall be carried out ahead/astern direction respectively to increase the H.P. turbine casing inside temp. up to abt. 180°C and above at the stand-by condition.

Warming – up

Cold Start

Stage 1

1) Confirm that the manoeuvring valve is in trip condition and the main steam stop valve is closed.
2) Confirm that the drain valve and astern guardian valve are opened.
3) Engage the turning gear.
4) Start the turning motor and rotate the turbine.

Caution

Never turn the turning motor switch while hand turning handle is inserted into the motor shaft end.

5) Open the stop valve on the auxiliary system.
   Open both the inlet and outlet stop valves for automatic packing steam control valve.
   Shut-off the bypass valve.
6) Supply the cooling water to the vacuum pump.
7) Check the level in the water separator.
8) Open the suction valve and its bypass valve for vacuum pump suction.
9) Start the vacuum pump. When condenser vacuum reaches -40kPag, close the suction valve, leave the bypass valve open and keep condenser vacuum in a range of –33.3~40.0kPag for about 30minutes to an hour.
10) Open the warming steam valve for turbines.
11) Open the bypass valve for the main steam stop valve. Warm up the main steam pipe.
12) Warm up the turbines for at least an hour.
13) Shut-off the warming steam valve for turbines.
14) Shut its bypass valve for vacuum pump.
15) Confirm that the condenser vacuum is above -96.3kPaG.
16) Go to " Stage 2" (Before Sail Out)

Caution

A higher vacuum during the warming up period would lengthen the time required to warm up the turbine. This might cause inequalities in temperature that would result in the distortion of turbine rotors.

In Harbor

Stage 1

During the ship's loading/unloading period, the turbine condition should be maintained as follows;

1) Condenser vacuum should be kept abt. 722 mmHg.
2) Engage the turning gear and start turning after stopping the engine.
3) Close the main stop valves (71B) located at the superheated steam line from boiler to main turbine.
4) Open bypass valves of the main steam pipe from boiler to turbine.

Keep the main steam stop valve for main turbine closed(MS001 & MS014). Open main steam bypass valve and main turbine warming valve in port. In port, the main steam stop valve for main turbine should not be open as long as loading / discharge arms are connected. The ship should be ready to leave the terminal.

Keep the warming valve close for the main turbine in order to keep the main turbine hot condition as long as possible.
Never the steam chest temp. of HP turbine is down to 150°C, open the warming steam valve to serv. warming steam to main turbine.

Stage 2 (Before Sail Out)

1) Open the drain valves for at least 30 minutes prior to starting the main turbine to completely warm up the main steam pipe.
2) Set the manoeuvring lever on neutral position and confirm the emergency manual handle on neutral.
3) Open the main steam stop valve and close its bypass valve.
4) Stop the turning motor and set back the lever on the disengage position, then lock up.
5) After disconnecting of the LNG loading pipe in harbor, carried out the spinning for over 30 minutes, the ahead / astern direction respectively.

(The temperature of the HP turbine steam chest shall be kept at about 300°C)

5.1.2.2 Running

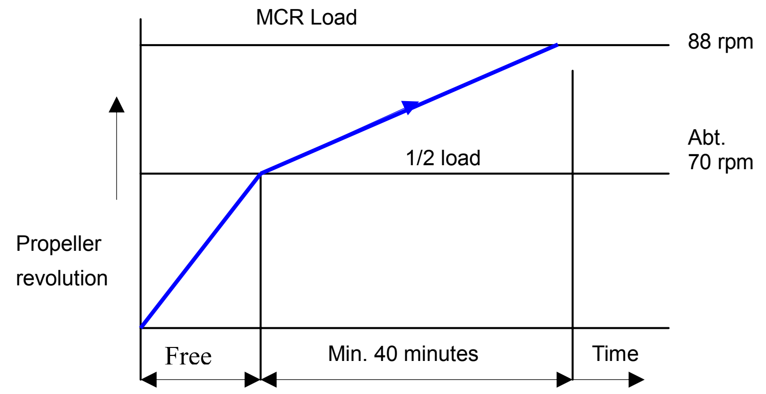
Stand-by

1) Within 3 minutes after disengaging the turning gear, start the main turbine or start the auto spinning.
   Don't stop the turbines for longer than 3 minutes when it is hot.
2) Make sure there is no abnormal noise inside the turbine and the reduction gear casing during the try-engine or idling period.
3) Continue idling until further information comes from the bridge. The warming-up condition is maintained on the main engine by this idling. (The temperature of HP turbine steam chest shall be kept at about 300°C)
4) Check the nozzle valve is fully closed.

Starting and Ahead Operation

1) Start the ahead operation by manoeuvring lever operation with the program control.

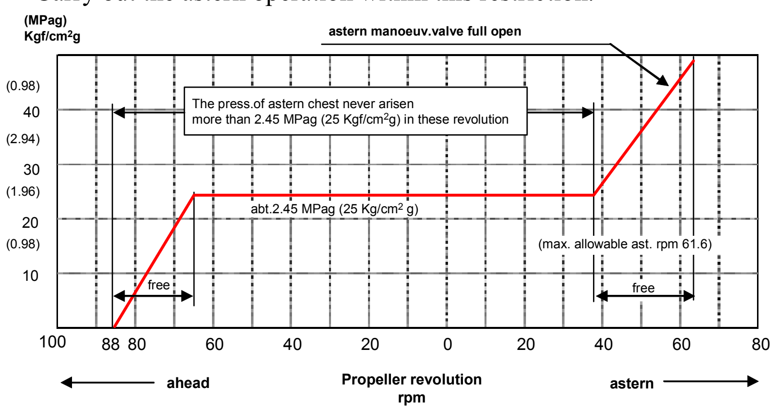
The program is shown in the following figure. In case of manual control, the speed should be increased according to the program.



2) The power can increase regardless of the time limit, up to 1/2 output (the main shaft revolution abt. 70 rpm).
   From 1/2 output to the full output min. 40 minutes are required.
3) Control valves are closed or opened automatically according to the setting values.
4) Aux. motor driven lub. oil pump is stopped at over 90% MCR Rev. automatically.
5) Check the turbine unit is operating normally according to the characteristic curve of the main turbine.
6) For slow-down during the voyage and throttling the manoeuvring handle, all control valves should be closed or opened automatically according to the setting values.
   Aux. motor driven lub. oil pump starts automatically.

Astern Operation

1) Confirm the astern guardian valve is opened.
2) Confirm the turbine drain valves are opened.
3) Confirm the water spray valve is opened.
4) The restriction on the astern operation is shown in the following diagram. Carry out the astern operation within this restriction.



5) Maintain the condenser vacuum normally.
6) During the running, pay attention to the noise in the turbine interior, the temperature of LP turbine exhaust chamber wall, the vibration, the noise and the temperature of the bearing.
7) Running at full-astern 61.6 rpm must not exceed more than 2 hours. In case of intermittent full astern running, the total full astern running time must not exceed 2 hours.
8) When converting to ahead running after a long hour of astern running, avoid a sudden increase in ahead load. It should increase gradually. The continuous maximum output operation must also be carried out after about 40 minutes of ahead running.
9) Start the astern operation by program control if the ordinary astern operation is sufficient for the ship.
10) Exhaust chamber temperature of the upper of LP turbine is 150°C. Keep close attention.
11) In case the astern, spray system does not function properly ;
Running at the full-astern (61.6 rpm) must not exceed more than 30 minutes.
Exhaust chamber temperature of the upper of LP turbine is 230°C.

Reducing Speed Operating Conditions

The nozzle control valve is used to change turbine load conditions between NCR and MCR.
The nozzle control valve always should be kept close when turbine load is changed between NCR and stop.

NOZZLE VALVE CONDITION		NO. OF NOZZLE	MAX. OUTPUT (PS)	MAIN SHAFT RPM
NO.1[*1]	NO.2[*2]			
Open		21+4+6	36,000(MCR)	88
Close	Open	21+6	34,600	abt. 86.8
Open	Close	21+4	32,400	85
Close		21	28,240	81.2

Remark : Output shall by obtained at bleeding condition.
*1 : Starboard side 4 nozzles
*2 : Port side (L.P.T. side) 6 nozzles

Caution

To prevent jamming, for opening and shut-off of nozzle valve, turn back the handle about 1/8 round after full opening or full shut-off.
If a nozzle valve is kept in the same positions for a long time, the valve rod may get stuck. To avoid this, move the valve a few millimeters in every voyage.

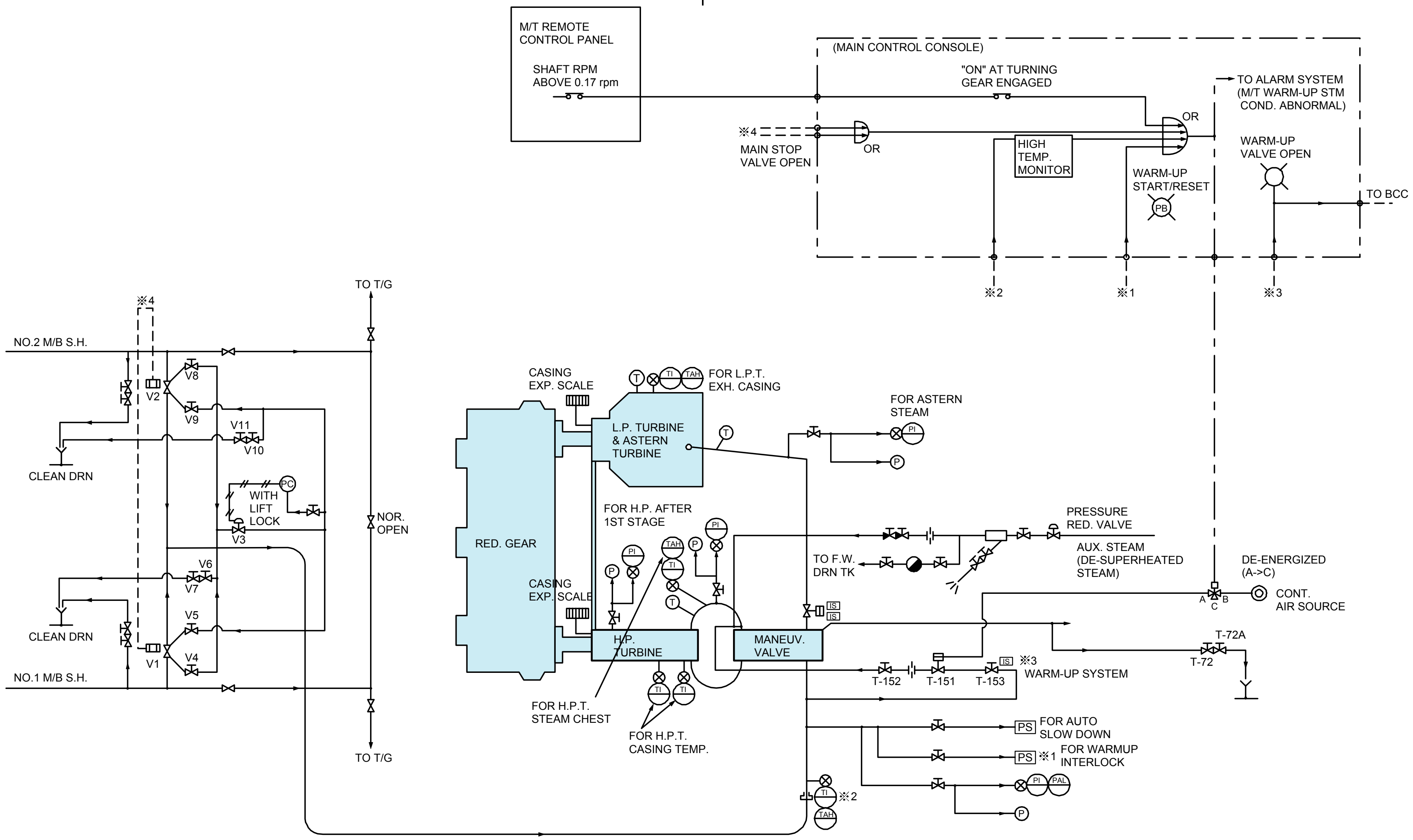
5.1.2.3 Finished Engine

1) Upon receiving the order to the stop and finished engine, slow down and put the manoeuvring lever on the stop-position.
During slow down, confirm the opening of the drain valves, astern guardian valve and the shutting of the bleeder valves.
2) Confirm perfect stop of the main engine (propeller revolution), then engage the turning gear.
3) Start the turning motor. Carefully turn the gear within three minutes after it stops.

! Caution

Never turn on the turning motor switch while the handle for hand turning is inserted into the motor shaft end.

4) Shut off the main steam stop valve completely.
5) After changing the auxiliary exhaust to the atmospheric condenser, stop the vacuum pump.
6) Keep the packing steam supply until the condenser vacuum reaches atmospheric pressure.
7) After confirming the stop of make-up and spill etc. from each auxiliary leading to the main condenser, the heater, gland condenser etc., stop the gland exhaust fan and the condensate pump
8) After having cooled the engine for 6 hours, stop the turning motor, set-off the turning clutch and lock up.
9) After confirming the stop of turning, stop the lub. oil pump.
10) Cut off the electric source and the air source to the control console, if the stop period is long.



Main Turbine Warming-up System

5.2 Main Turbine Control System

Maker:	Kawasaki
Type:	UA-360 Cross compound, impulse, double reduction geared marine turbine.
Output:	36,000 PS at MCR
HP Turbine Speed:	4,962 rev/min
LP Turbine Speed:	3,275 rev/min
Propeller Speed:	88 rev/min
Steam Condition:	5.88 Mpag and superheated at 510°C
Direction of Rotation:	Clockwise, looking from aft
Astern Maximum Continuous Speed	61.6 rev/min
Condenser Vacuum:	722 mmHg at a sea temperature of 21°C Steam Bleed Off:
HP Bleed	HP: HP turbine, 5th stage IP: Crossover pipe LP: LP turbine, 3rd stage

Control System

The remote control system serves for controlling the main turbine from the navigation console or in the machinery control room.
In conventional operation, according to the manoeuvring orders, the engine telegraph lever on the bridge or the manoeuvring lever in the control room is set to the desired position.
When any trouble occurs in the engine telegraph or manoeuvring lever system, the main turbine is controlled by the direct control switch regulator on the machinery control console or the machine side.

(1) Telegraph control (from navigation console)
The telegraph control system consists of the revolution control and the valve position control.

(2) Lever control (from machinery control room)
The lever control system consists of the revolution control, the valve position control and the program bypass control.
When the revolution control switch on the control console is changed to the BYPASS position, the revolution control is automatically cut.
When the program bypass switch on the control console is changed to the PROGRAM BYPASS position, the astern and the ahead program are canceled.

(3) Emergency manoeuvring control (from machinery control room and machine side)
When the selector switch on the control console for the selection of manoeuvring method is set to the DIRECT position, the main turbine is controlled by means of the direct control switch regulator with the control lever.

(4) Spinning
When the change-over switch for auto-spinning is set at the ON position and the main shaft revolution is decreased between +3 rpm and -3 rpm during navigation, auto-spinning is automatically done.
The change over switch (ON, OFF) is on the machinery control room console.
Warming through modes is provided for safe operation during hand-spinning for the completion of the warming-up of the main turbine.

Operation of the Control Valve

(1) Astern guardian valve operation
When the change-over switch is set to AUTO, this valve is automatically operated by detecting the manoeuvring valve lift and also remotely operated using the selector switch.
The change-over switch (AUTO, OPEN) is provided on the machinery control room console.

(2) Bleeder valve operation
a) HP bleeder valves
When the change-over switch is set to AUTO, this valve is automatically operated in accordance with the steam pressure at the HP bleeding point and also remotely operated using the selector switch.
The change-over switch (CLOSE, AUTO, OPEN) is on the machinery control room console.
b) IP & LP bleeder valves
When the change-over switch is set to AUTO, these valves are automatically operated in accordance with the steam pressure at the IP bleeding point and also remotely operated using selector switch.
The change-over switch (CLOSE, AUTO, OPEN) is on the machinery control room console.

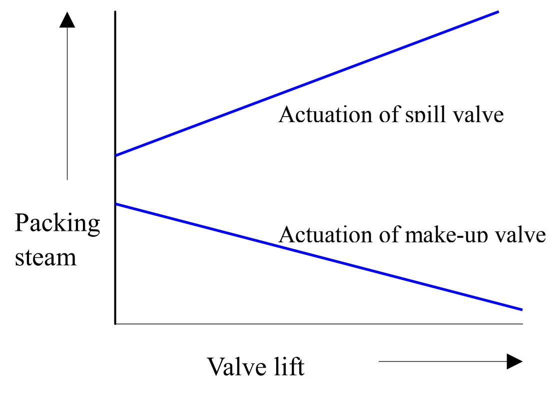
(3) Drain valves operation
a) Drain valves are provided for the manoeuvring valve, the HP turbine steam chest, the HP turbine 2nd stage, HP bleeder and the HP turbine casing.
When the change-over switch is set to AUTO, these valves are automatically operated by detecting the manoeuvring valve lift and also remotely operated using selector switch.
The change-over switch (AUTO, OPEN) is on the machinery control room console.

(4) Condensate recirculation valve.
The valve is automatically controlled with the signal of the condensate level transmitter for the main condenser hot well.

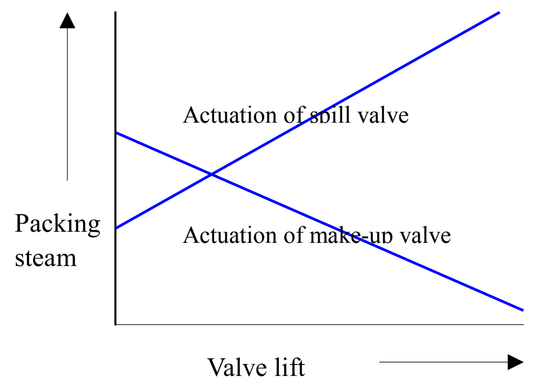
(5) Packing steam pressure control valve operation
Packing steam is controlled normally by two air operated control valves.
In case of low packing steam pressure, the make-up valve is opened and supplies the packing steam to the glands.
In case of high packing steam pressure, the spill valve is opened and the packing steam is spilled to the main condenser.
To prevent hunting or cycling, the packing steam controller should be adjusted as shown in the following figures.

If the control valves are not functioning properly, the packing steam pressure is controlled by manually operating the bypass valve of the make-up valve and the spill valves.

Good



Bad



(6) Lub. oil temperature control valve operation.
The temperature of the lub. oil for the bearings and the gear mesh is controlled automatically by the lub. oil temperature control valve.

(7) Astern spray water valve operation
This valve is automatically operated by opening the manoeuvring ast. valve.

(8) Dump spray water valve operation
This valve is automatically operated by opening dump valve.

(9) Setting of valve action (Recommendation)

VALVE NAME		SETTING	EMERGENCY CASE (AIR FAILURE)	REMARKS
BLEEDER VALVE	HP BLEEDER	OPEN AT 0.98 MPag CLOSE AT 0.88 MPag	CLOSE	WITH MANUAL OPERATING HANDLE
	IP BLEEDER LP BLEEDER	OPEN AT 0.304 MPag OF IP BLEED PRESS. CLOSE AT 0.255 MPag OF IP BLEED PRESS.		
GUARDIAN (T-3)		OPEN .. BELOW AHEAD abt. 72 rpm (MV lift) CLOSE.. ABOVE AHEAD abt. 75 rpm (MV lift)	OPEN	WITH MANUAL OPERATING HANDLE
DRAIN VALVE	MANEUV. VALVE DRAIN (T-51)		OPEN	WITH MANUAL OPERATING HANDLE
	HP STEAM CHEST DRAIN (T-52)			
	HP TURBINE 2ND STAGE DRAIN(T-53)			
	HP CASING DRAIN (T-54)			
	HP BLEEDER DRAIN (T-55)	OPEN AT HP BLEED VALVE CLOSE CLOSE AT HP BLEED VALVE OPEN		
MAIN CONDENSER LEVEL CONTROL (T-42)		NORMAL LEVEL AUTOMATICALLY CONTROL BY SIGNAL OF MAIN CONDENSER HOT WELL LEVEL TRANSMITTER	OPEN	
COND. WATER RECIRCULATION (T-43)			CLOSE	WITH MANUAL OPERATING HANDLE
PACKING STEAM	MAKE-UP (T-302)	19.6 kPag	OPEN	WITH MANUAL OPERATING HANDLE
	SPILL (T-303)		CLOSE	
LUB. OIL TEMP. CONTROL (T-145)		45°C	COOLER SIDE OPEN	WITH MANUAL OPERATING HANDLE
LUB. OIL PRESS. CONTROL		0.39 MPag	CLOSE	WITH MANUAL OPERATING HANDLE
SPRAY WATER FOR STEAM DUMP. (T-56)		OPEN .. NOT FULLY CLOSE OF STEAM DUMP VALVE CLOSE .. NOT FULLY CLOSE OF STEAM DUMP VALVE AND TIMER (ABOUT 5 MINUTES)	CLOSE	WITH MANUAL OPERATING HANDLE
SPRAY WATER FOR ASTERN OPERATION (T-57)		OPEN .. AST MV OPEN AND NOT AUTO SPINNING CONDITION CLOSE .. AST MV CLOSE AND TIMER (ABT. 5 MINUTES)	CLOSE	WITH MANUAL OPERATING HANDLE

(10) Main Turbine Auto Slow Down

Main turbine auto slow down circuit is operated in the following instances.

Main steam pressure low low

Main boiler steam drum level high high
Main boiler steam drum level low low
→ Automatic slow down (II)

Main condenser hotwell water level high high
Stern tube bearing temperature high high
One boiler trip
Main condenser vacuum low low
Main thrust pad temperature high high
→ Automatic slow down (III)

The function of the automatic slow down can be bypassed by AUTO SLOW DOWN BYPASS provided on the N/C(Navigation Console) and the ECC(Engine Control Console).

5.3 Functions of the Remote Control System

General

The main turbine remote control system is designed to control the propeller shaft revolution or simply the manoeuvring valve lift from the Wheel House (W/H), and the Engine Control Room (ECR) by operating the telegraph lever on console in each of these operating position and in the ECR and the machine side. In this manner, it is possible to operate the main turbine by using the switch to increase or decrease the valve lift.

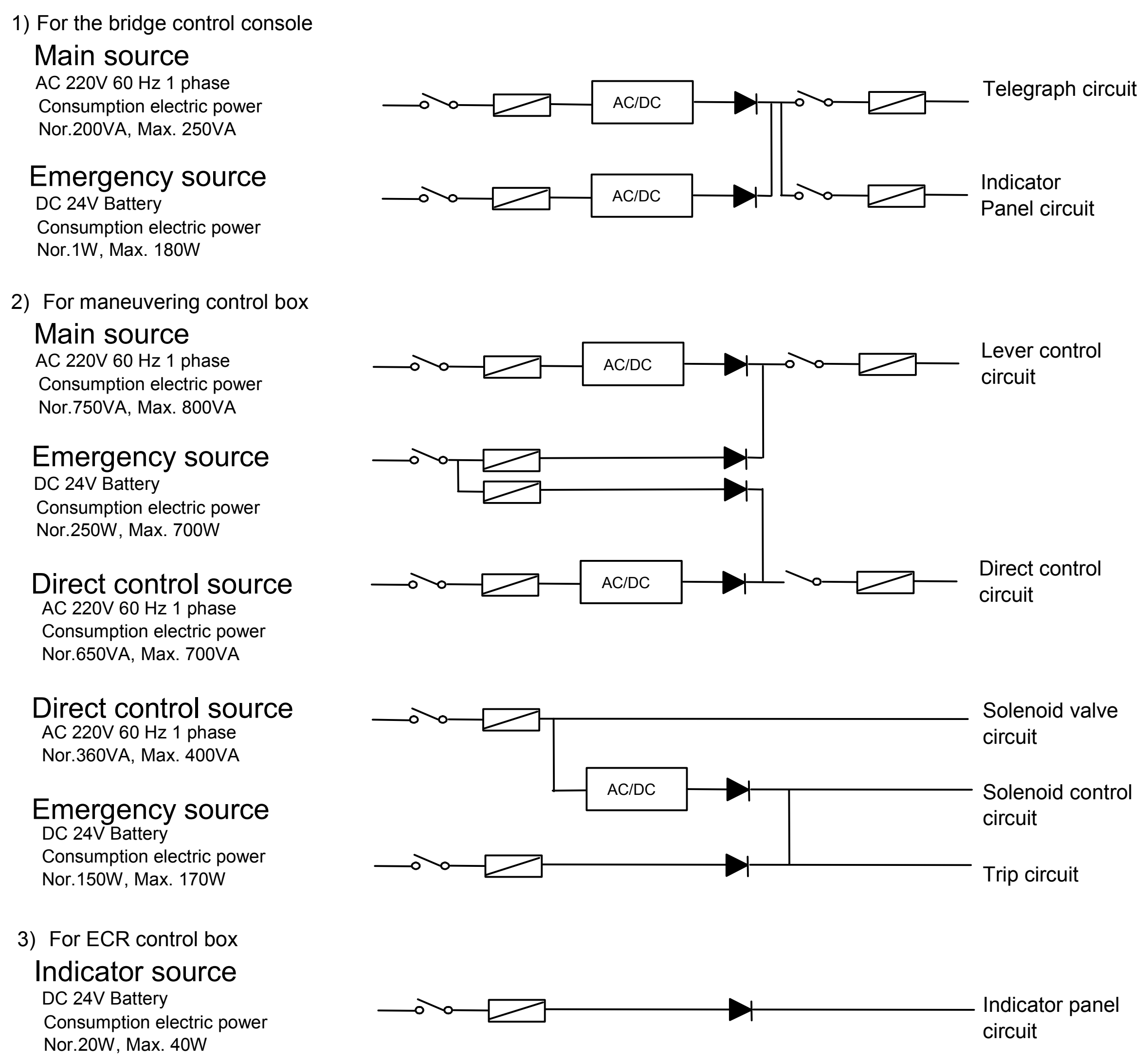
The control operation from each manoeuvring position and method are shown in Table 2-1.

Table 2-1 Manoeuvring Method at Manoeuvring Positions

MANOEUVRING POSITION	MANOEUVRING METHOD		SHAFT REVOLUTION / MANEUV. CONTROL VALVE LIFT	SAFETY SYSTEM / INTERLOCK
W/H	LEVER	AUTOMATIC CONTROL BY TELEGRAPH TRANSMITTER (MICRO COMPUTER-SERVO MOTOR)	CORRESPONDING TO THE ELECTRICAL SIGNAL OF TELEGRAPH TRANSMITTER, THE MICRO COMPUTER CALCULATES TO DRIVE THE SERVO MOTOR ACTUATING THE CONTROL VALVE.	- MANUAL TRIP - AUTO TRIP - AUTO SLOW DOWN - BOILER INTERLOCK - ROUGH SEA CONTROL (OVERSPEED PREVENTION)
ECR	LEVER	AUTOMATIC CONTROL BY TELEGRAPH TRANSMITTER (MICRO COMPUTER-SERVO MOTOR)	CORRESPONDING TO THE ELECTRICAL SIGNAL OF TELEGRAPH RECEIVER, THE MICRO COMPUTER CALCULATES TO DRIVE THE SERVO. MOTOR ACTUATING THE CONTROL VALVE.	- MANUAL TRIP - AUTO TRIP - AUTO SLOW DOWN - BOILER INTERLOCK - ROUGH SEA CONTROL (OVERSPEED PREVENTION)
	DIRECT CTRL	MANUAL CONTROL BY INC/DEC CONTROL SWITCH (ELECTRIC-SERVO MOTOR)	CONTACT SIGNAL OF INC/DEC CONTROL SWITCH IS AMPLIFIED TO DRIVE SERVO MOTOR ACTUATING THE CONTROL VALVE.	- MANUAL TRIP - AUTO TRIP
MACHINE SIDE	DIRECT CTRL	MANUAL CONTROL BY INC/DEC CONTROL SWITCH (ELECTRIC-SERVO MOTOR)	CONTACT SIGNAL OF INC/DEC CONTROL SWITCH IS AMPLIFIED TO DRIVE SERVO MOTOR ACTUATING THE CONTROL VALVE.	- MANUAL TRIP - AUTO TRIP
	MACHINANICAL HANDLE	MANOEUVRING VALVE IS OPERATED BY MECHANICAL HANDLE.	OPERATOR DIRECTLY CONTROLS MANOEUVRING VALVE BY OPERATING MECHANICAL HANDLE.	THE REMOTE CONTROL SYSTEM MAKES AUTO TRIP OF CONTROL OIL FOR SERVO MOTOR, WHILE THE HANDLE IS NOT IN NEUTRAL POSITION, SO THAT THE REMOTE CONTROL SYSTEM CANNOT AFFECT THE HANDLE OPERATION.

Electrical Power Source for the Remote Control System

The electric power supplied by ship builder is necessary to operate the remote control system as specified.



5.3.1 W/H Manoeuvring

Telegraph Lever Manoeuvring

When manoeuvring with the telegraph lever, the propeller revolution or the manoeuvring control valve lift is controlled corresponding to the lever position. The telegraph lever has eleven divisions (from EMERGENCY FULL to NAVIGATION FULL) and is normally positioned using the latch at the center of each divisions discretely to select the eleven points of revolution or the manoeuvring valve lift. It is also possible to change the lever position continuously to achieve fine control.
The relation between the lever position and the propeller revolution or the manoeuvring valve lift is preset as shown in Figure 1-2.
As for the control system diagram, please refer to Figure 1-3.

Block diagram of remote control system

The control system has two zones, as follows;
- In the case of the manoeuvring zone
  When the telegraph lever is being operated to a desired position, the propeller revolution is controlled corresponding to the telegraph lever position by RPM feedback control circuit.
- In the case of the normal sea going zone
  The manoeuvring valve lift is controlled to the corresponding to the telegraph lever position by manoeuvring valve lift feedback control.

: Manoeuvring zone (RPM feedback control)

: Normal Sea-going zone (Valve lift feedback control)

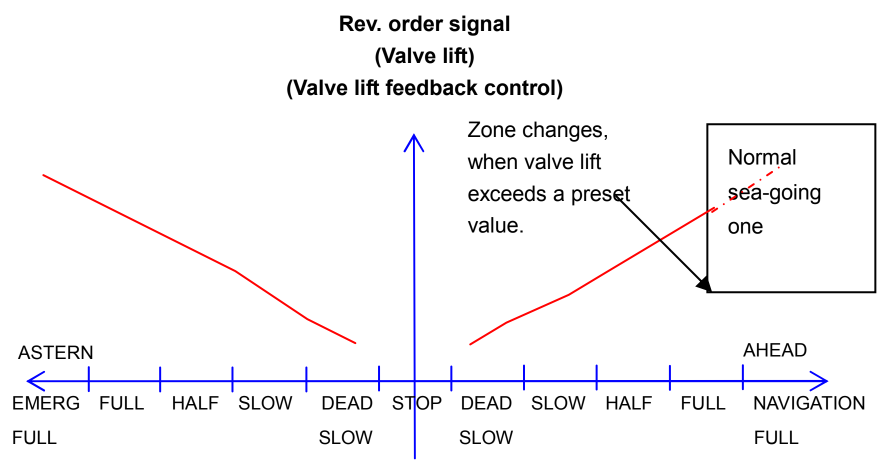


Figure 1-2 Telegraph Lever Position

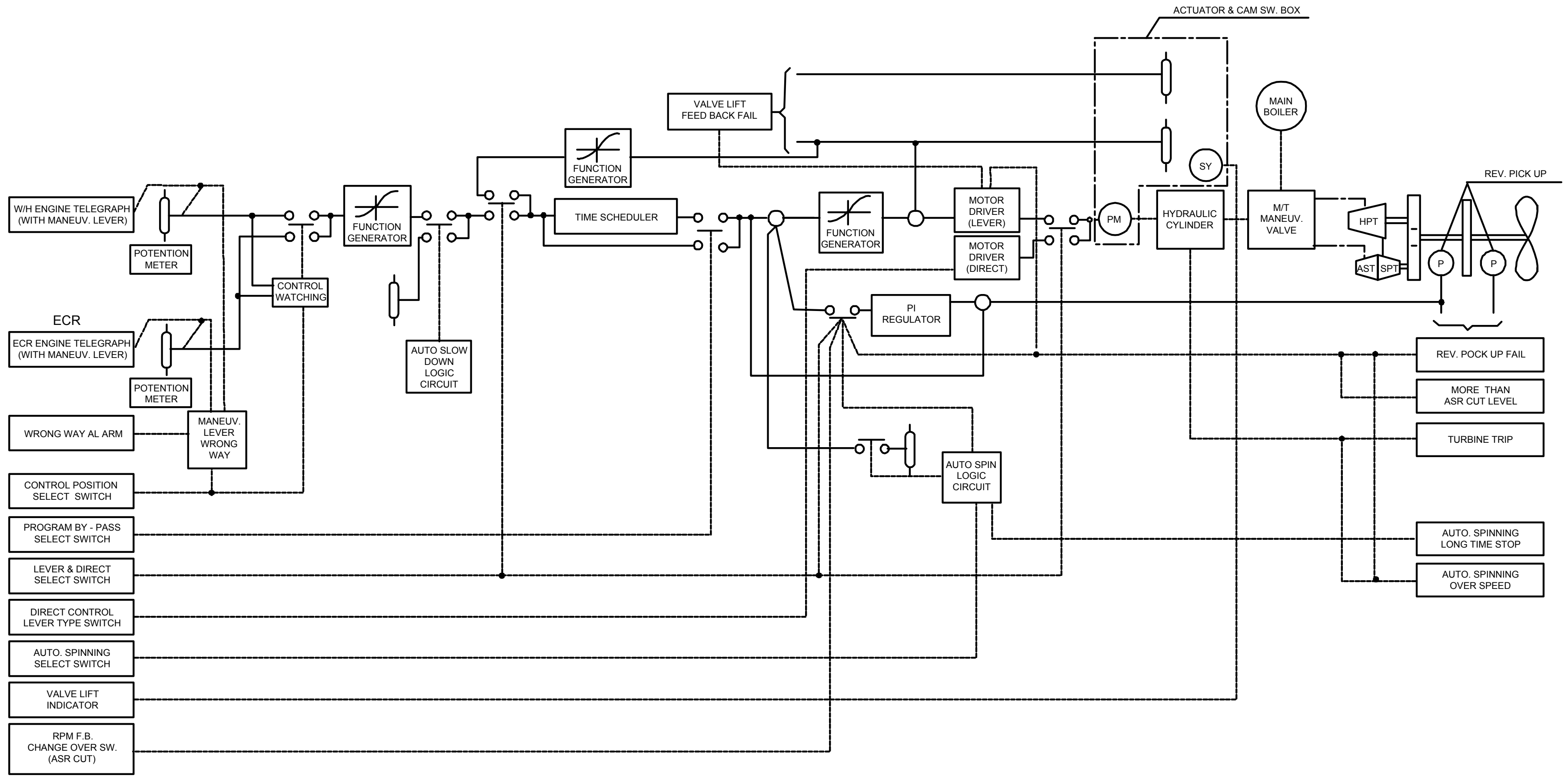


Figure 1-3 Block Diagram of the Remote Control System

(1) RPM Feedback Control

The remote control system has two speed detectors for control. For RPM feedback control one of these two detector outputs is used for feed back signal according to REV. SIGNAL selector switch on the manoeuvring control box, RPM feed back control is carried out in the range of the manoeuvring zone. When one of the following conditions takes places, the RPM feedback control is bypassed, and the manoeuvring valve lift control is performed;

a) The telegraph lever in the duty is in the normal sea going zone.
b) The manoeuvring valve position (cam angle) is in the normal sea-going zone.
c) The RPM FEEDBACK switch provided on the manoeuvring control box is set to the BYPASS position.
d) A REVOLUTION SIGNAL TROUBLE occurs, for which the remote control system detects an excessive difference in the signals of speed detectors provided on the propeller shaft.
(In this case, MAIN TURBINE REMOTE CONTROL SYSTEM FAIL. Alarm is annunciated on W/H and ECR, and the cause of the fault(REVOLUTION SIGNAL TROUBLE) is indicated on the manoeuvring control box. In this case, RPM feedback control becomes available, after the operator selects a normal detector by manually changing over the REV.SIGNAL selector switch.)

(2) Manoeuvring Valve Lift Feedback Control

During the manoeuvring valve lift feedback control, the manouvring valve lift corresponds to the telegraph lever position.
For feedback of the valve lift, two detectors are provided in the driving motor box. During operation, one of these two detector outputs is used for feedback signal according to the V. LIFT F.B. SIGNAL selector switch on the manouvring control box. The remote control system compares the signals from these detectors.

In case the difference of the two signals exceeds the preset value, MAIN TURBINE REMOTE CONTROL SYSTEM FAIL. Alarm is annunciated in W/H and ECR, and the cause of the fault(VALVE LIFT FEEDBACK TROUBLE) is indicated on the manoeuvring control box. In this case, the manoeuvring valve is kept at the current lift, and the manoeuvring valve will be uncontrollable using the telegraph lever. However, direct control is still available to operate the manoeuvring valve in the ECR or the machine side in this condition. In case that only one signal is abnormal at the signal selector switch position “No.1 working No.2 S/B” in the manoeuvring control box, the control signal for the valve lift changes to normal automatically. As such, the valve lift feedback control will still be available.

(3) Time Program

a) Acceleration / Deceleration Time Program

During operation with the telegraph lever, except for the STOP operation, the remote control system controls the manoeuvring valve in accordance with the time program, as shown in Figure 1-4, and while the program is being implemented, IN PROGRESS is indicated in the W/H and the ECR, and the signal is outputted for monitoring in the IAS.

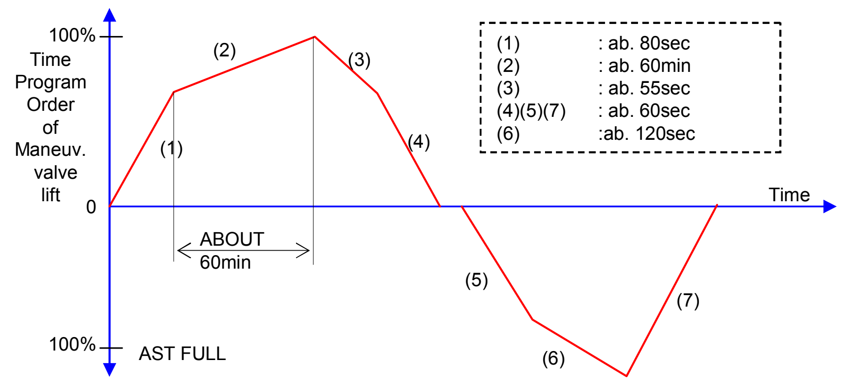


Figure 1-4 Time Program for Acceleration / Deceleration

b) Program Bypass

When the PROGRAM BYPASS switch on the W/H or the ECR console is being operated, the manoeuvring valve lift is not controlled to follow the time program, but the valve lift is controlled to immediately fit the telegraph lever position.
This program bypass is not effective, however, while the manoeuvring valve lift is about to change under the time program, whereby IN PROGRESS indication lamp is lighted.
To operate the program bypass,

i) First, force the time program to finish by operating the telegraph transmitter so that its desired valve lift moves to coincide with the actual lift.
Make sure IN PROGRESS is off.
ii) Secondly, operate the telegraph lever to the desired position after the PROGRAM BYPASS switch is operated to the BYPASS position

(4) Operation of the Telegraph Lever to the STOP Position

a) When the telegraph lever is operated to the STOP position, the manoeuvring valve closes in accordance with the profile [(3) and (4) in the ahead operation, (7) in the astern operation] in Figure 1-4, and the propeller revolution decreases gradually.
b) The astern (ahead) manoeuvring valve starts opening with the RPM feedback control circuit to decrease the revolution to zero, and break steam is supplied.
c) When the revolution is less than A RPM, the manoeuvring valve is closed upon the lapse of the preset time.
d) When the revolution exceeds B RPM ahead (astern) due to inertial rotation, the astern (ahead) manoeuvring valve is opened again by RPM feedback control circuit, and the break steam is supplied.
e) When the revolution is in the range of A to B RPM for more than the period of the preset time T2 after the manoeuvring valve closed as mentioned in c) above, the astern (ahead) manoeuvring valve starts opening. When the revolution comes down to less than A RPM ahead (astern), the astern (ahead) manoeuvring valve closes after the lapse of the preset time T3.
f) Procedures c) ~ e) above are repeated until the revolution decreases to zero.

g) When the revolution is within zero ± G RPM and the auto-spinning switch provided on the ECR console is at the ON position, auto-spinning automatically starts.

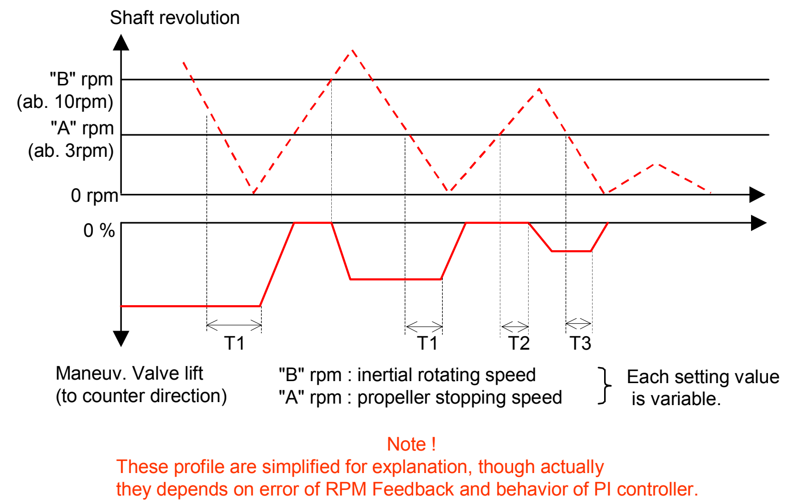


Figure 1-5 Brake Steam Supplied Sequence

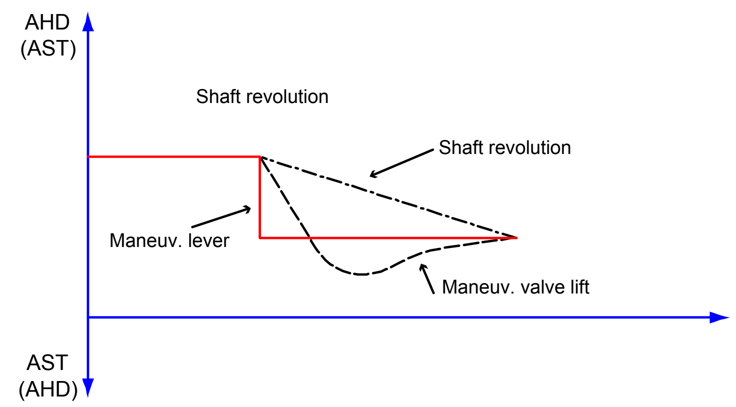


Figure 1-6 Example of Typical Control In Deceleration

(5) Reversing Operation

a) Ahead to Astern

When the telegraph lever is operated from Ahead to Astern, reversing of the rotating direction is performed in accordance with the following procedure.

i) The ahead manoeuvring valve is closed in accordance with the deceleration profile (3) and (4) of Figure 1-7.

ii) The astern manoeuvring valve is opened to the position equivalent to AST. E RPM in accordance with the acceleration profile (5) of Figure 1-7, and break steam is supplied. When the propeller revolution reaches D RPM, further acceleration is performed again to the astern side.

iii) The manoeuvring valve lift is controlled by RPM feedback control so that the revolution fits the telegraph transmitter position.

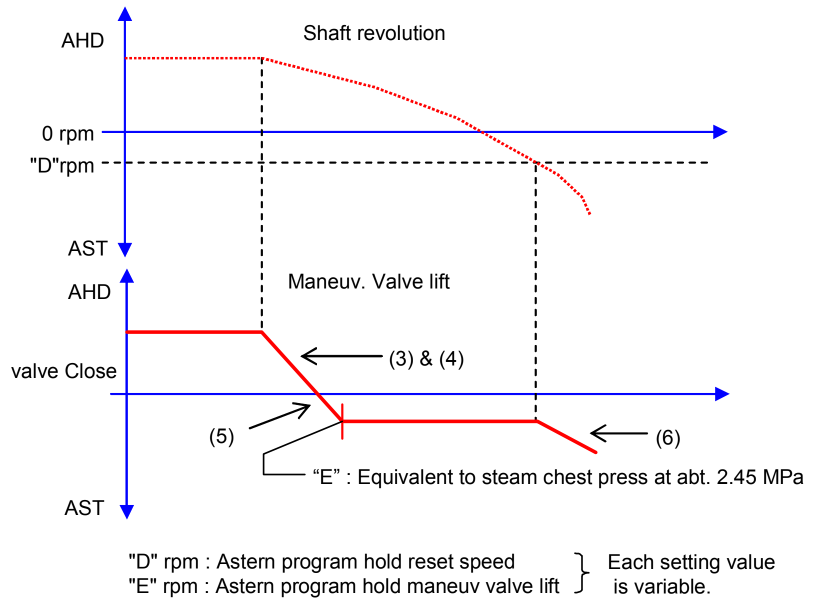


Figure 1-7 Manoeuvring Valve Lift In Reversing Operation (Ahead to Astern)

b) Astern to Ahead

When the telegraph lever is operated from Astern to Ahead, reversing of the rotating direction is performed in accordance with the following procedure.

i) The astern manoeuvring valve is closed in accordance with the deceleration (7) in Figure 1-8.

ii) The ahead manoeuvring valve is opened to the lever position in accordance with the time program.

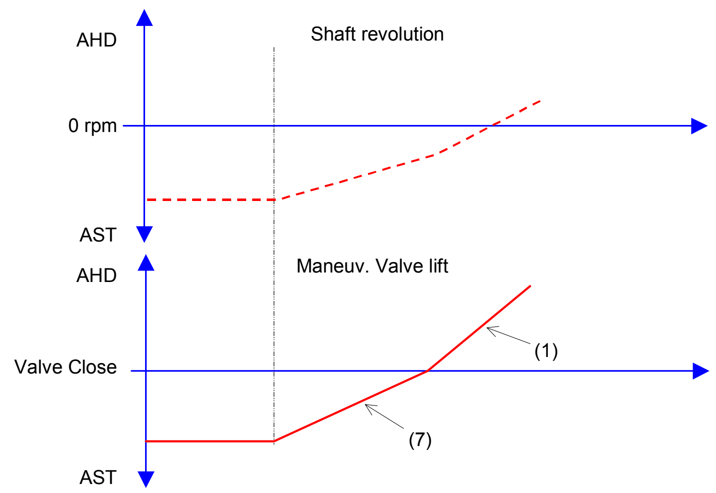


Figure 1-8 Manoeuvring Valve Lift In Reversing Operation (Astern to Ahead)

(6) Auto Spinning

When the following conditions are satisfied;

a) The CONTROL MODE switch on the ECR console is set to the LEVER position.

b) The telegraph lever in the duty position is set at the STOP position.

c) The AUTO SPINNING switch on ECR console is set at the ON position.

d) The propeller revolution is within zero ± G rpm.

e) The auto spinning mode is activated automatically, and the SPIN ZONE lamp on the W/H and the ECR is on.

After approx. 2.5 minutes passes without the revolution exceeding zero ± G rpm, the astern manoeuvring valve is opened to a preset lift and the AUTO SPINNING ON lamp on the W/H and the ECR turns on. When the revolution exceeds AST. F rpm, the astern manoeuvring valve is closed. Normally, the ahead manoeuvring valve is opened in 3 minutes, after the astern manoeuvring valve is opened. When the revolution is increased to AH F rpm or more, after the direction of spinning changes from astern to ahead, auto spinning is again performed to the astern side. Thus, the auto spinning operation keeps on changing its direction approx. every 3 minutes. (See Figure 1-9)

When the telegraph lever is operated to a particular position during the auto spinning operation, the auto spinning circuit is bypassed immediately, and the manoeuvring valve is controlled in accordance with the lever position. If the AUTO SPINNING change over switch is set to OFF, the auto spinning control is stopped immediately, and the AUTO SPINNING OFF lamp on the W/H and the ECR turns on.

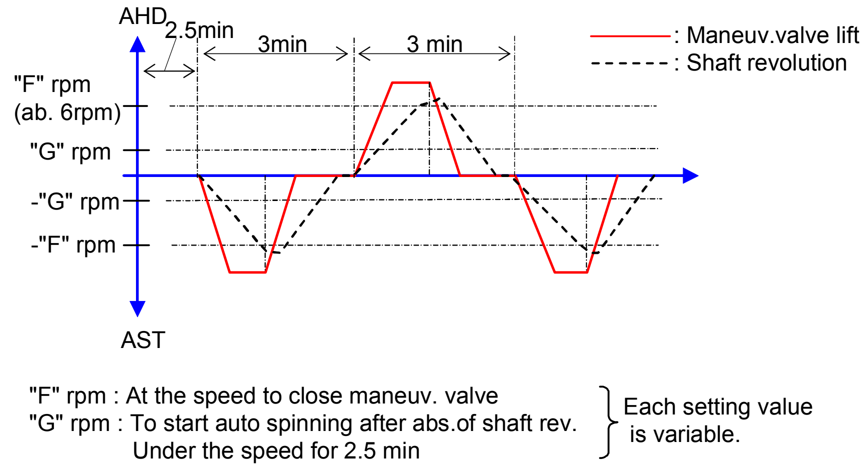


Figure 1-9 Auto Spinning Sequence

(7) Monitoring Function during Auto. Spinning Control

a) SHAFT STOP

When the propeller revolution is less than zero ± G rpm (about 1 rpm) for longer than 3 minutes, the SHAFT STOP indication lamp on the manoeuvring control box turns on.

In case of the turning gear engage condition, when the propeller revolution is less than ± 0.1 rpm for longer than 3 minutes, the SHAFT STOP indication lamp on the manoeuvring control box turns on.

b) AUTO SPINNING FAILURE

When the propeller revolution does not reach AH/AST F rpm (about 6 rpm) to either direction within 3 minutes after the auto spinning started, the AUTO SPINNING FAILURE indication lamp on the manoeuvring control box turns on.

c) AUTO SPINNING OVER SPEED

When the propeller revolution becomes more than AH/AST H rpm (about 12 rpm), the AUTO SPINNING OVER SPEED indication lamp on the manoeuvring control box turns on. Then the main turbine comes to tripped condition.

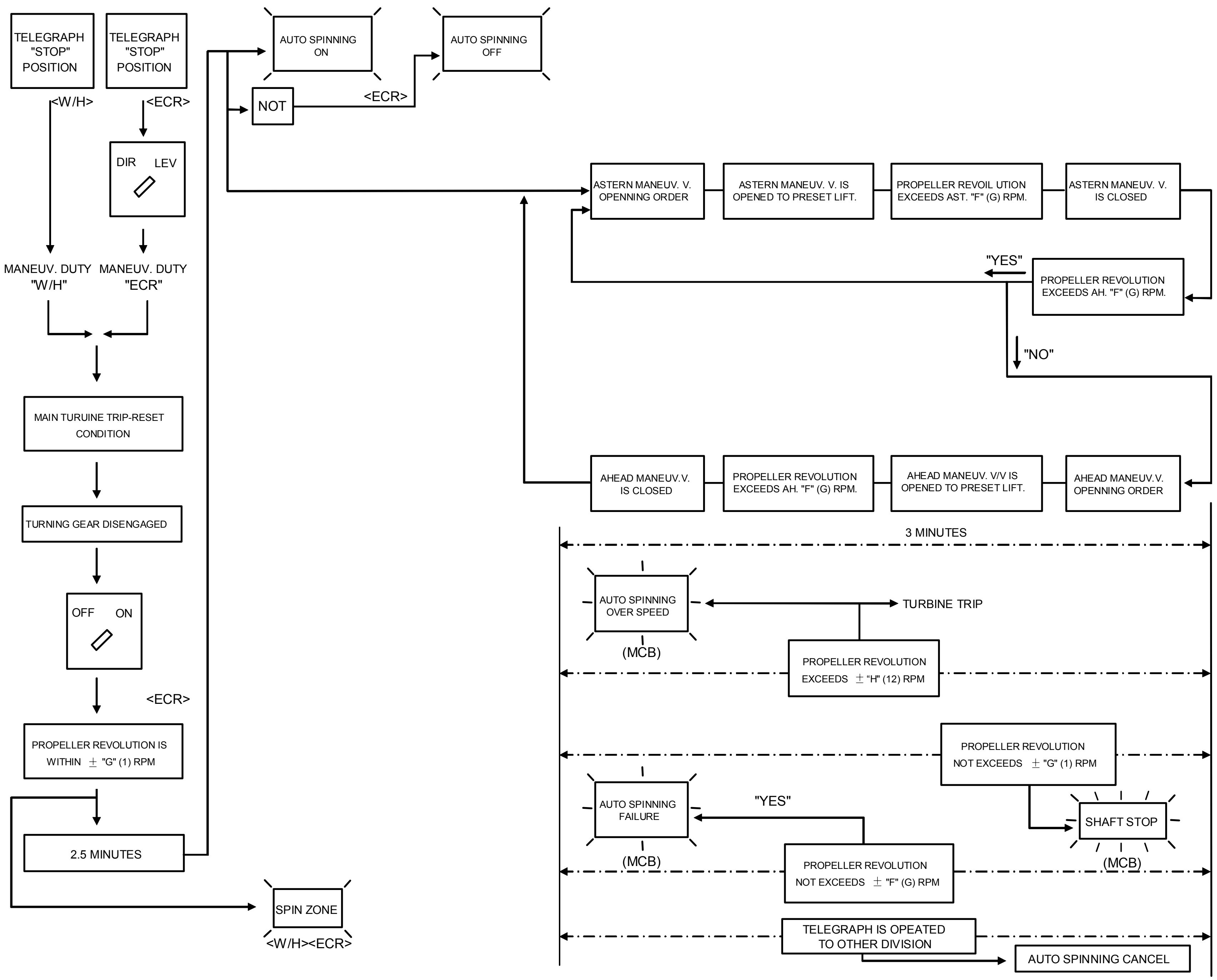


Figure 1-10 Block Diagram for Auto Spinning

(8) Rough Sea Control

When the selector switch of ROUGH SEA (ROUGH/CALM) is set at the ROUGH position, rough sea control to prevent overspeed is effected as described below;

- Once the propeller revolution exceeds the racing trip level (105% of MCR) due to some cause, the RPM feedback controller starts for its set point at a racing trip reset level.
- The shaft revolution is reduced to the racing trip reset level.
- When the revolution reaches at the reset level, rough sea control is canceled, and the shaft revolution returns to the lever position according to the time program.

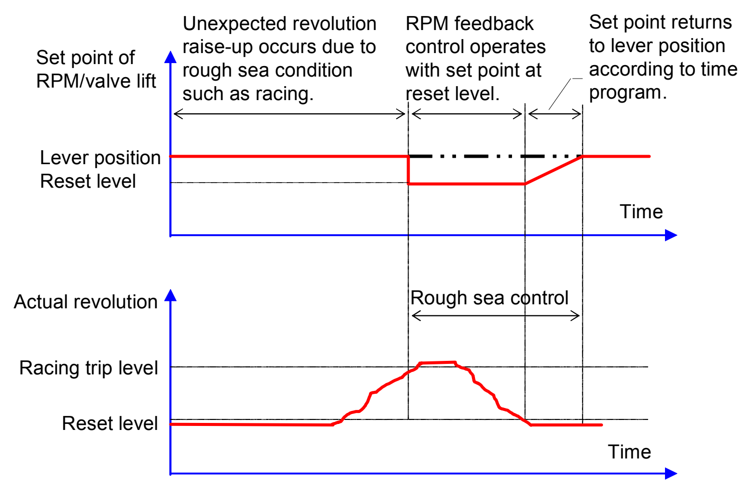


Figure 1-11 Control Pattern of Rough Sea Control

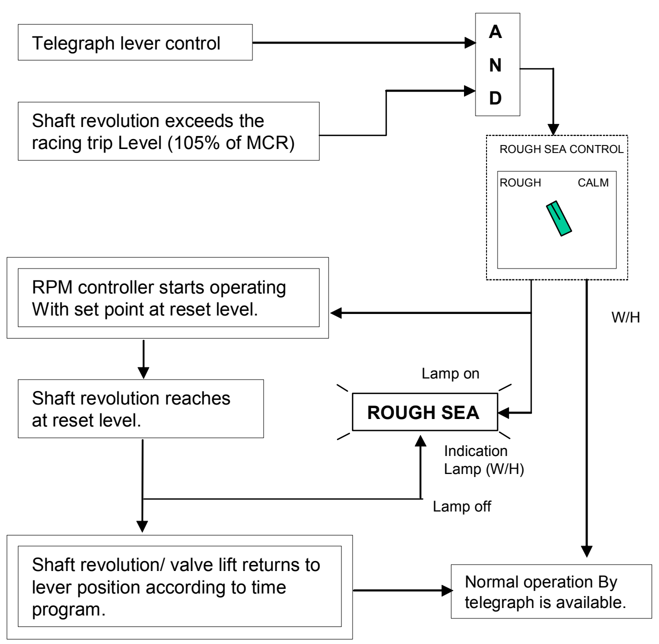


Figure 1-12 Control Pattern of Rough Sea Control

5.3.2 ECR Manoeuvring

Lever Manoeuvring

The same automatic control as the W/H control can be performed by operating the lever of the telegraph receiver. The time program control, the RPM feedback control, the manoeuvring valve lift feedback control, and auto spinning are available in the same manner as the W/H control, and the program bypass can be performed, as well.
Rough sea control is also available during lever manoeuvring in the ECR, but selection of rough sea control is limited only in the W/H.

Direction Control Manoeuvring

The manoeuvring valve lift can be controlled by operating the direct control switch (INC, DEC), referring to revolution indicator on the ECR. The time program control, the RPM feedback control, and the manoeuvring valve lift feedback control are not available in this direct control.

Control Method Change-over

Change over of the control method between the lever control and the direct control is performed as described in the following paragraphs.
Change over is not effective when the manoeuvring duty is not in the ECR, or is about to be transferred.
When the manoeuvring duty is transferred to another position, the control method is automatically changed to the permitted method for each position as shown in Table 2-1.
The effective method is indicated by lamps on the ECR console.

(1) Lever Control to Direct Control
When the control method selector switch on the ECR console is turned from LEVER to DIRECT, the servo motor can actuate the manoeuvring valve lift to increase/decrease according to the direct control switch.
During direct control, the lever control circuit is not effective, but keeps following the valve lift feedback preparing for return of the control method to the lever control.

(2) Direct Control to Lever Control
When the control method selector switch on the ECR console is turned from DIRECT to LEVER, the lever control becomes effective.
Because the lever control circuit keeps following the valve lift feedback during direct control, the change over can be done without bumping.
If the lever position is not coincident with the propeller revolution at the time of this change over, the revolution is controlled according to the time program, as described in the paragraph on the Time Program in this paper, whether or not the time program is bypassed.
If the program bypass operation is desired in this case, it can be effected by operating the lever as described in the paragraph on the program bypass in this paper.

5.3.3 Machine Side Manoeuvring

For machine side operation, the emergency control panel is provided, and the direct control switch (INC, DEC) for direct control manoeuvring and the instruments are provided on the panel for reference during direct control or mechanical handle control.

Direct Control Manoeuvring

Operation of the direct control with the direct control switch (INC, DEC) referring to the revolution indicator, is done in the same manner as that describrd in the paragraph on Direct Control Manoeuvring in this paper.

Mechanical Handle Manoeuvring

Pressure gauges, vacuum gauge, and a revolution indicator are provided for reference during operation with the mechanical handle.
When the mechanical handle is operated to other than the neutral position, the remote control system shuts down the control oil to the servo motor for the manoeuvring valve as described in the paragraph on Automatic Trip in this paper. It cannot be reset until the handle returns to the neutral position.

5.3.4 Automatic Slow Down

When one of the following conditions occurs during the lever control, the propeller revolution is automatically reduced according to the following paragraphs and the AUTO SLOW DOWN alarm is annunciated in the W/H and the ECR. Individual causes are to be indicated on manoeuvring control box in the ECR.

Main steam pressure low low	Automatic slow down (I)
Main boiler steam drum level high high Main boiler steam drum level low low	Automatic slow down (II)
Main condenser hotwell water level high high Stern tube bearing temperature high high One boiler trip Main condenser vacuum low low Main thrust pad temperature high high	Automatic slow down (III)

In case of Condition – Automatic Slow Down (I)

(1) The manoeuvring valve lift is limited to keep the operative range, as shown in Figure 1-13. When the main steam pressure becomes low low(5.2 MPag), if the valve lift is going out of range, the manoeuvring valve will close to a point where the actual pressure balances to valve lift along the border of the range with the propeller revolution slowing down.

(2) When the low pressure condition becomes normal, the valve lift is automatically increased to the lever position according to the time program described in the paragraph on the Time Program in this paper.

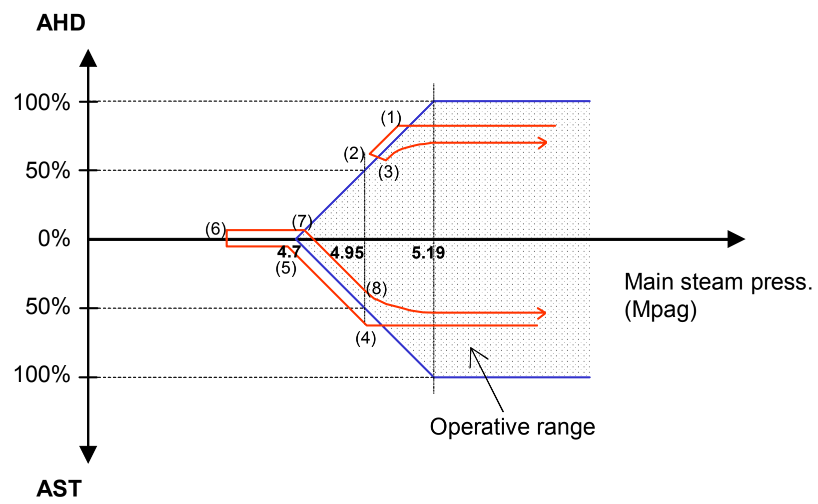


Figure 1-13 Operative Range of Maneuv. Valve

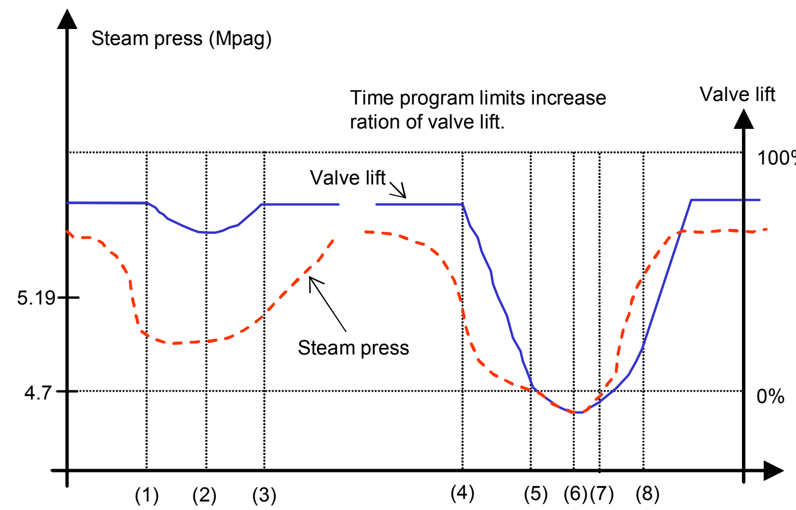
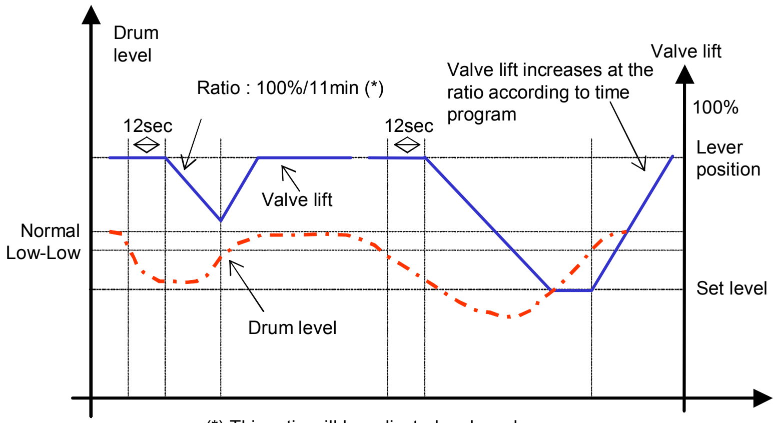


Figure 1-14 Control Pattern In Condition of Main Steam Pressure Low-Low

In case of Condition – Automatic Slow Down (II)

(1) 12 sec after the condition occurs, the manoeuvring valve lift is controlled to decrease at the ratio of 100% per 40 sec until it reaches at a set value of the valve lift. This ratio will be adjusted onboard.

(2) When the condition is recovered to normal, the decreasing of the valve lift stops. The valve lift is controlled by the lever position according to the time program after the reset action, when the lever is operated to a lower position.



(*) This ratio will be adjusted on board

The same operation is performed in condition of drum level high high

Figure 1-15 Control Pattern In Condition of Main Steam Drum Level High-High or Low-Low

In case of Condition – Automatic Slow Down (III)

(1) If the lever position is higher than AH. DEAD SLOW, and one of the conditions continues for longer than the time set for each condition, then the revolution is reduced to AH. DEAD SLOW.

(2) When the lever is operated to AH. DEAD SLOW or lower, this slow down can be reset.
(Even if the condition recovers to normal, unless the above reset action is performed, the control system remains at AH. DEAD SLOW.)

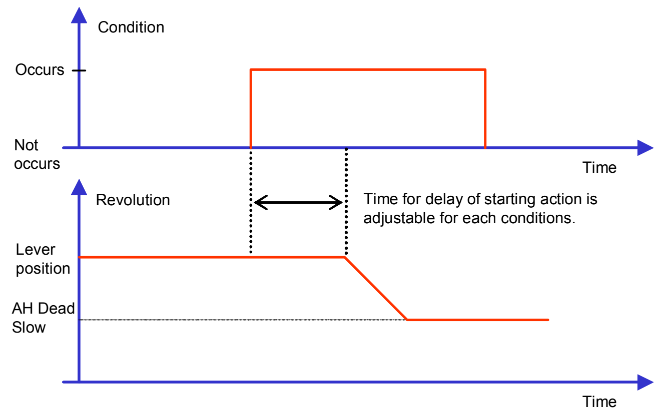


Figure 1-16 Control Pattern In Condition

When M/T operated in astern condition, auto slow down occur with the exception of following condition.

- Main condenser hotwell water level high
- Stern tube bearing temp. high high
- One boiler trip
- Main condenser vacuum low
- Main thrust pad temp. high high

Cancellation of Automatic Slow Down

The automatic slow down function can be canceled by setting the AUTO SLOW DOWN switch at the OVERRIDE position on the W/H and the ECR console.
During automatic slow down, if CANCEL is selected, SLOW DOWN OVERRIDE indication lamp on the W/H and the ECR console turns on and normal telegraph operation can be continued.

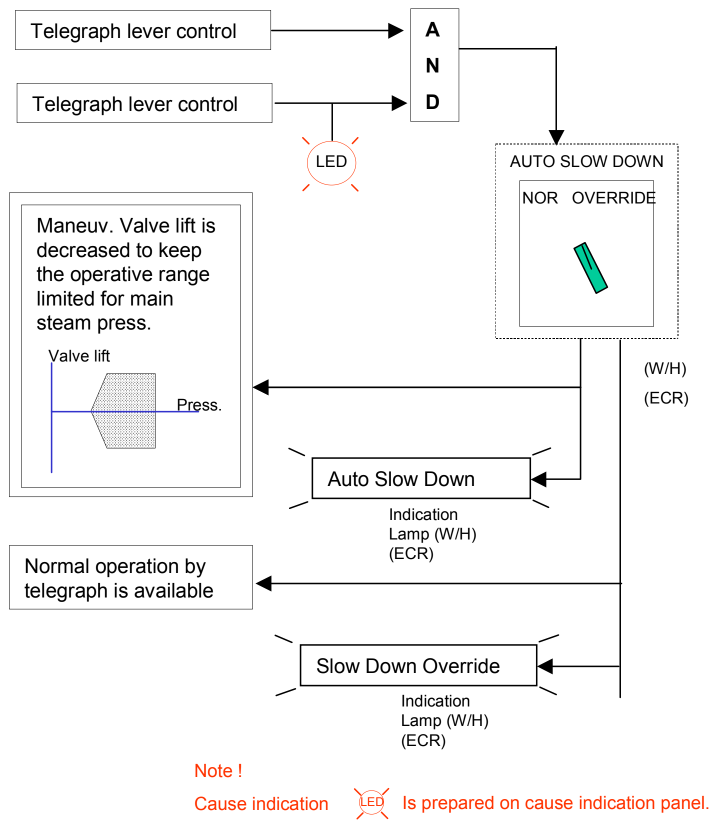


Figure 1-17(1) Block Diagram for Automatic Slow Down

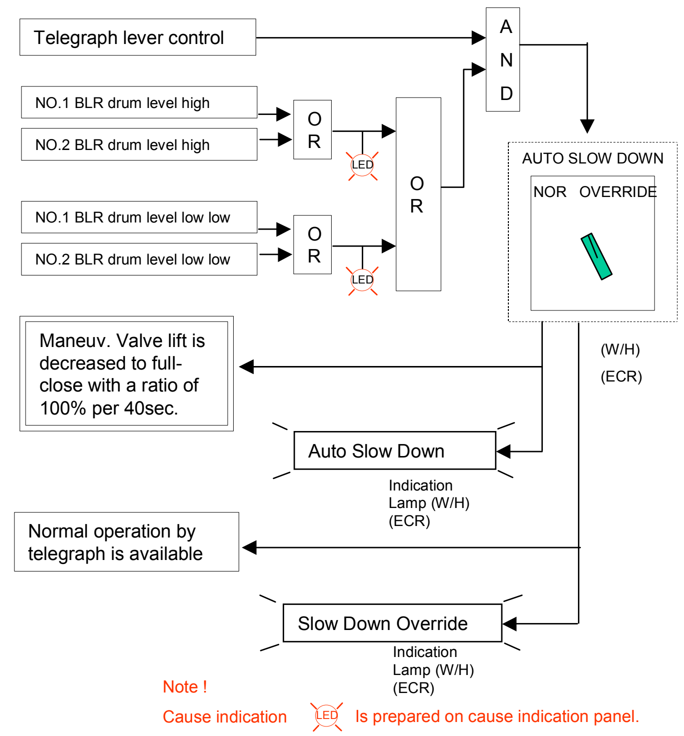


Figure 1-17(2) Block Diagram for Automatic Slow Down

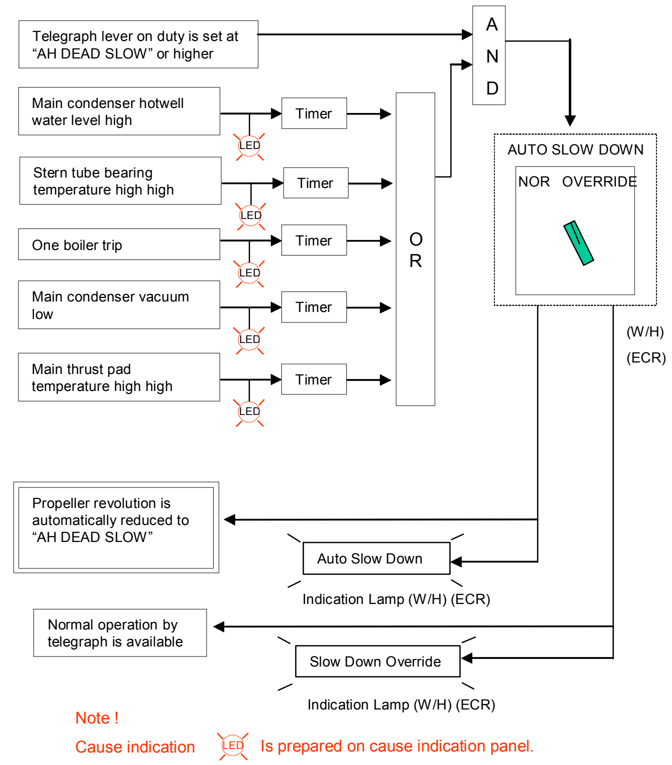


Figure 1-17(3) Block Diagram for Automatic Slow Down

5.3.5 Program Interlock

Acceleration of the main turbine is stopped and the PROGRAM INTERLOCK alarm is annunciated in the W/H and the ECR, when either of the following conditions occurs. Individual causes are indicated on the cause indication panel provided by shipbuilder and on manoeuvring control box in the ECR.

The function of the program interlock can be canceled by PROGRAM INTERLOCK BYPASS switch on the ECR console. During CANCEL operation, the PROGRAM INTERLOCK BYPASS indication lamp on the W/H and the ECR console turns on.

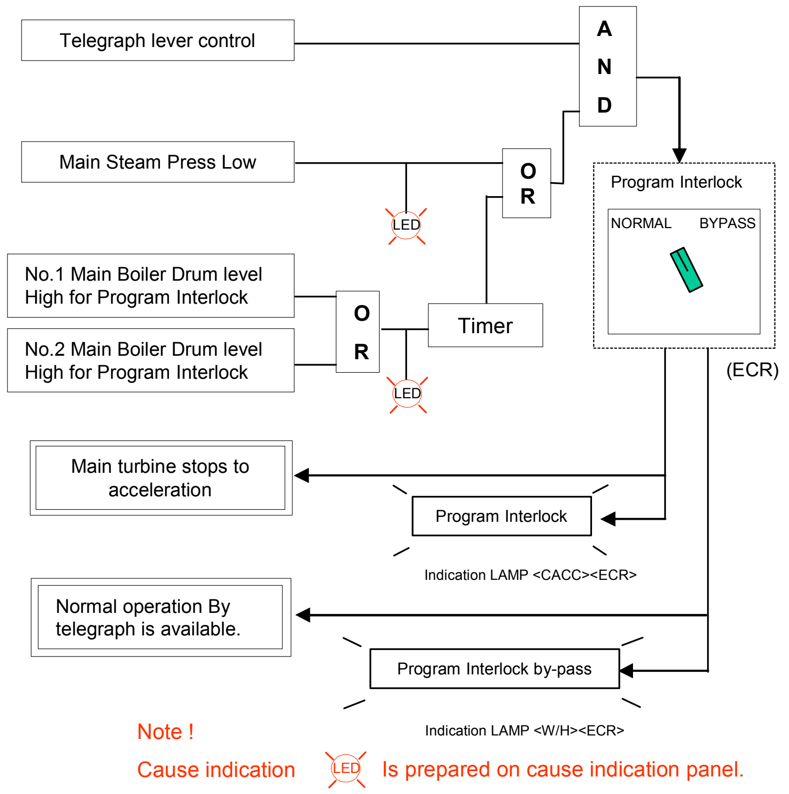


Figure 1-18 Control Pattern of Rough Sea Control

Turning Gear Interlock

When the turning gear is engaged, both the mechanical interlock and the emergency trip circuit shut off the control oil to servo motor of the manoeuvring valve and the valve closes to trip. After that, when the gear is disengaged, reset can be accepted in accordance with the procedure described in the paragraph on Reset of Emergency Trip in this paper.

5.3.6 Control System Monitoring Function

M/T Remote Control System Failure

When one of the following conditions occurs, the M/T REMOTE CONTROL SYSTEM FAIL alarm is annunciated in the W/H and the ECR, and the individual status is indicated on the mimic panel of the manoeuvring control box. In these cause, the following action is carried out automatically or has to be carried out by manual operation.

ITEM OF FAILURE	ACTION
(A) MICRO-COMPUTER ABNORMAL	1) WHEN ONLY ONE OUT OF TWO CPU/MEMORY SYSTEMS FAILS, CONTROL IS AUTOMATICALLY SWITCHED TO THE OTHER SYSTEM 2) IN CASE BOTH CPU/MEMORY SYSTEMS FAIL, THE VALVE LIFT IS KEPT AT THE CURRENT POSITION, UNLESS OPERATOR MANOEUVRES BY DIRECT CONTROL OR MECHANICAL HANDLE.
(B) W/H TELEGRAPH TRANSMITTER POTENTIOMETER DISCONNECTION (C) ECR TELEGRAPH RECEIVER POTENTIOMETER DISCONNECTION	1) IN CASE OF CIRCUIT DISCONNECTION IN MANOEUVRING THE DUTY POSITION, THE VALVE LIFT IS KEPT AT THE CURRENT POSITION, UNLESS THE DUTY POSITION IS CHANGED OVER TO THE OTHER POSITION OR CONTROL IS CHANGED TO DIRECT CONTROL / MECHANICAL HANDLE CONTROL. 2) IN CASE OF CIRCUIT DISCONNECTION IN OTHER THAN THE MANOEUVRING DUTY POSITION, THE ALARM JUST SOUNDS.
(D) NO.1 REVOLUTION SIGNAL ABNORMAL (E) NO.2 REVOLUTION SIGNAL ABNORMAL	1) IN CASE THE ONLY THE NO. 1 SIGNAL IS ABNORMAL AT THE SIGNAL SELECTOR SWITCH POSITION "NO. 1 WORKING NO. 2 S/B "IN THE MANOEUVRING CONTROL BOX, THE CONTROL SIGNAL FOR REVOLUTION AUTOMATICALLY CHANGES TO NO. 2 SIGNAL RPM FEEDBACK CONTROL THUS CONTINUES. 2) IN CASE THE ONLY ONE SIGNAL SELECTED AS RPM FEEDBACK SIGNAL IS ABNORMAL, CONTROL IS AUTOMATICALLY CHANGED TO VALVE LIFT CONTROL MANUAL CHANGE TO THE REMAINING NORMAL SIGNAL AS THE FEEDBACK SIGNAL BY SELECTOR SWITCH IS NECESSARY TO CONTINUE RPM FEEDBACK CONTROL. 3) IN CASE THE ONLY ONE SIGNAL NOT SELECTED AS RPM FEED BACK SIGNAL IS ABNORMAL, RPM FEEDBACK CONTROL IS STILL AVAILABLE. 4) IN CASE BOTH SIGNALS ABNORMAL OF RPM FEEDBACK CONTROL IS NOT AVAILABLE, THE VALVE LIFT FEEDBACK CONTROL IN THE LEVER CONTROL IS STILL AVAILABLE.
(G) NO.1 MANOEUVRING VALVE LIFT FEEDBACK SIGNAL ABNORMAL (H) NO.2 MANOEUVRING VALVE LIFT FEEDBACK SIGNAL ABNORMAL	1) IN CASE ONLY ONE SIGNAL IS ABNORMAL AT THE SIGNAL SELECTOR SWITCH POSITION "NOR" IN THE MANOEUVRING CONTROL BOX, THE CONTROL SIGNAL FOR THE VALVE LIFT AUTOMATICALLY CHANGES TO NORMAL. SO THAT THE VALVE LIFT FEEDBACK CONTROL IS STILL AVAILABLE. 2) WHEN THE ONLY SIGNAL SELECTED AS THE VALVE LIFT FEEDBACK SIGNAL IS ABNORMAL, THE VALVE LIFT IS KEPT AT THE CURRENT POSITION UNTIL DIRECT CONTROL OR MECHANICAL HANDLE CONTROL IS CARRIED OUT, OR THE VALVE LIFT FEEDBACK SIGNAL IS MANUALLY CHANGED TO REMAINING NORMAL SIGNAL BY SELECTOR SWITCH ON THE MANOEUVRING CONTROL BOX. 3) IN CASE THE ONLY SIGNAL NOT SELECTED AS THE VALVE LIFT FEEDBACK SIGNAL IS ABNORMAL, VALVE LIFT FEEDBACK CONTROL IS STILL AVAILABLE. 4) IN CASE BOTH SIGNALS ARE ABNORMAL, VALVE LIFT FEEDBACK CONTROL IS NOT AVAILABLE AND THE VALVE LIFT IS KEPT AT THE CURRENT POSITION. THUS, NO CONTROL FUNCTION IN THE LEVER CONTROL IS AVAILABLE, WHILE DIRECT CONTROL OR MECHANICAL HANDLE CONTROL IS STILL AVAILABLE.
(I) AUTO SLOW DOWN SIGNAL DISCONNECTION / ABNORMAL RANGE	THE REMOTE CONTROL SYSTEM CANNOT CARRY OUT AUTO SLOW DOWN IN CASE OF DISCONNECTED SIGNAL, IT IS NECESSARY TO CARRY OUT MANUAL SLOW DOWN CONTROL USING CONCERNING INSTRUMENTS BY OPERATOR.
(J) AUTO SLOW DOWN OVERRIDE SWITCH CIRCUIT DISCONNECTION	1) AUTO SLOW DOWN CANNOT BE BYPASSED DURING LEVER CONTROL, WHEN IT OCCURS WHILE THE DUTY POSITION IS BEING MANOEUVRED. 2) AUTO SLOW DOWN OVERRIDE IS EFFECTIVE DURING LEVER CONTROL, WHEN IT OCCURS IN CONDITION OTHER THAN WHEN THE DUTY POSITION IS BEING MANOEUVRED.

M/T Control System Power Failure

When one of the following conditions takes place, the M/T CONTROL SYSTEM POWER FAIL alarm is annunciated in the W/H and the ECR, and individual status is indicated on the mimic panel of the manoeuvring control box;

(1) Main electric source failure (AC)

(2) Emergency electric source failure (DC)

(3) Direct control electric power source failure

In the case of (1) and (2) during lever control, or in the case of (2) and (3) during direct control, the valve lift is kept at the current position and cannot be controlled unless the control method (lever/direct) is changed to another. (Change over of control method and transfer of duty position are still available under these condition.)

Engine Telegraph Power Failure

In case of telegraph source failure, the M/T CONTROL SYSTEM POWER FAIL alarm is annunciated in the W/H and the ECR. ENGINE TELEGRAPH POWER FAIL is indicated on the mimic panel of the manoeuvring control box. In this case, main and sub telegraph function and telegraph logger described in paragraph Engine Telegraph are not available, but the lever control is still available.

Wrong Way

In the case of the following condition, the WRONG WAY alarm is annunciated in the W/H and the ECR.

(1) If there is a difference in the direction (Ahead/Astern) between the W/H telegraph transmitter and opening of manoeuvring valve during the direct mode control, this condition is kept for longer than the preset time.

Mimic Board for ECR

The mimic board is provided on the manoeuvring control box in the ECR to indicate the manoeuvring system by means of LED indicators.

5.3.7 Safety System

Manual Trip

Manual trip switches are provided at the following places;

(1) W/H console : Selector switch

(2) ECR console : Selector switch

(3) Local : Selector switch

When the manual trip switch is being operated, the main turbine is tripped by closing the manoeuvring valve. At the same time, the EMERG. TRIP alarm is annunciated in the W/H, the ECR and the M/S, and the switch operated position is indicated on cause indication panel in the ECR.

Automatic Trip

The main turbine is automatically tripped by closing the manoeuvring valve, when one of the following conditions occurs;

(1) Over speed

(2) LO pressure (L-L)

* (3) HP turbine rotor excessive vibration (H-H)

* (4) LP turbine rotor excessive vibration (H-H)

* (5) HP turbine rotor excessive axial displacement (H-H)

* (6) LP turbine rotor excessive axial displacement (H-H)

* (7) Main condenser vacuum low-low (V-L)

* (8) Steam drum level very high

* (9) Control oil pressure low-low

* (10) Two boilers trip

* (11) Manual trip

* (12) Main reduction bearing excessive vibration (H-H)

(13) Main condenser hotwell level (H-H)

(14) Emergency manoeuvring handle not in neutral position

(15) Auto spinning over speed

(16) Turning gear engaged

In the event of a trip, the EMERG. TRIP is annunciated in the W/H, the ECR and the M/S and the above individual causes are indicated on the manoeuvring control box in the ECR.

Cancellation of Automatic Trip

In the case of the conditions marked with "*" above, the automatic trip is canceled, when the EMERG. TRIP OVERRIDE selector switch is set at the OVERRIDE position on the W/H, bridge wings and the ECR console and on the emergency control panel in the machine side.
With this override operation, the main turbine can be started even in these abnormal condition. Even in this case, the TRIP OVERRIDE indication lamp on the W/H, the bridge wings and the ECR console and on the emergency control panel in the machine side are turns on, and individual abnormal causes are indicated on the cause indication panel in the ECR.

Exception of Trip in Astern Operation

During W/H telegraph transmitter orders astern operation, the main turbine is not tripped automatically in the event of conditions (3), (4), (5), (6), (7), (8), (10),(12) and (13) above.

Resetting of Emergency Trip

After all of the following conditions are satisfied, the TURBINE RESET indication lamp in the W/H, the ECR and the M/S starts flickering;

(1) The above trip conditions except (9) are eliminated.

(2) The telegraph transmitter/receiver lever in the manoeuvring duty position is placed at the STOP position.

(3) The actuator for the servo motor of the manoeuvring valve is at the STOP position.
(Manoeuvring valves for both ahead and astern are closed.)
The reset can be done after RESET PB in the W/H, the ECR and the M/S is pushed for confirmation and the TURBINE RESET lamp continuously lights.

5.3.8 Safety System Monitoring Function

Main Turbine Safety System Failure

The M/T SAFETY SYSTEM FAIL alarm is annunciated in the W/H and the ECR, and individual cause is indicated on the cause indicator panel, in case of the following conditions;

(1) Trip solenoid valve circuit disconnection

(2) Trip sensor circuit disconnection

(3) Manual trip switch circuit disconnection

(4) M/T trip override switch circuit disconnection

Main Turbine Safety System Power Failure

In case of trip electric source failures, the SAFETY SYSTEM FAIL alarm is annunciated in the W/H and the ECR.

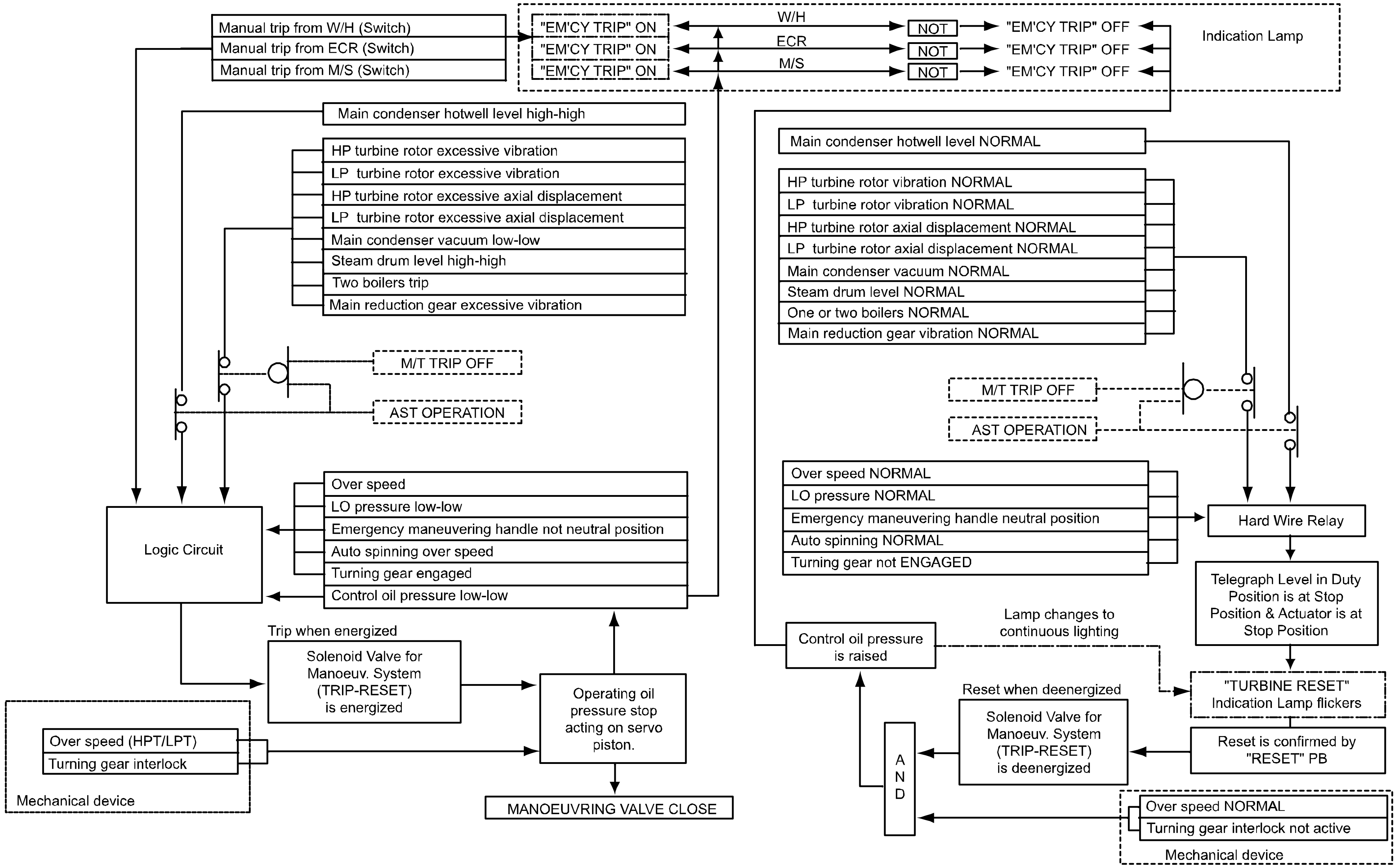


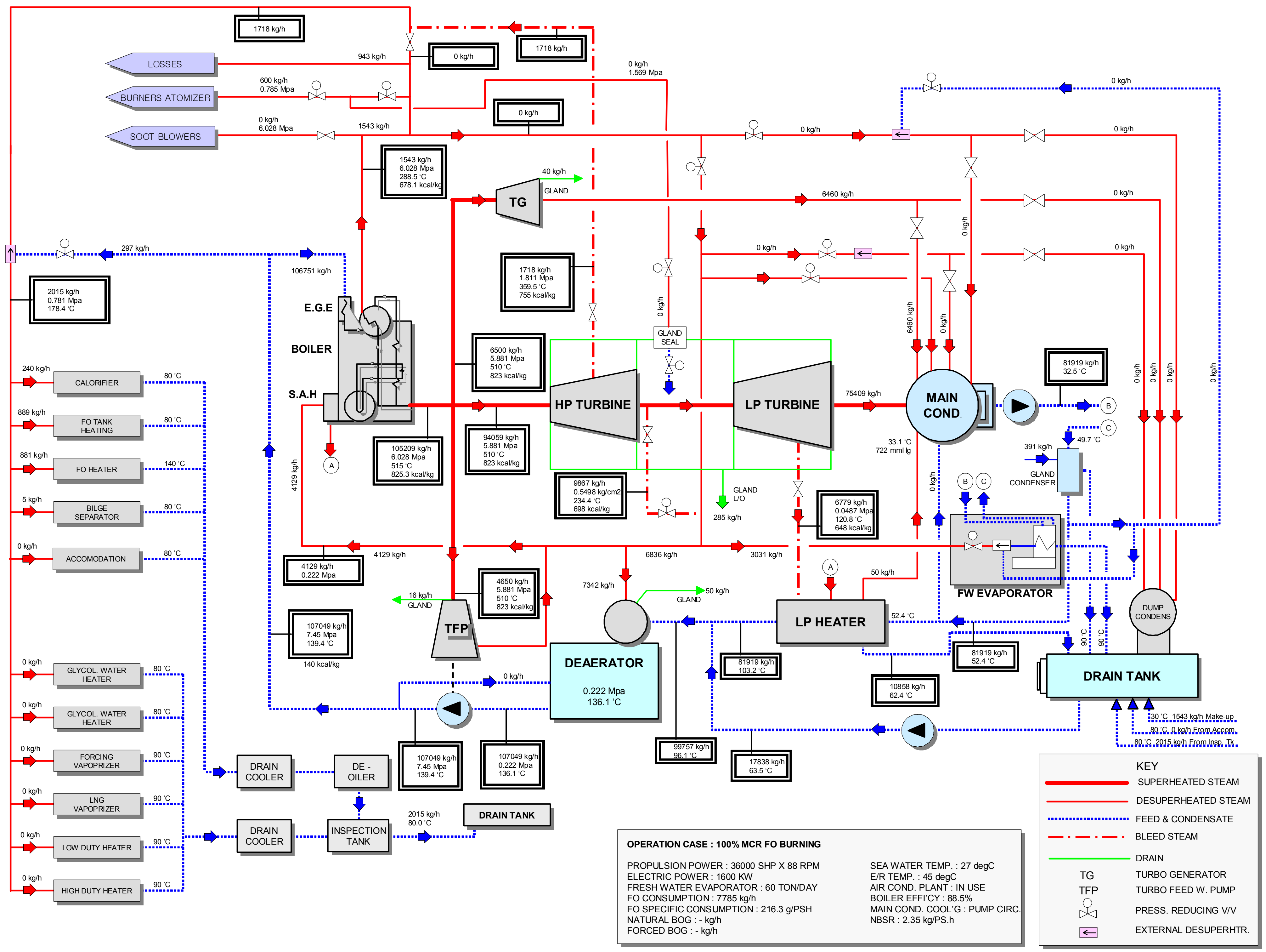
Figure 1-19 Block Diagram for the Safety System

Part 6 : Steam Plant Heat Balance System

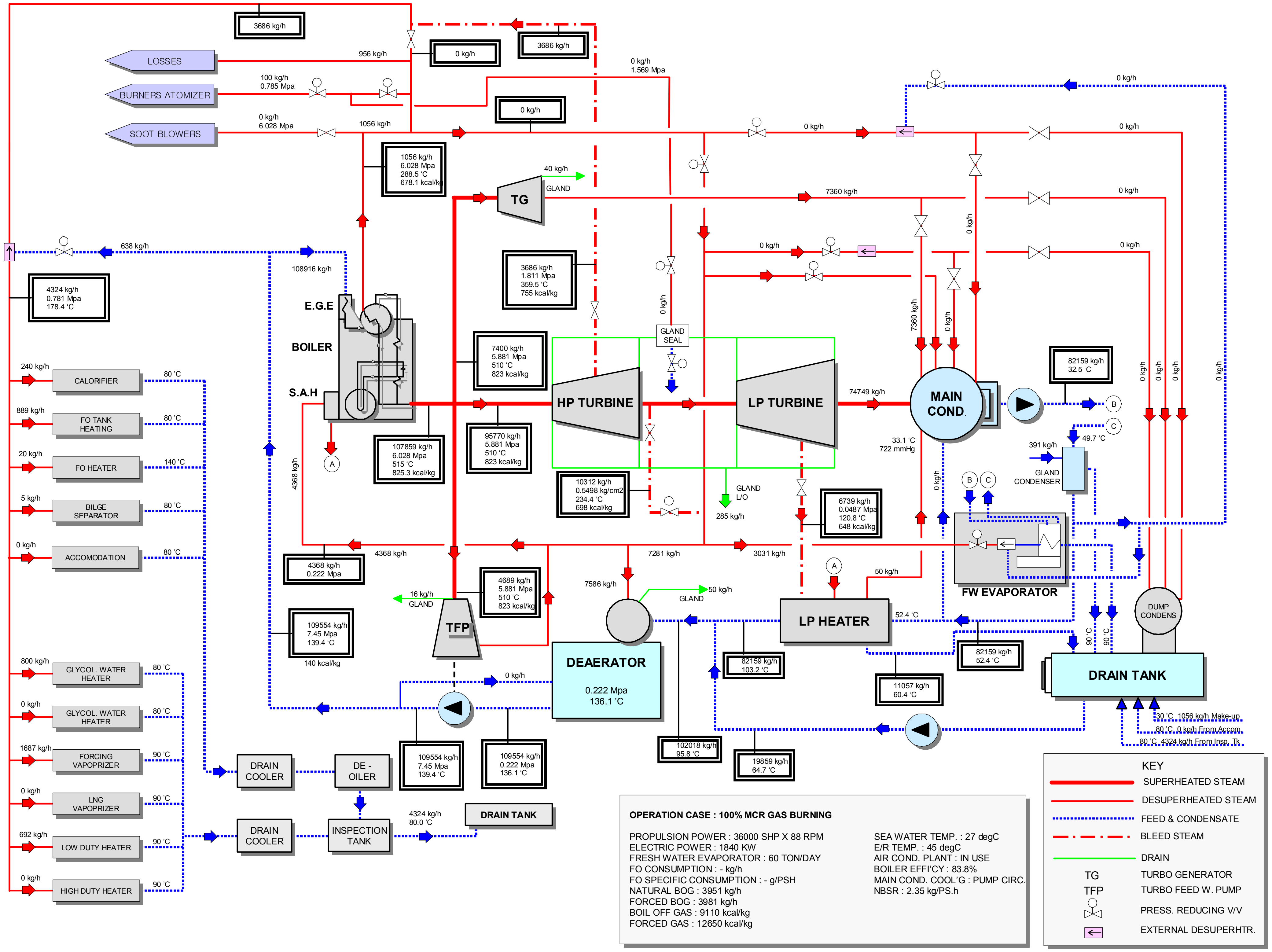
Part 6
Steam Plant Heat Balance

Part 6 : Steam Plant Heat Balance System

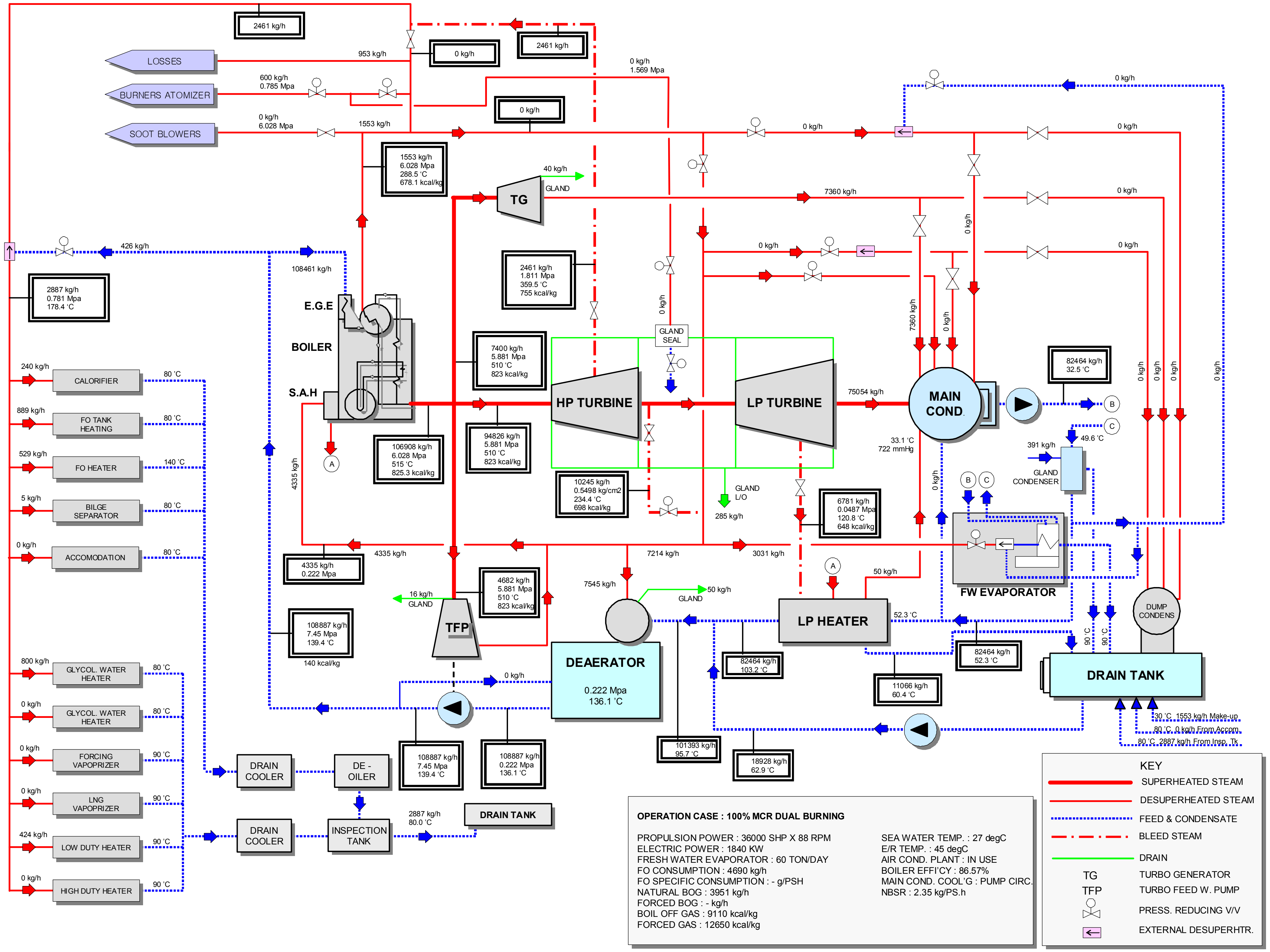
6.1 100% MCR FO Burning



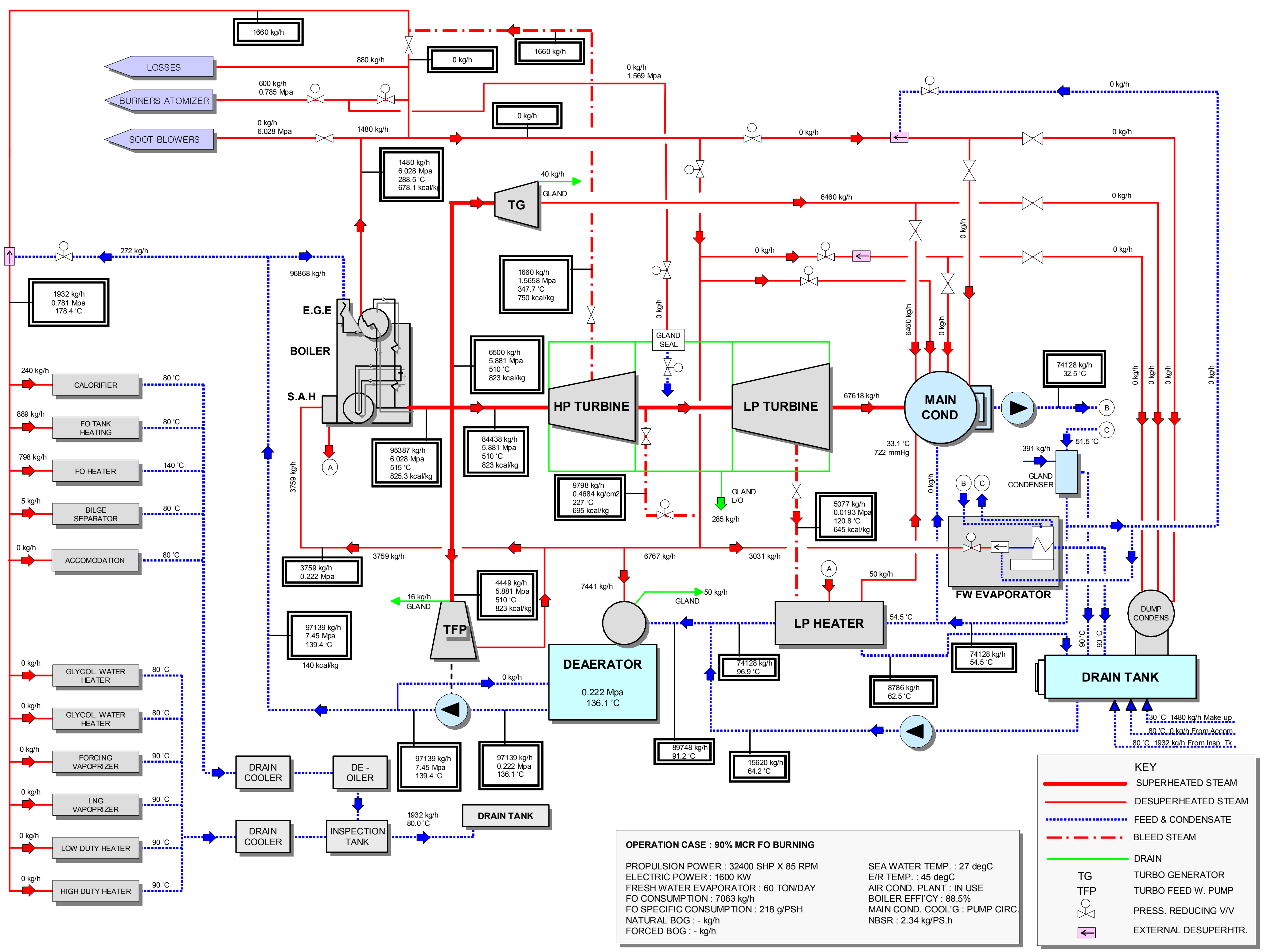
6.2 100% MCR GAS Burning



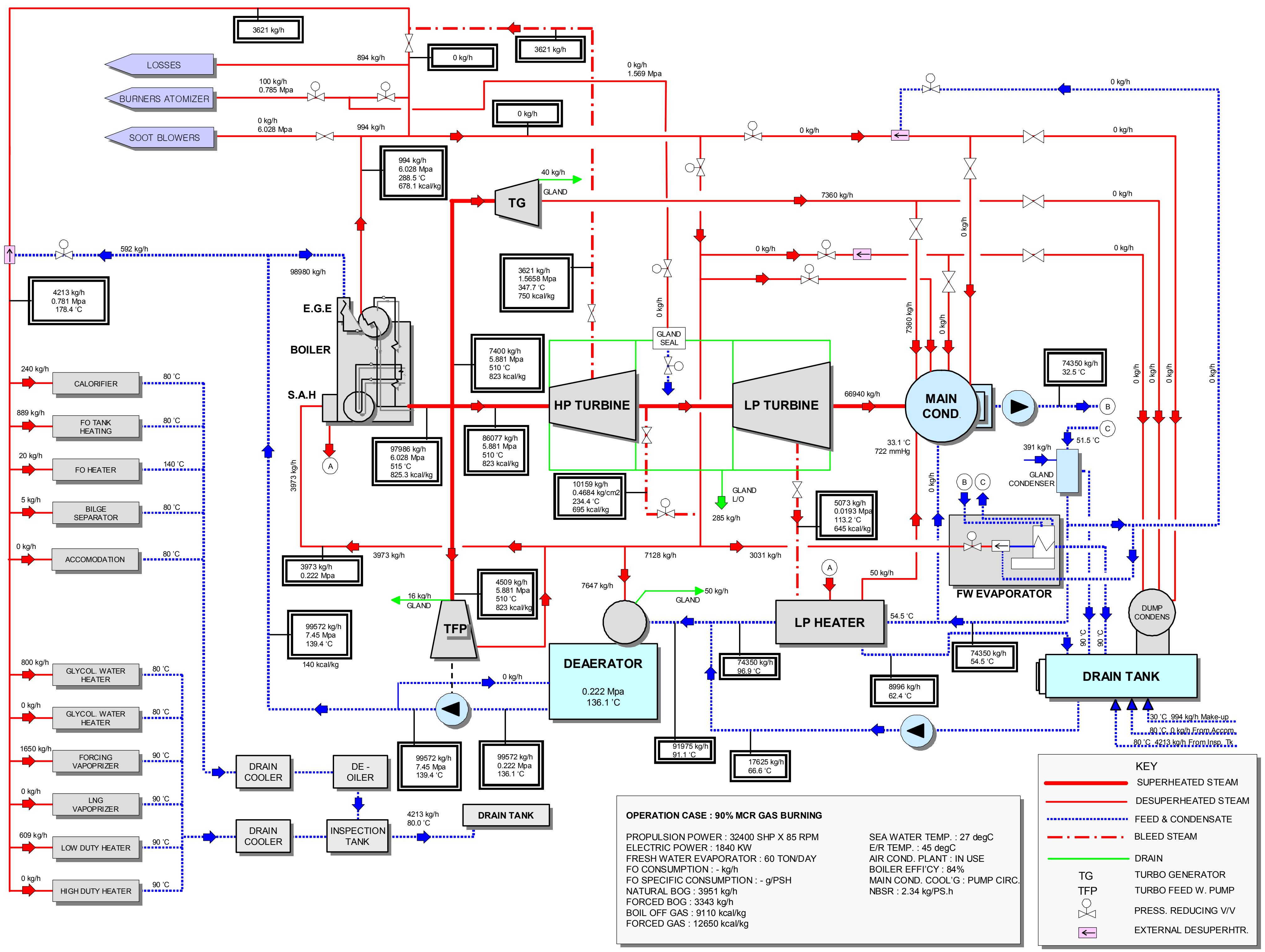
6.3 100% MCR Dual Burning



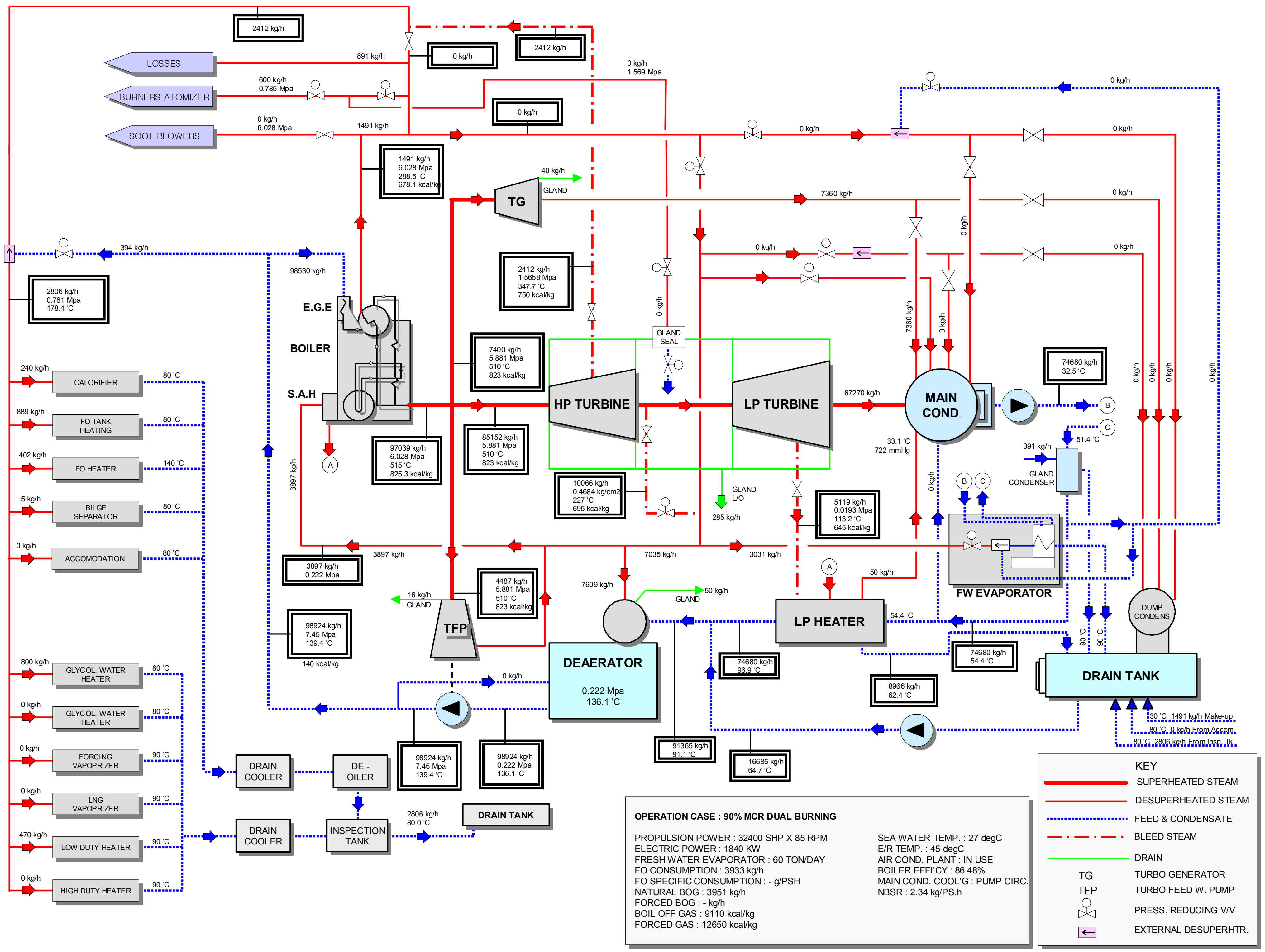
6.4 90% MCR FO Burning



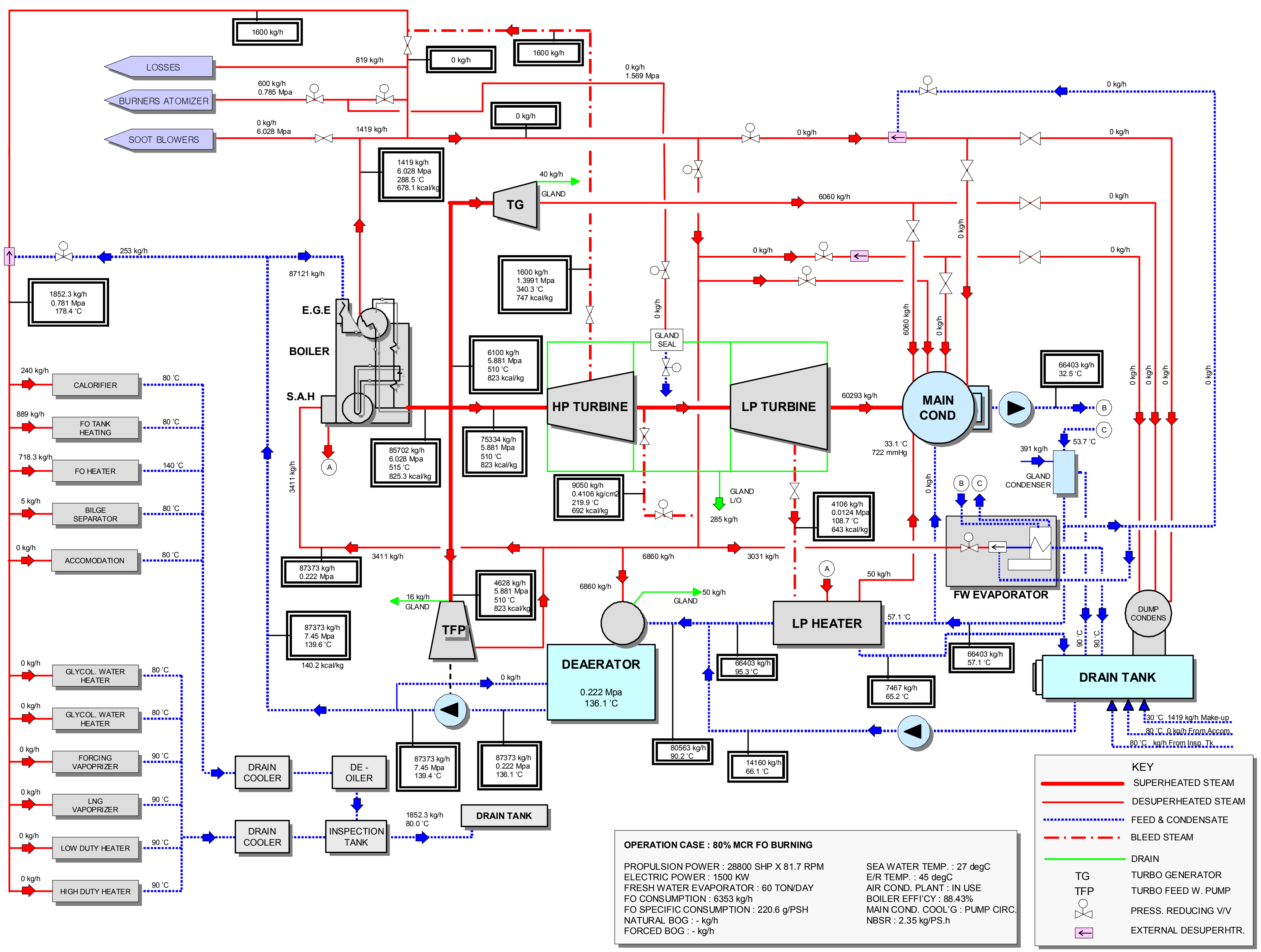
6.5 90% MCR GAS Burning



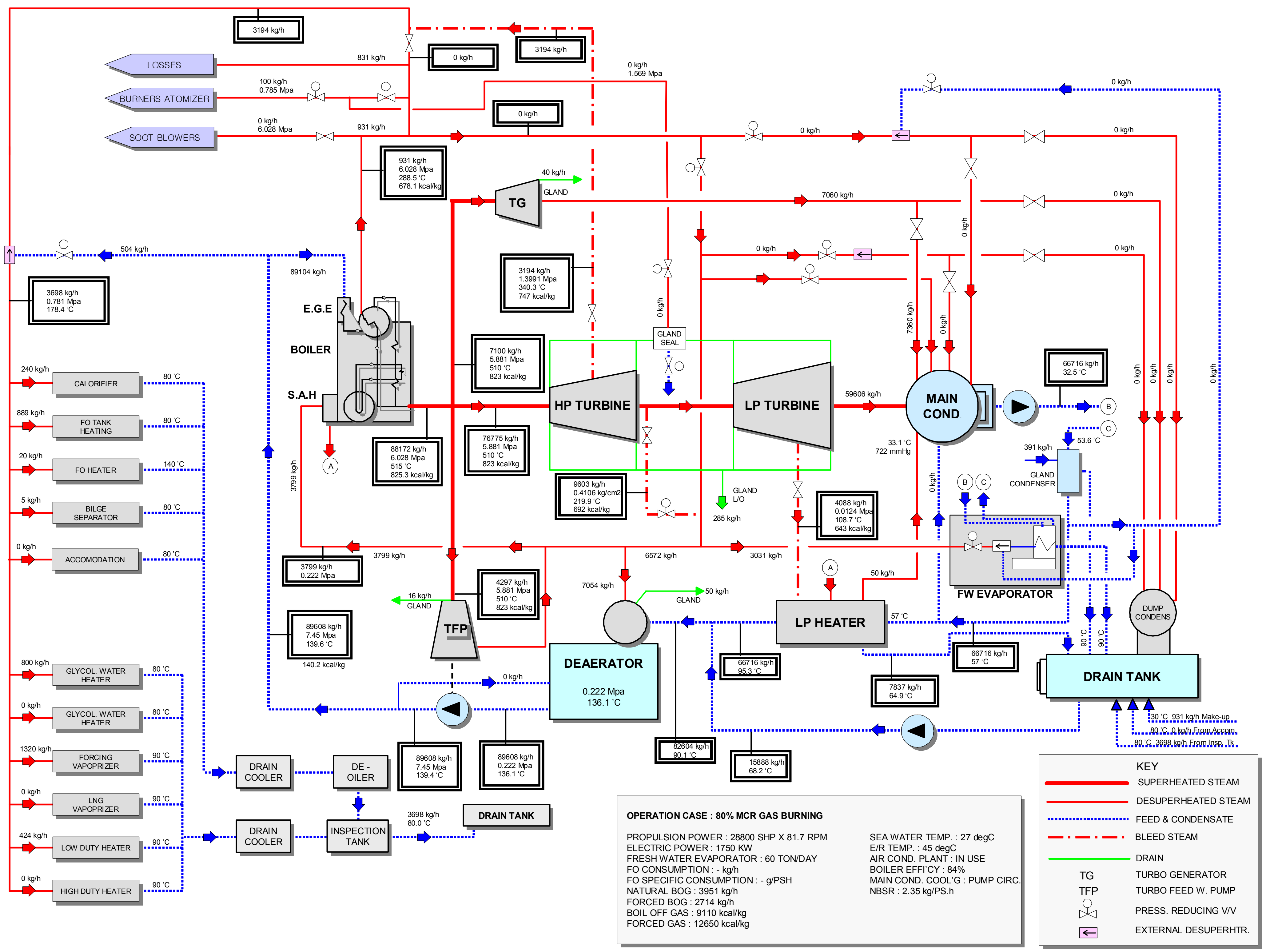
6.6 90% MCR DUAL Burning



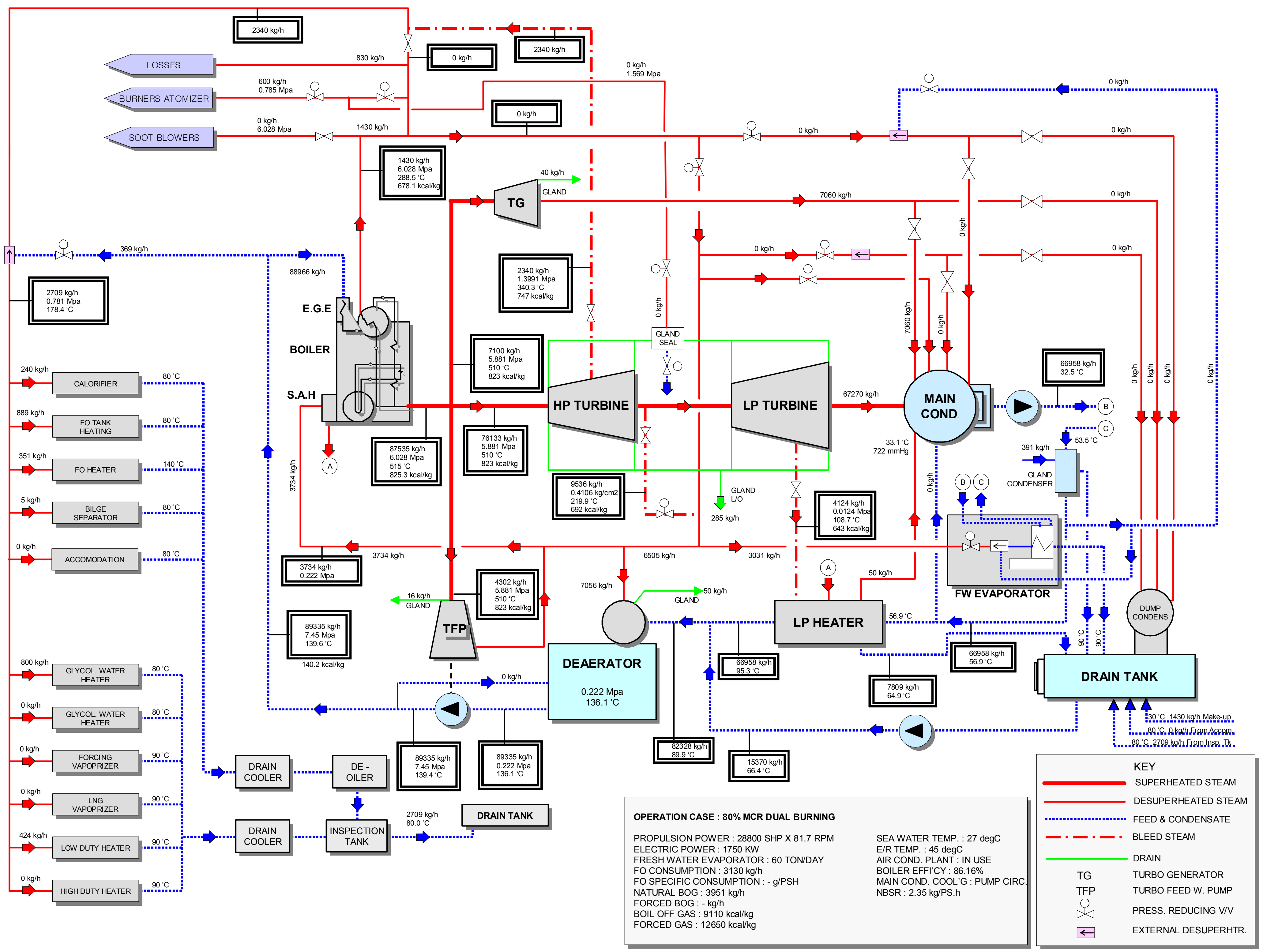
6.7 80% MCR FO Burning



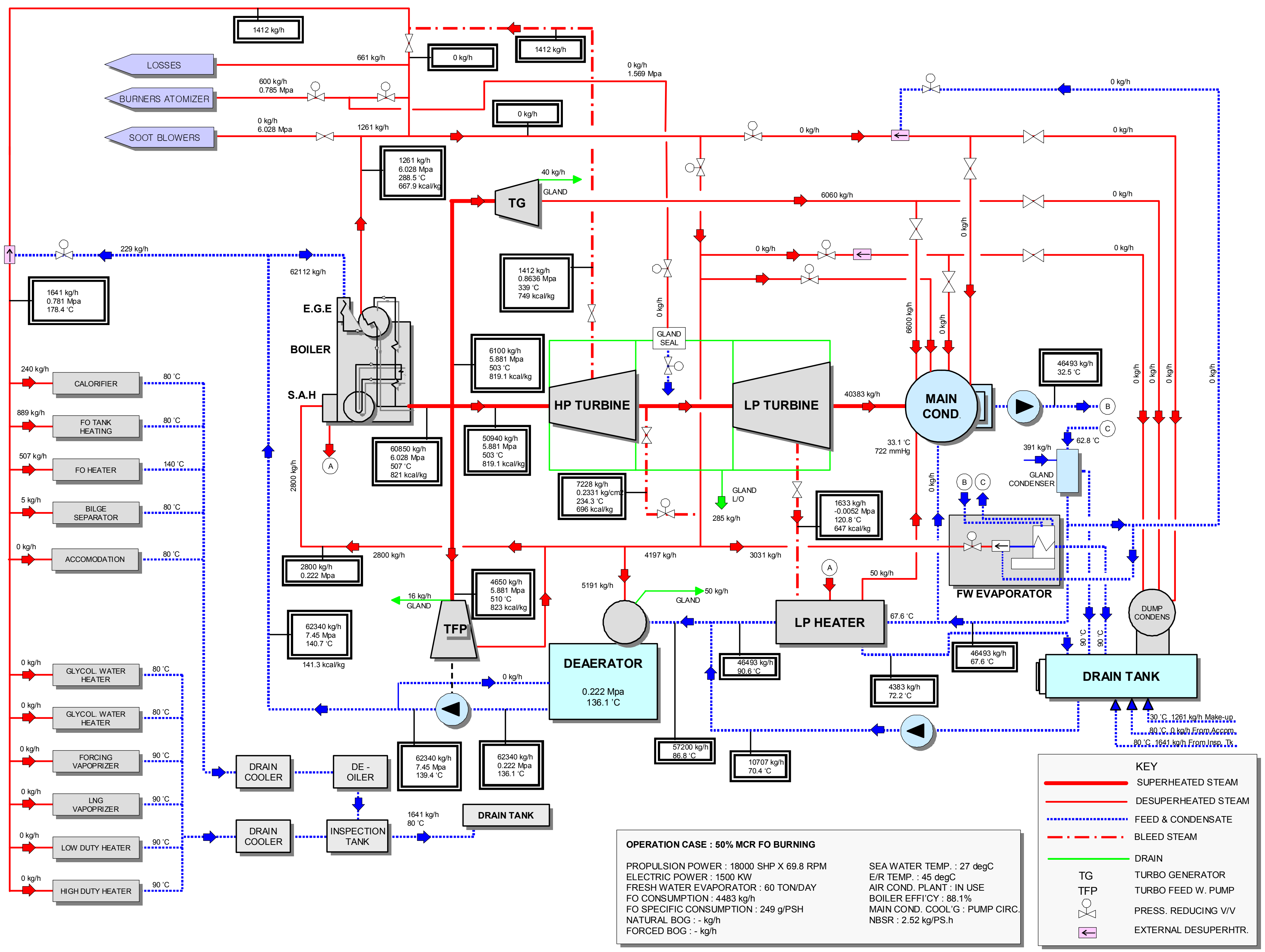
6.8 80% MCR GAS Burning



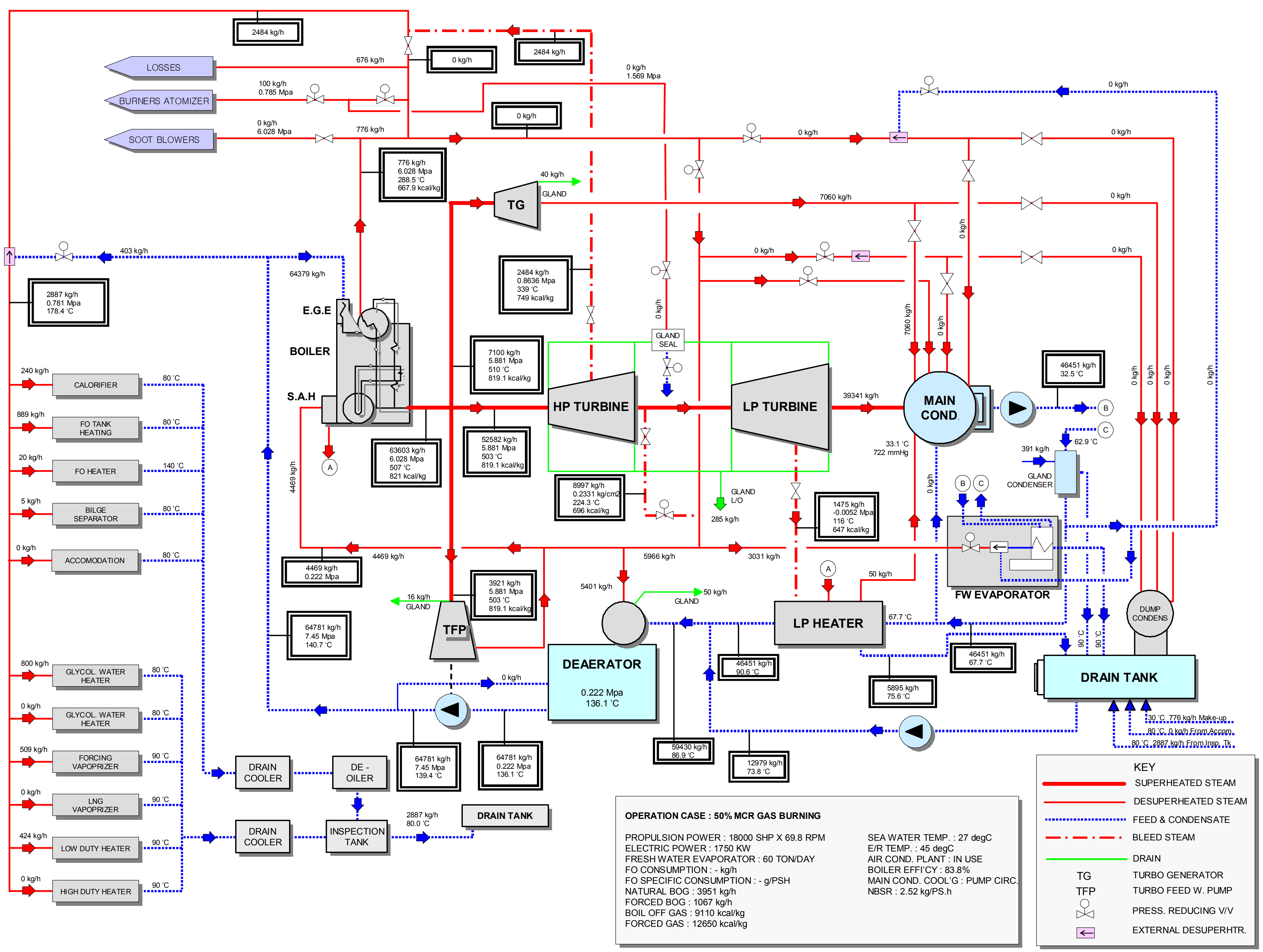
6.9 80% MCR DUAL Burning



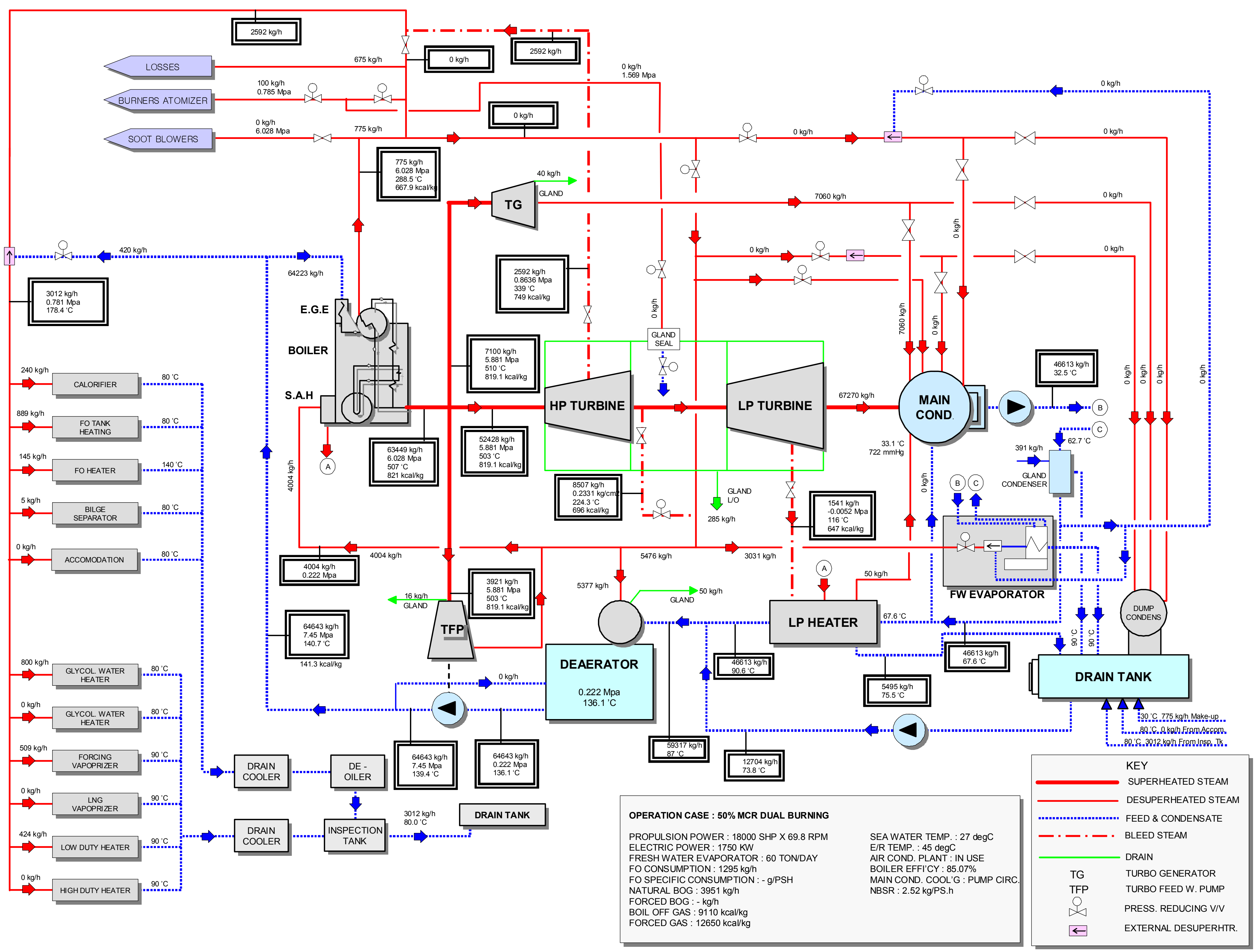
6.10 50% MCR FO Burning



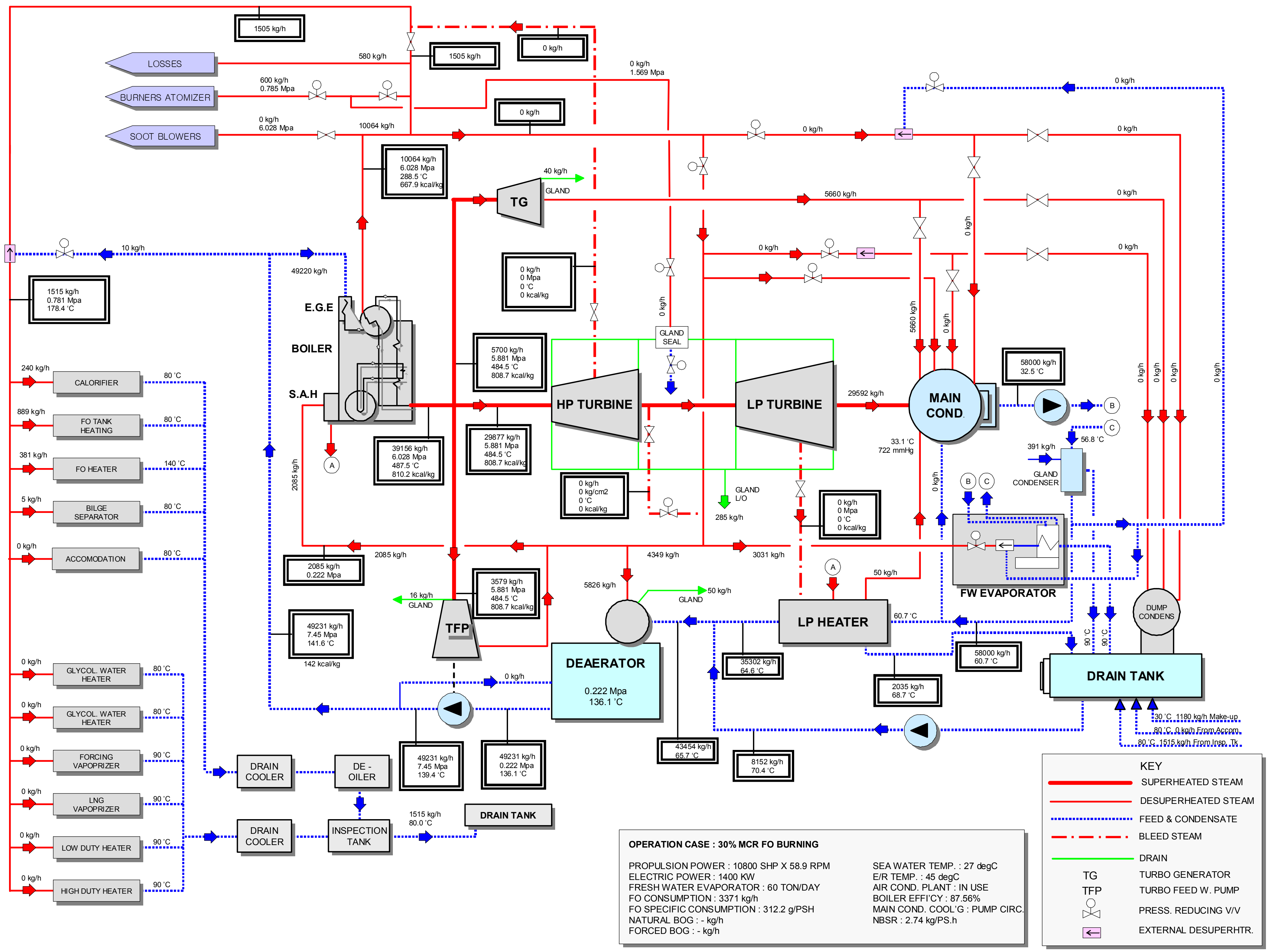
6.11 50% MCR GAS Burning



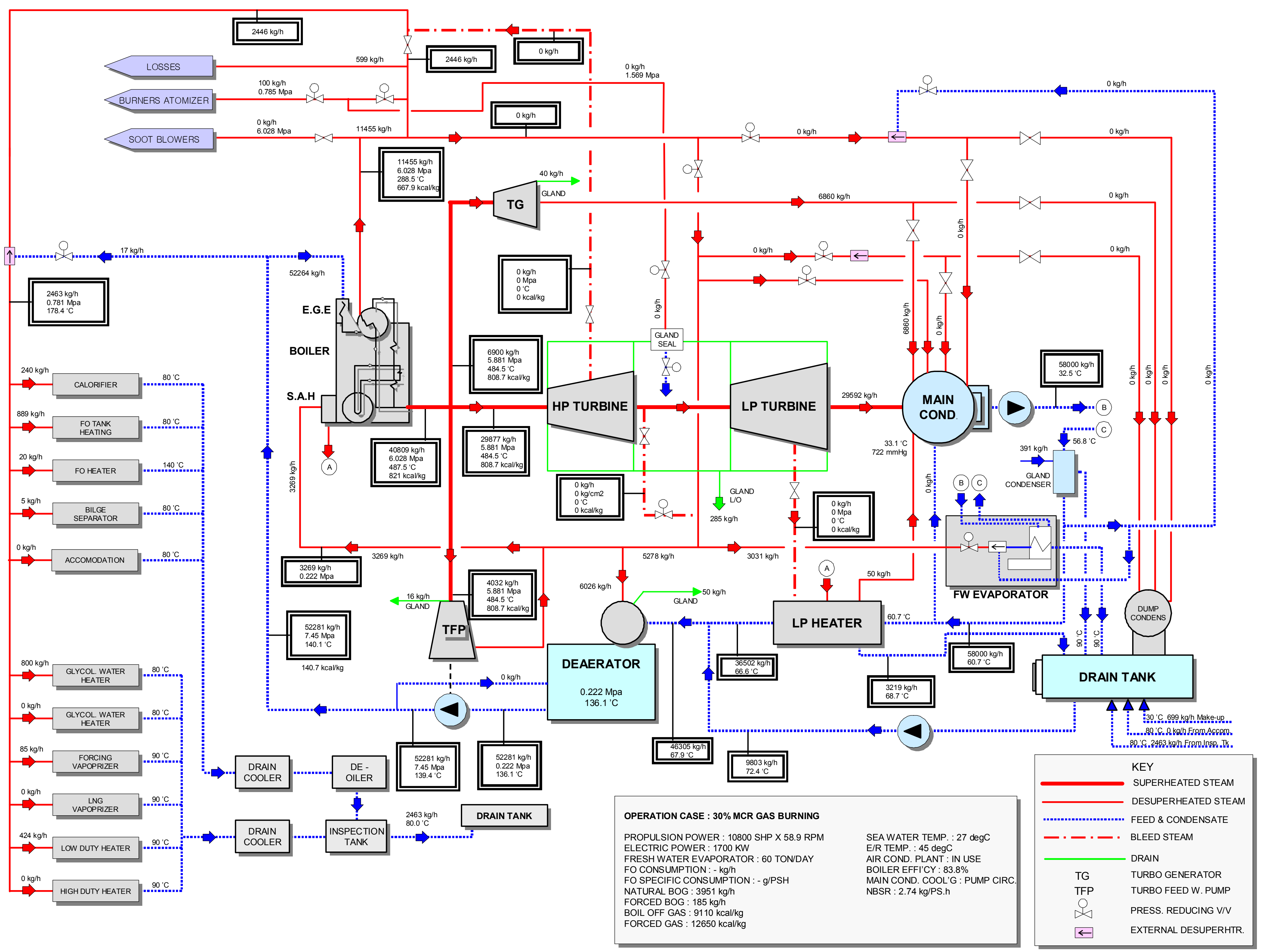
6.12 50% MCR DUAL Burning



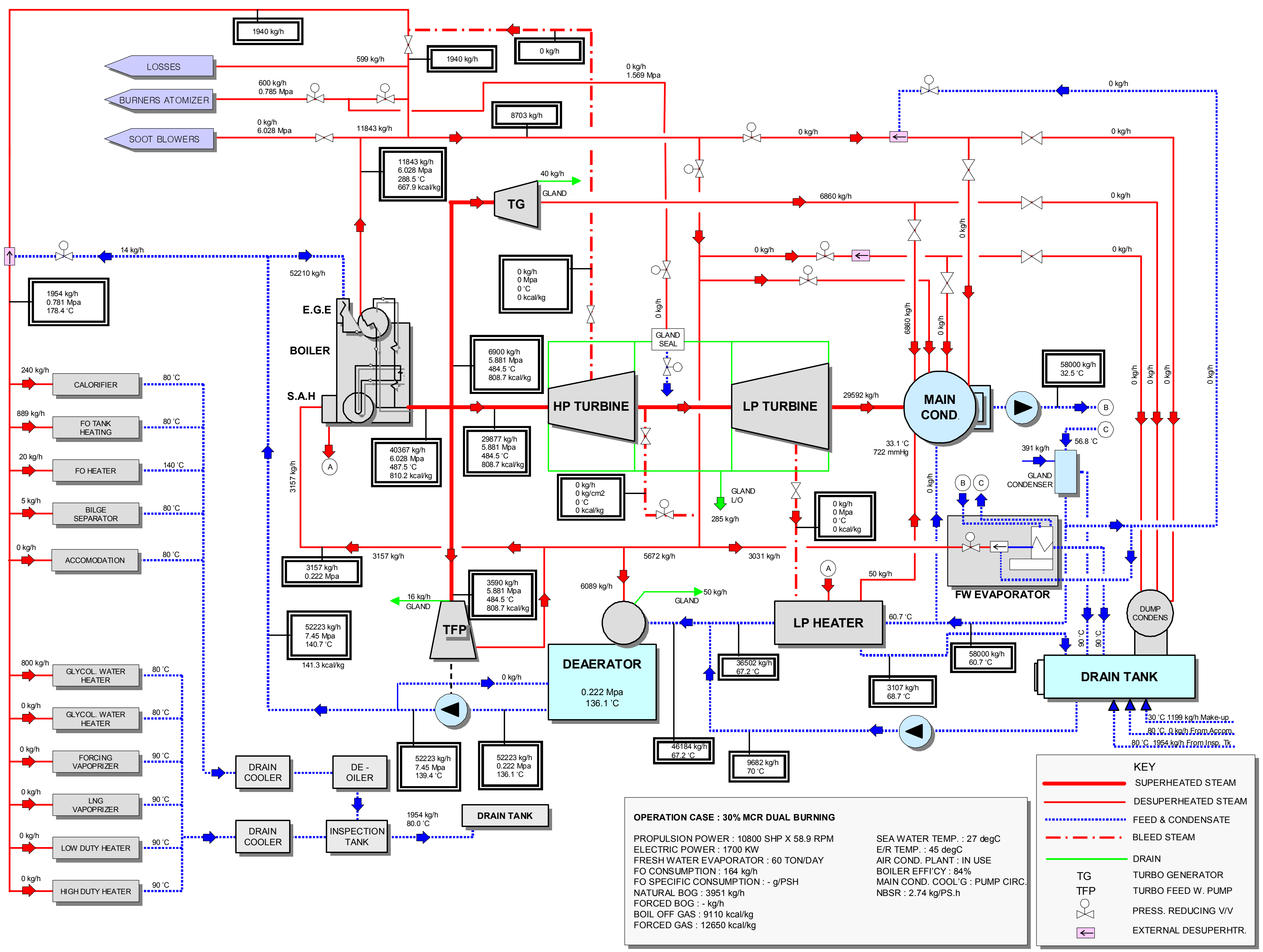
6.13 30% MCR FO Burning



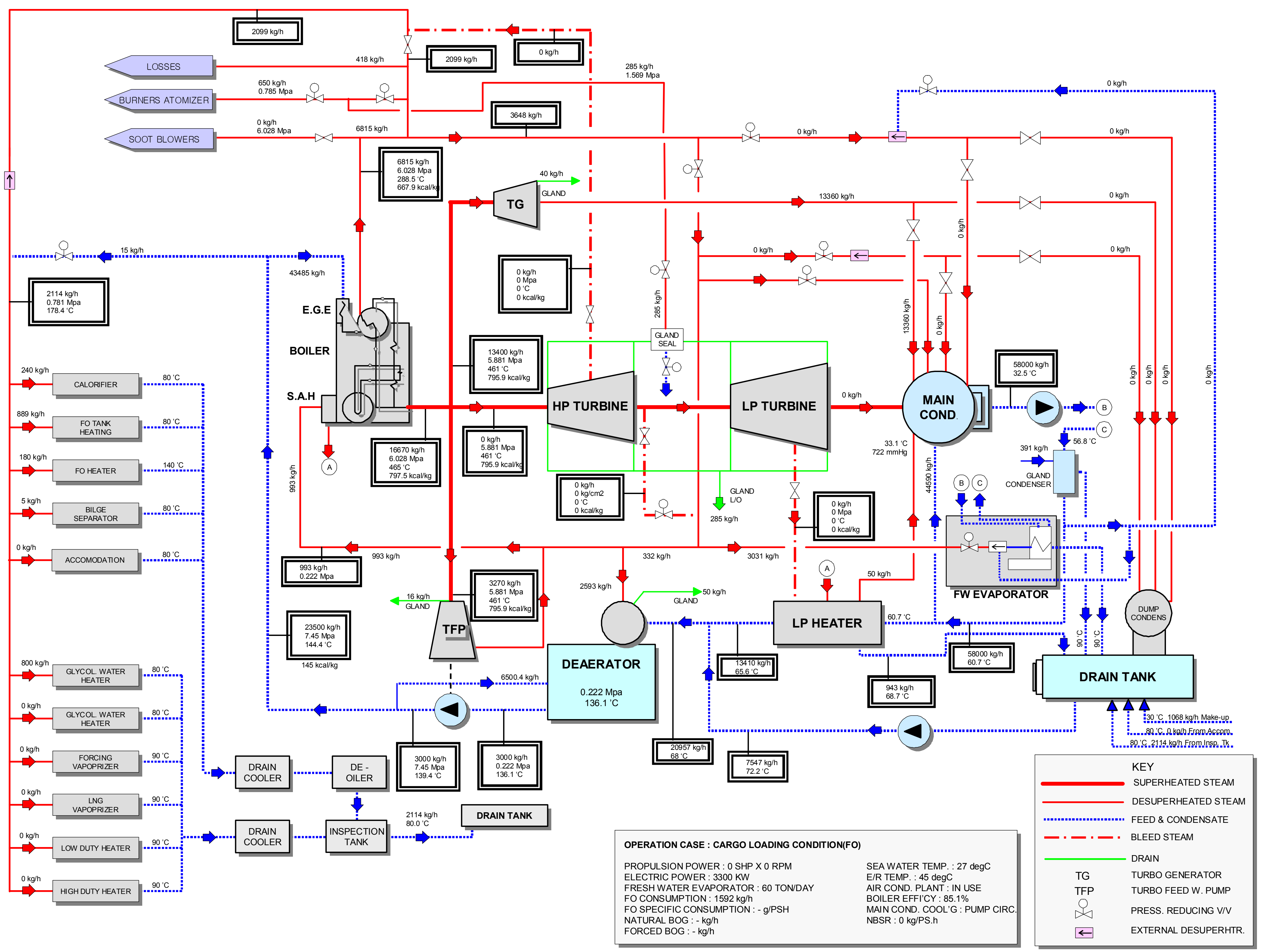
6.14 30% MCR GAS Burning



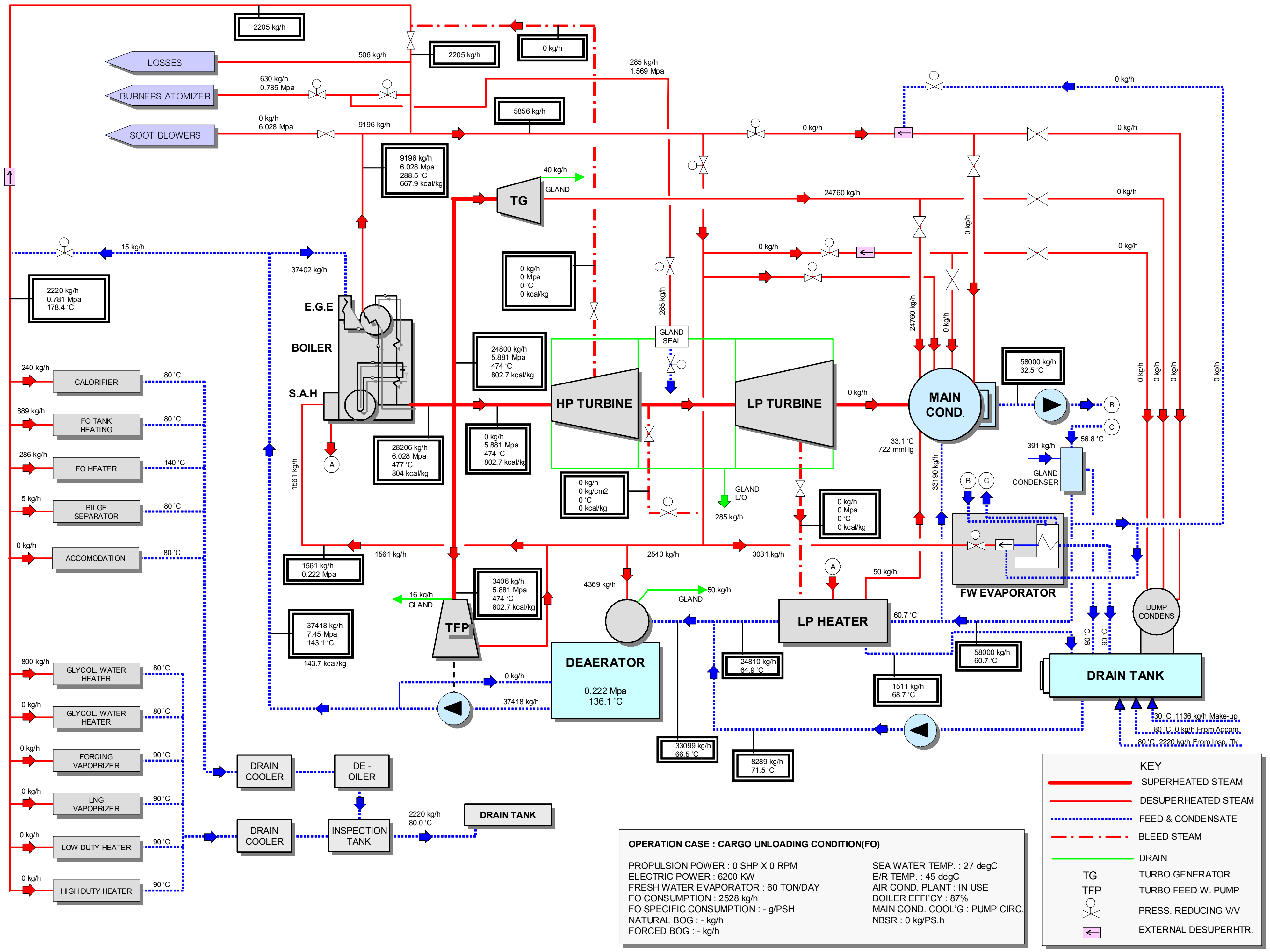
6.15 30% MCR DUAL Burning



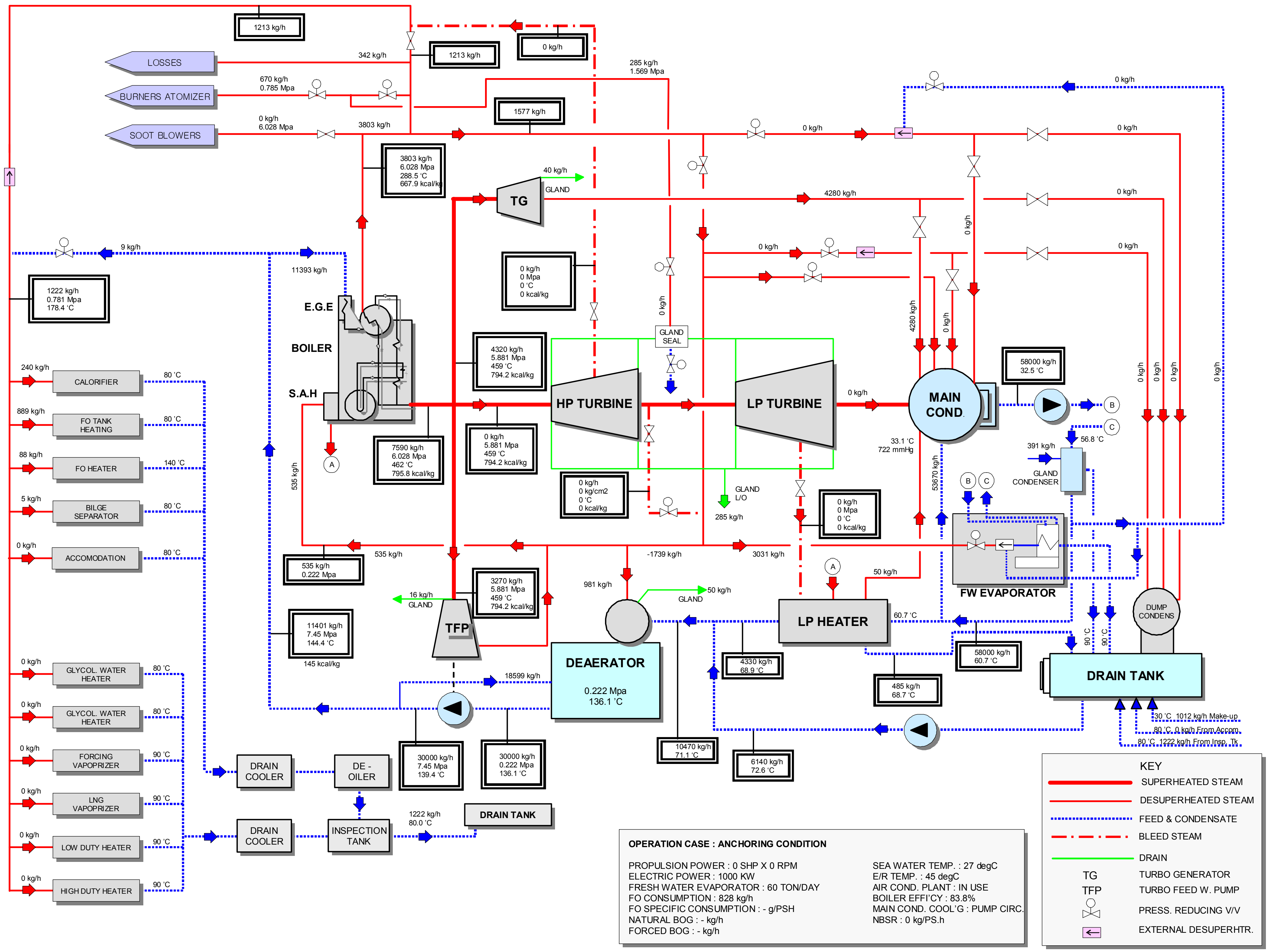
6.16 Cargo Loading (FO)



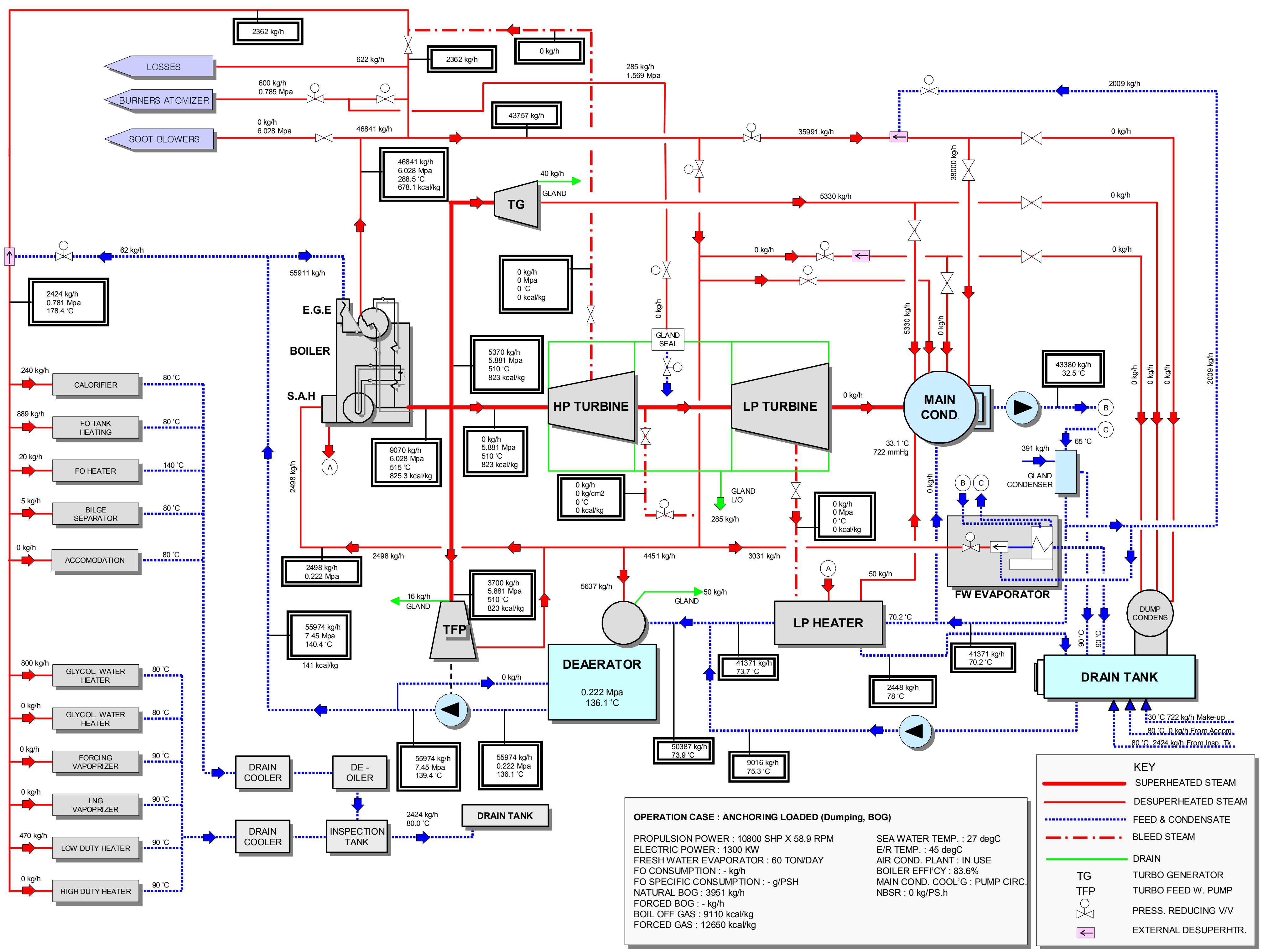
6.17 Cargo Unloading (FO)



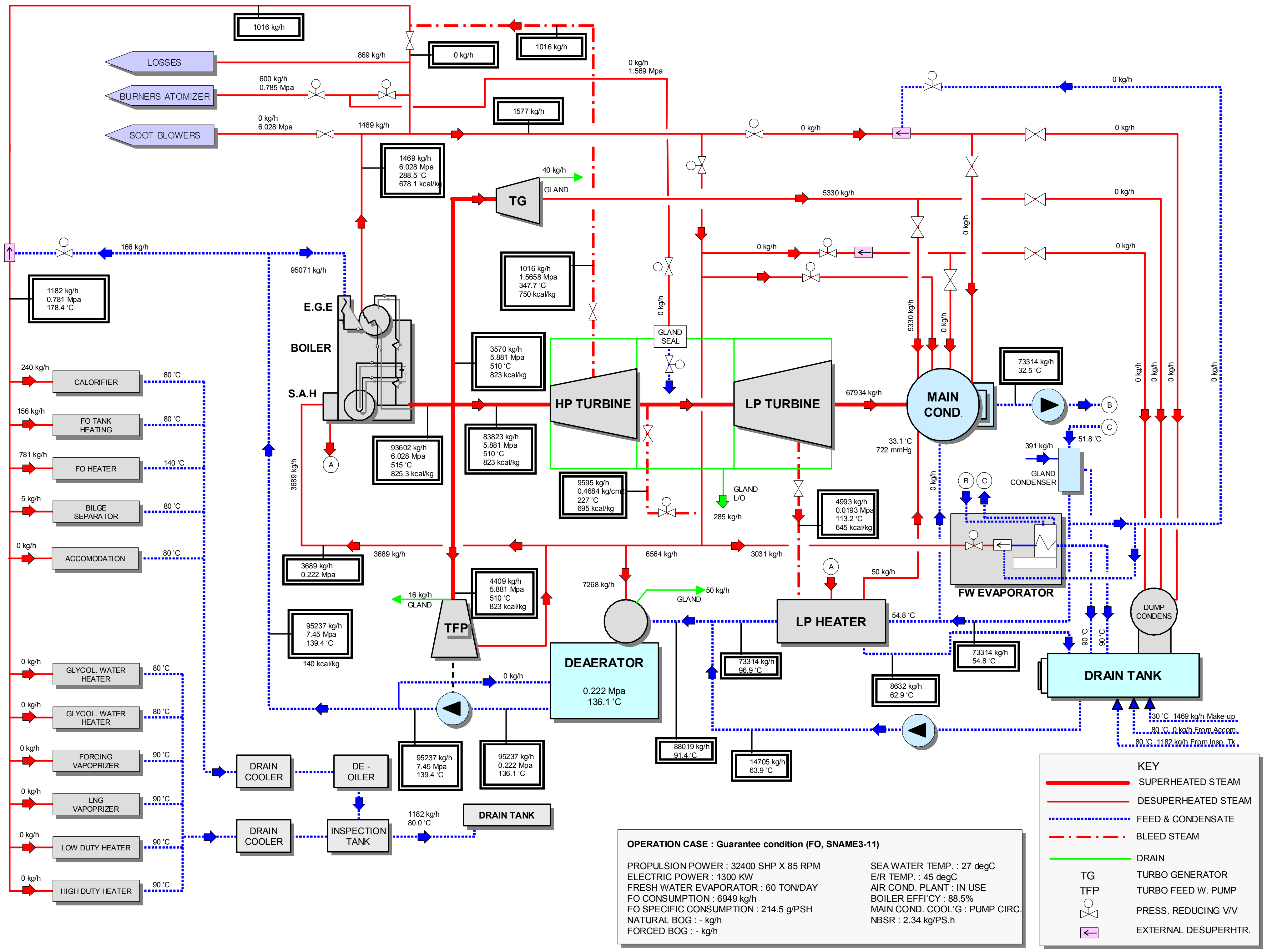
6.18 Anchoring (FO)



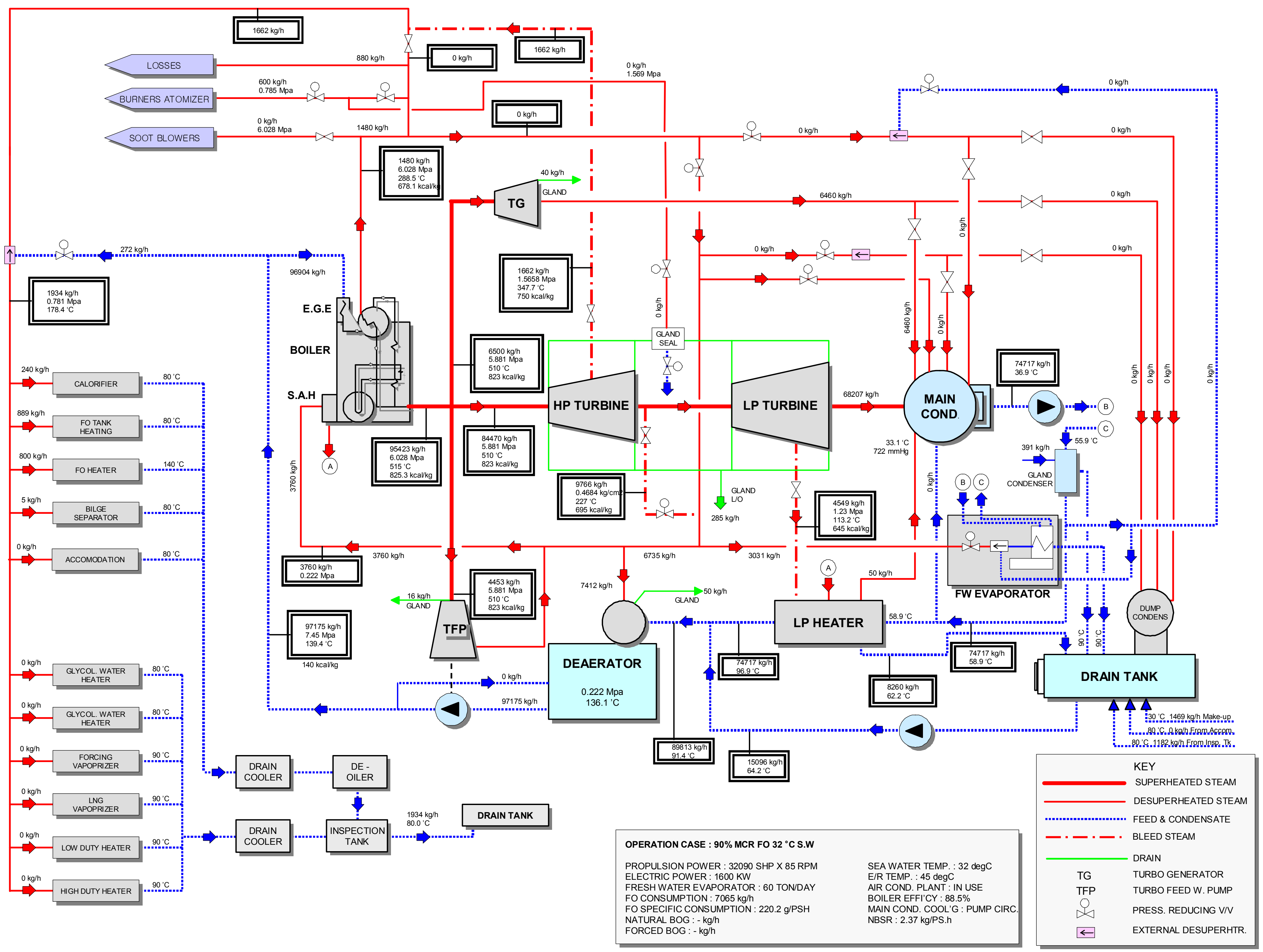
6.19 Anchoring Loaded (Dumping, BOG)



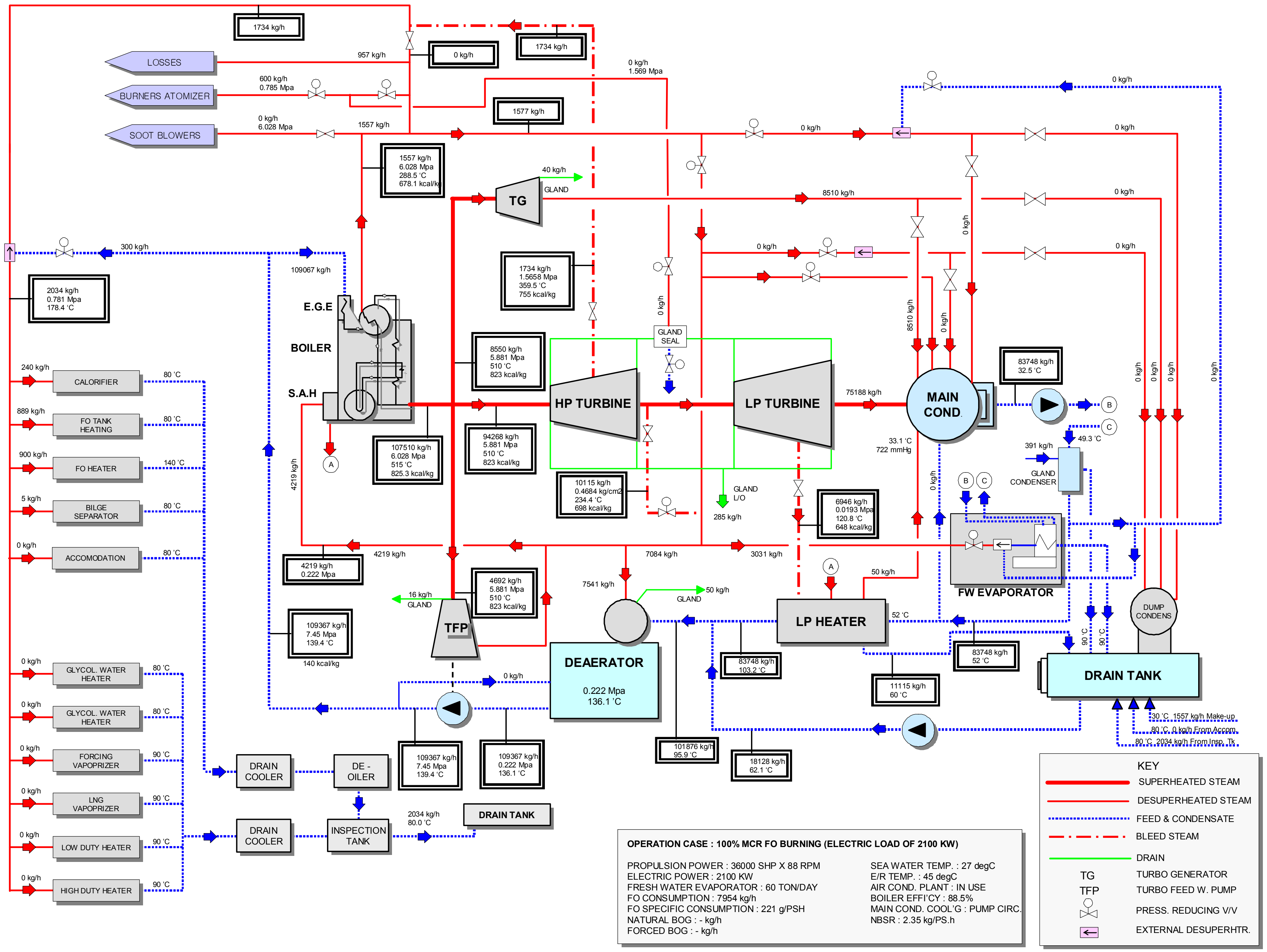
6.20 Guarantee (FO, SNAME3-11)



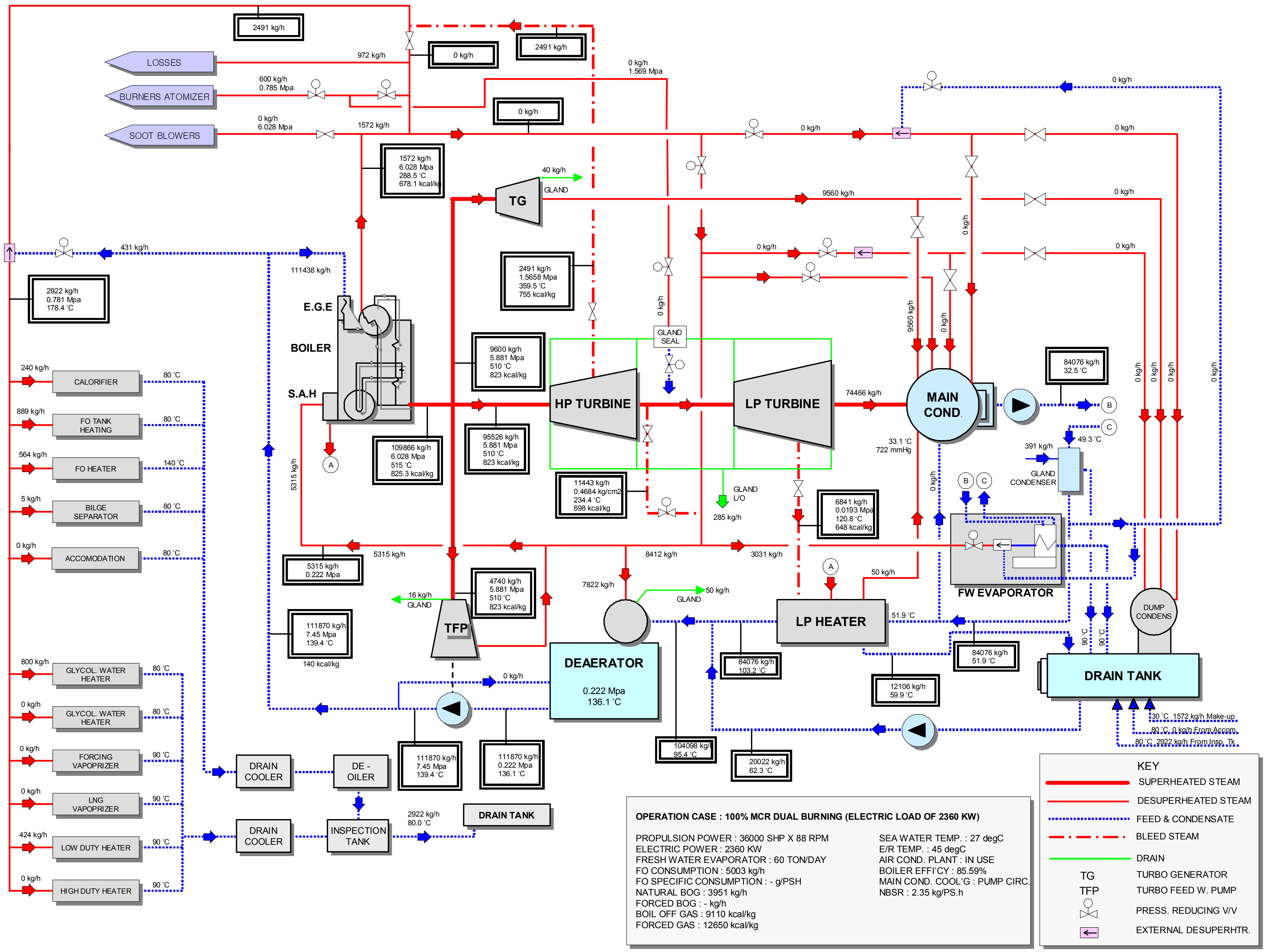
6.21 90% MCR FO Burning(32 ˚C S.W)



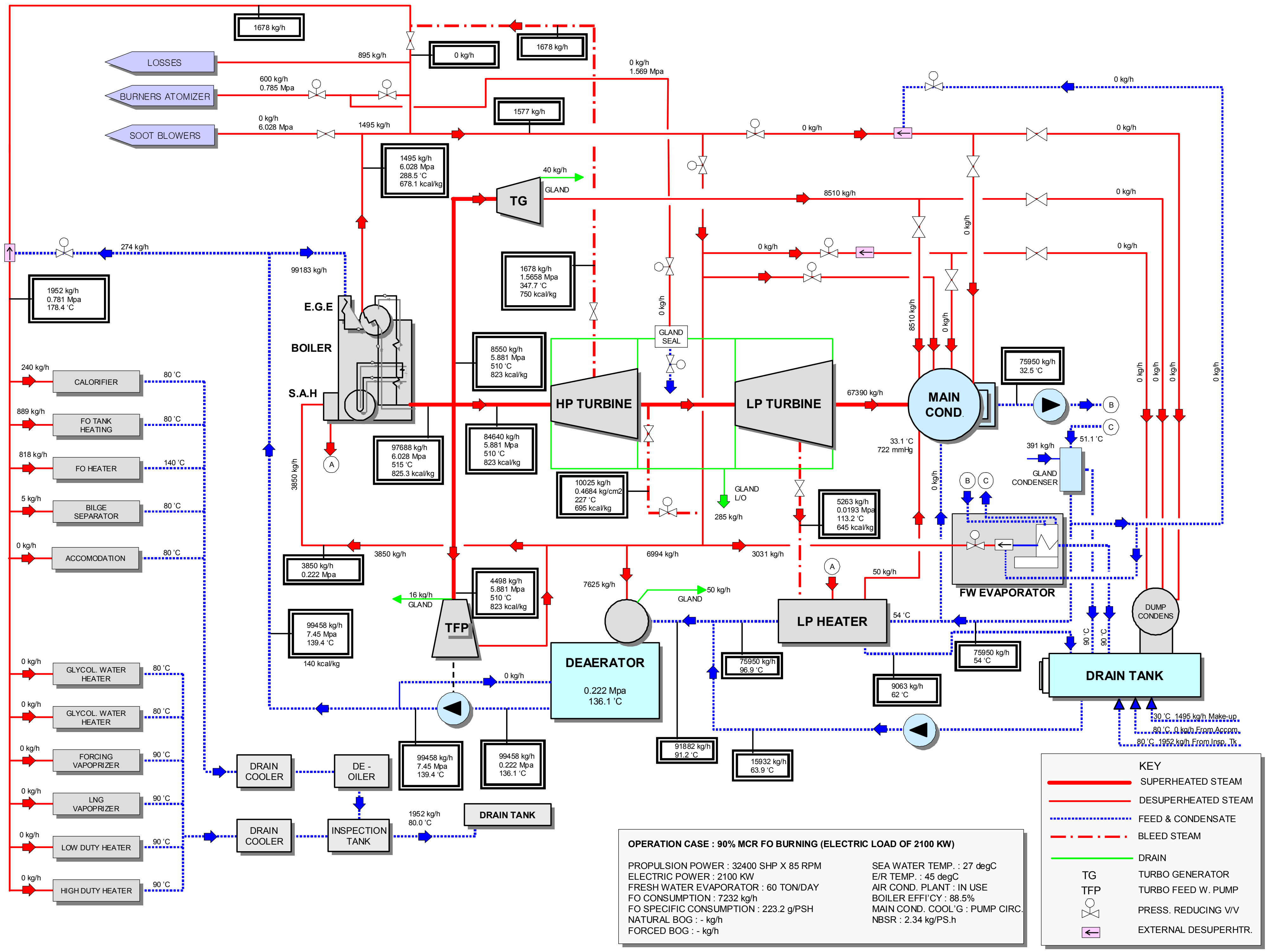
6.22 100% MCR FO Burning (Electric load of 2,100 Kw)



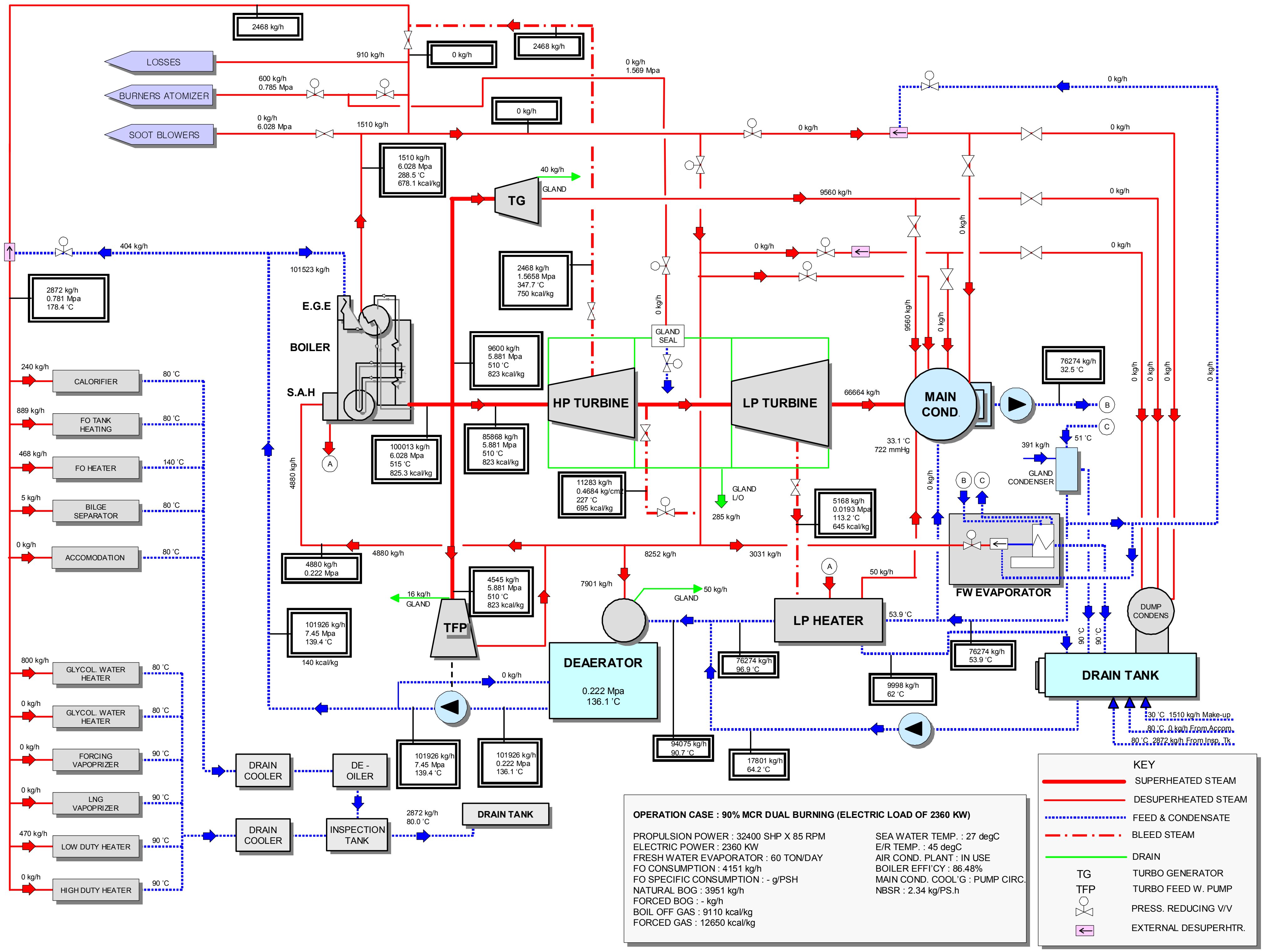
6.23 100% MCR DUAL Burning (Electric load of 2,360 Kw)



6.24 90% MCR FO Burning (Electric load of 2,100 Kw)



6.25 90% MCR DUAL Burning (Electric load of 2,360 Kw)



Part 7 : Description of Emergency Operation

Part 7
Description of Emergency Operation

Part 7 : Description of Emergency Operation

7.1 Flooding in the Engine Room

General

Under normal circumstances, the engine room bilge is pumped into the bilge holding tank using the reciprocating bilge pump. The pump starts and stops and the suction valve opens and closs by level switches in the port and starboard midship bilge wells, which are covered by the automatic system. The bilge holding tank is then pumped into the bilge water separator with the water discharged overboard. A oil separated by the bilge water separator is discharged into the oily bilge tank.

If, however, the level in the well being pumped has not reached the pump stop level after the pump starts, an alarm goes off on the central alarm system after a preset time (The time is adjustable).

For the ‘bilge pump long run’ alarm, or high bilge level alarms, the procedure detailed in Illustration Floodable time, control position and method for valve operation on page 7-2 should be followed.

Note !

Flooding in the engine room may be cause by collision, running aground, corrosion of water pipes, broken rubber expansion bellows, etc. The immediate action will depend upon the nature and severity of the flooding.

In such cases, the first priority is keeping the water from rising, either by controlling the inflow or pumping the water out. Pipework damage is relatively easy to control by isolating sections, whereas hull damage is not so easily checked.

Isolating sections of pipework must involve shutting down the items being served by that section of pipework in the plant. To help avoid this, a fibre rope wrapped around a sea water pipe is often effective in reducing the flow and reinforcing the pipe.

If the flow can be effectively reduced, build a cement box and seal the pipe. Add baking powder to the cement mix to quicken the drying process, but do not use excessive amounts or else it will make the cement brittle.

If the main circulating system is damaged and cannot be repaired in service, the main engine and turbine generators must be shut down and the boilers secured until repaired. If the sea water service system is damaged and cannot be repaired in service, all engine room services must be shut down and the emergency diesel generator turned on.

If plastic steel or other proprietary compound is used to repair a section of a pipe, follow the manufacturer’s instructions, and wait 24 hours after application to let the compound dry before pressurizing the pipe.

If a cement box is used to repair the pipe, allow the cement to dry thoroughly before pressurizing the pipe.

Emergency Hand Pump Operation

Pump Model : PHP 25-05
Max. hand pump Pressure : 30 MPag
Oil displacement per double stroke : 25 cm^2
Oil viscosity range : 12 – 300 cSt
Standard hose : 2m or 5m

All hydraulic position type operating valves have an emergency hand pump connection. There are three portable emergency hand pump units: in the engine room, in the duct keel space, and in the deck store. First shut off the isolating valves on the distribution block and fit the hoses of the emergency hand pump on the connectors snap. Control the direction via manual change over control block.

Operating Procedure

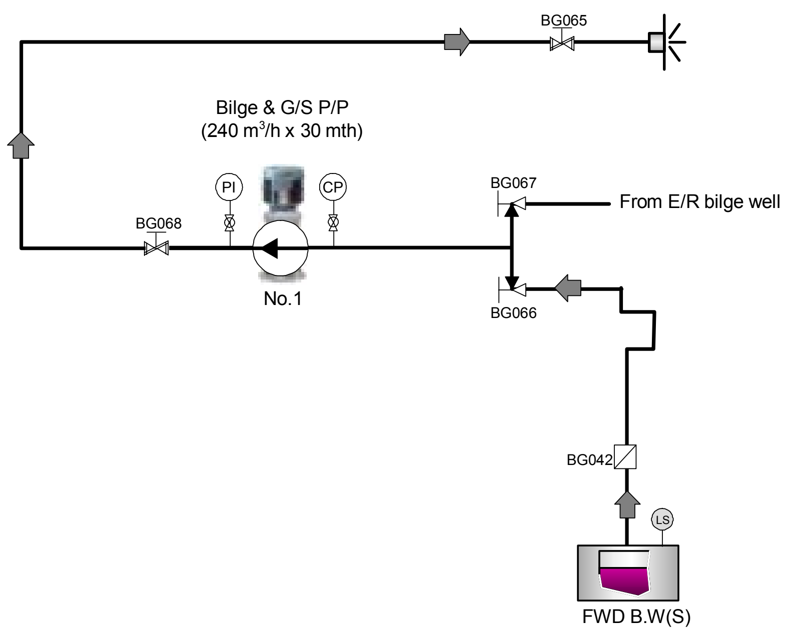
Opening the valve

- Close the stop valves on the control block that is mounted on the actuator.
- Connect hoses “B” and “A” to the emergency control block(HS-block) mounted on the actuator.
- Turn the pilot valve on the hand pump to the “open” position and continue to pump until the actuator/valve opens (see visual indicator on the actuator or pressure gauge for nominal working pressure 10.5(13.5)MPag).
- When the pilot valve is placed in position ,the valve will keep from closing.

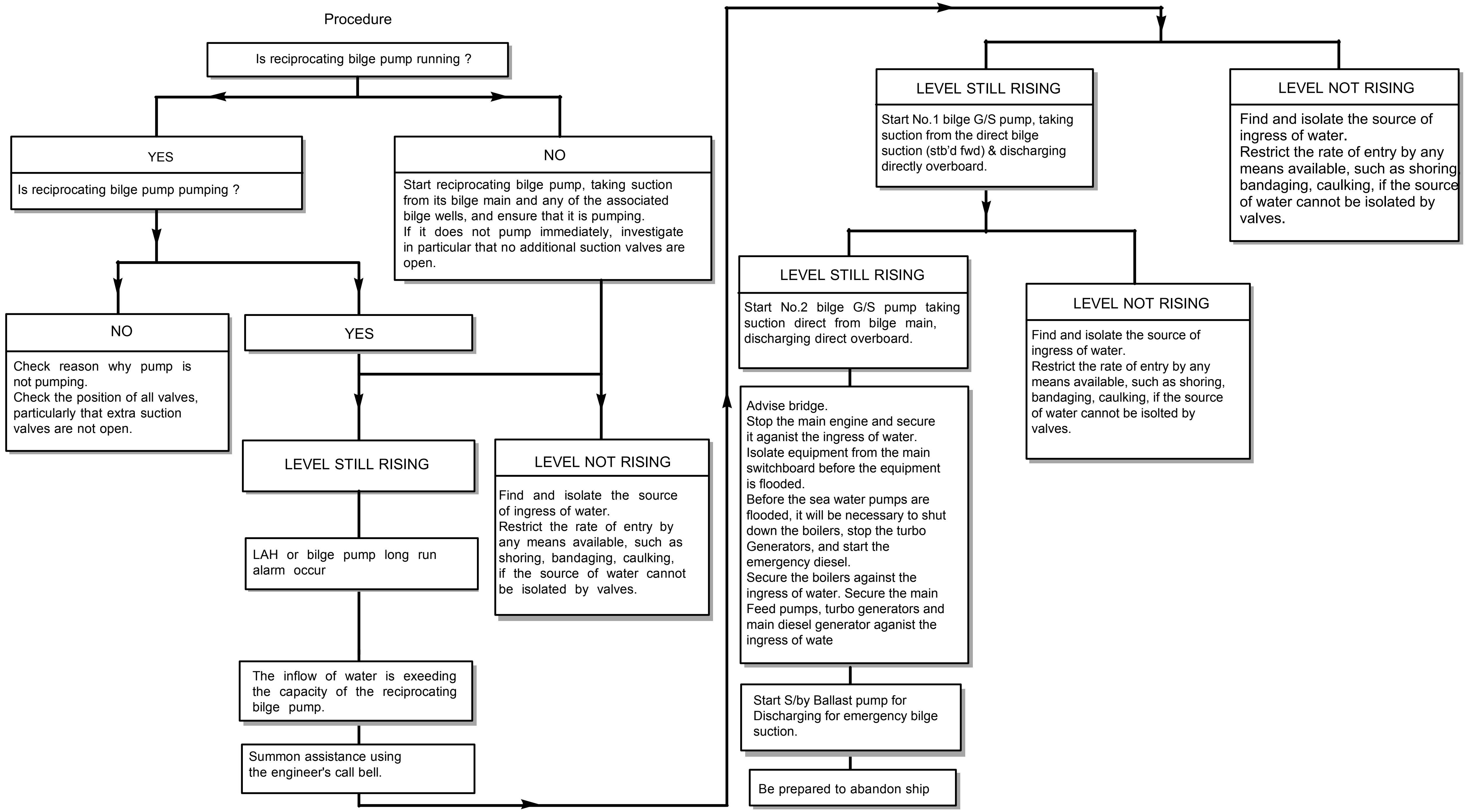
Closing the valve

- Turn the pilot valve on the hand pump to the “closed” position

E/R Emergency bilge pumping by No. 1 bilge & G/S pump from FWD ST’BD bilge well.



Floodable time, control position and method for valve operation



7.2 Main Boiler Emergency Operation

7.2.1 Main Boiler Initial Ignition by Portable Igniter

General

When the base burner or fixed igniter is out of order, use a portable to start the boilers. The portable igniter can be used for any burner. A after fixing the portable igniter, the boiler initial start sequences are automatically executed by pressing the designated FO burner on switch. The electric source is always established in the portable igniter system, therefore, additional electric source connections for the portable igniter is not necessary. The portable igniter increases the No.2 or No.3 fuel oil burner, and ignites in place of the base burner flame.

Portable Igniter Operating Procedures– Initial Ignition

(1) Insert the portable igniter into the designated burner.

(2) Check if the igniter lamp slowly flickers at a rate of a flicker per second. On the boiler graphic operation panel, push the FO burner "ON" switch.

(3) The burner ignition sequence automatically starts.

(4) Take out the portable igniter after the FO burner fires up (flicker should be at a rate of a flicker per 0.1 second).

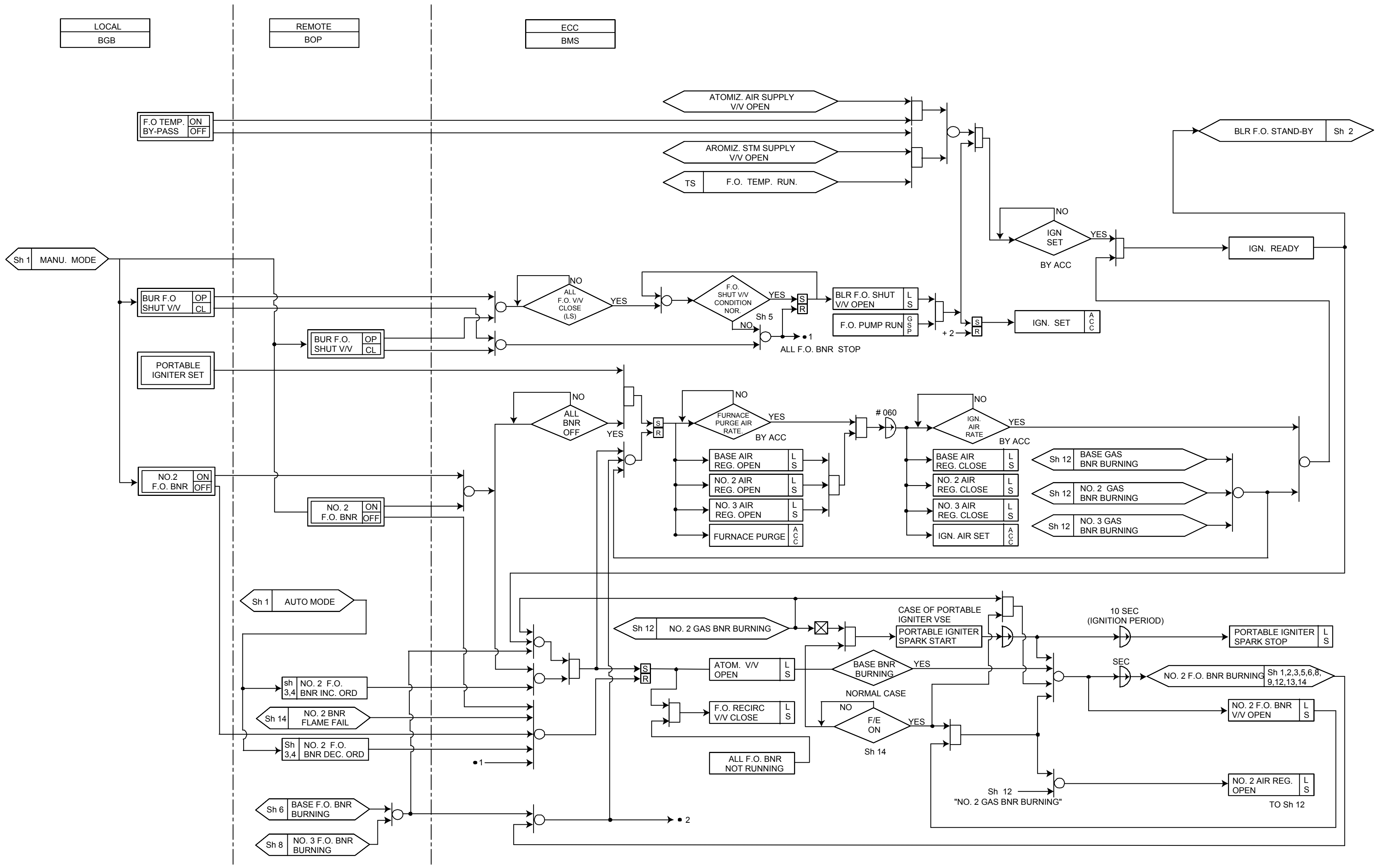
Procedure of Portable Igniter Operating

(1) Insert the portable igniter into the designated burner.

(2) Check if the igniter lamp slowly flickers at a rate of a flicker per second. On the boiler graphic operation panel, push the FO burner "ON" switch.

(3) The burner ignition sequence automatically starts.

(4) Take out the portable igniter after the FO burner fires up (flicker should be at a rate of a flicker per 0.1 second).



Block diagram of FO burner ignition sequence

7.2.2 One Boiler Operation

During emergencies when it becomes necessary to run the ship with only one boiler functioning, pay attention to the following points in running the boiler.

Allowable Maximum Continuous Evaporation for a One-Boiler Operation

Allowable maximum continuous evaporation is 63 t/h. Whether continuous evaporation reaches the maximum level or not should be judged by the burner oil pressure or ACC oil flow meter. At the maximum continuous evaporation, the oil pressure is 1.57 MPag, and oil flow about 4,551 kg/h with three burners in use.

Running a One-Boiler Operation at Maximum Evaporation

(1) Pay attention to the condition of combustion and adjust the air flow properly. Since the fan is operating near maximum load, so take care that black smoke is not emitted at load change.

(2) Change boiler load as slowly as possible.

(3) Reduce boiler load before cleaning the burner tips. When only one burner is in service, the maximum evaporation of the boiler is 21 t/h, so the boiler load should be lower than this. If the boiler load is not reduced, steam pressure decreases.

(4) Pay attention to the rise of steam temperature. Reduce the boiler load if steam temperature is 515°C or higher with the STC control valve fully opened.

Instructions for Boiler out of Operation

(1) Completely isolate the inoperative boiler from the functional boiler. When making repairs, check the main steam stop valve, feed water valve, ACC steam pressure detecting root valve, auxiliary steam desuperheated steam outlet valve, drain valve, chemical dosing valve and other lines connecting both boilers to one another.

(2) When the boiler is shut down for a long time, preserve the boiler with the wet lay-up method.

Main Boiler Wet Lay Up Methods

The wet lay-up is used to preserve the main boiler. The method requires less preparation, maintains the boiler, and provides adequate protection for the water side. This method can be safely used for a lay-up of any length of time, if the fire room temperature is not below freezing.

(1) When the cool down, a boiler compound (NA/PO_4=2.8 mole ratio) of trisodium phosphate (Na_3PO_4), disodium phosphate (Na_2HPO_4), and hydrazine should be added to the boiler water via the chemical injection system. This mixture should make boiler water of about 50 ppm phosphate acid (PO_4^{3-}) and hydrazine (N_2H_4) of 100 ~ 200 ppm (pH is about 10.5 ~ 10.6). The boiler water should be kept in high alkalinity to protect the boiler from corrosion. Since the boiler water density during the wet laid up period is very high compared to the density during ordinary conditions, the boiler should be carefully blown down when it starts, to bring the boiler water concentration down to normal values (with the boiler water treating limits). thus, some amount of make-up water is necessary while distilled water should be prepared beforehand.

(2) After boiler shuts down, and steam pressure falls down to about 0.2 MPag, the superheater and desuperheater headers should be drained thoroughly through their respective drain valves.

(3) When the pressure is almost lost, nitrogen gas should be blown into the saturate steam pipe and the superheater tube by providing good ventilation around the boiler.

(4) Measure oxygen or nitrogen at superheater header drain nozzle, the air vent valve on this steam drum and the starting steam valve. when the boiler's air space gets filled with nitrogen gas close the drain valves on the superheater headers.

(5) Feed hot water through the feed water heater and deaerator to the boiler. When it starts to overflow from the air vent on the steam drum, close the valve. Continue to feed water into the boiler. When it begins overflow from the superheater vent valve and desuperheater drain valve, close those valves.

(6) When the feeding water to the boiler pressurised to 0.35 ~ 0.5 MPag and cools down to the ambient temperature, open the air vent valve on the steam drum and superheater vent valve to release. Then, lay up the boiler with a water pressure of 0.2 ~ 0.35 MPag.

(7) It is important to maintain a uniform level of boiler water alkalinity in the boiler. Periodically check this level during lay up period, and when necessary, add alkalinity or hydrazine as required.

(8) To prevent freezing in the boiler, the boiler ambient temperature should be kept at a temp. not less than 5°C in cold water.

(9) When using the boiler again after wet lay-up, drain the boiler properly to lower the water level, and pour distilled water into the steam drum through the manifold at the outlet of the superheater. This washes the superheater from the inside by having water flow back into the steam drum. Then the boiler water should be conditioned within treating limits.

(10) When the boiler is kept out of service for a short time, fill it to the steam drum. The superheater should be drained thoroughly.

7.2.3 Operation of 1-FAN 2-BOILER

When a fan cannot be used for some reason, it becomes necessary to fire two boilers with one fan. If one of the fans fail for some reason, the boiler on the same ship side shuts down via the fuel oil emergency shut-off equipment. On the other hand, a normally functioning boiler receives ACC signals so it may take over the load of the boiler which was shut down. Once the fan failure alarm sounds, the load on the main engine should be reduced immediately. When running a one-fan, two-boiler operation, follow these steps:

(1) Close the outlet damper on the inoperative fan.

(2) Open the common duct damper. Place the F.D. fan at high speed. The fuel oil emergency shut-off valve for the shut down boiler is now ready to open.

(3) Switch ACC from auto to manual. The fuel oil auto/manual switch and fan auto/manual switch should be put in manual mode for both No.1 and No.2 boilers.

(4) Purge the inoperative boiler's furnace. Open the air slide of the base burner, put the burner wind box air pressure at about 200 Pa and purge for at least 5 minutes. Pay attention to air flow adjustment so that the functional boiler will not be short of air.

(5) Fully open the boiler starting valve.

(6) Open the fuel oil emergency shut-off valve.

(7) Light up the inoperative boiler. After lighting up, adjust oil pressure to about 0.4 MPag and raise steam pressure at the same combustion rate until the pressure reaches the same pressure as that of the other boiler. Take care that the rate of pressure is not higher than the pressure raising curve.

(8) Start the two-boiler operation. When the pressure of the boiler has reached the same pressure as the other boiler, run the two-boiler operation and close the superheater starting valve.

(9) Balance the load between the two boilers. Make the number of burners and burner oil pressure the same for both boilers. Adjust the air damper to make air distribution to both boilers the same.

(10) Put the fuel auto/manual switch in auto position for both boilers. Switching should be made after boiler load becomes steady.

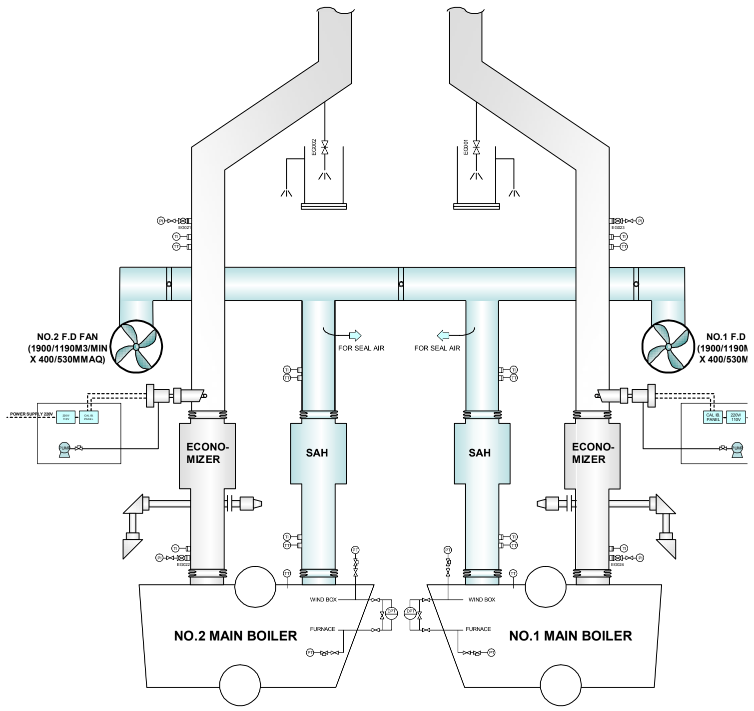
(11) Keep the fan auto/manual switch in manual position. After boiler load steadies and air distribution to both boiler adjusts, set the air damper in that position. With the fan auto/manual switch, adjust air flow manually to match the boiler load.

(12) Increase the main engine load gradually.

Note !

1 Since the fan operated near the maximum capacity and air pressure is low, so draft loss is liable to occur. Therefore increase the frequency of soot blowing for the main boiler and economizer to 3~4 times a day.

2. The steam outlet valve of the shut-down boiler need not run at all. Cleaning the burner tip. Change the burner to gas burner for each boiler and clean it. Shut down one burner at a time for each boiler, and after cleaning, light up one burner at a time simultaneously for each boiler. Note that if the number of burners in use is different between two boilers, air distribution becomes uneven, and will cause problems in air flow adjustment.



7.2.4 Main Boiler Emergency Operation When Both CPU Fails

Operation When Both BMS CPU Fails

When both BMS CPU fails, the boiler can run on the BMS CPU bypass mode. An "EMERGENCY OPERATION PANEL" is provided on the BGB. (#show an interlock condition.) In case of emergency as follow these steps:

(1) For starting the FO burner
a : # Start the FD FAN
b : Start the FO PUMP
c : # Fully open the FD FAN inlet vane and purge the furnace.

Note !

Purge the furnace for 3 minutes or more using the FD FAN inlet vane. Let all burner air register a fully open condition.

d : # Put the FO SHUT-V/V SWITCH on OPEN.
e : # Put the Base burner IGNITER SWITCH on INSERT. Switch the Base burner V/V SWITCH to "OPEN" after switching on the igniter switch.

Note !

The time for the trying ignition should not set for more than 15 seconds.

f : If the FO still does not ignite, repeat steps C to E.

(2) Extinguish the FO burner

a : Put the Base, No.2 or No.3 FO burner V/V SWITCH on "CLOSE".

Note !

1. Sufficiently purge furnace.

2. If the boiler is on emergency operating mode, the following FO SHUT-OFF conditions are actuated.
Other FO SHUT-OFF conditions except the following are to be overridden. Only an operator must directly confirm and operate.
- FD FAN STOP
- STEAM DRUM WATER LEVEL L-L
- BLACK OUT
- FLAME FAIL
- MANUAL TRIP

3. The gas burner will not run on EMERGENCY MODE.

BMS Emergency Operation

The FO Burner can start or stop by using the Emergency Operation Panel at the local(BGB) position when the BMS controller cannot run.
In this case, the operator must watch and confirm all the interlock conditions directory.
When the ABC controller is running normally, the operator can select the (AUTO/MAN) ABC control mode(Air Flow and FO Flow) after burner ignites.

7.3 HP and LP Turbine Solo Running Operation (Emergency Operation)

Emergency Operation of the Main Turbine

If the HP or LP turbines, or any associated gears fail, the pipelines can be altered to allow either turbine to operate singly at reduced power. Some additional piping will have to be added while some should blank off. When the LP turbine gets damaged and the ship can only run on the HP turbine, then no astern power will be available.

Operating with the HP Turbine Only

a) Remove the ring-flange (B) from the crossover pipe.
b) Insert the blank flange (E).
c) Remove the blank flange (C) from the crossover pipe.
d) Remove the blind flange (D) from the lower exhaust casing.
e) Using emergency piping connect the HP turbine exhaust directly to the LP turbine exhaust casing. For this connection, insert an orifice (F) between the crossover pipe and emergency piping.
f) Disconnect the LP turbine coupling to avoid turning the LP turbine.

Operating with the LP Turbine Only

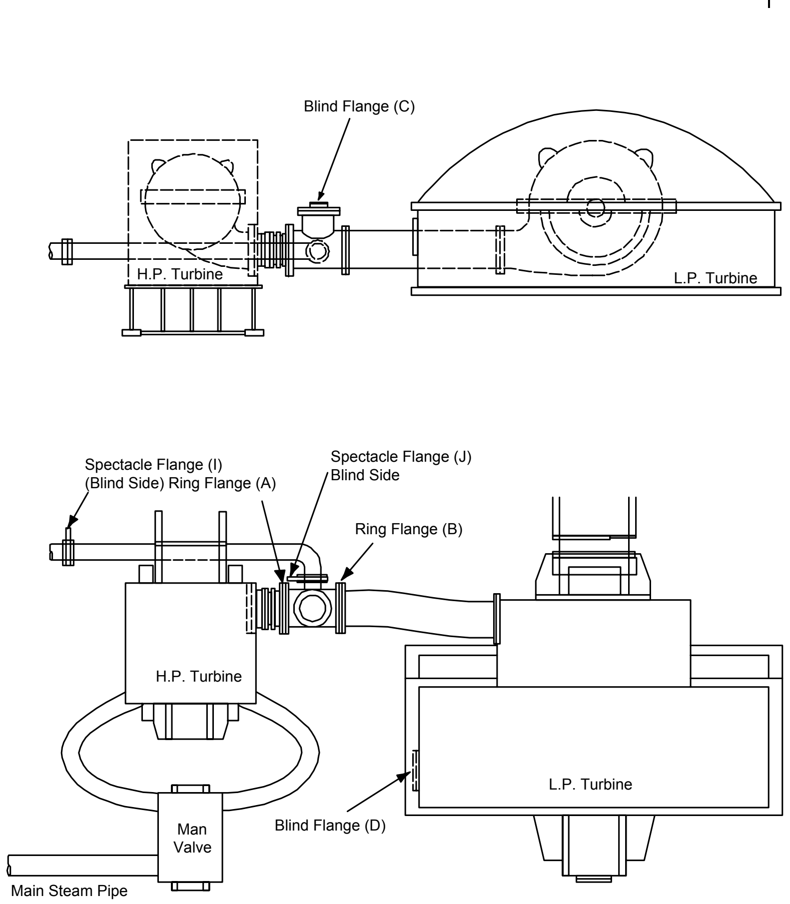
a) Remove the ring-flange (A) from the crossover pipe.
b) Insert the blind flange (E).
c) Move the spectacle flange (l) and make it fit on the orifice.
d) Move the spectacle flange (J) in the emergency piping from the blank to the open side.
e) Disconnect the HP turbine coupling.
f) Running ahead can be carried out by operating the steam stop valve.

The following conditions should apply during emergency operations.

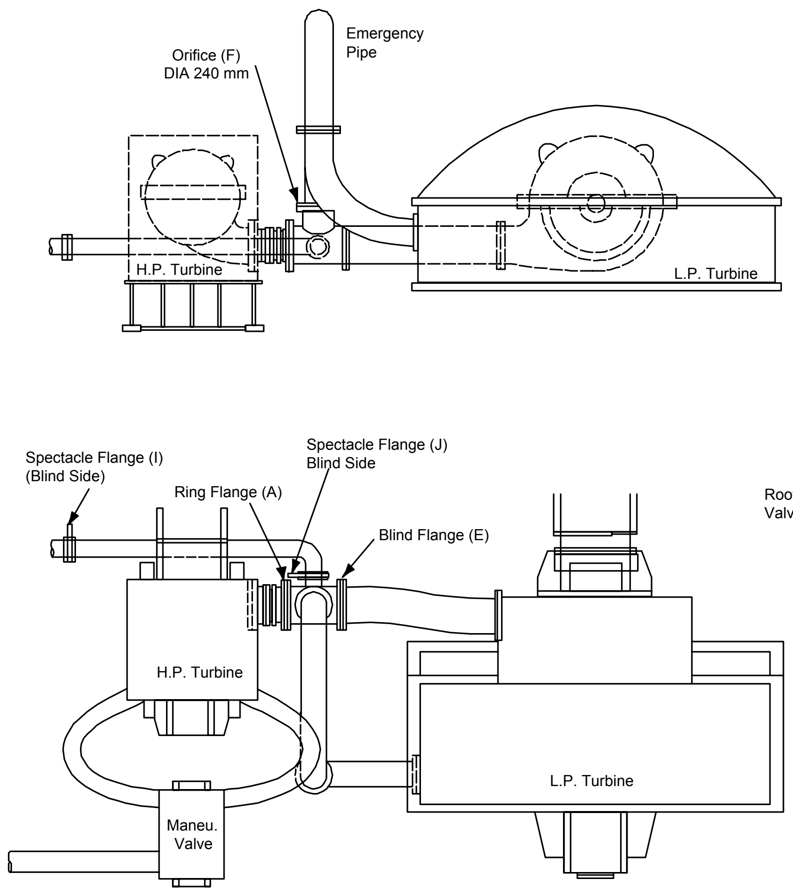
	HP Turbine in use	LP Turbine in use
Steam Condition	3.92 MPag at 500°C	0.343 MPag at 245°C
Output	11,500 PS	11,000 PS
RPM	59	60

It Failure will likely occur at sea, so the turbines will therefore be hot and will need to cool for some time while work is carried out. Before opening the main engine for internal inspection, it should be cooled down with the turning gear in use, unless internal mechanical damage prevents this.

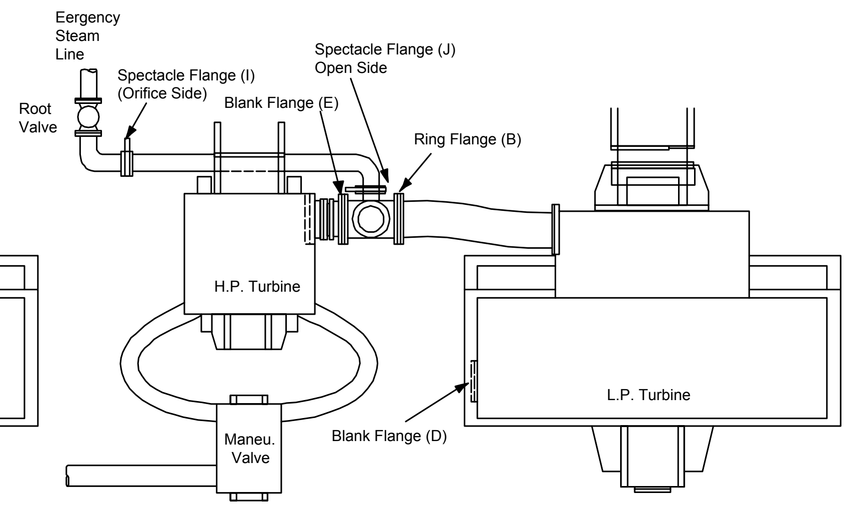
If it is impossible to cool the engine using the turning gear, care must be taken when starting the disabled turbine. It should run at low revolutions for several hours in order to straighten out any bowing of the rotor which may have happened at cool down/stationary stage. If vibrations occur when speed increases, decrease the speed until vibrations stop and allow the temperature of the rotor to stabilise. Speed can then increase slowly to the maximum permitted value.



Normal Operation

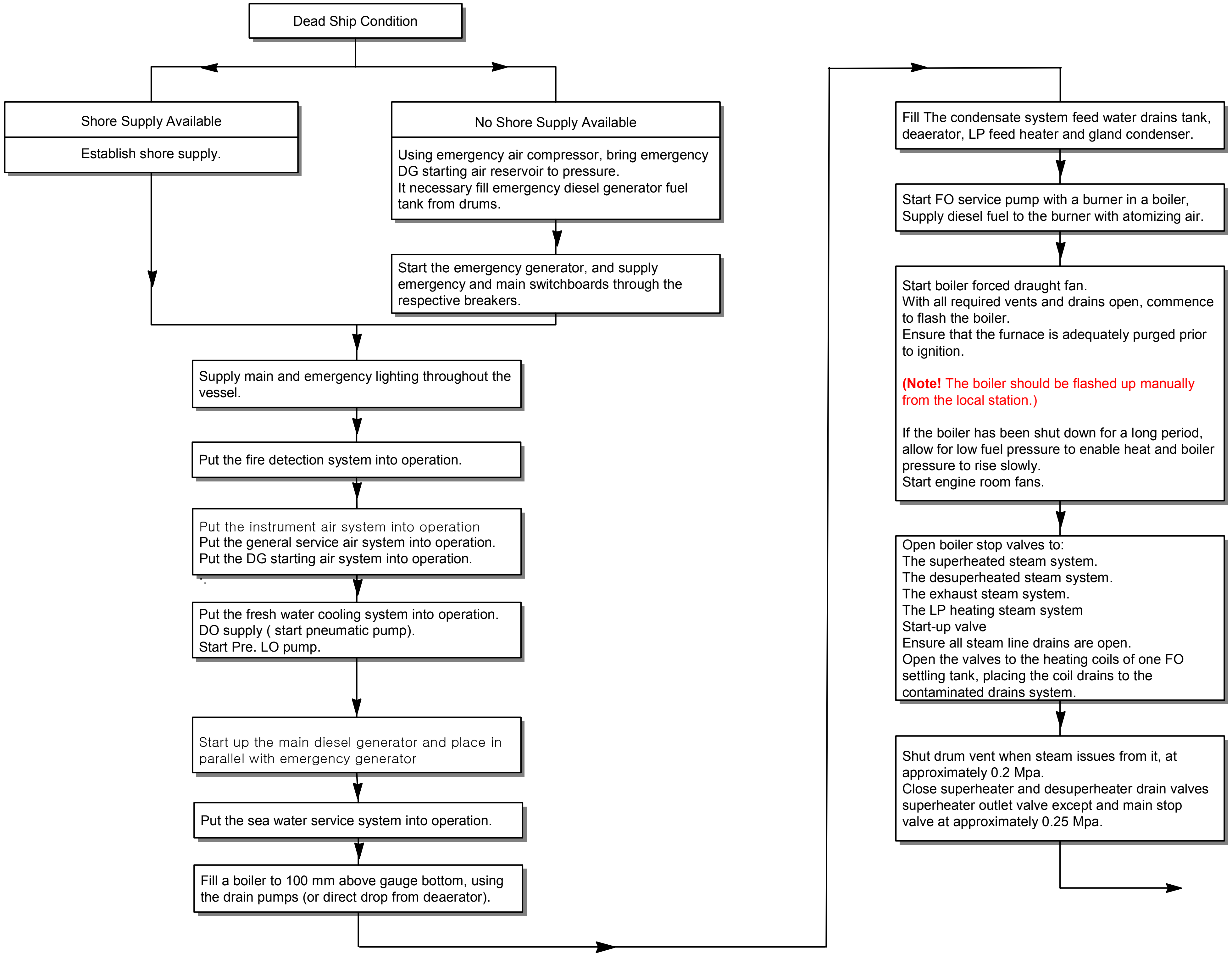


Operation With H.P Turbine



Operation With L.P Turbine

7.4 Restore Engine Room Plant after Black Out



By manual operation of the burner registers, place the No.1 unit in use.
When the fuel temperature is approximately 90'C open settling tank outlet valve and close the diesel oil supply.
Allow the No.1 burner to operate, and continue to raise the steam pressure in the boiler, on heavy fuel oil.

As the steam pressure rises, use the emergency feed pump to maintain the boiler water level.
With boiler now being fired on heavy fuel oil, the fuel pressure will require adjusting to maintain pressure rise.

Start auxiliary sea water circulating pump to supply atmospheric condenser. When boiler at approximately 1.8 Mpa pressure, ensure the drains pump system is operating to the deaerator.
Put one main feed pump into operation to maintain the boiler level.
The turbine exhaust will be to the deaerator, steam air heater and HP dump to atmospheric condenser.

At 3.0 Mpa, start warming of main turbo generator.
At approximately 5.0 Mpa, start up on main turbo generator.
The electrical load for em'cy generator shifts to main turbo generator with short time black out.
Shut down the emergency generator and place on standby.

With the boiler superheater being circulated, as steam being supplied to the feed pump and turbo generator, all the boiler drains and vents can now be closed.
Continue to raise steam pressure, with fuel control on manual.
Check each system now in use, and gradually change over all control systems to automatic and/or remote.
Ensure systems and components that have been used are placed back on stand-by condition or isolated e.g. emergency feed pump, emergency diesel generator etc.

At a boiler pressure of 5.88 Mpa, close the boiler start-up valve and ensure the boiler ACC steam flow/pressure valves are open, and change over the boiler master/fuel and air controllers to automatic.

The boiler should now be providing normal steam pressure to turbo generator/main feed pump/and fuel oil heating etc.

Start up all remaining auxiliaries-refrigeration units/air condition units/not in use fans/galley and accommodation supplies etc.

(**Note !** If the vessel is in dry dock, or alongside a shore installation, electric power maybe supplied through the shore breaker.)
However, this is normally used for dry dock purposes when separate arrangements are made for cooling water supplies to air compressors/refrigeration and air conditioning units.

Vessel in Live Condition

7.5 Generator Manual Synchronizing Procedure

7.5.1 Parallel Operation

CAUTION Conditions for Generator Paralleling;

1) The incoming generator voltage is approximately equal to the bus voltage.

2) The incoming generator frequency is approximately equal to the bus frequency.

3) The circuit breaker (VCB) for the incoming generator must be closed at an exact instant when the generator voltage is in phase with the bus voltage.

The following describes, as an example, the steps to follow on a live bus. The live bus is served by the No.1 turbo generator by controlling the No.1 MSB.

Engine Start

From the main switchboard ,start the diesel engine for the diesel generator, Let the diesel generator voltage establish.

Voltage Check and Adjustment

Set the “VOLTMETER” switch for the diesel generator panel to each phase-to-phase position, then compare the generator by ‘BUS’ voltmeter. If they are not equal to each other, adjust the generator voltage so it will be the same as the bus voltage (assumed as the rated value).

Frequency Check and Adjustment

Compare the generator frequency with the bus frequency by “GEN” and “BUS” frequency meter. The bus frequency is maintained at the rated value by automatic frequency control. The generator frequency should be slightly higher than the bus frequency in this step and the next step.

Closing the Generator ACB at Manual Synchronism

CAUTION Synchronous Closing Operation

Closing must be synchronous when close the generator ACB while voltage is being applied to the main bus. Closing the VCB without synchronization may cause an abnormal tripping of the VCB.

Set the “SYNCHROSCOPE” switch COS-CH on the cargo feeder & synchro panel to the check position, Observe the movement of the synchroscope pointer as well as the brilliance change of the synchronization check lamps.

(1) The synchroscope pointer will rotate in FAST (clockwise) direction.

(2) This indicates that the generator frequency (Diesel generator’s) is higher than the bus frequency (Turbo generator’s). The sequence for brilliance change of the three synchro lamps also runs clockwise. In this case, set the “GOVERNOR MOTOR” control panel for the diesel generator to “RAISE” until the synchroscope pointer changes its direction of rotation from SLOW to FAST.

(3) The synchroscope pointer is stationary.

(4) This condition indicates that the generator frequency is exactly equal to the bus frequency, and the position of the stationary pointer indicates the relative phase angle between the generator and the bus voltage. There is no brilliance change in the syncro lamps. In this case, set the “GOVERNOR MOTOR” control switch for diesel generator to : “RAISE” until the synchroscope pointer starts to rotate in FAST direction.

(5) The synchroscope pointers indicate a 12 o’clock position.
Whether the pointer is moving slowly or stationary, this condition indicates that the generator voltage is in phase with the bus voltage (synchronism). At this instant, the middle top synchro lamp is completely dark and the two lower outer lamps are turned on with the same brightness.

Closing the generator VCB at Synchronism

CAUTION Manual Synchronous Closing Operation

Do not close the generator ACB unless it synchronizes point with the generator :

1) Close the generator ACB within range of approximately 15^{o} on both the FAST side and the SLOW side. The synchroscope pointer must point at 12 o’clock position-this is the synchronization point.

2) The ACB synchronous closing operation outside the range described in item 1) may pull the generator out of synchronism and cause an abnormal tripping of the VCB. This may lead to a no-voltage on the main bus.

Observe the synchroscope / synchronization check lamp. Place the the “GOVERNOR MOTOR” control switch for the diesel generator to “RAISE” and adjust the frequency of the diesel generator. Gradually lower the generator frequency until the synchroscope pointer rotates in FAST direction Complete one rotation in 3 to 4 seconds. Make sure the synchronization check lamp flickers at a rate of 3 to 4 seconds. (This will result in the difference between bus and generator frequencies that are approximately 0.3Hz.) The the closure of diesel generator VCB should occur at the exact instant of synchronization. Shortly before synchronization, turn the “ACB CONTROL” switch for the diesel generator to “CLOSE” Close the diesel generator VCB, after the “SYNCHROSCOPE” switch is turned “OFF”.

Operation of Check Synchronizer

CAUTION Manual Synchronous Closing Operation

Do not close the generator VCB unless it synchronizes point with the generator :

1) Close the generator VCB within range of approximately 15° on both the FAST side and the SLOW side, with the synchroscope pointer placed at a 12 o’clock position.

2) The VCB synchronous closing operation outside the range described in item 1) may pull the generator out of synchro. and cause abnormal tripping to the VCB. This may result in a no-voltage on the main bus.

Failure caused by closing the VCB outside synchronism can be prevented by using the check synchronizer. Turn “ON” the “CHECK SYNCHRO” switch (COS_CH) on the cargo feeder & synchro panel. While observing the synchroscope and synchro indicator lamps, perform the VCB closing operation. If done in a state outside synchronism, ACB closing becomes impossible, since the check synchronizer did not transmit the signal. The permissible range for synchronized closing is ±15^{o} at synchronism.

CAUTION Heading of check synchronizer

In adjusting the permissible range and handling, refer to the instruction manual of the check synchronizer (AUTOMATIC SYNCHRONISM DETECTOR type ESC-1M).

Automatic Load Sharing Control

If the control mode setting is OPTIMUM or PROPORTION by the “TG1 OPTIMUM CONT” illuminated push-button switch or “PROP CONTROL” illuminated push-button switch on the cargo feeder & synchro panel, or above setting after closing to ACB of diesel generator and put on line. As soon as the diesel generator is on line, the GAC automatic load sharing control function starts to control the governor motors of the turbo generator and the diesel generator. This way each generator will be loaded with the same percentage in reference to their rated kW output values while the bus frequency will be maintained at the rated value. Nevertheless, the generator kilowatt meters on the cargo feeder & synchro panel indicate the kW load values on the respective generators.

Manual Load Sharing Control and Load Shift Control

Normally, the load sharing control automatically runs.
It can also be initiated a manually. For “POWER CONTROL OFF”, press the push-button on the cargo feeder & synchro (manual control mode).

(1) Manual Load Sharing Control

The diesel generator is placed onto a live bus, which is served by the turbo generator. Set the “GOVERNOR MOTOR” control switch for the diesel generator to “RAISE” so that the diesel generator will take on kW load. This lightens the kW load on the turbo generator and increases the bus frequency, provided that the total kW load remains uncharged during control. Therefore, set the “GOVERNOR MOTOR” control switch for the turbo generator to “LOWER”, Make sure to operate the “GOVERNOR MOTOR” control switches for turbo generator and diesel generator simultaneously to generate speed load sharing control and bus frequency control. The turbo generator and diesel generator should be equally loaded by this control. The load division between the turbo generator and diesel generators, once determined, will remain unchanged, but the bus frequency will change if the total kW load will change. In this case, the bus frequency should be controlled by placing both generator’s “GOVERNOR MOTOR” control switches to “RAISE” if the bus frequency is lower than the rated value, or to “LOWER” if the bus frequency is higher than the rated value.

(2) Manual Load Shift Control

The following describes, a sample, the case where the diesel generator is removed from the bus when the turbo generator and diesel generators are on line. Set the diesel generator “GOVERNOR MOTOR” control switch to “LOWER” and the turbo generator to “RAISE”, This lightens the kW load on the diesel generator and increases the kW load on the turbo generator i.e., the load on the diesel generator is shifted to the turbo generator. When removing the diesel generator from the bus, wait until the load on the diesel generator is reduced to about 5% of its rated kW output. Then set the diesel generator’s “ACB CONTROL” switch to “OPEN”. Adjust the bus frequency to the rated value as necessary by switching the turbo generator’s “GOVERNOR MOTOR” control switch to “LOWER” or “RAISE”.

CAUTION Manual Load Sharing and Load Shift Control

1) Pay attention to variations in bus frequency during load sharing control or load shift control. Maintain the bus frequency at the rated value.

2) To remain online during the load shift control, pay attention to the kW load on the generator. Restore the original parallel operation if the generator to remain online is expected to be overloaded.
If the kW load on the generator that will removed is reduced beyond zero during the load shift control, the reverse power protection function will operate to trip the generator ACB.

7.5.2 Stopping a Generator Engine

Whether the “CONTROL POSITION” selection switch on the machine side GELP is in “LOCAL” or “REMOTE”, and whether the “ACB CONTROL” select switch on the cargo feeder & synchro panel is in “MSB” or “IAS”, the generator diesel engine stop control is always performed in M/S or MSB or IAS. Remove the diesel generator from the bus, and perform the following steps to stop the engine :

1. When the diesel generator is in single unit operation, remove unnecessary loads to lighten the load on the generator.

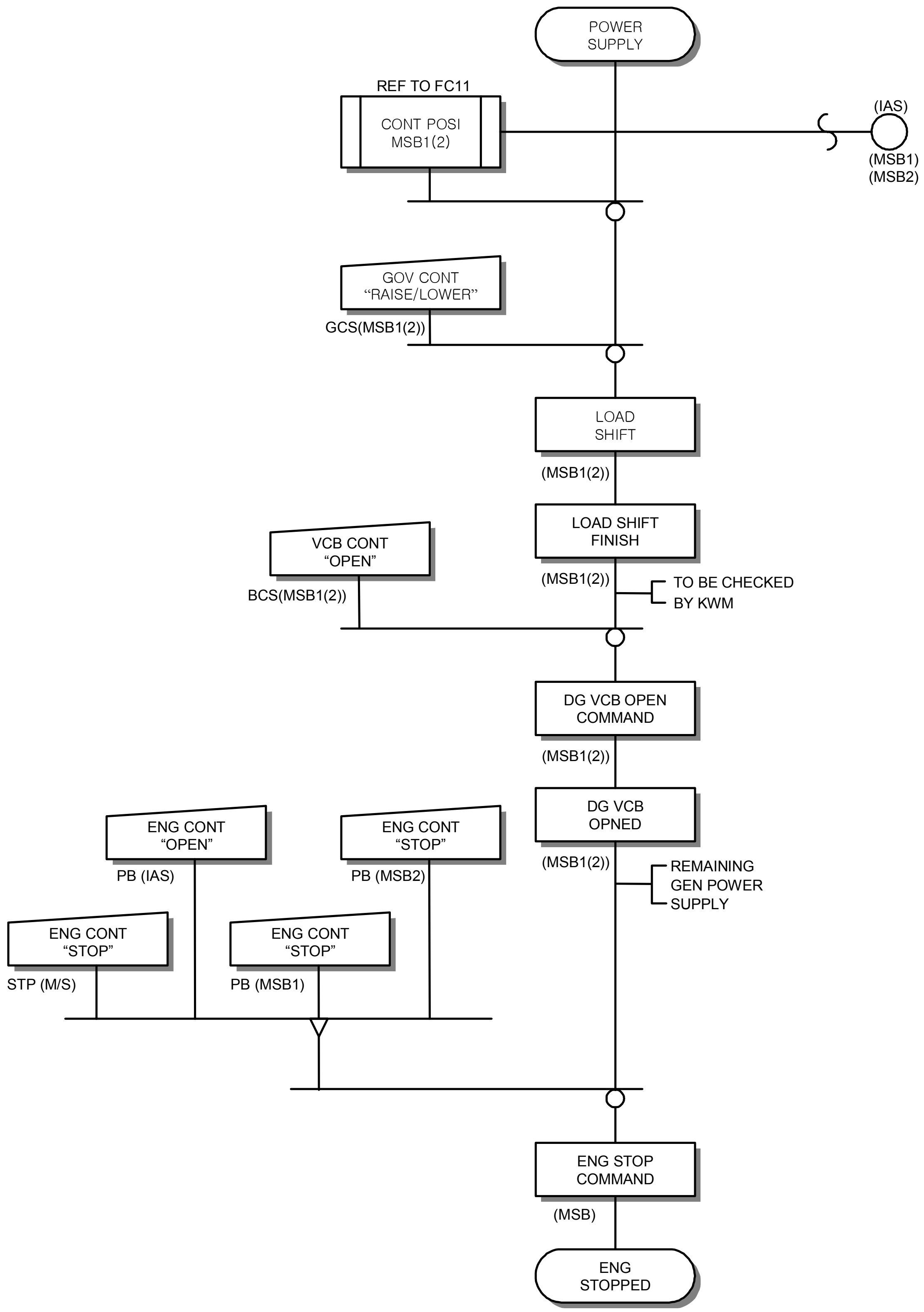
2. Turn the “ACB CONTROL” switch on the cargo feeder & synchro panel to “OPEN” to remove the diesel generator from the bus.

3. When the generator is in parallel operation with another generator, perform 2) “Manual Load Shift Control”.

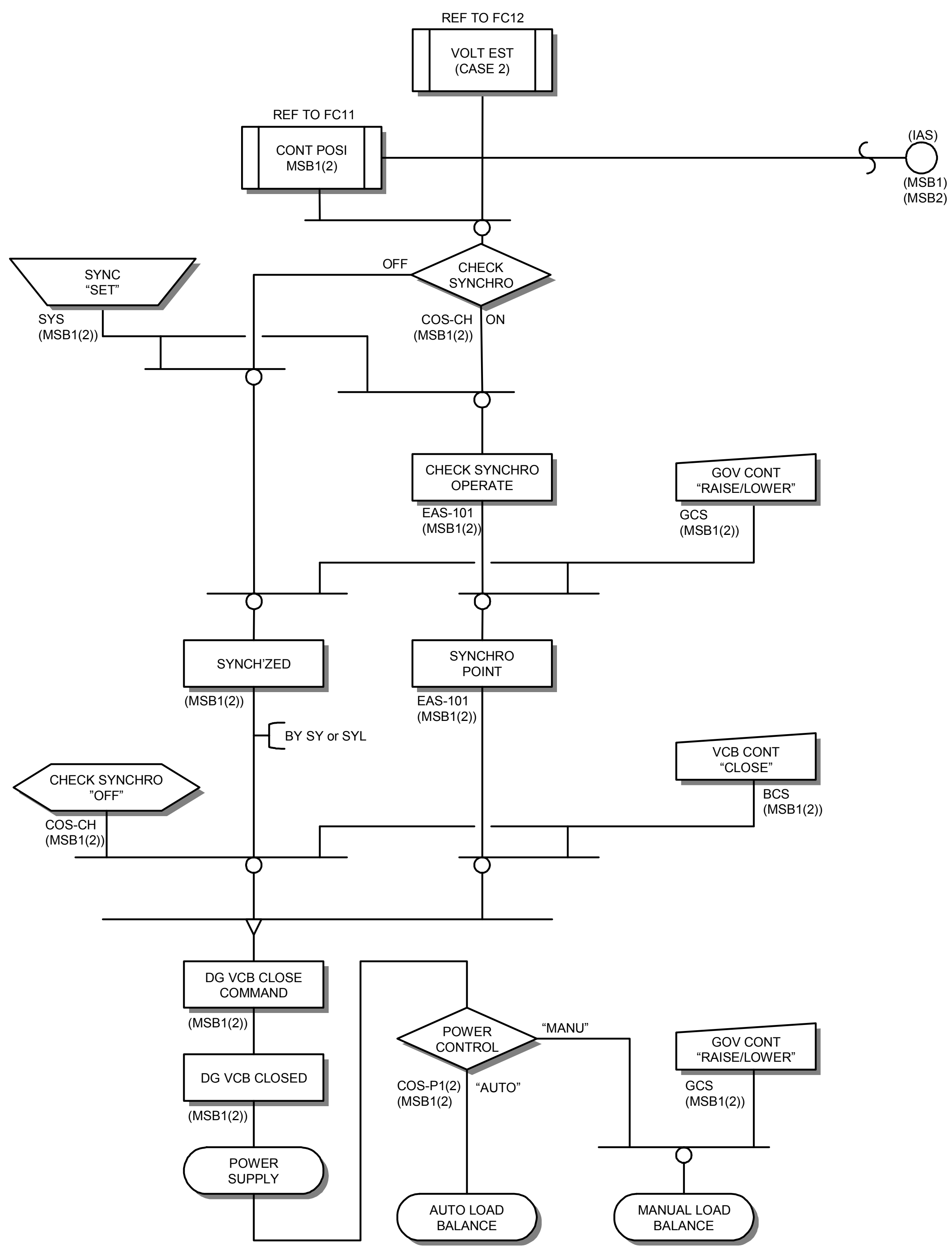
4. Turn the “ENGINE CONTROL” switch on the cargo feeder & synchro panel to “STOP” to stop the generator diesel engine. The diesel engine can be stopped on the machine side GELP and IAS.

CAUTION Generator ACB abnormal Tripping

Stopping the generator diesel engine manually while the generator ACB is closed will result in the abnormal tripping of the generator ACB.

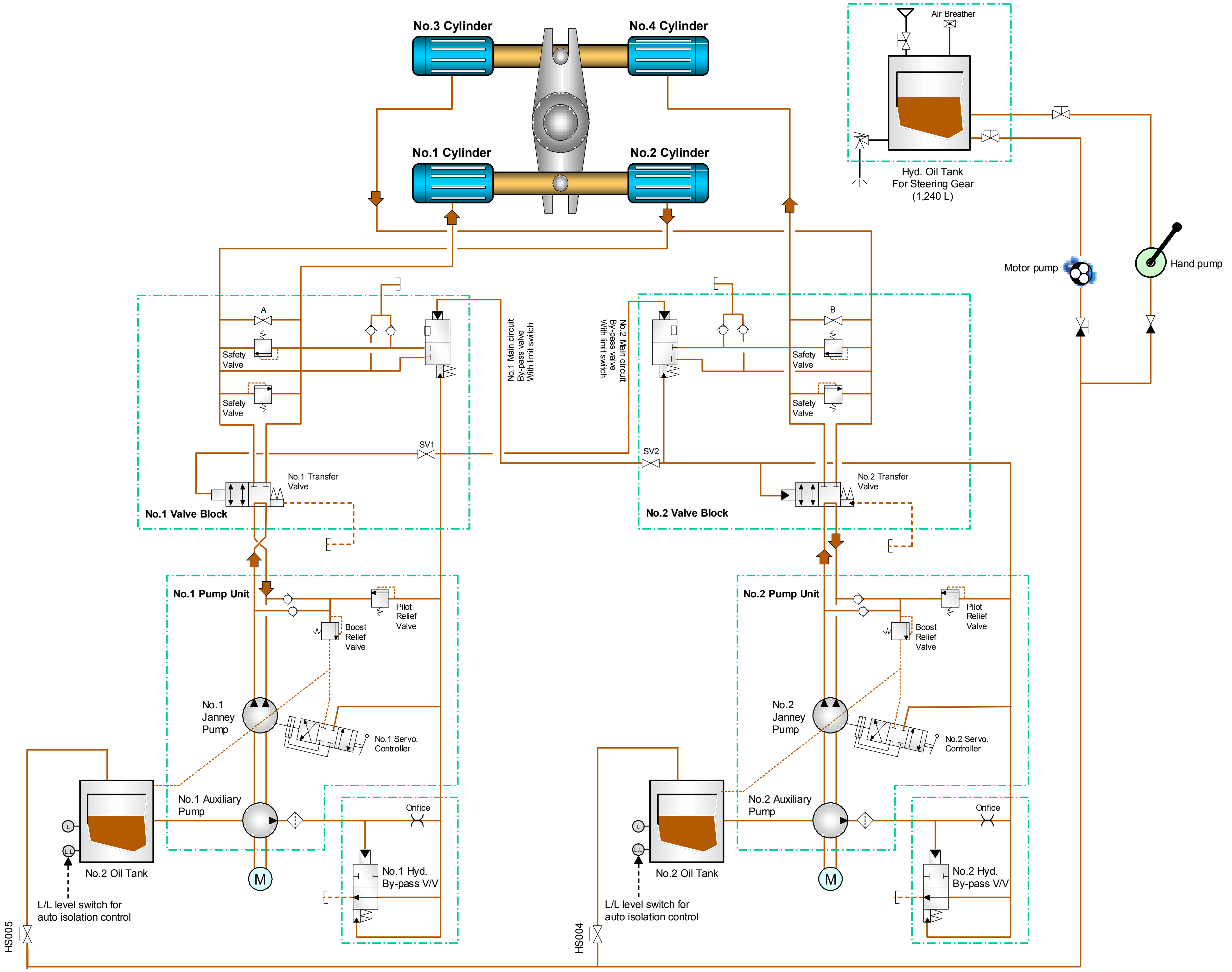


Refer to Inst. Manual for 6.6kV main switchboard & Generator automatic control panel FC15



Refer to Inst. Manual for 6.6kV main switchboard & Generator automatic control panel FC14

Illustration 7.6i Procedure of Steering Gear Emergency Operation



7.6 Procedure of Steering Gear Emergency Operation

General Description

YOOWON – MITSUBISHI Electro – hydraulic steering gear has a compact build, is highly reliable, and is practical in application.
This 2-Ram, 4-Cylinder, Rapson-slide type was constructed with two variable displacement pumps.
It runs on auto. pilot, follow-up control and non follow-up control.
The maximum rudder angle was designed to have the ram stop at 47.5° for a maximum rudder angle of 45° on each side.

Operating procedure

Mechanical lever steering(S/G compartment)

a) Put the selector switch of the auto-pilot control box(rudder servo unit) to the local or off position.
b) Select which janney pump to use for manual steering.
c) With mechanical control lever in mid position, run the selected janney pump.
d) Operate the manual control lever according to the steering command.
e) Upon achieving the ordered rudder angle, return the mechanical control lever to neutral.

Note !

1. Change-over for the power units should be done by operating the electric motor start/stop switches.
2. When an alarm sounds out to warn of failure in any power unit, stop the particular power unit, and then start another one. Investigate what went wrong with the defective unit.
3. In case of failure in the hydraulic circuitry, operate the power unit and valves according to the operating instructions that are mounted on the steering gear compartment.

Operating Mode Valve Positions

Case	Working pump	Working cylinder	By-pass valve		Stop valve		Notices
			A	B	SV1	SV2	
1	1	1,2	X	X	O	O	O-V/V to be open
2	2	3,4	X	X	O	O	X-V/V to be close

(1) The cases for 1, and 2 are of ordinary use.
(2) Both systems can not simultaneously run, because a system would be interlocked by a motor starter.
(3) Should the auto pilot torque motor fail, pull out the corresponding torque motor linkage pin and then switch to the manual operation described in mechanical steering.

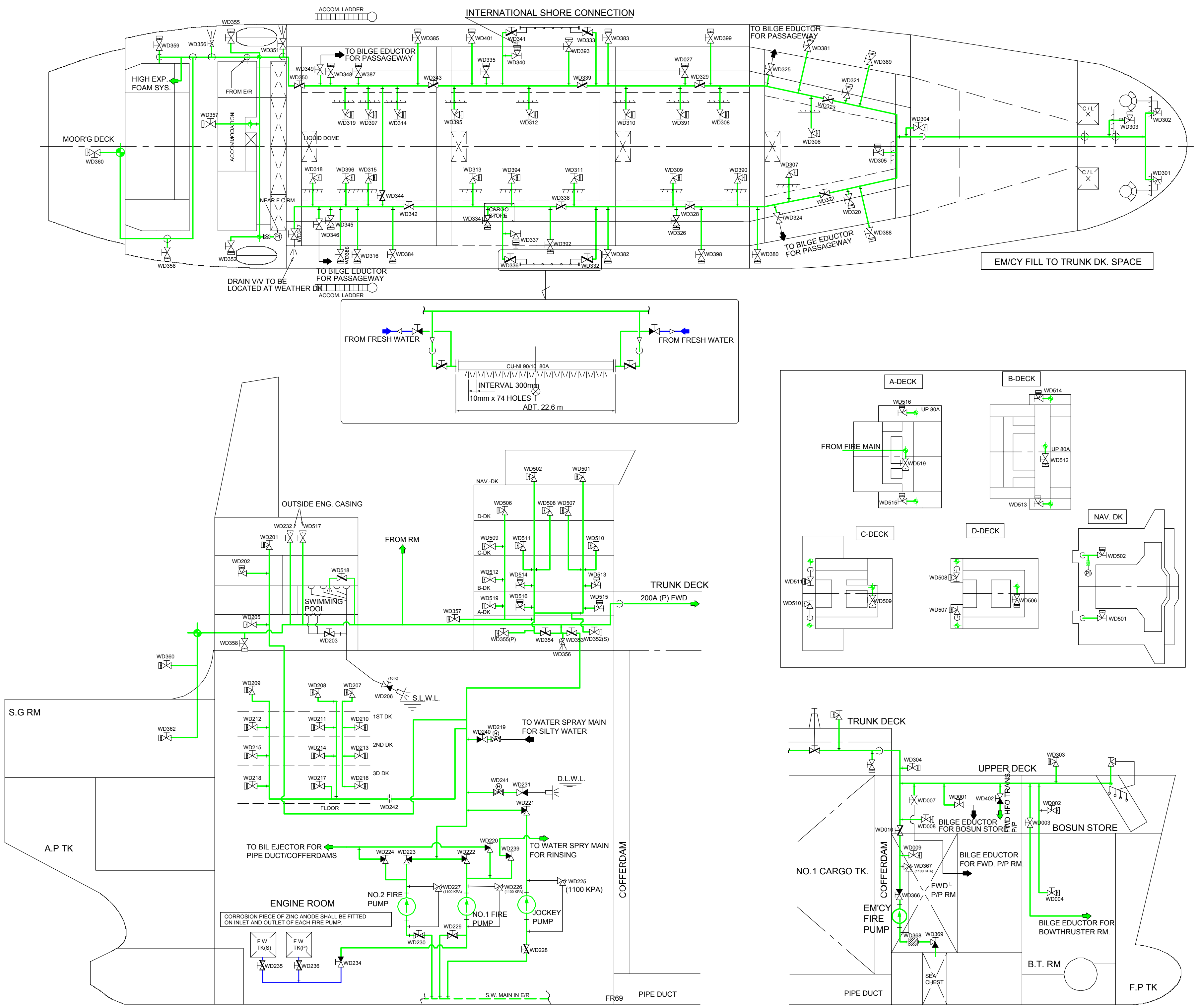
Isolation system when single failure should occur

(1) Use the “Automatic Isolation System for IMO-100 type Mitsubishi Steering Gear”, according to the RULE REQUIREMENTS.
(2) The auto isolation panel is not necessary to this system.
(3) Two sets of actuators (each with a capacity of 100% of design capacity) are provided so that each actuator can offer 100% capacity. The power system is completely doubled.
(4) In instances when a single failure that accompanies oil leakage occurs, when the oil piping system has one pump in service and the other out of service, the oil level in either the No.1 or No.2 oil tank falls Then low level switch in the operation system is set in motion, sending an alarm to the bridge and engine room.
(5) When the oil level in either the No.1 or No.2 oil tank (connected with the failed system) falls to the low-low level, activate the low-low level switch fitted to the tank in order to automatically stop either the No.1 or No.2 motor and have the other motor to automatically start. This system should be designed on the electric circuit of the motor starter by shipyard.
(6) In this case, the actuator has a capacity of 100% and the ship speed need not be reduced.

Part 8 : Fire Fighting Systems

Part 8
Fire Fighting Systems

Illustration 8.1i Fire and Deck Wash System



Part 8 : Fire Fighting Systems

8.1 Fire and Deck Wash Systems

The fire main system is supplied from the engine room, by the two Fire pumps. They are single speed centrifugal pumps, with a delivery capacity of 150 m^3/h at 1MPag.

The emergency fire pump is located in the forward pump room in a well. This pump is a self-priming centrifugal pump with its own direct sea suction. The pump is rated at 340 m^3/h and is supplied from the emergency switchboard.

The fire main is kept pressurized by a jockey topping up pump rated at 10 m^3/h at 1 MPag. This pump has an automatic pressure cut-in/out switch and is kept topped up and under pressure at all times.
(Auto. start : 0.5 MPag, Auto. stop : 0.75 MPag)

The deck fire main has a main isolator valve WD353 before the port and starboard main ring main isolator valves. The ring main is fitted with a further four section isolator valves on each side at regular intervals along the deck to allow any part of the system to be supplied from either side of the ship.

The fire main also serves the water curtain below the port and starboard manifold areas during loading and unloading conditions.

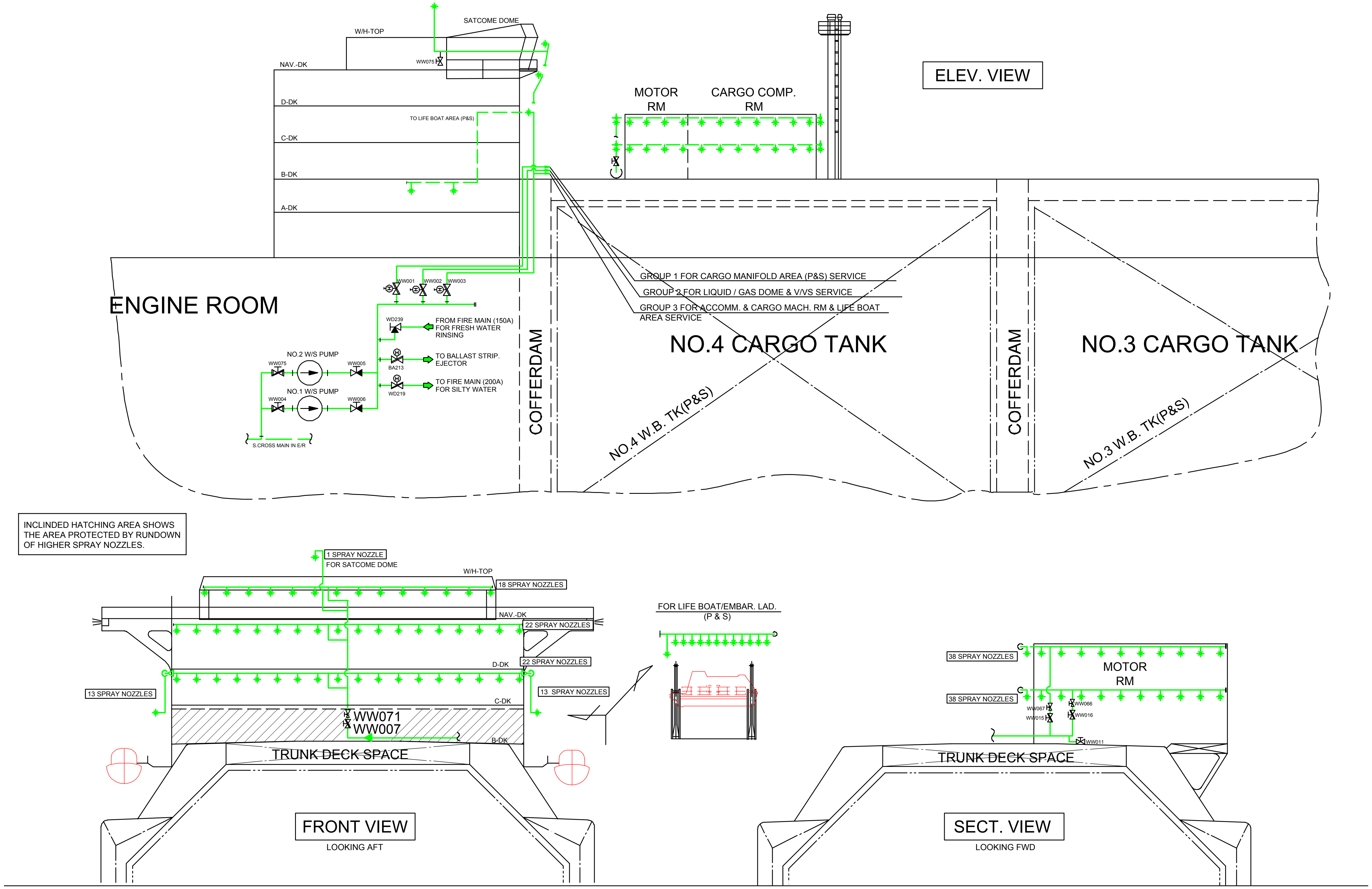
The fire main supplies the driving water for the bilge eductors in the side passage way, duct keel pipe duct, forward pump room, bow thrust room and boson store. It also supplies anchor washing water filling.

There are 24 fire hydrants situated along the cargo space, each with its fire hose mounted adjacent.

The emergency fire pump can be started locally, from the bridge or the fire control center (FCC).

Under normal operating conditions the fire main will be under pressure during port time, supplying the manifold water curtain and with hoses run out as a fire precaution.

Illustration8.2i Water Spray System



8.2 Water Spray System

A water spray system protects the accommodation block front, compressor house, cargo tank liquid and vapour domes, and manifold areas from fire, gas leakage, or liquid spill. There are two 700 m^3/h two(2) spray pumps, mounted on the bottom platform in the engine room, delivering to 3 spray rails across the accommodation block front, lifeboat embarkation areas port and starboard, compressor house sides, and deck domes/manifolds. They are grouped into three sections as follows;

Group 1	Cargo manifold port and starboard.
Group 2	Cargo liquid dome, cargo vapour dome and valves
Group 3	Accommodation and cargo machinery rooms and lifeboat embarkation area and satcome dome

Each group main spray rail has a remotely operated hydraulic isolating valve at the fire control room, CCR, and manually at the local side. The spray pump can be started locally, from the wheelhouse, CCR, on the main deck close to the accommodation exits, and the fire control room.

Each main group is subdivided into smaller sections, with a flow regulating and a section isolating valve fitted. The accommodation front covers 3 such subsections, beginning at deck level D, right through to the navigation/bridge deck. The decks below the D deck will have sufficient flow passing over them so that they do not need to be covered by a fixed rail.

The nozzle arrangement is as shown below; plain vertical surfaces, nozzles are set 800 mm apart and at 45° to the vertical. Headers are 250 mm from bulkheads and nozzles are drived from a flat cone design.

Number of Nozzles and Capacity

Group 1

Cargo manifold	
Port	22 nozzles at total flow of 982.92 l/min
Starboard	22 nozzles at total flow of 982.92 l/min

Group 2

No.1 liquid dome	24 nozzles at total flow of 698.00 l/min
No.2 liquid dome	22 nozzles at total flow of 616.72 l/min
No.3 liquid dome	23 nozzles at total flow of 705.10 l/min
No.4 liquid dome	20 nozzles at total flow of 664.06 l/min
No.1 gas dome	4 nozzles at total flow of 167 l/min
No.2 vapour dome	4 nozzles at total flow of 175.5 l/min
No.3 vapour dome	5 nozzles at total flow of 223.8 l/min
No.4 vapour dome	7 nozzles at total flow of 272 l/min

Group 3

Nav. Bridge-deck	18 nozzles at total flow of 320.4 l/min
D-deck	22 nozzles at total flow of 435.6 l/min
C-deck	22 nozzles at total flow of 435.6 l/min
Satcome Dome	1 nozzles at total flow of 252 l/min
Lifeboat embarkation	
Port	12 nozzles at total flow of 104.7 l/min
Starboard	12 nozzles at total flow of 104.7 l/min
Cargo m/c room	
Forward (L/U)	11/11 nozzles at total flow of 231/215 l/min
Aft (L/U)	11/11 nozzles at total flow of 336/313 l/min
Port (L/U)	16/16 nozzles at total flow of 231/215 l/min

There are drain connections provided at main deck level below the manifold area and below the cargo machinery room.

The water spray pump can also be crossconnected onto the fire main in an emergency via valve WD239, located in the engine room. Under normal circumstances this valve is kept locked shut.

The water spray system can be flushed with fresh water by cross connecting the bilge fire general service pump to the suction from fresh water tanks.

.

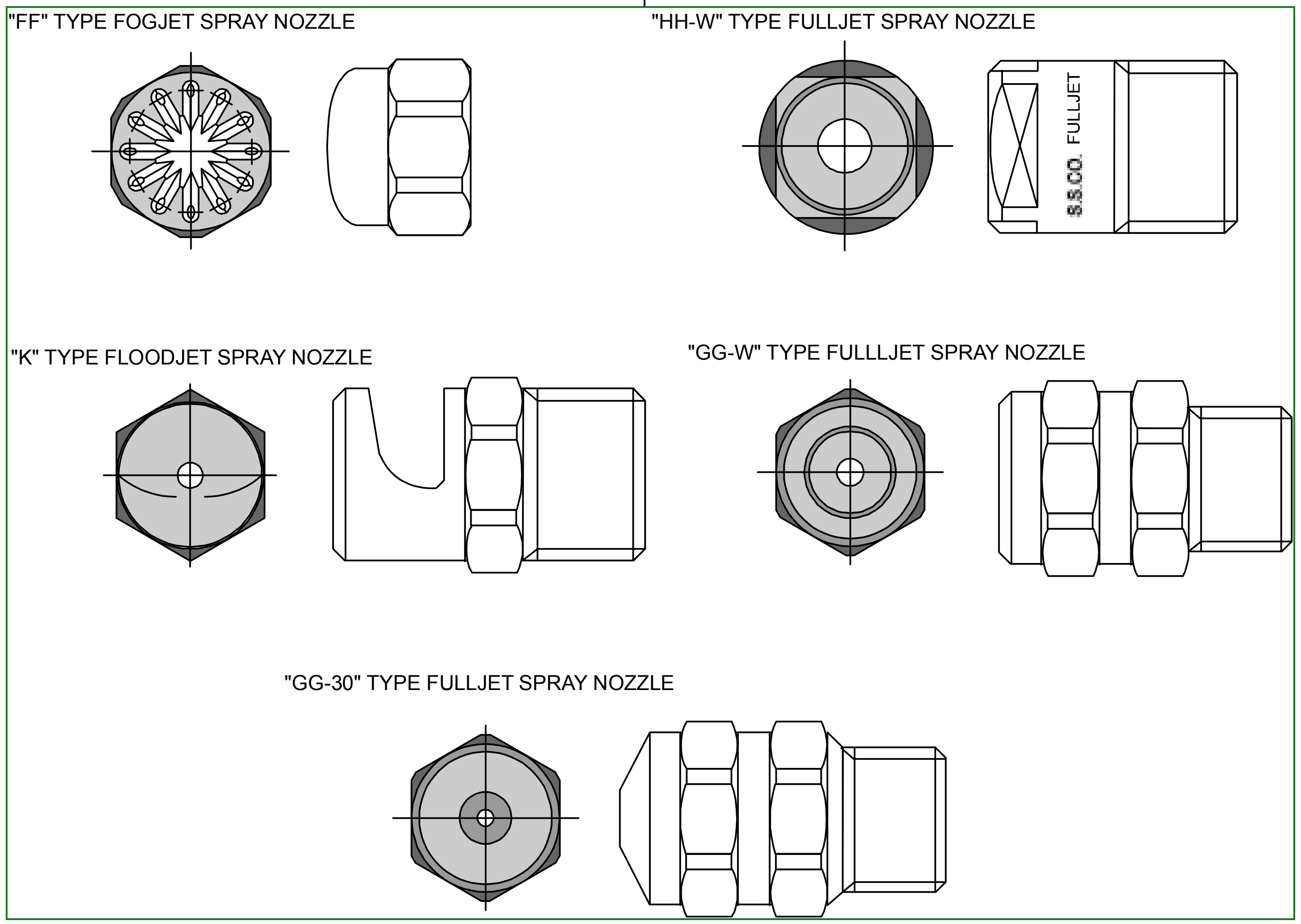
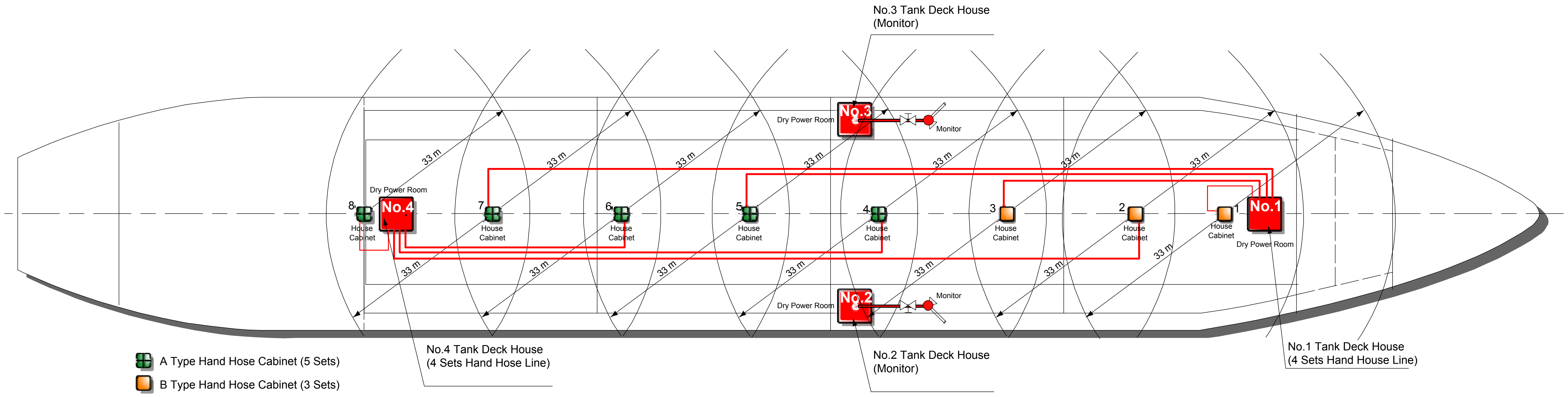
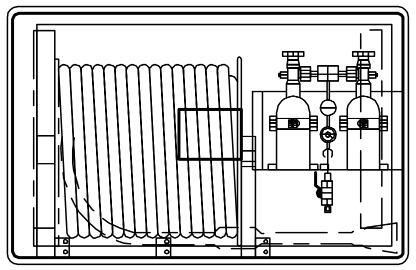


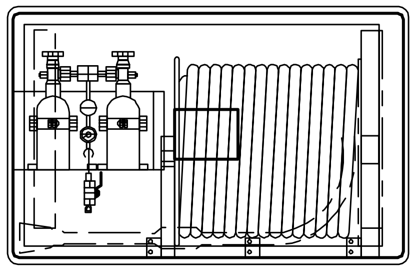
Illustration 8.3.1i Dry Powder System

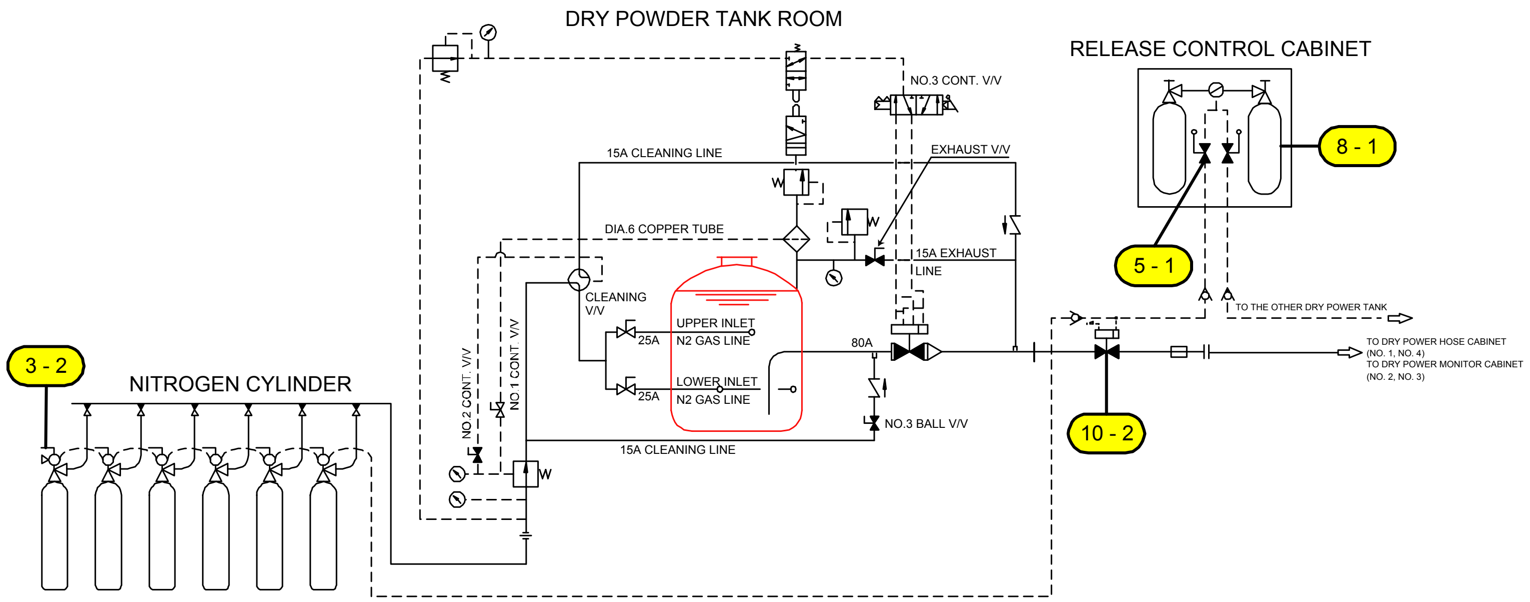


A Type



B Type





TO OPERATE DRY POWDER MONITOR RELEASE CABINET

1. Open door.
2. Open one cylinder valve. 8 - 1
3. Open ball valve. 5 - 1
4. System Should Operate.
5. If system fails to operated go to dry powder tank room and follow emergency operation procedure.

EMERGENCY OPERATING

1. Open valve 3 - 2 and 10 - 2

AFTER USE OF SYSTEM

1. Set No.3 control valve to "close" position.
   → Main valve is closed.
2. Set No.1 control valve to "N2 STOP" position.
   → Stop pressurizing dry powder tank.
3. Set exhaust valve to "OPEN" position
   → Dissipate remaining gas in dry powder tank.
4. Set exhaust valve to "CLOSE" position.
5. Set No.3 ball valve to "OPEN" position.
6. Set No.2 control valve to "N2 RELEASE" position.
   (For about 5 seconds.)
7. Set No.2 control valve "NORMAL" position.
   (slowly changeover)
8. Set No.3 ball valve to "CLOSE" position.
9. Set cleaning valve to "CLEANING" position.
10. Set No.2 control valve "N2 RELEASE" position.
11. Set exhaust valve to "OPEN" position.
12. Return valve to normal positions after all nitrogen gas has been dissipated.
13. Recharge N2 cylinders.
14. Refill dry chemical agents to dry chemical container.

8.3 Dry Powder System

Maker:	NK Co., Ltd
No. of sets:	4 consisting of: 2 tank units supplying 2 monitors port and starboard 2 tank units supplying a total of 8 hand hose nozzles, forward and aft
Type:	Sodium bicarbonate with anti-caking agent
Tank capacities:	Monitor units 1,600 litres Hand hose units 1,000 litres N2 cylinders 68 litres
Location of sets:	Monitors port and starboard of cargo manifold Hand hoses to port of the centre line, each hose being 33m in length at the minimum
discharge time:	- 60 seconds for each individual monitor - 60 seconds for each group of 4 hose stations at their rated discharge capacities.
Capacities:	Monitor 23kg/sec Hand bosses 3.5kg/sec Monitor angular sweep horizontal 360ºC Vertical + 90 to – 45ºC

Introduction

Monitor System

The system comprises two tanks containing the sodium bicarbonate connected to a battery of N_2 cylinders, which are operated by CO_2 cylinders from either the cargo control room, the fire control station, or locally.

The monitors are situated just aft of the cargo discharge manifold, aligned to face and cover the liquid and vapour lines and valves at either the port or starboard manifold.

The N_2 cylinders can be opened either manually or remotely from six positions. They can also be cross-connected. Activation of any CO_2 bottle and operation of the ball valve will open the N_2 battery bank and start the fire fighting operation.

Hand Hose System

This system comprises two tanks containing the dry powder feeding four hose reels each. Operation is the same for the monitors; on opening the CO_2 cylinders and ball valves, the N_2 cylinders are opened, and fire fighting begins.

Procedure for Operating the System

a) The monitor should have been pre-aligned with the cargo discharge manifold and the dry powder supply valve left in the open position. This area is most susceptible to gas leaks and fires.

b) Open the CO_2 cabinet door.

c) Remove the securing device from one CO_2 cylinder.

d) Open the CO_2 cylinder valve by fully turning the valve handle counter-clockwise.

e) Open the ball valve to allow CO_2 gas to open the N_2 battery by moving the handle downwards. This activates the pressurizing of the dry powder charge, and opens the selection valve and main valve.

Dry powder discharge begins.

Procedure for Operating Port (No.1) Tank with the Starboard Manifold Monitor and vice versa

a) Crossover valves P32 and S32, together with the monitor isolating valves PM1 and SM1, must remain FULL OPEN when the systems are at STANDBY READY FOR USE.

b) Should the starboard manifold monitor be in use, resulting in the total consumption of No.2 tank dry powder charge and further fire fighting capability required, the No.1 tank dry powder charge can be discharged via the starboard monitor as follows:

   i) Open the appropriate second starting CO_2 cylinder valve.
   ii) Open the corresponding valve P-S in either the fire control station, cargo control room, or at the port dry powder tank unit.

c) Similarly should the port manifold monitor be in use, resulting in the total consumption of No.1 tank dry powder charge and further fire fighting capability required, the No.2 tank dry powder charge can be discharged via the port monitor as follows:

   i) Open the appropriate second starting CO2 cylinder valve.
   ii) Open the corresponding valve P~S in either the fire control station, cargo control room, or at the port dry powder tank unit.

Procedure for Operating the Dry Powder Fire Extinguishing System using the Hand Hoses

a) Open the dry powder hand hose cabinet door.

b) Remove the securing device on the CO_2 bottle.

c) Open the CO_2 cylinder valve by fully turning counter-clockwise.

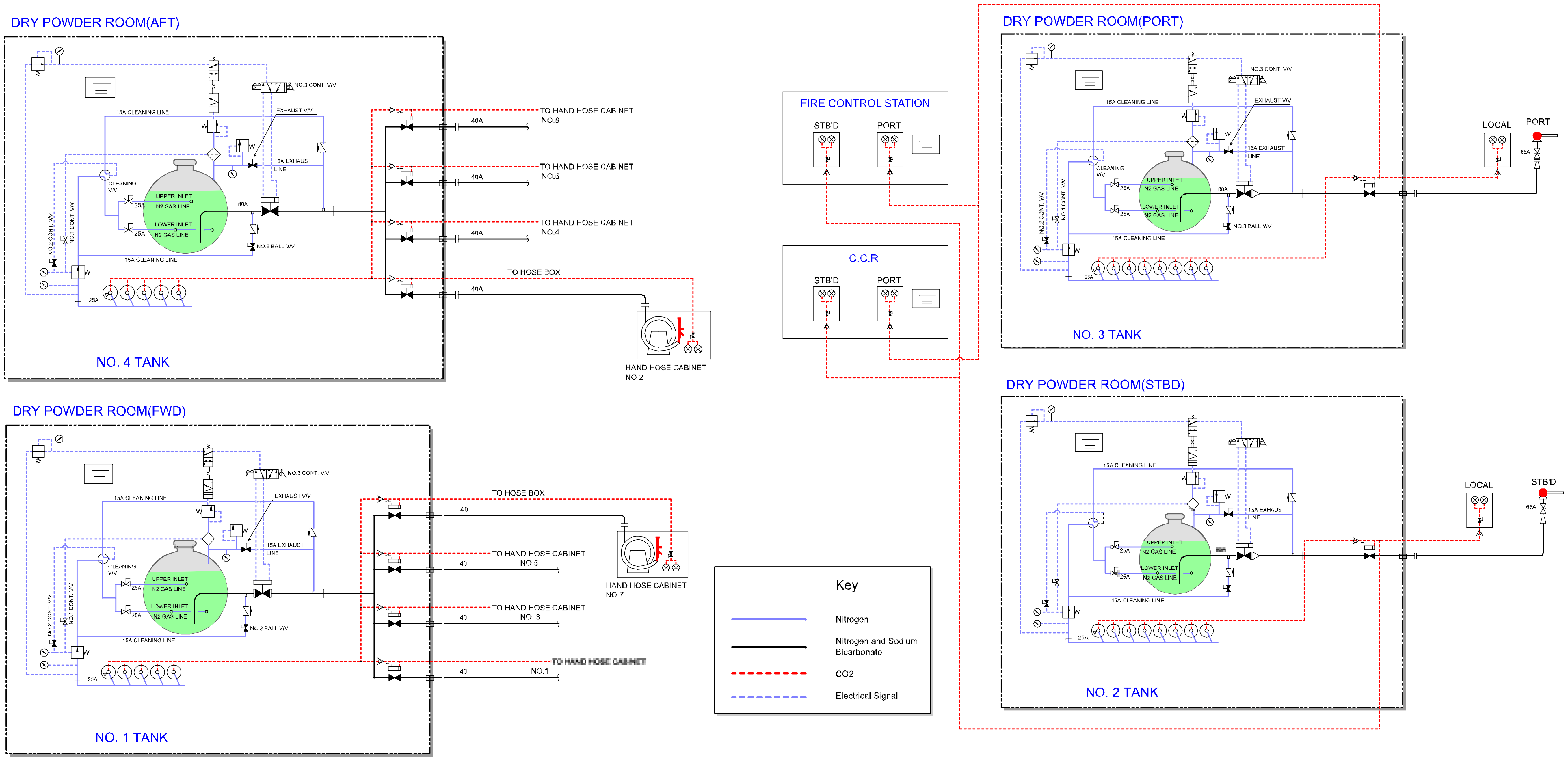
d) Open the ball valve by turning the handle downwards.

e) Pull out the hose completely from the drum, which is about 33 metres long.

f) Aim the nozzle at the side of the scene of the fire, and pull the fire nozzle trigger.

g) Sweep the dry powder jet across the scene of the fire from side to side.

Illustration 8.3.2i Dry Powder System



Precautions

- Always wear full fireproof clothing and personal protection equipment
- After opening the cabinet door, the operation must begin quickly to prevent powder caking
- Be aware of the reaction of the nozzle gun on the start of the discharging
- Prevent kinking of the hose and twists in the line.

Procedure for Cleaning the Dry Powder System after Use

After any operation of the dry powder system it is essential that the system must be cleaned at once with N_2. This is to prevent any residue powder remaining in the lines, thereby causing a blockage to subsequent use. There is usually enough N_2 remaining in the bottle bank to do this.

a) No.3 control valve is set to CLOSE The main valve is closed.

b) No.1 control valve to the N_2 STOP position. This stops pressurizing the dry powder tank.

c) Set the exhaust valve to the OPEN position. This exhausts the remaining gas in the powder tank.

d) Set the exhaust valve to the CLOSE position.

e) Set the agitation valve to the OPEN position.

f) Set the No.2 control valve to the N_2 RELEASE position, for about 5 seconds.

g) Set the No.2 control valve to the NORMAL position.

h) Set the agitation valve to the CLOSE position.

i) Set the cleaning valve to the CLEAN position.

j) Set the No.2 control valve to the N_2 RELEASE position.

k) Set the exhaust valve to the OPEN position.

l) Restore all the valves to their normal positions after the N_2 gas has been exhausted.

m) Recharge the N_2 cylinders.

n) Refill the dry powder tank.

Procedure for Exhausting N_2 and CO_2 from the Control Lines, Valves and Main Tanks

a) Exhaust the N_2 in the dry powder tank by releasing the securing bolts on the dry powder filling connection on top of the dry powder tank.

CAUTION

During this operation care should be taken during the release of the residual gases. To minimize the risk of injury the flange should be released gradually.

b) To completely exhaust the CO_2 in the control lines, one of the connections on the N_2 cylinders should be released. Care should be taken when doing this.

Closing the Main and Selection Valves

c) As these valves are operated by N_2 and CO_2 respectively, close the valves manually.

Note!

The valve seat and ball of the MAIN and SELECTION valves should be cleaned in accordance with the maker's instructions before returning them to service.

Recharging the Dry Powder Tank

d) After the release of the N_2 in the dry powder tank, it must be refilled with the correct quantity of the dry powder. Sodium bicarbonate type No must be used. No other type of agent should be used.

e) After refilling the tank the through the manhole, the tank should be restored by securing the blind flange to the tank flange. All bolts should be tightened correctly.

f) After recharging the dry powder, carry out the routine for agitating the charge by using the ship's N_2 supply via the portable hose.

Procedure to Recharge the N_2 Cylinders

This recharging process is achieved by changing the exhausted N_2 bottles for full ones. This is done as follows;

a) Remove the actuating cylinder from the cylinder valve.

b) Unscrew the union nut of the connecting link line at the cylinder valve, and remove the connecting line, being careful of the seal on the ends of the line and valve.

c) Screw the protecting cap onto the discharged N_2 cylinder.

d) Unscrew the clamping device(s) from the discharged gas cylinder.

e) Remove the discharged cylinder.

f) Replace the full N_2 cylinder.

g) Replace the clamping device(s) and leave stack until the bottle is aligned with the piping.

h) Remove the protection from the valve on the new cylinder and align the bottle with the connecting piping.

i) Reconnect the cylinder with the connecting piping on both the CO_2 and the N_2 lines.

j) Tighten all connections.

Replace the actuating cylinder.

8.4 Fire Detection System

Illustration 8.4i(1) Block Diagram for Fire Detection and Alarm System

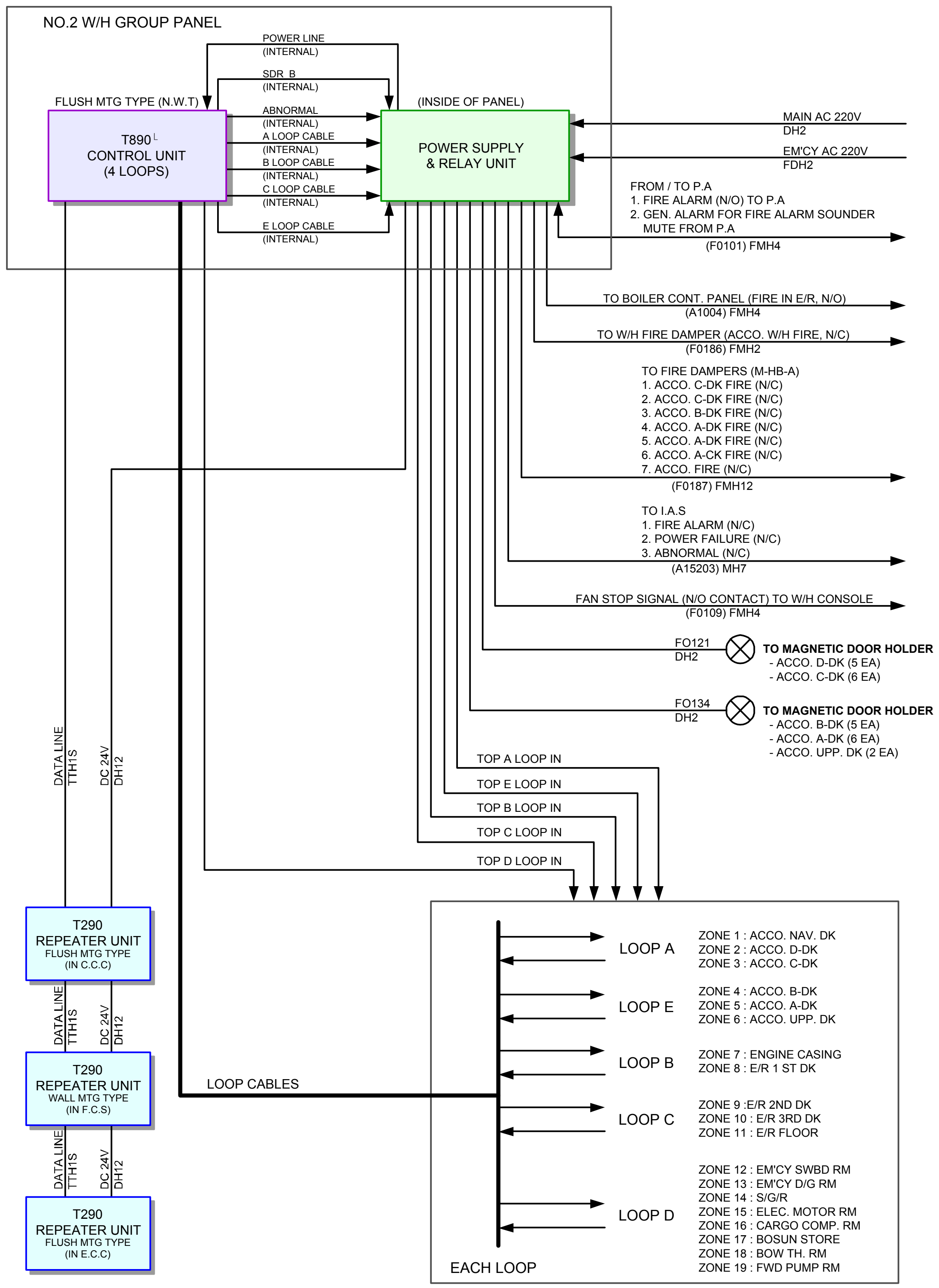
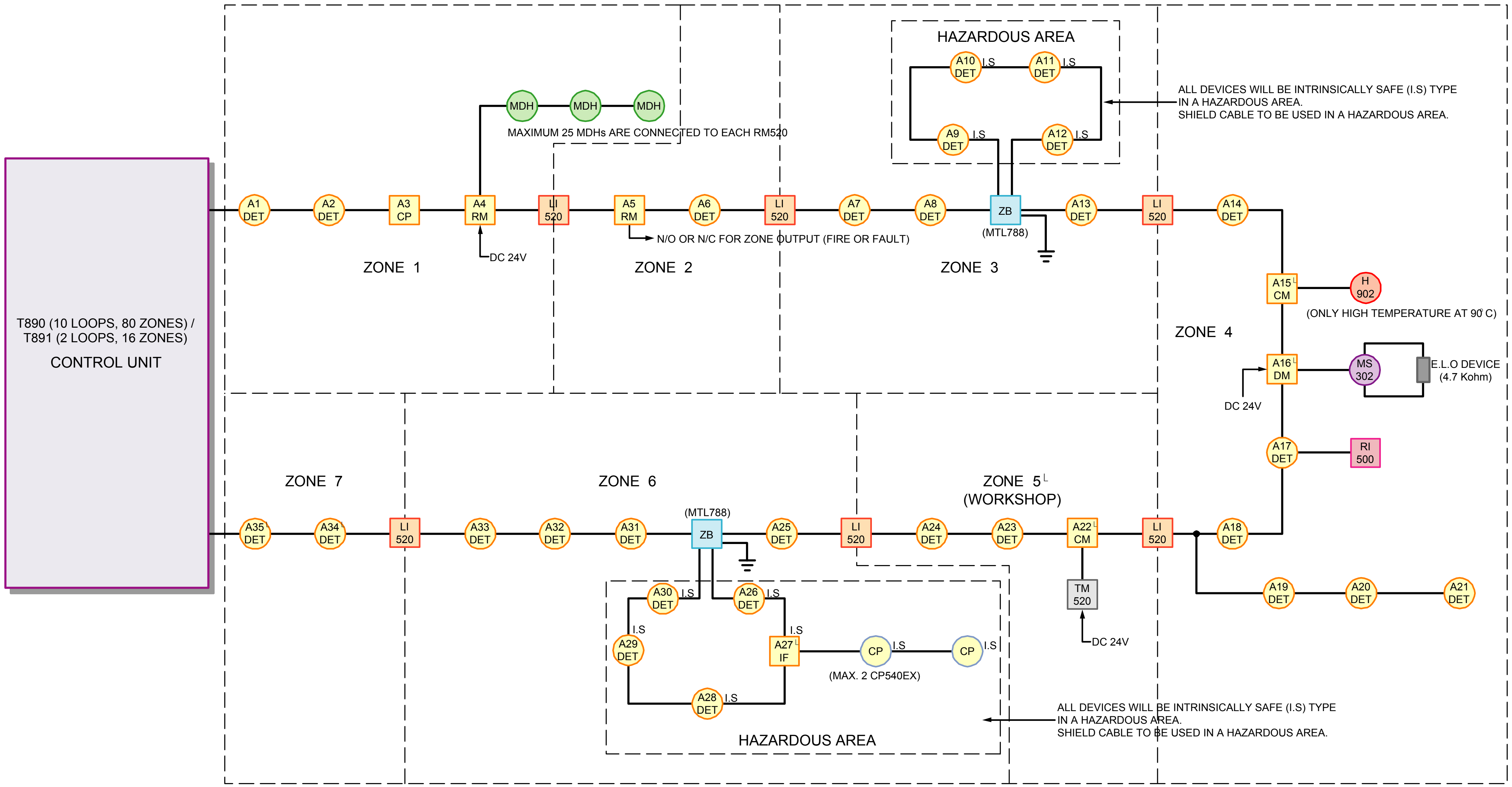


Illustration 8.4i(2) Block Diagram For Device Arrangement



LEGEND

A1~A35 : ADDRESS NUMBER
DET : DETECTOR
MS302 : MS302EX IS FLAME DETECTOR (CONVENTIONAL TYPE)
CP : CALL POINT
LI520 : LINE ISOLATOR
TM520 : TIMER MODULE
RM : RM520 ADDRESSABLE RELAY MODULE
DM : DM520 CONVENTIONAL DETECTOR MODULE
CM : CM520 ADDRESSABLE CONTACT MONITORING MODULE
MDH : MAGNET DOOR HOLDER (40 mA, POWER CONSUMPTION)
IF : IF500EX INTRINSICALLY SAFE ADDRESSABLE INTERFACE MODULE
ZB : I.S ZENER SAFETY BARRIER
RI500 : REMOTE INDICATOR

Illustration 8.4i(3) Typical Schematic of Fire Detection & Alarm System

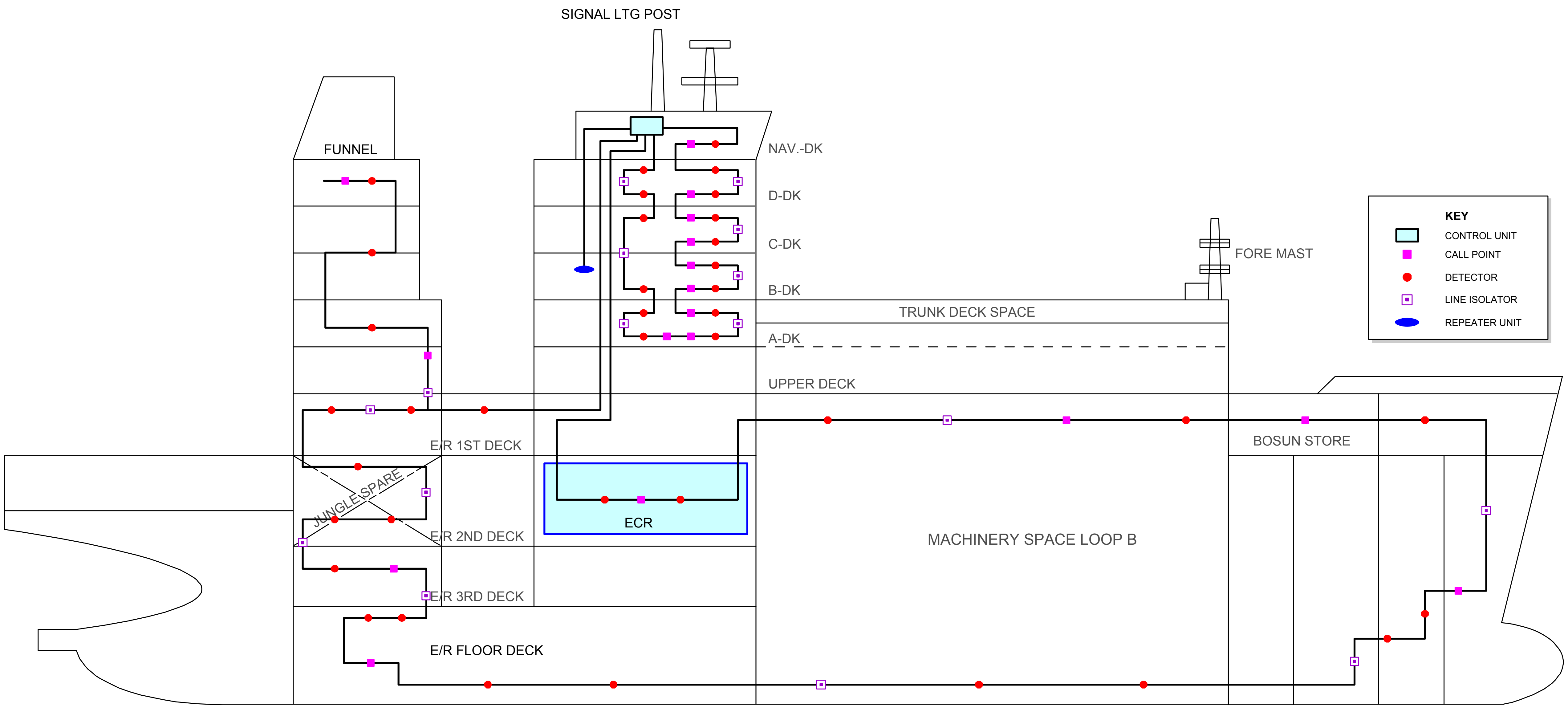
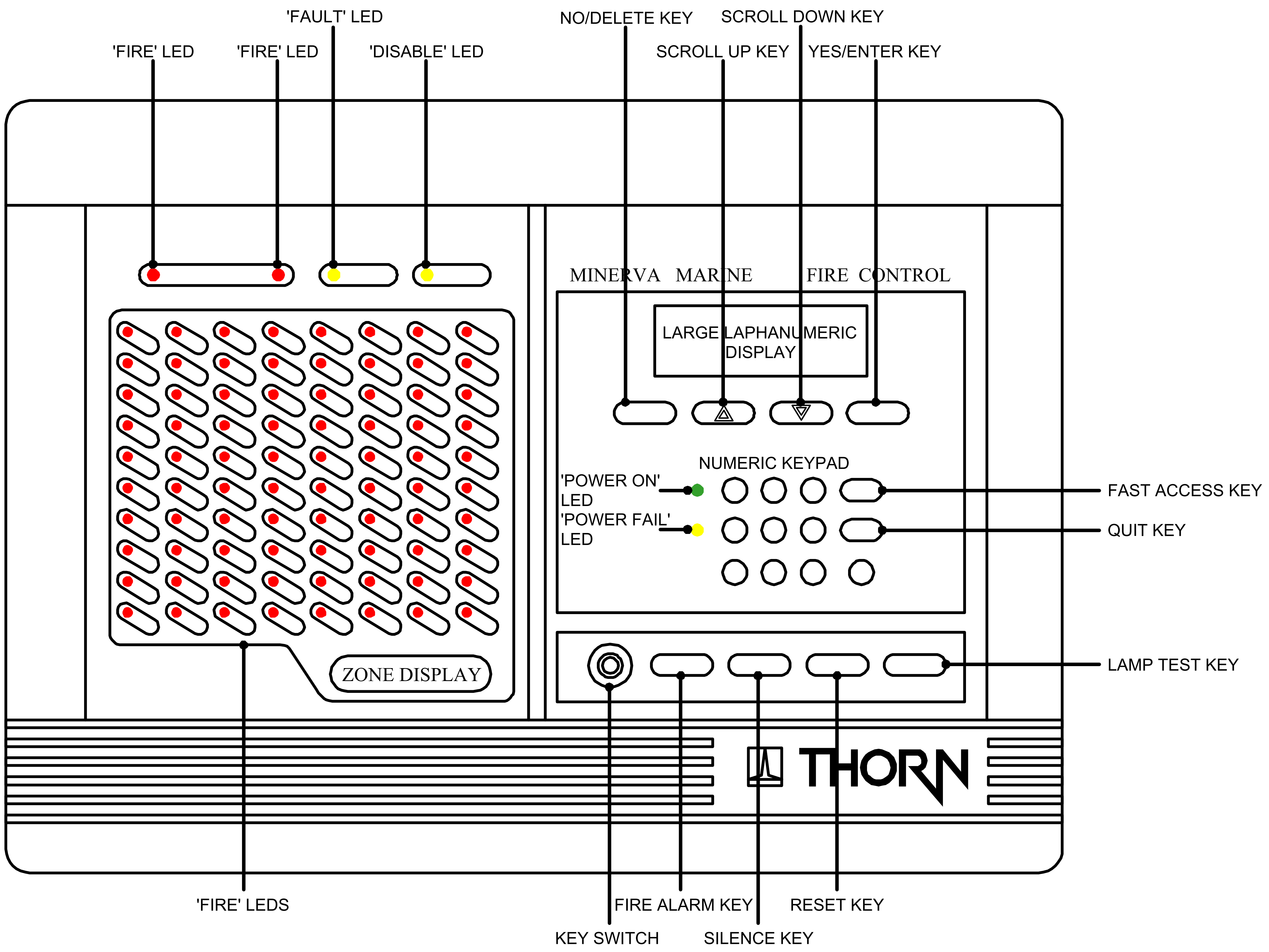


Illustration 8.4i(4) T891 MINERVA Marine Control Unit Front Panel Layout



8.5 High Expansion Foam Fire Extinguishing System

General

Type	: STHAMEX-SV
Mix. rate	: Foam liquid 2% + sea water 98%
Foam expansion ratio	: 600 times
Foam discharge rate	: 1.0 m/min.

When fire breaks out in the vessel, it is difficult to carry out appropriate extinguishing without any trouble.
Therefore, it is quite important to know need to be done properly in order to save all the crew members on board, and keep the vessel's damage to a minimum.

The high expansion foam system makes full use of its extinguishing ability, and has following special effects.

- Isolating effect
  The system will generate a large quantity of foam, isolate the area on fire from other areas to prevent fire from expanding and extinguish the fire quickly.

- Cooling effect
  Water including generated foam liquid can cool the heat in the area on fire, and decrease the atmospheric temperature for better extinguishing.

Even when the crew is mistakenly caught in the foam, they will never suffer from suffocation because of the air in the high expansion foam.
Therefore, the vessel has to be well organized in finding a fire before spreads, and the crew has to be well trained to be able to extinguish the fire calmly.
The crew will know their each duty and extinguish the fire appropriately and quickly during an emergency if they know the location of the system, regularly check and maintain the system, and are properly trained to extinguish fires.

1. Air Foam Liquid

a) Type
The foam liquid consists of various types of solutions based on a surface, active agent from hydrocarbon, and is used for high expansion foam and middle expansion foam systems.
This liquid has great fluidity, stability, and ability to generate foam with an expansion ratio of from 600 times.

b) Validity and Analysis
The foam liquid is valid for more than four years when it is kept in a sealed tank under the temperature of -12 to +50°C.
After four years, the liquid must be replaced with a new one, or its performance must be analyzed using 4L of sample liquid.
When sea water gets into the tank, or the liquid deteriorates due to other reasons, we will test the sample, analyze it, and report the result.

2. System Outline

The foam generators are equipped on the ceiling for each protected deck area. Generated foam at the upper areas flows down to lower areas through openings. Diaphragm control valve is installed in the piping of the foam liquid to keep the amount of the flow constant to maintain required mixing ratio (seawater 98%, foam liquid 2%) in the generator in each deck.

3. Outline of each equipments

a) Foam generator
Foam generator is composed of spray nozzle, body, and generating net.
When the system is started, seawater mixed with foam liquid is sent to the generator and sprayed toward the net, air is drawn form inlet of the generator, and foam is generated from the net of the generator an expansion ratio of 600 times.
Foam generators are placed in each ceiling of the fire protected area.

b) Mixing unit
The diaphragm control valve placed in the piping of foam liquid is used to keep the amount of the flow constant and mixing ratio.

c) Control panel
The electric source must always kept "ON" (No fuse breaker in panel) the control panel monitors' "START" and "STOP" of the system, "OPEN" and "CLOSE" of each valves, the pressure of the seawater and foam liquid.
Test switches are located inside of the main control panel door.
Please pay attention to test switches at "NORMAL" position and do not turn it except testing.
After testing the switches are used for its test, turn it to "NORMAL" position.

4. After operation
- Drain out the foam solution lines and liquid lines by air blowing.
- Re-fill the foam liquid with the required amount.
- Check the foam generator for fire damage and etc.
- Test the fire lines by compress air.
- Test the operation of all the valves.

5. Operation

- To start

a) When fire in a protected area is detected, break the acrylic plate and press the "SYSTEM STAND-BY" button.
The emergency stop system will be operational with alarm sounding off in the protected area.

b) Start the emergency fire pump manually on the control panel.

c) Press the "FOAM DISCHARGE" button on the control panel.

Engine room :
As soon as the sea water pressure rises above 0.5 MPag, the foam liquid pump will start operating, and the sea water valve (AV1), foam liquid suction valve (AV7), foam liquid discharge valve (AV3), and pilot valve (AV5) will be opened.

As soon as the foam liquid pressure rises above 0.5 MPag, the discharge valve (AV8) will be opened.

Following the operation above, the foam will be discharged in the fire protected area, and start extinguishing the fire.

Incinerator room :
As soon as sea water pressure rises above 0.5 MPag, the foam liquid pump will start operating, and the sea water valve (AV2), foam liquid suction valve (AV7), foam liquid discharge valve (AV4), and pilot valve (AV6) will be opened.

As soon as the foam liquid pressure rises above 0.5 MPag, the discharge valve (AV9) will be opened.

Following the operation above, the foam will be discharged in the fire protected area, and start extinguishing the fire.

Steering gear room :
As soon as the sea water pressure rises above 0.5 MPag, the foam liquid pump will start operating, and the sea water valve (AV2), foam liquid suction valve (AV7), foam liquid discharge valve (AV4), and pilot valve (AV6) will be opened.

As soon as the foam liquid pressure rises above 0.5 MPag, the discharge valve (AV10) will be opened.

Following the operation above, the foam will be discharged in the fire protected area, and start extinguishing the fire.

Paint store :
As soon as the sea water pressure rise above 0.5 MPag, the foam liquid pump start and the sea water valve (AV2), foam liquid suction valve (AV7), foam liquid discharge valve (AV4), pilot valve (AV6) are opened.

As soon as foam liquid pressure rise above 0.5 MPag, the discharge valve (AV11) is opened.

From above operation, the foam will be discharged in the fire protected area, and start extinguishing the fire.

Diesel generator room

As soon as the sea water pressure rises above 0.5 MPag, the foam liquid pump will start operating, and the sea water valve (AV2), foam liquid suction valve (AV7), foam liquid discharge valve (AV4), and pilot valve (AV6) will be opened.

As soon as the foam liquid pressure rises above 0.5 MPag, the discharge valve (AV12) will be opened.

From above operation, the foam will be discharged in the fire protected area and start extinguishing the fire.

Purifier room

As soon as the sea water pressure rises above 0.5MPag(5 kgf/cm^2), the foam liquid pump will start operating, and the sea water valve (AV2), foam liquid suction valve (AV7), foam liquid discharge valve (AV4), and pilot valve (AV6) will be opened.

As soon as the foam liquid pressure rises above 0.5 MPag, the discharge valve (AV13) will be opened.

Following the operation above, the foam will be discharged in the fire protected area, and start extinguishing the fire.

Engine control room

As soon as the sea water pressure rises above 0.5 MPag, the foam liquid pump will start operating, and the sea water valve (AV2), foam liquid suction valve (AV7), foam liquid discharge valve (AV4), and pilot valve (AV6) will be opened.

As soon as the foam liquid pressure rises above 0.5 MPag, the discharge valve (AV14) will be opened.

Following the operation above, the foam will be discharged in the fire protected area, and start extinguishing the fire.

- To stop

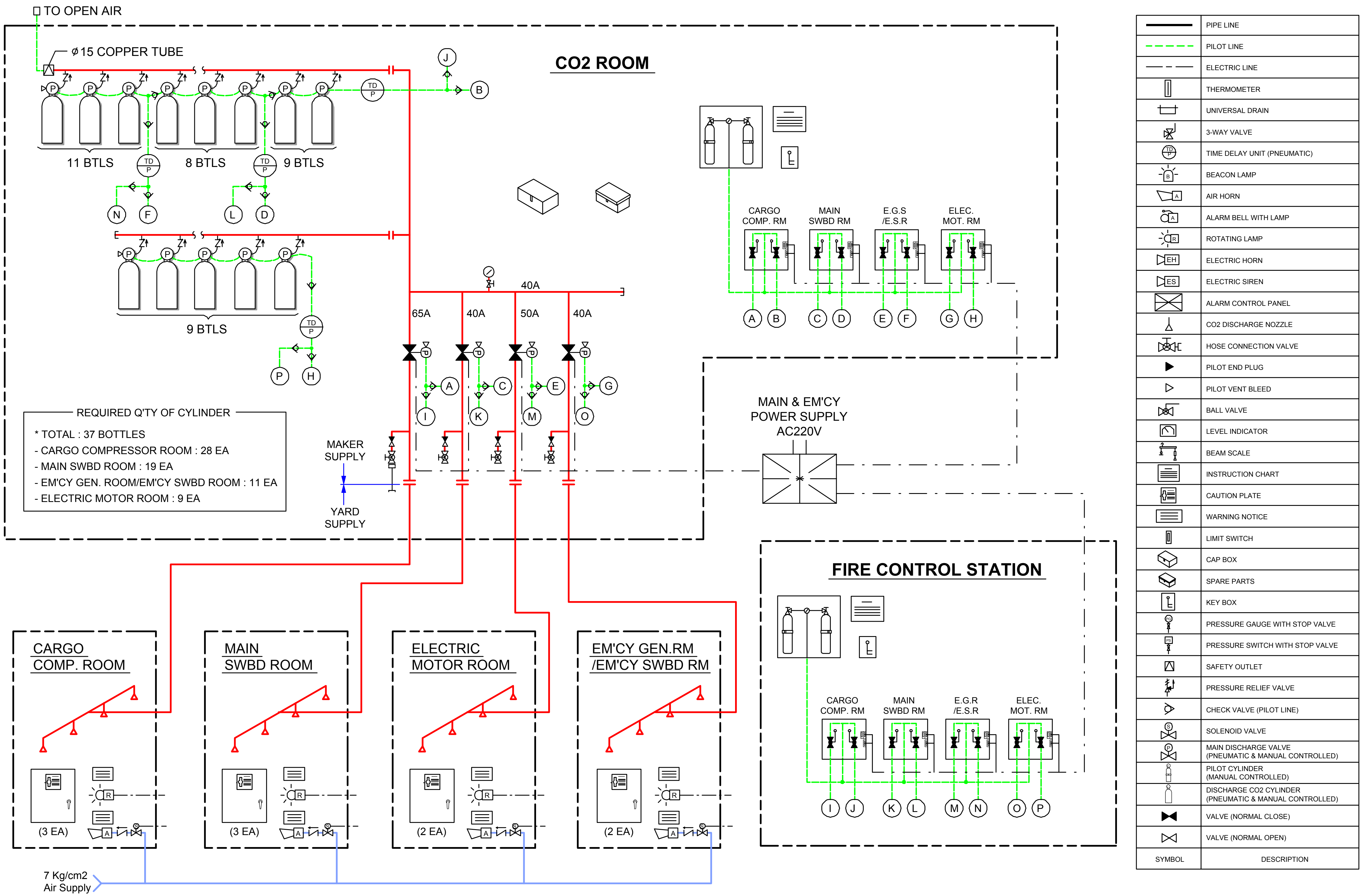
a) Press the “STOP” button on the control panel.
The foam liquid pump will stop operating, and each automatic valves will be closed.

b) Stop the emergency fire pump manually on the control panel.

Caution

After the fire and cool down, the protected space must be well ventilated before crew may enter.

Illustration 8.6i CO_2 System



8.6 CO_2 System

Cargo Deck CO_2 Flooding System

Maker : NK
Type : High Pressure

The CO_2 flooding system for the cargo areas consists of 37x45 kg high pressure cylinders. These are contained in the CO_2 room on the upper deck.

The deck CO_2 system covers the following areas:

Cargo machinery room:	cylinders required 28
Electric motors room:	cylinders required 9
Main SWBD room:	cylinders required 19
Em'cy Gen. room	cylinders required 11

Flooding the protected areas is achieved with the operation of the ball valves from their respective cabinets in the fire control station, or CO_2 room, and the release of the pilot CO_2 cylinders (release cabinets in CO_2 room No.2 fire control station, and manually, in CO_2 rooms). Upon opening the control cabinet door, the CO_2 alarm is activated and the ventilation fans in that area are stopped. The pilot gas is directed with the operation of the respective ball valve, onto the gang release line (having first operated the time delay switch down stream of the HP cylinders), and master valve for the selected area.

The emergency generator room and paint store both share the same CO_2 cylinders, although they have a separate main discharge line to their space.

Warning

Release of CO_2 into any space must only be considered when all other options have failed and then only on the direct instructions of the Master.

Operation

In the event of fire in each protected space

Go to the key box/control cylinder cabinet, located at the CO_2 room or at the fire control station and follow instructions.:

1 Key box
- Break the glass
- Take the key

2 Control valve cabinet

a) Open the door of the control valve cabinet of the protected space on fire.
b) Make sure that all personnel have vacated the protected space.
c) Close doors and hatches.
d) Open valves No.1 and No.2
e) Go to the control cylinder cabinet.

3 Control cylinder cabinet
- Open the door with the key
- Open one cylinder valve

4 Until arriving at the port, keep all openings closed and control valves open.

5 Do not open the hatches or other openings of compartments that are flooded with CO_2 until arriving at the port.
This is allow burned compartment to cool and prevent rekindling others.

Emergency Operation

In case of failure in the operation of the system from the control cylinder cabinet, go to the CO_2 room.

1. Make sure that all personnel have been evacuated from the protected space.

2. Make sure that all vent fans have stopped operating, and that all doors and hatches are closed.

3. Open the relevant main valve.
   - Hand wheel type
     Open by rotating the wheel counter-clockwise.
   - Lever type
     Remove the safety pin
     Pull up (or pull down) the operating lever

4. Go to the cylinder and open the cylinder valve
   - Remove the safety pin of the actuator fitted on the cylinder valve
   - Pull down the operating lever and the CO_2 gas will be discharged.

5. Take the same action quickly with the required quantities of CO_2 cylinders.

6. Now the system is in operation.

After Discharge

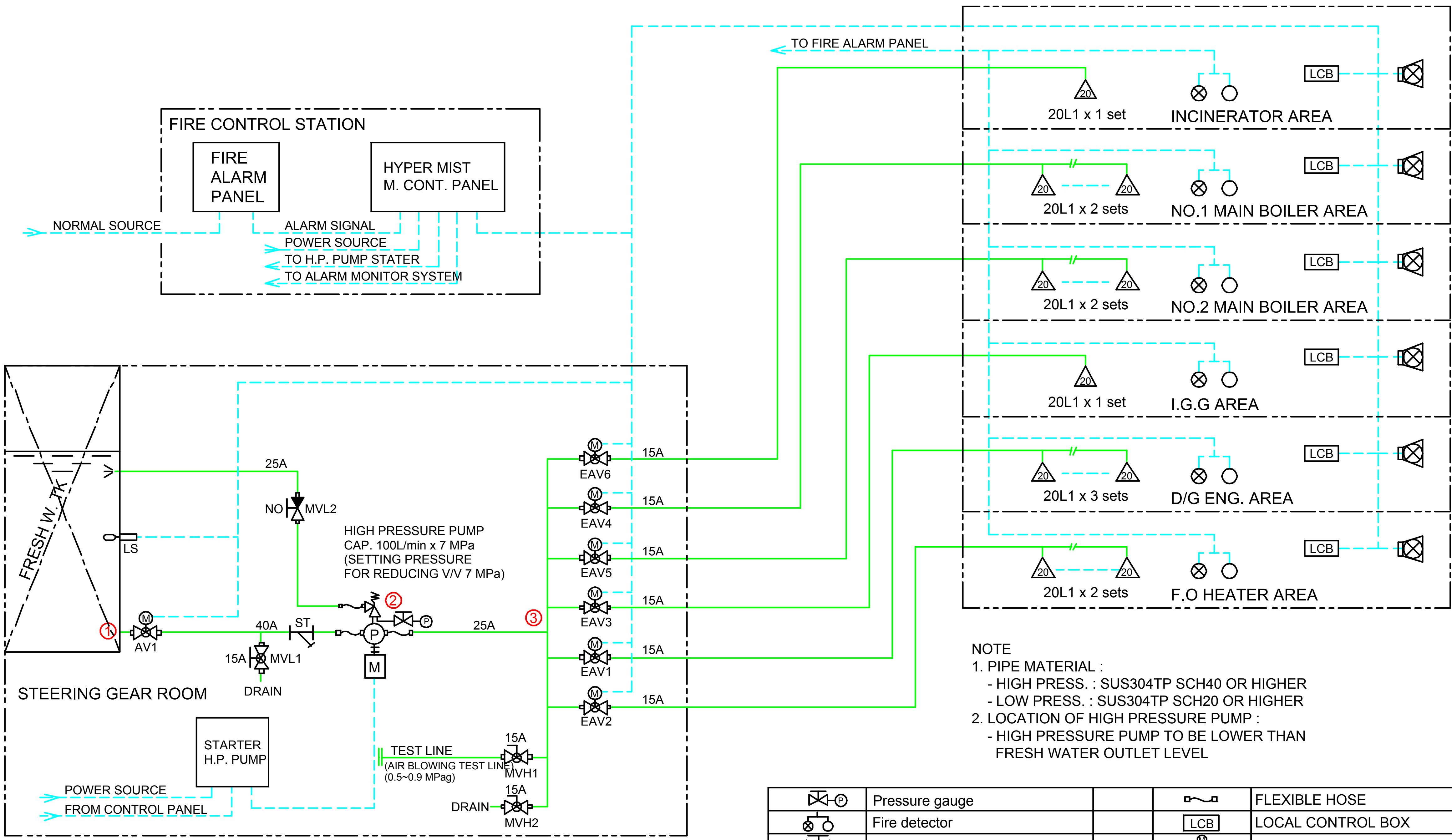
1. Allow enough time for the CO_2 gas to extinguish the fire.

2. Do not reopen the space until all reasonable precautions have been taken to ascertain that the fire has been extinguished.

3. When the fire has been extinguished, ventilate the space thoroughly.

4. Persons re-entering the space must wear compressed air breathing apparatus until the atmosphere has been checked and found the oxygen content is over 21%

Illustration 8.7i Hyper-Mist System



NOTE
1. PIPE MATERIAL :
- HIGH PRESS. : SUS304TP SCH40 OR HIGHER
- LOW PRESS. : SUS304TP SCH20 OR HIGHER
2. LOCATION OF HIGH PRESSURE PUMP :
- HIGH PRESSURE PUMP TO BE LOWER THAN FRESH WATER OUTLET LEVEL

SYMBOL	NAME	TAG	SYMBOL	NAME	TAG
	Pressure gauge			FLEXIBLE HOSE	FH
	Fire detector		LCB	LOCAL CONTROL BOX	LCB
	Globe check valve (low press.)			ELECT. TYPE AUTO. V. (LP)	AV
	Manual valve (low press.)			ELECT. TYPE AUTO. V. (HP)	EAV
	Manual valve (high press.)	MVH	M	MOTOR FOR HIGH PRESS. P/P	M
	Strainer (40 mesh)	ST		HIGH PRESS. P/P WITH REDUCING V.	HPP
	Alarm device (column light)	AD	12	12S1 WATER MIST NOZZLE	WMN
	Level switch	LS	20	20L1 WATER MIST NOZZLE	WMN

8.7 Hyper-Mist System

General

The system mainly consists of the plunger type, high pressure pump, remote distribution valves, spray nozzles, and control panels.
The high pressure pump leads fresh water from the ship's hull tank to the spray nozzles via selected distribution valves spraying mist water for at least 20 minutes.
The fire detection system is provided for each piece of protected equipment, and connected to the Hyper-Mist system for automatic operation. This fire detection system is an independent system from the ship's main fire detection system.
The Hyper-Mist system can be operated automatically by fire detecting signals, and also operated manually by remote from the main control panel and local control box. It can be stopped manually at control panels whenever fire has been extinguished.

Description of each equipment

(1) High pressure pump

Type	: Plunger type pump
Design rate	: 100 L/min. at 7.0 MPag
Motor	: 18.5 kW, 4 poles, 60 Hz
Drive method	: Belt with pulley

(2) Branch valve

Type	: Electric operated ball valve
Material of body	: Stainless casting (SCS14A)

(3) Pump suction valve

Type	: Electric operated ball valve
Material of body	: Stainless casting (SCS13A)

(4) Water mist nozzle

Type	: Dry type
Flow rate	: 11.5 L/min at 5.0 MPag (WMN-12SI)
	20.3 L/min at 5.0 MPag (WMN-20L1)
Material	: Stainless steel

(5) Level switch for fresh water tank

Type	: Horizontal Float with magnet
Material of float	: Synthetic rubber

(6) Control panel (Main & Local)

The main control panel is installed outside of the protected space, and the local control panel is installed near the protected area.

Operation method

(1) Preparation

a) Fresh water level must be high enough.
b) Check the electric power to the panels, high pressure pump and pneumatic air to the branch valves must be in sufficient supply.
c) Check if the fire detection system is in good working condition, if it is linked with this system.
d) The manual valve (MVL2) at the pump return line must be open.
e) Drain valves and the test line connection must be closed.
f) There must be no obstruction for the high pressure pump operation.

(2) Automatic Operation with Fire Detection system and Remote Manual Operation.

The system start select switch on the main control panel must be the AUTO. & MANUAL position, otherwise the automatic starting system will not be functioning.

Start

a) Automatic Start
The Hyper-Mist system will be automatically released to the particular area where fire is caught by the detecting system. Also audible and visible alarms go off.
Related valves, such as pump suction valve and high pressure pump, are automatically operated, and water mist will be discharged to the protected area.
b) Remote Manual Start
The Hyper-Mist system can be released manually whenever needed from the main control panel, as well as from the local control box regardless of the signal from the fire detecting system. Related devices are automatically operated, and water mist will be discharged to protected area.

Stop

a) If the fire detecting signal is stopped, the Hyper-Mist system can be stopped manually from the main control panel, as well as from the local control box, or will be automatically stopped after 20 min.
b) As long as the detecting signal is supplied, the Hyper-Mist system will not be stopped even if it is manually stopped at the control panel.

(3) Manual Remote Operation without the Fire Detecting System

When the system start select switch on the main control panel is at the MANUAL position, the Hyper-Mist system can be released only by remote manual operation from the main control panel, or from the local control box, even if the fire is was caught by the detecting system.

Start

a) At the main control panel, press the start button for the particular area catching fire, or start from the local control box located beside each protected area.
Related devices such as high pressure pump, distribution valves and pump suction valves, are automatically operated, and then, water mist will be discharged to the particular area.

Stop

a) Press the "Stop" switch at the main control panel or local control box. The high pressure pump will be stopped, and automatic valves will automatically close.

Part 9 : General Information

Part 9
General Information

Part 9 : General Information

9.1 Maker List

NO.	EQUIPMENT	Q'TY	SPECIFICATION	MAKER/ SUPPLIER	MODEL	FAX/TEL/EMAIL
1	STEERING GEAR	1	TYPE : ELEC-HYD. 2RAM-4CYL. CAP. : 380 TON-M (AT 35 DEG) MOTOR: AC440VX60HZX3PHX90KW	YOOWON INDUSTRIES LTD. KOREA	YSFTX2-380-2 (45 DEG)	FAX)+82-51-205-8540 TEL)+82-51-205-8541 yoowon@korea.com
2	LATHE	1	TYPE : HEAVY DUTY CENTER DISTANCE :2000 MM SWING OVER BED :580 MM	NAMSUN PRECISION MACH. CO., LTD. KOREA	DL580X2000G	FAX)82-42-934-3707 TEL)82-42-934-3700 nskr@hitel.net
3	DRILLING MACHINE	2	TYPE : INDEP. ELEC. MOTOR DRIVEN CAP.: MAX. DIA. 38 MM (1 SET) MAX. DIA. 16 MM (1 SET)	YOUNG KWANG MACH. CO., LTD. KOREA	YKD-20, YKD-30	FAX)+82-54-776-6455 TEL)+82-54-776-6456/9 machine@ykmc.co.kr
4	GRINDING MACHINE	1	TYPE : HEAVY DUTY CAP.: WHEEL DIA. : 255MM	YOUNG KWANG MACH. CO., LTD. KOREA	YKGV-300	FAX)+82-54-776-6455 TEL)+82-54-776-6456/9 machine@ykmc.co.kr
5	PLASMA WELDER	1	CAP.: 220A AT 60% DUTY CYCLE (PLASMA) : 170A AT 100% DUTY CYCLE (TIG) CURRENT RANGE : DC, 5-220 A	ESAB SEAH CO., LTD. KOREA	PLASMAWELD 202	FAX)82-55-289-8863 TEL)82-55-289-8111 webmaster@weldingbiz.co.kr
6	PIPE BENDING MACHINE	1	TYPE : UP TO 4 INCH PIPE DIA 0-90' BENDING DEGREE	YOUNG KWANG MACH. CO., LTD. KOREA	TPB-4	FAX)+82-54-776-6455 TEL)+82-54-776-6456/9 machine@ykmc.co.kr
7	PIPE THREAD MACHINE	1	CAP.: 15A-100A PIPE DIA.	YOUNG KWANG MACH. CO., LTD. KOREA	KSU-100A	FAX)+82-54-776-6455 TEL)+82-54-776-6456/9 machine@ykmc.co.kr
8	GAS WELDING EQUIPMENT	1	TYPE : CENTRAL INSTALLATION NO. OF CYL. : 6 OX + 3 AC (40L)	UNITOR SHIPS SERVICE KOREA CO., LTD.		FAX)82-51-728-7100 TEL)82-51-728-4900 pusan@unitor.com
9	ELECTRIC WELDING EQUIPMENT	1	TYPE : DC WELDING, DRIP PROOF WELDING CURRENT : 250A AT 60% DUTY CYCLE	UNITOR SHIPS SERVICE KOREA CO., LTD.	UWR-303	FAX)82-51-728-7100 TEL)82-51-728-4900 pusan@unitor.com
10	INCINERATOR	1	CAP. : ABT. 700,000KCAL/H - WASTE OIL : 82 KG/H - SOLID WASTE : 150 KG/H	HYUNDAI MARINE MACH. CO., LTD. KOREA	MAXI 150SL-1WS	FAX)+82-032-561-3615 TEL)+82-032-561-3611 hmmcoqa@kornet.net
11	TROLLEY (PLAIN TYPE)	7	3 TON X 1 2 TON X 2 / 1 TON X 4	DAE KYUNG CO., LTD. KOREA		FAX)82-51-264-6615 TEL)82-51-264-6611 dkmworld@dkmworld.com
12	TROLLEY (GEARED TYPE)	15	30 TON X 2/5 TON X 5 3 TON X 2/2 TON X 5/1 TON X 1	DAE KYUNG CO., LTD. KOREA		FAX)82-51-264-6615 TEL)82-51-264-6611 dkmworld@dkmworld.com
13	ELECTRIC HOIST FOR MAIN TURBINE	4	S.W.L 10 TON X 2 SETS (FOR H.P TURBINE) S.W.L 15 TON X 2 SETS (FOR L.P TURBINE)	DAE KYUNG CO., LTD. KOREA	DEHA-10.0 EHA-15.0	FAX)82-51-264-6615 TEL)82-51-264-6611 dkmworld@dkmworld.com
14	PACKAGE TYPE AIR COND. UNIT FOR E/R W/S, ECR & MSBR	4	COOLING CAPA. : 30,000 KCAL/H (FOR E.C.R, NO.2 MSBR) : 45,000 KCAL/H (FOR W/S, NO.1 MSBR)	CENTURY CO. KOREA	MP-G10HF3 MP-G15HF3	FAX)+82-2-316-7299 TEL)+82-2-316-7376 +82-41-530-3745 master@gocentury.co.kr
15	E/R SUPPLY FAN	4	TYPE : VERTICAL AXIAL FLOW, TWO SPEED CAP.: 102,000 / 75,852 M3/H	HI-PRES KOREA CO., LTD.	AQ-1400/578	FAX)82-55-346-3501 TEL)82-55-340-5220 hipres@hipres.co.kr
16	E/R EXHAUST FAN	2	TYPE : VERTICAL AXIAL FLOW, REVERSIBLE CAP.: 102,000 M3/H	HI-PRES KOREA CO., LTD.	AQ-1250/500	FAX)82-55-346-3501 TEL)82-55-340-5220 hipres@hipres.co.kr

NO.	EQUIPMENT	Q'TY	SPECIFICATION	MAKER/ SUPPLIER	MODEL	FAX/TEL/EMAIL
17	WORK SHOP EXHAUST FAN	1	TYPE : VERTICAL AXIAL FLOW CAP. : 600 M3/H	HI-PRES KOREA CO., LTD.	ADW-400/C6	FAX)82-55-346-3501 TEL)82-55-340-5220 hipres@hipres.co.kr
18	PURIFIER ROOM EXHAUST FAN	1	TYPE : VERTICAL AXIAL FLOW CAP.: 6,000 M3/H		AQ-560/330	FAX)82-55-346-3501 TEL)82-55-340-5220 hipres@hipres.co.kr
19	BOIL OFF LEAK GAS EXTRACTION FAN	1	TYPE : VERTICAL AXIAL FLOW CAP.: 4,500 M3/H	HI-PRES KOREA CO., LTD.	ADW-560/280	FAX)82-55-346-3501 TEL)82-55-340-5220 hipres@hipres.co.kr
20	SUPPLY FAN FOR S/G ROOM	1	TYPE : VERTICAL AXIAL FLOW CAP.: 20,000 M3/H	HI-PRES KOREA CO., LTD.	AQ-800/330	FAX)82-55-346-3501 TEL)82-55-340-5220 hipres@hipres.co.kr
21	CALORIFIER	2	TYPE : STEAM & ELEC. HEATED CAP. : 2.0M3/H (10-70 °C) TK CAP : 0.2 M3 ELEC. HEATER : 30KWX1SET	KANGRIM IND. CO., LTD. KOREA	LFA01DW2210/1 1	FAX)+82 55 269 7798~9 TEL)+82 55 269 7700 business1@kangrim.com
22	HOT WATER CIRCULATING PUMP	2	TYPE : HORIZONTAL CENTRIFUGAL CAP. : 2M3/HX5MTH MOTOR: 440VX60HZX0.4KWX1800RPM	SHINKO IND. CO. JAPAN	HJ40M	FAX)+81-82-508-1020 TEL)+81-82-508-1000 sogawa@shinkohir.co.jp
23	REHARDENING FILTER	1	TYPE : CYLINDERICAL FILLED WITH DOLOMITE CAP. : 2.5M3/H	SE-WON INDUSTRIES CO., LTD. KOREA	SWM-2.5	FAX)+82-51-728-4198 TEL)+82-51-728-4191 sales@sewon-ind.com
24	STERILIZER	2	TYPE : ULTRA VIOLET - 1 SET CAP. : 5 M3/HR TYPE : SILVER ION TYPE - 1 SET CAP. : 2.5 M3/HR	SAMKUN CENTURY CO., LTD. KOREA	JSA-5000 SS-3000	FAX)+82-55-366-0129 TEL)+82-55-366-0130 sk@samkunok.com
25	DOMESTIC F.W. HYDROPHORE UNIT	1	TANK : 2.0M3 PUMP : 8M3/HX60MTHX2SETS P/P MOTOR : 440VX60HZX5.5KWX3600RPM ON :0.55, OFF:0.65	SHINKO IND. CO. JAPAN	UH202-50M	FAX)+81-82-508-1020 TEL)+81-82-508-1000 sogawa@shinkohir.co.jp
26	MAIN TURBINE	1	TYPE : CROSS COMPOUND IMPULSE TURBINE WITH DOUBLE REDUCTION GEAR MCR : 36,000 PS X 88RPM NCR : 32,400 PS X 85RPM STEAM CONSUMP. RATE : 2.34G/PS.H (NON-BLEEDING EQUIVALENT) -BASED ON NCR OUTPUT, STEAM CONDITION : 5.88MPagX510ºC, VACUUM COND.:722MMHGVAC.	KAWASAKI HEAVY IND. LTD. (TURBINE) JAPAN	UA-360	FAX)+81-3-3435-2022 TEL)+81-3-3435-3374 hashimoto_h@khi.co.jp
27	VACUUM PUMP FOR MAIN COND.	2	TYPE : WATER SEALED ROTARY TYPE CAP. : 12.7M3/H (21 DEG.C DRY AIR) SUCTION VACUUM 730MMHG VAC MOTOR: 30KW X 440V X 60HZ X 900RPM	KAWASAKI HEAVY IND. LTD. (TURBINE) JAPAN	SLPH75330 +SGPV53 13W	FAX)+81-3-3435-2022 TEL)+81-3-3435-3374 hashimoto_h@khi.co.jp
28	GLAND CONDENSER	1	TYPE : HORIZONTAL SHELL AND TUBE COOLER COOLING AREA : 25M2 COOLING WATER : CONDENSATE WATER	KAWASAKI HEAVY IND. LTD. (TURBINE) JAPAN	3181289/90-66	FAX)+81-3-3435-2022 TEL)+81-3-3435-3374 hashimoto_h@khi.co.jp

NO.	EQUIPMENT	Q'TY	SPECIFICATION	MAKER/ SUPPLIER	MODEL	FAX/TEL/EMAIL
29	GLAND CONDENSER FAN	1	TYPE : HORIZONTAL CENTRIFUGAL CAP. : 7M3/MIN X 300 MMAQ MOTOR : 3.7KW X 440V X 60HZ X 1800RPM	KAWASAKI HEAVY IND. LTD. (TURBINE) JAPAN	BHM5	FAX)+81-3-3435-2022 TEL)+81-3-3435-3374 hashimoto_h@khi.co.jp
30	MAIN CONDENSER	1	TYPE : SINGLE PASS SURFACE COOLING COOLING AREA : APPOX. 3300 M2 VACUUM : 722 MMHG VAC AT MCR BASED ON ATMO.760MMHG & 27ºC SEA WATER COOLING WATER QUANTITY : 19,000 M3/HR	KAWASAKI HEAVY IND. LTD. (TURBINE) JAPAN		FAX)+81-3-3435-2022 TEL)+81-3-3435-3374 hashimoto_h@khi.co.jp
31	DEHUMIDIFIER	1	MODEL : CHEMICAL(DESICCANT) OPEN TYPE CAP. : 50 M3/H AIR FAN MOTOR : 220V X 60HZ X 40W X 3600RPM DRIVE MOTOR : 220V X 60HZ X 3.9W X 3600RPM	KAWASAKI HEAVY IND. LTD. (TURBINE) JAPAN	M-120	FAX)+81-3-3435-2022 TEL)+81-3-3435-3374 hashimoto_h@khi.co.jp
32	M/T TURNING GEAR	1	OUTPUT TORQUE ; 850 KG - M MOTOR : 440V X 60HZ X 11KW X 1730RPM TOTAL RATIO : 1/184 OUTPUT REV. : 9.4 RPM	KAWASAKI HEAVY IND. LTD. (TURBINE) JAPAN		FAX)+81-3-3435-2022 TEL)+81-3-3435-3374 hashimoto_h@khi.co.jp
33	M/T L. O. PUMP	1	TYPE : MAIN TURBINE DRIVEN GEAR PUMP CAP. : 210 M3/H X 0.44MPag X 901 RPM(MCR)	KAWASAKI HEAVY IND. LTD. (TURBINE) JAPAN	LBS-190KH	FAX)+81-3-3435-2022 TEL)+81-3-3435-3374 hashimoto_h@khi.co.jp
34	MAIN BOILER	2	TYPE : VERT. 2-DRUM, WATER TUBE CAP. : MAX. 63T/H, NOR. 54.6T/H SUPERHEATED STEAM : 6.03MPag, 515 DEG.C	MITSUBISHI HEAVY IND. LTD. JAPAN	MB-4E	FAX)+81-3-3798-5943 TEL)+81-3-3798-5941 toshiaki_kitamura@bp.hq.mhi.co.jp
35	FORCED DRAFT FAN	2	TYPE : HORIZONTAL CENTRIFUGAL CAP : 1900/1190 M3/MIN X 3.92/5.19 kPag MOTOR : 360/155KW X 440V X 1180/885 RPM	MITSUBISHI HEAVY IND. LTD. JAPAN	TAC5-1155	FAX)+81-3-3798-5943 TEL)+81-3-3798-5941 toshiaki_kitamura@bp.hq.mhi.co.jp
36	SEAL AIR FAN	2	TYPE : HORIZONTAL CENTRIFUGAL CAP.: 240M3/H X 8.82kPag X 3500RPM (AT38ºC) MOTOR: 440V X 60HZ X 3.7KW	MITSUBISHI HEAVY IND. LTD. JAPAN	CTB-E-MD	FAX)+81-3-3798-5943 TEL)+81-3-3798-5941 toshiaki_kitamura@bp.hq.mhi.co.jp
37	BOILER CHEMICAL UNIT	2	- BOILER WATER AMINE INJECTION EQUIPMENT STOR. TK : 300L (150L+150L) P/P : 0-15L/HR X MAX.7.85MPag MOTOR: 0.4kW X 440V X 60HZ - FEED WATER HYDRAZINE INJECTION EQUIPME STOR. TK : 300L P/P : 0-3.5L/HR X MAX. 0.79MPag MOTOR: 0.4kW X 440V X 60HZ	MITSUBISHI HEAVY IND. LTD. JAPAN	MQ2322RX MQ2312RX	FAX)+81-3-3798-5943 TEL)+81-3-3798-5941 toshiaki_kitamura@bp.hq.mhi.co.jp
38	MAIN BURNER	6	HAMWORTHY LNG/OIL BURNER ROOF FIRED - DOWNWARD FIRING TURN DOWN RATIO ON OIL - 15:1 TURN DOWN RATIO ON GAS - 7:1	MITSUBISHI HEAVY IND. LTD. JAPAN	HAMWORTHY HXG490 LNG/OIL BURNER	FAX)+81-3-3798-5943 TEL)+81-3-3798-5941 toshiaki_kitamura@bp.hq.mhi.co.jp
39	STEAM AIR HEATER	2	TUBULAR EXTENDED SURFACE(FIN TUBE) TYPE SURFACE AREA : 959.4 M2 FLUID Q'TY - AIR :71,666KG/HR (38ºC) STEAM : 2,585KG/HR FLUID TEMP.(IN/OUT) - AIR : 38.0 / 120ºC - STEAM : 210 AT 0.23MPag/138.9ºC	MITSUBISHI HEAVY IND. LTD. JAPAN		FAX)+81-3-3798-5943 TEL)+81-3-3798-5941 toshiaki_kitamura@bp.hq.mhi.co.jp
40	WATER ANALYSIS UNIT	1	WATER SAMPLING FROM - NO.1 BOILER WATER - NO.2 BOILER WATER - FEED WATER	MITSUBISHI HEAVY IND. LTD. JAPAN		FAX)+81-3-3798-5943 TEL)+81-3-3798-5941 toshiaki_kitamura@bp.hq.mhi.co.jp
41	EXHAUST GAS ECONOMIZER	2	TYPE : EXTENDED SURFACE TYPE (FIN TUBE) SURFACE AREA : 1787 M2 GAS FLOW : NOR.64560KG/HR, MAX.74278KG/HR	MITSUBISHI HEAVY IND. LTD. JAPAN		FAX)+81-3-3798-5943 TEL)+81-3-3798-5941 toshiaki_kitamura@bp.hq.mhi.co.jp
42	LP FEED WATER HEATER	1	TYPE : SHELL & TUBE CAP : 110M2 SHELL SIDE : 6,781/4,335KG/H TUBE SIDE : 82,464KG/H	DONG-HWA ENTEC. KOREA	DHFH-018506	FAX)+82-51-970-1071 TEL)+82-51-970-1070 ccj@dhmail.dh.co.kr
43	DEAERATOR	1	TYPE : HORI.,SPRAY SCRUBBER CAP. : 21 M3 FEED Q'TY : 126 T/H	SASAKURA ENG. CO., LTD. JAPAN		FAX)+81-6-6473-2839 TEL)+81-6-6473-2132 yamazaki@skm.sasakura.co.jp
44	FIXED PITCH PROPELLER	1	TYPE : FIXED PITCH MATERIAL : NI-AL BRONZE DIA. : 8.5M NO. OF BLADE : FIVE(5)	HYUNDAI HEAVY IND. CO., LTD. KOREA		FAX)82-52-230-6995 TEL)82-52-230-6623 engineas@hhi.co.kr
45	PROPELLER NUT	1	TYPE : HYDRAULIC MATERIAL : JIS SF590 SIZE : DIA.975 MM	DAEWOO/ DAERYUCK KOREA		FAX)+82-55-680-7226,7150 TEL)+82-55-680-2941 asteam@dsme.co.kr
46	PROPELLER SHAFT	1	MATERIAL : FORGED STEEL LENGTH : 9732 MM DIA. : 770 MM	DAEWOO/ DOOSAN KOREA		FAX)+82-55-680-7226,7150 TEL)+82-55-680-2941 asteam@dsme.co.kr
47	INTERMEDIATE SHAFT	2	MATERIAL : FORGED STEEL LENGTH : 9600MM,6782MM DIA. : 595MM,595MM	DAEWOO/ DOOSAN KOREA		FAX)+82-55-680-7226,7150 TEL)+82-55-680-2941 asteam@dsme.co.kr
48	SHAFT BEARING	2	TYPE : SIZE630, TILTING PAD FORCED LUB.	JAPAN MARINE TECHNOLOGIES LTD. JAPAN		FAX)+81-764-51-3161 TEL)+81-764-51-3150 e.iwawaki@jmtl.co.jp
49	FORWARD STERN TUBE BUSH BEARING	1	MAT'L : CAST IRON WITH WHITE METAL (LEAD BASE) SIZE : ID 773 X L 530MM	JAPAN MARINE TECHNOLOGIES LTD. JAPAN		FAX)+81-764-51-3161 TEL)+81-764-51-3150 e.iwawaki@jmtl.co.jp
50	AFT STERN TUBE BUSH BEARING	1	MAT'L : CAST IRON WITH WHITE METAL (LEAD BASE) SIZE : ID 771 X L 1630MM	JAPAN MARINE TECHNOLOGIES LTD. JAPAN		FAX)+81-764-51-3161 TEL)+81-764-51-3150 e.iwawaki@jmtl.co.jp
51	FORWARD STERN TUBE SEAL	1	TYPE : STERNGUARD MARKII SIZE850	JAPAN MARINE TECHNOLOGIES LTD. JAPAN		FAX)+81-764-51-3161 TEL)+81-764-51-3150 e.iwawaki@jmtl.co.jp
52	AFT STERN TUBE SEAL	1	TYPE : AIRGUARD 3AS SIZE850	JAPAN MARINE TECHNOLOGIES LTD. JAPAN		FAX)+81-764-51-3161 TEL)+81-764-51-3150 e.iwawaki@jmtl.co.jp
53	SHAFT EARTHING DEVICE	1	TYPE : SILVER BAND WITH MILLI-VOLTMETER	KOREA CATHELCO LTD. KOREA		FAX)+82-51-831-7726 TEL)+82-51-831-7720 kcind@cathelco.com

NO.	EQUIPMENT	Q'TY	SPECIFICATION	MAKER/ SUPPLIER	MODEL	FAX/TEL/EMAIL
54	DIESEL GENERATOR ENGINE	1	TYPE : 4-STROKE, TRUNK-PISTON CAP. : 3664KW X 720RPM FUEL OIL : M.D.O	STX CORPORATION, KOREA	8L32/40	FAX)+82-55-282-6907 TEL)+82-55-280-0590 yechoi@stx.co.kr
55	D/G ENG. D.O SERV. P/P	1	TYPE : HORIZONTAL SCREW CAP. : 2.3 M3/HR X 0.7MPag MOTOR: 2.5KW X 440V X 60HZ X 1700 RPM	IMO AB. SWEDEN	ACE038K3NVBP	FAX)+46-8-645-1509 TEL)+46-8-506-22-800 info@imo.se
56	EM`CY D.O SERV. P/P UNIT	1	AIR MOTOR DRIVEN SCREW P/P CAP. : 0.6 M3/HR X 0.5 MPag	STX CORPORATION, KOREA	IMO ACEN3 GAST 2AM-ARV-92	FAX)+82-55-282-6907 TEL)+82-55-280-0590 yechoi@stx.co.kr
57	TURBO GENERATOR	2	TYPE : HORIZONTAL MULTI-STAGE IMPULSE CONDENSING TURBINE CAP. : 3450KW X 1800RPM STEAM: 5.88 MPag X 510ºC	MITSUBISHI HEAVY IND. LTD JAPAN	AT42CT-B	FAX)+81-3-3798-5943 TEL)+81-3-3798-5941 takahiro_fukuda@nsmw.mhi.co.jp
58	EMERGENCY GENERATOR ENGINE	1	TYPE : 4-STROKE, WATER COOLED CAP.: 850 KW X 1800 RPM	STX CORPORATION, KOREA	KTA38DMGE	FAX)+82-55-282-6907 TEL)+82-55-280-0590 yechoi@stx.co.kr
59	H.F.O TRANSFER PUMP	2	TYPE : VERTICAL SCREW P/P CAP. : 50M3/H X 0.4MPag MOTOR :0 17.3KW X 440V X 60HZ X 1760RPM	IMO AB. SWEDEN	ACF090K4IRBO	FAX)+46-8-645-1509 TEL)+46-8-506-22-800 info@imo.se
60	D.O TRANSFER PUMP	1	TYPE : VERTICAL SCREW P/P CAP. : 30M3/H X 0.4MPag MOTOR: 12.7KW X 440V X 60HZ X 1760RPM	IMO AB. SWEDEN	ACF080K4IRBO	FAX)+46-8-645-1509 TEL)+46-8-506-22-800 info@imo.se
61	D.O PURIFIER	1	TYPE : CENTRIFUGAL AUTO SELF-CLEANING TOTAL DISCH. CAP. : 2000L/H MOTOR : 5.5KWX440VX60HZX4PH	SAMGONG CO., LTD.	SJ10F	FAX)+82 51 200 3046 TEL)+82 51 205 7101 skoh@sam-gong.co.kr
62	SLUDGE PUMP	1	TYPE : HORI. MONO CAP. : 10M3/H X 0.4MPag MOTOR: 3.53KWX440VX60HZX1690RPM	IMO AB. SWEDEN	AEDB 1E 150	FAX)+46-8-645-1509 TEL)+46-8-506-22-800 info@imo.se
63	M/B F.O SERVICE PUMP	2	TYPE : HORIZONTAL SCREW CAP. : 11.9M3/H X 2.8MPag MOTOR: 22KWX440VX60HZX1800RPM	MITSUBISHI HEAVY IND. LTD. JAPAN	GH-R2T-168	FAX)+81-3-3798-5943 TEL)+81-3-3798-5941 toshiaki_kitamura@bp.hq.mhi.co.jp
64	M/B F.O HEATER	2	TYPE : SHELL & TUBE SURFACE AREA : 13.86M2 F.O : 50/150ºC	DONG-HWA ENTEC KOREA	DHOH-018503	FAX)+82-51-970-1071 TEL)+82-51-970-1070 ccj@dhmail.dh.co.kr
65	M/B F.O FLOWMETER	1	TYPE : POSITIVE DISPLACEMENT	VAF INSTRUMENT B.V. NETHERLANDS	J5080	FAX)+31-78-617-7068 TEL)+31-78-618-3100 sales@vaf.nl
66	D/G ENGINE F.O FLOWMETER	1	TYPE : POSITIVE DISPLACEMENT	VAF INSTRUMENT B.V. NETHERLANDS	B5025	FAX)+31-78-617-7068 TEL)+31-78-618-3100 sales@vaf.nl
67	M/B F.O VISCOSITY CONTROLLER	1	TYPE : ELECTRIC TYPE VISCO. SENSOR WITH INTERFACE BOX	VAF INSTRUMENT B.V. NETHERLANDS	VS	FAX)+31-78-617-7068 TEL)+31-78-618-3100 sales@vaf.nl
68	L.O TRANSFER PUMP	1	TYPE : HORIZONTAL SCREW CAP. : 5M3/H X 0.4MPag MOTOR: 3.5KWX440VX60HZX3470RPM	IMO AB. SWEDEN	ACE 032N3 NVBP	FAX)+46-8-645-1509 TEL)+46-8-506-22-800 info@imo.se
69	MAIN L.O PURIFIER	2	TYPE : CENTRIFUGAL AUTO SELF-CLEANING TOTAL DISCH. CAP. : 2,100L/SAE#30 DETERGENT MOTER: 5.5KW X 440V X 60HZ X 4PH	SAMGONG CO., LTD.	SJ30F	FAX)+82 51 200 3046 TEL)+82 51 205 7101 skoh@sam-gong.co.kr

NO.	EQUIPMENT	Q'TY	SPECIFICATION	MAKER/ SUPPLIER	MODEL	FAX/TEL/EMAIL
70	L.O PURIFIER FEED PUMP	2	TYPE:HORIZONTAL SCREW CAP:2.1M3/H X 0.25MPag MOTOR: 1.75KW X 440V X 60HZ X 3440RPM	IMO AB. SWEDEN	ACE 025N3 NVBP	FAX)+46-8-645-1509 TEL)+46-8-506-22-800 info@imo.se
71	MAIN L.O PURIFIER HEATER	2	TYPE : ELECTRIC TYPE CAP. : 2.1M3/H X 40/85°C (55KWX440VX60HZX3PH)	DONG-HWA ENTEC KOREA	DHEH-018504	FAX)+82-51-970-1071 TEL)+82-51-970-1070 ccj@dhmail.dh.co.kr
72	M/T AUX. L.O PUMP	2	TYPE : DEEP WELL CENT CAP. : 180M3/H X 0.45MPag MOTOR : 55KWX440VX60HZX1800RPM	SHINKO IND. CO. JAPAN	SAF150-2	FAX)+81-82-508-1020 TEL)+81-82-508-1000 sogawa@shinkohir.co.jp
73	STERN TUBE L.O PUMP	2	TYPE : HORIZONTAL SCREW CAP. : 2.0M3/H X 0.3MPag MOTOR: 1.75KWX440VX60HZX3440RPM	IMO AB. SWEDEN	ACE 025N3 NVBP	FAX)+46-8-645-1509 TEL)+46-8-506-22-800 info@imo.se
74	M/T L.O COOLER	2	TYPE : PLATE TYPE CAP. : 912,000 KCAL/H	KOREA PHE CO., LTD.	J107-MGS7/5	FAX)+82-32-563-4282 TEL)+82-32-563-7564 kphe114@chollian.net
75	STERN TUBE L.O COOLER	1	TYPE : SHELL & TUBE SURFACE AREA : 2 M2 L.O : 2 M3/HR (47.5/45ºC)	DONG-HWA ENTEC KOREA	DHLC-018508	FAX)+82-51-970-1071 TEL)+82-51-970-1070 ccj@dhmail.dh.co.kr
76	M/T L.O AUTO. FILTER	1	TYPE : AUTO. BACK FLUSHING (20 MICRON) BY-PASS : MANUAL (ABS 50 MICRON)	YOOWON INDUSTRIES LTD. KOREA	200-K8E8Z-WC20+X/BF	FAX)+82-51-205-8540 TEL)+82-51-205-8541 yoowon@korea.com
77	MAIN S.W CIRC. PUMP	3	TYPE : VERT. CENTRIFUGAL CAP. : 9,500/4,700M3/H X 5/8MTH MOTOR: 200KWX440VX60HZX360RPM	SHINKO IND. CO. JAPAN	CVN1000MG CVN1000LMG	FAX)+81-82-508-1020 TEL)+81-82-508-1000 sogawa@shinkohir.co.jp
78	MAIN COOLING S.W PUMP	2	TYPE : VERTICAL CENTRIFUGAL CAP. : 1050M3/H X 25MTH MOTOR: 110KWX440VX60HZX1800RPM	SHINKO IND. CO. JAPAN	GVD360M	FAX)+81-82-508-1020 TEL)+81-82-508-1000 sogawa@shinkohir.co.jp
79	MARINE GROWTH PREVENTING SYS.	2	TYPE : CHLORINE DOSAGE CAP. : 20,100M3/H	NIPPON CORROSION ENGINEERING. JAPAN	SNR-5000G	FAX)+81-3-3737-8458 TEL)+81-3-3737-8451 tok3@nitibo.co.jp
80	CENTRAL COOL. F.W. PUMP	2	TYPE : VERTICAL CENTRIFUGAL CAP. : 870M3/H X 25MTH MOTOR : 90KW X 440V X 60HZ X 1800RPM	SHINKO IND. CO. JAPAN	GVD360M	FAX)+81-82-508-1020 TEL)+81-82-508-1000 sogawa@shinkohir.co.jp
81	CENTRAL FRESH WATER COOLER	2	TYPE : PLATE TYPE CAP. : 6,733,300 KCAL/H	KOREA PHE CO., LTD.	B110-MGS7/3	FAX)+82-32-563-4282 TEL)+82-32-563-7564 kphe114@chollian.net
82	D/G STARTING AIR COMPRESSOR	2	TYPE : 2-STAGE, AIR COOLED PISTON CAP. : 22M3/H X 2.45MPag MOTOR: 5.5KW X 440V X 60HZ X 1200RPM	JONG-HAP MARITIME INC. KOREA	AHV-20	FAX)+82-51-831-3772 TEL)+82-51-831-3277 infocomp@jonghap.co.kr
83	EM'CY AIR COMPRESSOR	1	TYPE : ENGINE DRIVEN, 2-STAGE CAP. : 22M3/H X 2.45MPag ENG. : 4 CYCLE DIESEL, 7.5KW, 2200RPM	JONG-HAP MARITIME INC. KOREA	AHV-20E	FAX)+82-51-831-3772 TEL)+82-51-831-3277 infocomp@jonghap.co.kr
84	D/G STARTING AIR RESERVOIR	1	TYPE : VERTICAL CYLINDER CAP. : 1.0M3 X 2.45MPag	KUMKANG PRECISION CO.,LTD. KOREA		FAX)+82-51-262-4895 TEL)+82-51-262-4896 kumkang20@korea.com
85	EMERGENCY AIR RESERVOIR	1	TYPE : VERTICAL CYLINDER CAP. : 500L X 2.45MPag	KUMKANG PRECISION CO.,LTD. KOREA		FAX)+82-51-262-4895 TEL)+82-51-262-4896 kumkang20@korea.com

NO.	EQUIPMENT	Q'TY	SPECIFICATION	MAKER/ SUPPLIER	MODEL	FAX/TEL/EMAIL
86	SERVICE AIR COMPRESSOR	2	TYPE : SINGLE-STAGE, WATER COOLED SCREW TYPE CAP. : 700M3/H X 0.9MPag MOTOR: 105KW X 440V X 60HZ X 3600RPM	ATLAS COPCO MFG KOREA CO., LTD.	ZR90	FAX)+82-2-522-1989 TEL)+82-2-2189-4000 mhkim@kr.atlascopco.com yeari.min@kr.atlascopco.com
87	SERV. AIR RESERVOIR	2	TYPE : VERTICAL CYLINDER CAP. : 6M3 X 0.882MPag	KUMKANG PRECISION CO., LTD. KOREA		FAX)+82-51-262-4895 TEL)+82-51-262-4896 kumkang20@korea.com
88	AIR RESERVOIR & CONTROL PANEL FOR Q.C.V	2	TYPE : VERTICAL CYLINDERICAL CAP : FOR E/R - 150L X 0.88MPag FOR F.W.D HFO DEEP TK - 10L X 0.88MPag	POONG JIN METAL CO., LTD. KOREA		FAX)+82-51-831-8514 TEL)+82-51-831-8510~3 pjmetal@unitel.co.kr
89	AIR DRYER	3	TYPE : REGENERATIVE X 2SETS REFRIGERATED X 1SET CAP. : 350NM3/H EACH	KYUNG NAM DRYER CO., LTD. KOREA	KHDM-400 KADM-400	FAX)+82-031-962-0180 TEL)+82-031-963-0080 kndryer@yahoo.co.kr
90	MAIN FD. W PUMP	2	TYPE : SINGLE STAGE - HORIZONTAL IMPULSE STEAM TURBINE DRIVEN CAP. : 136/160 M3/H X 855MTH	COFFIN TURBO PUMP INC.	DEB-16	FAX)+1-201-568-4716 TEL)+1-201-568-4700 jmotisi@coffinpump.com
91	EM'CY FEED WATER PUMP	1	TYPE : HORI. PLUNGER CAP. : 6M3/H X 855MTH MOTOR: 30KW X 440V X 60HZ X 1200RPM	SHINKO IND. CO. JAPAN	HLX6	FAX)+81-82-508-1020 TEL)+81-82-508-1000 sogawa@shinkohir.co.jp
92	ATMOS. CONDENSER	1	TYPE : SHELL & TUBE SURFACE AREA : 508M2	DONG-HWA ENTEC		FAX)+82-51-970-1071 TEL)+82-51-970-1070 ccj@dhmail.dh.co.kr
93	DRAIN COOLER	1	TYPE : SHELL & TUBE SURFACE AREA : 5 M2	DONG-HWA ENTEC		FAX)+82-51-970-1071 TEL)+82-51-970-1070 ccj@dhmail.dh.co.kr
94	OIL MIST DETECTION SYSTEM	1	TYPE : MULTI TYPE WITH 24 SENSORS	SPECS CORPORATION. KOREA	OMD95	FAX)+82-342-706-5214 TEL)+82-342-706-5211 specs@specs.co.kr
95	MAIN CONDENSATE PUMP FOR M/T	2	TYPE : VERTICAL CENTRIFUGAL CAP. : 110M3/H X 100MTH MOTOR: 60KW X 440V X 60HZ X 1800RPM	SHINKO IND. CO. JAPAN	EVZ130-2M	FAX)+81-82-508-1020 TEL)+81-82-508-1000 sogawa@shinkohir.co.jp
96	LOW DUTY COND. P/P	1	TYPE : VERTICAL CENTRIFUGAL CAP. : 40 M3/HR X 100MTH MOTOR: 30KW X 440V X 60HZ X 1800RPM	SHINKO IND. CO. JAPAN	EVZ100M	FAX)+81-82-508-1020 TEL)+81-82-508-1000 sogawa@shinkohir.co.jp
97	DRAIN PUMP	1	TYPE : VERTICAL CENTRIFUGAL CAP. : 54 M3/H X 90MTH MOTOR: 30KW X 440V X 60HZ X 1800RPM	SHINKO IND. CO. JAPAN	EVZ100MH	FAX)+81-82-508-1020 TEL)+81-82-508-1000 sogawa@shinkohir.co.jp
98	NAVIGATION DRAIN PUMP	2	TYPE : VERTICAL CENTRIFUGAL CAP. : 27M3/H X 90MTH MOTOR: 18.5KW X 440V X 60HZ X 1800RPM	SHINKO IND. CO. JAPAN	EVZ70MH	FAX)+81-82-508-1020 TEL)+81-82-508-1000 sogawa@shinkohir.co.jp
99	ION EXCHANGER	1	TYPE : DUPLEX TYPE FOR DEMINERALISATION CAP. : 2.7M3/H	RWO WATER TECHNOLOGY	AGV80-130	FAX)+49-421-5370540 TEL)+49-421-537050 info@rwo.de
100	DE-OILER	1	TYPE : SIMPLEX CARTRIDGE WITH A DUPLEX STRAINER AT INLET CAP. : 4.6 M3/HR	SASAKURA ENG. CO., LTD. JAPAN	20GPM	FAX)+81-6-6473-2839 TEL)+81-6-6473-2132 yamazaki@skm.sasakura.co.jp
101	GREASE EXTRACTOR	1	TYPE: FILTER CLOTH TYPE CAP. : 100 M3/H	SIMULATION TECH.	STI-GE100	FAX)+82-2-6678-4106 TEL)+82-2-6678-4100 master@simulationtech.co.kr

NO.	EQUIPMENT	Q'TY	SPECIFICATION	MAKER/ SUPPLIER	MODEL	FAX/TEL/EMAIL
102	FRESH WATER GENERATOR	2	TYPE : SINGLE-STAGE PLATE TYPE, CONDENSATE COOLED TYPE, SEA WATER COOLED TYPE CAP. : 60TON/DAY SAL. : MAX 1.5PPM	ALFA-LAVAL KOREA LTD.	VSP-36-125CC VSP-36-125SWC	FAX)+82-2-3406-0701 TEL)+82-2-3406-0600 peter.jeppesen@alfalaval.com daebok.jung@alfalaval.com
103	FRESH WATER GENERATOR EJECTOR PUMP	2	TYPE : VERTICAL CENTRIFUGAL - FOR COND. WATER COOLED F.W.GEN. CAP.:80M3/HR X 42MTH MOTOR : 22KWX440VX60HZX1800RPM - FOR SEA WATER COOLED F.W.GEN. CAP.:90M3/HR X 0.41MPag MOTOR : 22KWX440VX60HZX1800RPM	SHINKO IND. CO. JAPAN	GVC125-2M	FAX)+81-82-508-1020 TEL)+81-82-508-1000 sogawa@shinkohir.co.jp
104	HACK SAW	1	TYPE : ELECTRIC CAP.: MAX.250 MM ROUND BAR : 200 X 200 CUTTING SQUARE BAR	YOUNG KWANG MACH. CO., LTD. KOREA	WS-250	FAX)+82-54-776-6455 TEL)+82-54-776-6456/9 machine@ykmc.co.kr
105	MILLING MACHINE	1	TYPE : INDEP. ELEC. MOTOR DRIVEN WORKING SURFACE : ABT 1,100 X 290MM	YOUNG KWANG MACH. CO., LTD. KOREA	NSM-9300	FAX)+82-54-776-6455 TEL)+82-54-776-6456/9 machine@ykmc.co.kr
106	SHAPER	1	TYPE : ELEC. MOTOR DRIVEN CAP. : RAM STROKE : MAX. 750MM	NAMSUN PRECISION MACH. CO., LTD. KOREA	SKS-710	FAX)82-42-934-3707 TEL)82-42-934-3700 nskr@hitel.net
107	BILGE WATER SEPARATOR PUMP	1	TYPE : HORIZONTAL, PISTON CAP. : 5M3/H X 50MTH MOTOR: 1.5KW X 440V X 60HZ	HANYOUNG ENG. CO., LTD. KOREA	OS-5.0	FAX)+82-55-345-1684 TEL)+82-55-345-2933-4 hyows@unitel.co.kr
108	E/R BILGE WATER PUMP	1	TYPE : PISTON CAP. : 10M3/H X 40MTH MOTOR: 3.7KW X 440V X 60HZ X 1200RPM	SHINKO IND. CO. JAPAN	VPS10	FAX)+81-82-508-1020 TEL)+81-82-508-1000 sogawa@shinkohir.co.jp
109	BILGE WATER SEPARATOR	1	TYPE : AUTO. OIL DISCHARGE CAP. : 5M3/H X 15PPM	HANYOUNG ENG. CO., LTD. KOREA	OS-5.0	FAX)+82-55-345-1684 TEL)+82-55-345-2933-4 hyows@unitel.co.kr
110	HIGH EXPANSION FOAM SYSTEM	1	DISCHARGE RATE : 1.0 M/MIN EXPANSION RATIO : 600 TIMES MIX. RATE : FOAM LIQUID 2%+SEA WATER 98%	KASHIWA CO., LTD. JAPAN		FAX)81-03-5449-2430 TEL)81-03-5449-2431 sales@kashiwa-tech.co.jp
111	CO2 FIRE EXTINGUISHING SYSTEM	1	TYPE : HIGH PRESSURE 45KG CYL.	NK CO., LTD. KOREA		FAX)+82-51-204-2215 TEL)+82-51-204-2211 khkim@nkcf.com
112	BILGE & G/S PUMP	2	TYPE: VERTICAL CENTRIFUGAL CAP.: 240M3 / 30MTH MOTOR: 30KW X 440V X 60HZ X 1800RPM	SHINKO IND. CO. JAPAN	GVD200MS	FAX)+81-82-508-1020 TEL)+81-82-508-1000 sogawa@shinkohir.co.jp
113	DOMESTIC F.W COOL. PLANT CIRC. PUMP	2	TYPE: HORIZONTAL CENTRIFUGAL CAP.: 5M3 / 10MTH MOTOR: 0.75KW X 440V X 60HZ X 1800RPM	SHINKO IND. CO. JAPAN	HJ40M	FAX)+81-82-508-1020 TEL)+81-82-508-1000 sogawa@shinkohir.co.jp
114	FIXED WATER BASED LOCAL APPLICATION FIRE FIGHTING SYSTEM	1	TYPE: HIGH PRESSURE H.P PUMP CAP.: 100L/MIN X 7MPag MOTOR: 18.5KWXAC440VX60HZ	KASHIWA CO., LTD. JAPAN	HYPER-MIST	FAX)81-03-5449-2430 TEL)81-03-5449-2431 sales@kashiwa-tech.co.jp

9.2 Tank Capacity Plan and List

Cargo Tanks (Measured Volume) at –160 °C, S.G. = 0.47						
Compartment	Location Frame Number	Capacities		Center of Gravity		Max. F.S.M. M^4
		Volume 100% (m^3)	Volume 98% (m^3)	L.C.G. From Mid (Mid)	V.C.G. Above B.L. (Mid)	
No. 1 Cargo Tank	121-133	21935.8	21497.1	78.66	16.21	69286
No. 2 Cargo Tank	104-120	40452.0	39643.0	38.61	16.46	198254
No. 3 Cargo Tank	87-103	40442.9	39634.1	-8.99	16.46	198254
No. 4 Cargo Tank	72-86	35266.5	34561.2	-53.79	16.46	172858
Total		**138097.2**	**135335.4**	-	-	-

Ballast Water Tanks S.G.=1.025						
Compartment	Location Frame Number	Capacities		Center of Gravity		Max. F.S.M. M^4
		Volume 100% (m^3)	Weight 100% (Tons)	L.C.G. (m)	V.C.G. (m)	
F.P.TK	164-F.E	1355.9	1389.8	129.41	10.86	1428
FWD Deep WB. TK(P)	134-157	1575.7	1615.0	108.38	12.01	961
FWD Deep WB. TK(S)	134-157	1575.7	1615.0	108.38	12.01	961
NO.1 DB.W.B.TK(P)	120-134	2086.8	2138.9	79.05	2.83	9449
NO.1 W.W.B.TK(P)	120-134	3791.1	3885.8	83.54	18.37	4956
NO.1 DB.W.B.TK(S)	120-134	2086.8	2138.9	79.05	2.83	9449
NO.1 W.W.B.TK(S)	120-134	3791.0	3885.8	83.54	18.37	4956
NO.2 DB.W.B.TK(P)	103-120	3469.2	3555.9	36.67	2.40	26257
NO.2 W.W.B.TK(P)	103-120	2328.8	2387.0	37.19	18.02	747
NO.2 DB.W.B.TK(S)	103-120	3469.2	3555.9	36.67	2.40	26257
NO.2 W.W.B.TK(S)	103-120	2328.8	2387.0	37.19	18.02	747
NO.3 DB.W.B.TK(P)	86-103	3584.1	3673.7	-10.40	2.39	27777
NO.3 W.W.B.TK(P)	86-103	2330.1	2388.3	-10.40	18.02	739
NO.3 DB.W.B.TK(S)	86-103	3584.1	3673.7	-10.40	2.39	27777
NO.3 W.W.B.TK(S)	86-103	2330.1	2388.3	-10.40	18.02	739
NO.4 DB.W.B.TK(P)	71-86	2830.1	2900.9	-53.85	2.45	20957
NO.4 W.W.B.TK(P)	71-86	2055.3	2106.7	-55.19	18.02	659
NO.4 DB.W.B.TK(S)	71-86	2830.1	2900.9	-53.85	2.45	20957
NO.4 W.W.B.TK(S)	71-86	2055.3	2106.7	-55.19	18.02	659
E/R W.B. TK(P)	48-71	897.9	920.3	-85.34	15.05	170
E/R W.B. TK(S)	48-71	897.9	920.3	-85.34	15.05	170
A.P. TK	A.E-15	1174.1	1203.5	-127.20	13.51	18057
Total	-	**52428.1**	**53738.3**	-	-	-

Fresh Water Tanks S.G.=1.000						
Compartment	Location Frame Number	Capacities		Center of Gravity		Max. F.S.M. M^4
		Volume 100% (m^3)	Weight 100% (Tons)	L.C.G. (m)	V.C.G. (m)	
Distilled W. Tk(P)	7-15	253.7	253.7	-124.13	18.72	280
Distilled W. Tk(S)	7-15	253.7	253.7	-124.13	18.72	280
Fresh Water Tk(P)	A.E-7	246.0	246.0	-131.57	18.99	183
Fresh Water Tk(S)	A.E-7	246.0	246.0	-131.57	18.99	183
Total	-	**999.4**	**999.4**	-	-	-

Fuel Oil Tanks S.G.=0.980						
Compartment	Location Frame Number	Capacities		Center of Gravity		Max. F.S.M. T-M
		Volume 100% (m^3)	Weight 98% (Tons)	L.C.G. (m)	V.C.G. (m)	
HFO.Deep Tk(C)	138-157	3533.9	3393.9	110.14	12.81	2798
E/R HFO.Tk(P)	48-71	1009.6	969.6	-83.59	16.59	102
E/R HFO.Tk(S)	67-71	261.7	251.3	-77.80	16.07	18
Low Sulphur Stor. Tk(S)	48-67	709.9	681.8	-85.71	16.71	84
Low Sulphur Sett. Tk(S)	60-63	38.0	36.5	-83.80	17.97	3
HFO.Sett.Tk(P)	48-60	225.6	216.7	-89.80	19.57	11
HFO.Sett.Tk(S)	48-60	225.6	216.7	-89.80	19.57	11
Total	-	**6004.3**	**5766.5**	-	-	-

Diesel Oil Tanks S.G.=0.850						
Compartment	Location Frame Number	Capacities		Center of Gravity		Max. F.S.M. M^4
		Volume 100% (m^3)	Weight 98% (Tons)	L.C.G. (m)	V.C.G. (m)	
DO. Stor. Tk(P)	40-47	332.7	277.1	-98.15	16.30	115
DO. Serv. Tk(P)	44-47	37.7	31.4	-96.60	23.72	6
DO. Tk for IGG	40-47	131.3	109.4	-98.66	23.68	85
Total	-	**501.7**	**417.9**	-	-	-

Lubricating Oil Tanks S.G.=0.900						
Compartment	Location Frame Number	Capacities		Center of Gravity		Max. F.S.M. M^4
		Volume 100% (m^3)	Weight 98% (Tons)	L.C.G. (m)	V.C.G. (m)	
Main LO. Grav. Tk(S)	32-36	33.6	29.6	-105.80	17.97	1
Main LO. Sett. Tk(S)	36-40	51.3	45.2	-102.60	17.97	4
Main LO. Stor. Tk(S)	40-47	59.9	52.8	-97.79	22.86	26
D/G LO. Stor. Tk(S)	40-42	12.2	10.8	-100.20	22.86	2
D/G LO. Sett. Tk(S)	38-40	12.2	10.8	-101.80	22.86	2
T/G LO. Stor. Tk(S)	36-40	16.7	14.8	-102.60	22.86	1
T/G LO. Sett. Tk(S)	36-38	12.2	10.8	-103.40	22.86	2
Main LO. Sump Tk(C)	29-37	68.1	60.1	-106.34	2.11	124
Total	-	**266.2**	**234.9**	-	-	-

Miscellaneous Tanks S.G.=1.000						
Compartment	Location Frame Number	Capacities		Center of Gravity		Max. F.S.M. M^4
		Volume 100% (m^3)	Weight 100% (Tons)	L.C.G. (m)	V.C.G. (m)	
Bilge Holding Tk(C)	15-26	110.8	110.8	-115.86	1.77	124
HFO. Overf. Tk(P)	58-65	64.3	64.3	-83.80	1.20	52
S/T C.W. Tk(C)	7-15	47.8	47.8	-122.97	3.70	8
Waste Oil Tk(C)	26-28	31.9	31.9	-111.39	1.82	65
S/T LO. Drain Tk(C)	21-23	4.1	4.1	-115.40	2.80	4
FO. Sludge Tk(S)	38-40	3.1	3.1	-101.80	10.17	1
LO. Sludge Tk(S)	38-40	5.0	5.0	-101.79	10.17	7
Total	-	**267.0**	**267.0**	-	-	-

Other Tanks S.G.=1.025						
Compartment	Location Frame Number	Capacities		Center of Gravity		Max. F.S.M. M^4
		Volume 100% (m^3)	Weight 100% (Tons)	L.C.G. (m)	V.C.G. (m)	
No. 1 Cargo(Pri. Barrier)	121-133	1083.4	1110.5	78.20	16.16	-
No. 2 Cargo(Pri. Barrier)	104-120	1604.2	1644.3	38.60	16.30	-
No. 3 Cargo(Pri. Barrier)	87-103	1604.2	1644.3	-9.00	16.30	-
No. 4 Cargo(Pri. Barrier)	72-85	1455.0	1491.4	-53.80	16.30	-
No. 1 Cargo(2nd Barrier)	121-133	1463.9	1500.5	78.07	16.11	-
No. 2 Cargo(2nd Barrier)	104-120	2224.3	2279.9	38.60	16.29	-
No. 3 Cargo(2nd Barrier)	87-103	2224.3	2280.0	-9.00	16.29	-
No. 4 Cargo(2nd Barrier)	72-86	2020.2	2070.7	-53.80	16.30	-
No.1 Cofferdam	133-134	1240.9	1271.9	98.78	15.74	1715
No.2 Cofferdam	120-121	2834.3	2905.1	62.40	17.04	13610
No.3 Cofferdam	103-104	2834.3	2905.1	14.80	17.04	13610
No.4 Cofferdam	86-87	2834.3	2905.1	-32.80	17.04	13610
No.5 Cofferdam	71-72	2774.2	2843.5	-74.78	17.04	13606
No.1 Trunk Deck Space	121-133	738.2	756.6	76.19	31.99	7306
No.2 Trunk Deck Space	104-120	1744.2	1787.9	38.60	31.98	34397
No.3 Trunk Deck Space	87-103	1744.2	1787.9	-9.00	31.98	34397
No.4 Trunk Deck Space	72-86	1526.2	1564.4	-53.80	31.98	30097
PIPE DUCT(C)	67-138	2842.7	2913.7	12.19	1.60	1759
Total	-	**34793.0**	**35662.8**	-	-	-

9.3 Lubrication Oil Chart

NO.	EQUIPMENT (MAKER/TYPE)	Q'TY	APPLICATION POINT	KIND OF LUB. OIL	AMOUNT (PER SET)	UNIT	REMARK OR CHANGE INTERVAL
1	MAIN TURBINE AND RECUCTION GEAR (KAWASAKI / UA-360)	1	MAIN L.O STOR. TANK	MOBIL DTE OIL HEAVY MEDIUM	24800	L	80% VOLUME
		1	MAIN L.O SUMP TANK	MOBIL DTE OIL HEAVY MEDIUM	60000	L	-
		1	MAIN L.O GRAV. TANK	MOBIL DTE OIL HEAVY MEDIUM	26800	L	80% VOLUME
		1	BEARINGS & GEARS	MOBIL DTE OIL HEAVY MEDIUM	3500	L	APPROX. 600 LITER PER YEAR
		1	NOZZE VALVE	NEVER-SEEZE	0.09	L	EVERY SIX MONTHS
		1	MANOEUVRING VALVE LEVER	NEVER-SEEZE	0.25	L	EVERY SIX MONTHS
		1	MANOEUVRING VALVE CAM	MOBIL GREASE XHP 222	0.25	KG	EVERY SIX MONTHS
		1	TURNING GEAR BEARING & CHAIN	MOBIL GEAR 627	8.5	L	APPROX. 1000 HOURS
		2	CONDENSER VACUUM PUMP	MOBIL GREASE XHP 222	0.02	KG	MAKE-UP 1000 HRS, REPLACE ONE YEAR
		1	L.O COOLER & AUTO FILTER	MOBIL DTE OIL HEAVY MEDIUM	1310	L	-
		1	PIPE INSIDE	MOBIL DTE OIL HEAVY MEDIUM	2347	L	-
2	MAIN BOILER (MITSUBISHI / MB-4E-NS)	8	BOILER FEET	MOBIL GREASE XHP 222	* 0.01	KG	TWO YEARS
		4	BALL BEARING OF MOTOR FOR L/R S/B	MOBILUX EP 0	* 0.25	KG	FIVE YEARS
		4	METAL BEARING OF TRAVEL'G HEAD & MOTOR FOR L/R S/B	MOBIL GREASE XHP 222	* 0.1	KG	MAKE UP ONE YEAR
		4	BALL & METAL BEAR'G OF TRAVEL HEAD FOR L/R S/B	MOBIL TEMP SHC 100	* 0.4	KG	THREE YEARS
		12	GEAR & CHAIN OF ROTARY S/B	MOBIL GREASE XHP 222	* 0.1	KG	MAKE UP ONE YEAR
		12	RED. GEAR OF ROTARY S/B	MOBIL TEMP SHC 100	* 0.6	KG	THREE OR FIVE YEARS
		2	ACTUATOR OF FD.W. MOTOR V/V(20B)	MOBILUX EP 0	* 4.5	L	TWO YEARS
		2	SEAL POT FOR F.O PT(257B)	ETHYLENE GLYCOL	2.5	L	EVERY TWO YEARS
		2	SEAL POT FOR F.O MIN. KEEP'G V/V(232B)	ETHYLENE GLYCOL	1.8	L	EVERY TWO YEARS
		2	GLAND PACK'G OF FD.W. CONT. V/V(26B)	PS6(CLIMAX LUB.)	* 0.025	KG	MAKE UP SIX MONTHS
		2	GLAND PACK'G OF STEAM TEMP. CONT. V/V(130B)	PS6(CLIMAX LUB.)	* 0.025	KG	MAKE UP SIX MONTHS
		2	GLAND PACK'G OF ATM. STM. PRESS. CONT. V/V(226B)	PS6(CLIMAX LUB.)	* 0.025	KG	MAKE UP SIX MONTHS
		1	GLAND PACK'G OF F.O TEMP. CONT. V/V(195B)	PS6(CLIMAX LUB.)	* 0.025	KG	MAKE UP SIX MONTHS
		10	GLOBE CHECK V/V (1B, 4B, 11B, 12B, 145B)	MOBIL GREASE XHP 222	* 0.15	KG	MAKE UP ONE YEAR
		2	GLOBE ANG. V/V(13B)	MOBIL GREASE XHP 222	* 0.15	KG	MAKE UP ONE YEAR
		2	GLOBE STR. V/V(3B)	MOBILUX EP 0	* 1	KG	MAKE UP ONE YEAR
		2	GLOBE CHECK V/V(71B)	MOBILUX EP 0	* 3.5	KG	MAKE UP ONE YEAR
		2	GLOBE ANG. V/V(131B)	MOBILUX EP 0	* 3	KG	MAKE UP ONE YEAR
		2	GATE V/V(132B)	MOBIL GREASE XHP 222	* 0.2	KG	MAKE UP ONE YEAR
		2	GLOBE CHECK V/V(141B)	MOBIL GREASE XHP 222	* 0.25	KG	MAKE UP ONE YEAR
		3	F.D. FAN	MOBIL GREASE XHP 222	* 1.055	KG	MAKE UP 3000 HRS, REPLACEMENT 6000 HRS
		3	MOTOR FOR F.D. FAN	MOBIL GREASE XHP 222	* 0.06	KG	MAKE UP 4600 HOURS
		2	BEARING OF F.O PUMP	MOBIL GREASE XHP 222	* 0.04	KG	MAKE UP ONE MONTHS, REPLACEMENT ONE YEAR
		1	AMINE INJECTION EQUIP.	MOBIL DTE 18M	4.2	L	INITIAL 500 HRS, AFTER 2500 HRS
		1	HYDRAZINE INJECTION EQUIP.	MOBIL DTE 18M	4.2	L	INITIAL 500 HRS, AFTER 2500 HRS

NO.	EQUIPMENT (MAKER/TYPE)	Q'TY	APPLICATION POINT	KIND OF LUB. OIL	AMOUNT (PER SET)	UNIT	REMARK OR CHANGE INTERVAL
3	TURBO GENERATOR (MITSUBISHI / AT42CT-B)	1	T/G L.O STOR. TANK	MOBIL DTE OIL LIGHT	13000	L	80% VOLUME
		2	TURNING GEAR	MOBIL GEAR 634	7	L	CHECK & PURIFYING EVERY 2500 HOURS
		2	MAIN STOP V/V	MOBIL GREASE XHP 222	0.03	KG	CHECK ONCE A YEAR
		2	BEARINGS, GEAR, GOVERNOR	MOBIL DTE OIL LIGHT	1600	L	CHECK & PURIFYING EVERY 2500 HOURS
4	MAIN FEED WATER PUMP TURBINE (COFFIN / DEB-16)	3	UNIT BEARINGS, MITER GEARS & GOVERNOR ASSEMBLY	MOBIL DTE OIL HEAVY MEDIUM	23	L	2000 OPERAT'G HOURS
		3	CPT NUT & BAR ASSEMBLY	MOBIL GREASE XHP 222		BIT	APPLY UNTIL VISIBLE AT BOTTOM, MAKE UP MONTHLY
5	DIESEL GENERATOR ENGINE (STX / 8L32/40)	1	D/G L.O STOR. TANK	MOBILGARD 412	9800	L	80% VOLUME
		1	L.O SUMP TANK	MOBILGARD 412	3745	L	-
		1	ENGINE INTERNAL	MOBILGARD 412	900	L	-
6	D/G STARTING AIR COMPRESSOR (SPERRE / HV1/85)	2	CRANK CASE	MOBIL RARUS 827	1.5	L	FIRST 200 HOURS, EVERY 1000 HOURS
7	SERVICE / CONTROL AIR COMPRESSOR (JONGHAP TANABE / TASK-1545GW-A)	2	OIL SUMP	MOBIL RARUS SHC 1025	30	L	FIRST 500 HOURS, EVERY 2000 HOURS
9	INCINERATOR (KANGRIM / KEI-70SDA)	1	BURNER GEAR BOX	MOBIL GEAR 627	* 0.2	L	EVERY 12 MONTHS
10	DIESEL OIL PURIFIER (ALFA-LAVAL / MMPX404)	1	GEAR HOUSING	MOBIL SHC 630	0.5	L	FIRST 200 HOURS, EVERY 1000 HOURS
11	LUB. OIL PURIFIER (ALFA-LAVAL / MMPX404)	2	GEAR HOUSING	MOBIL SHC 630	0.5	L	FIRST 200 HOURS, EVERY 1000 HOURS
12	MAIN COOL.S.W. PUMP (SHINKO / GVD360M)	2	PUMP COUPLING SIDE BEARING	MOBIL GREASE XHP 222	* 0.03	KG	-
13	MAIN S.W.CIRC. PUMP (SHINKO / CVF850M)	3	PUMP COUPLING SIDE BEARING	MOBIL GREASE XHP 222	* 0.23	KG	-
14	F.W.GEN.S.W. FD PUMP (SHINKO / GVP100M)	1	PUMP COUPLING BEARING	MOBIL GREASE XHP 222	* 0.01	KG	-
15	CENTRAL COOL.F.W. PUMP (SHINKO / GVD300-2M)	2	PUMP COUPLING SIDE BEARING	MOBIL GREASE XHP 222	* 0.03	KG	-
16	MAIN COND. PUMP (SHINKO / EVZ130-2M)	2	PUMP COUPLING SIDE BEARING	MOBIL GREASE XHP 222	* 0.055	KG	-
17	DRAIN PUMP (SHINKO / EVZ100MH)	1	PUMP COUPLING SIDE BEARING	MOBIL GREASE XHP 222	* 0.055	KG	-
18	NAVIGATION DRAIN PUMP (SHINKO / EVZ70MH)	2	PUMP COUPLING SIDE BEARING	MOBIL GREASE XHP 222	* 0.035	KG	-
19	EM'CY FEED W. PUMP (SHINKO / SK40M)	1	PUMP COUPLING SIDE BEARING	MOBIL GREASE XHP 222	* 0.008	KG	-
		1	PUMP END SIDE BEARING	MOBIL GREASE XHP 222	* 0.008	KG	-
20	E/R BILGE PUMP (SHINKO / VSP10)	1	PUMP COUPLING SIDE BEARING	MOBIL GREASE XHP 222	* 0.03	KG	-
		1	PUMP END SIDE BEARING	MOBIL GREASE XHP 222	* 0.07	KG	-
		1	OIL BOX OR GEAR CASE	MOBIL DTE OIL HEAVY MEDIUM	* 0.3	L	-
21	BALLAST PUMP (SHINKO / GVD500-2MS, GVD500-2LMS)	3	PUMP COUPLING SIDE BEARING	MOBIL GREASE XHP 222	* 0.1	KG	-
22	BILGE FIRE & G.S PUMP (SHINKO / GVX260MS)	2	PUMP COUPLING SIDE BEARING	MOBIL GREASE XHP 222	* 0.02	KG	-
23	EM'CY FIRE PUMP (SHINKO / GVP160-2MS)	1	PUMP COUPLING SIDE BEARING	MOBIL GREASE XHP 222	* 0.03	KG	-

NO.	EQUIPMENT (MAKER/TYPE)	Q'TY	APPLICATION POINT	KIND OF LUB. OIL	AMOUNT (PER SET)	UNIT	REMARK OR CHANGE INTERVAL
24	SPRAY PUMP (SHINKO / GVD300-3M)	1	PUMP COUPLING SIDE BEARING	MOBIL GREASE XHP 222	* 0.05	KG	-
25	AUX. COOL.S.W. PUMP (SHINKO / GVC125-2M)	2	PUMP COUPLING SIDE BEARING	MOBIL GREASE XHP 222	* 0.02	KG	-
26	AUX. COOL.F.W. PUMP (SHINKO / GVC100M)	2	PUMP COUPLING SIDE BEARING	MOBIL GREASE XHP 222	* 0.01	KG	-
27	GLYCOL W.CIRC. PUMP (SHINKO / GVC100M)	2	PUMP COUPLING SIDE BEARING	MOBIL GREASE XHP 222	* 0.01	KG	-
28	REMOTE CONTROL SEA VALVE (AMRI / ACTO)	2	ACTO 200	MOBIL DTE 11M	0.317	L	-
		6	ACTO 400	MOBIL DTE 11M	0.964	L	-
		2	ACTO 800	MOBIL DTE 11M	2.037	L	-
		3	ACTO 1600	MOBIL DTE 11M	4.246	L	-
		1	PIPE INSIDE	MOBIL DTE 11M	183	L	-
29	CONTROL AIR DRYER (KEUMSUNG / KRD-300N)	1	REFRIGERANT COMPRESSOR	MOBIL ELA ARCTIC 32	* 0.5	L	-
30	L.O AUTO FILTER (YOOWON / K8E)	1	OILER ON AIR UNIT	MOBIL DTE 13M	* 0.2	L	MAKE UP 600 HOURS
		3	GREASE NIPPLE	MOBIL GREASE XHP 222	* 0.03	KG	MAKE UP 250 HOURS
		1	BEARING BOX	MOBIL DTE OIL HEAVY MEDIUM	* 0.1	L	MAKE UP TWO YEARS
31	SCREW PUMP (IMO / SCREW)	1	HFO TRANSFER P/P	MOBIL GREASE XHP 222	* 0.023	KG	5000 HOURS
		2	FWD HFO TRANSFER P/P	MOBIL GREASE XHP 222	* 0.015	KG	5000 HOURS
		1	D.O. TRANSFER P/P	MOBIL GREASE XHP 222	* 0.015	KG	5000 HOURS
		1	SLUDGE P/P GREASE POINT	MOBIL GREASE XHP 222	* 0.018	KG	5000 HOURS
		1	SLUDGE P/P GEAR BOX	MOBIL GREASE XHP 222	* 0.51	L	5000 HOURS
32	B.W. SEP. FEED PUMP (HANYOUNG / PISTON)	1	CRANK CASE	MOBIL DTE 13M	* 2.6	L	-
33	STEERING GEAR (TONG MYUNG / FE21-350-T050)	1	NO.1/2 POWER UNIT TANK INCL. CYL/PIPING	MOBIL DTE 16M	2400	L	EVERY SIX MONTHS
		1	HYD. OIL STORAGE TANK	MOBIL DTE 16M	1200	L	-
		1	GREASE PUMP FOR R/CARRIER	MOBILUX EP 0	40	KG	-
34	PROPELLER (LIPS / F.P.P)	1	CAP INTERNAL	MOBILUX EP 0	410	KG	-
35	INTER. SHAFT BEARING (KOBELCO / F-0287)	1	PIPE INTERNAL	MOBIL DTE OIL HEAVY MEDIUM	23	L	-
36	STERN TUBE SEAL,BEARING (KOBELCO /)	1	AFT SEAL TANK	MOBIL DTE OIL HEAVY MEDIUM	35	L	-
		2	GRAVITY TANK	MOBIL DTE OIL HEAVY MEDIUM	80	L	100 L x 80% = 80 L
		1	SUMP TANK	MOBIL DTE OIL HEAVY MEDIUM	3280	L	4100 L x 80% = 3280 L
		1	STERN TUBE INTERNAL	MOBIL DTE OIL HEAVY MEDIUM	1550	L	-
		1	PIPE INTERNAL	MOBIL DTE OIL HEAVY MEDIUM	62	L	-
37	A/C PLANT (HI-PRES KOREA / MCU 108/323102V)	2	CRANKCASE	MOBIL EAL ARCTIC 100	120	L	20,000 HOUR
38	PROV. REF. PLANT (HI-PRES KOREA / MCU 4/271230 V)	2	CRANKCASE	MOBIL EAL ARCTIC 68	12	L	30,000 HOUR

NO.	EQUIPMENT (MAKER/TYPE)	Q'TY	APPLICATION POINT	KIND OF LUB. OIL	AMOUNT (PER SET)	UNIT	REMARK OR CHANGE INTERVAL
39	ELEVATOR (HYUNDAI / 500KG (6 PERSON))	1	GEAR CASE OF TRACTION MACHINE	MOBIL SHC 630	6	L	FIRST 3 MONTH, EVERY 12 MONTH
		1	BEARING PART OF TRACTION MACHINE	MOBIL GREASE XHP 222	300	G	EVERY ONE MONTH
		1	GUIDE RAIL	MOBIL DTE OIL HEAVY MEDIUM	2	L	EVERY ONE MONTH
		1	CAGE DOOR & SAFETY DEVICE	MOBIL DTE OIL HEAVY MEDIUM	2	L	EVERY ONE MONTH
		1	GOVERNOR & TENSION SHEAVE	MOBIL DTE OIL HEAVY MEDIUM	2	L	EVERY ONE MONTH
		1	AROUND ENT. DOOR	MOBIL DTE OIL HEAVY MEDIUM	2	L	EVERY ONE MONTH
40	DUMB WAITER (DAEMYUNG ELEVATOR / 100 KG)	1	WORM WHEEL/SHAFT	MOBIL GEAR 632	4	L	FIVE YEARS
41	LATHE (NAMSUN / NSL480 X 1500G)	1	HEAD STOCK & GEAR BOX	MOBIL DTE 13M	* 10	L	EVERY SIX MONTHS
		1	APRON & CARRIAGE	MOBIL DTE 13M	* 2	L	EVERY TWO WEEKS
		1	CROSS SADDLE SCREW	MOBIL DTE 13M	*	BIT	ONCE A DAY
		1	CARRIAGE SLIDE	MOBIL DTE 13M	*	BIT	ONCE A DAY
		1	SWIVEL SLIDE WAY	MOBIL DTE 13M	*	BIT	ONCE A DAY
		1	TAIL STOCK	MOBIL DTE 13M	*	BIT	ONCE A DAY
42	DRILLING MACHINE (YOUNG KWANG / YKD-30)	1	SLEEVE	MOBIL DTE 13M	* 0.1	L	2 WEEK
		1	BAND GEAR BOX	MOBIL DTE 13M	* 0.1	L	TWO WEEKS
		1	SPINDLE	MOBIL DTE 13M	* 0.1	L	TWO WEEKS
		1	HEAD GEAR BOX	MOBIL DTE 13M	* 0.3	L	FOUR WEEKS
		1	COLUMN	MOBIL GREASE XHP 222	* 0.15	KG	TWO WEEKS
43	JOCKEY PUMP (SHINKO / SHQ50M)	1	PUMP COUPLING SIDE BEARING	MOBIL GREASE XHP 222	* 0.02	KG	-
44	N2 AIR COMPRESSOR (TAMROTOR / EML 65/13 EWNA)	2	COMPRESS OIL RECEIVER VESSEL	MOBIL RARUS SHC 1025	20	L	3000 HRS OR EVERY YEAR
45	EM'CY D/G (DEMP / D 2842 LE 201)	1	L.O SYSTEM	MOBIL DELVAC 1 SHC 5W-40	* 32	L	-
		1	HYD. STARTER	MOBIL DTE 11M	* 2.1	L	-
46	H/D COMPRESSOR MOTOR (TAIYO / ISCW-560LL)	2	BEARING NO.6318C3	MOBIL DTE 16M	5	L	EVERY SIX MONTHS
47	L/D COMPRESSOR MOTOR (TAIYO / ISTC-500L)	2	BEARING NO.6318C3	MOBIL DTE 16M	5	L	EVERY SIX MONTHS
48	H/D COMPRESSOR (CRYOSTAR / CM400/55)	2	SUMP TANK	MOBIL DTE 15M	320	L	PROPER INTERVAL
		2	OIL COOLER, PUMPS, FILTERS, PIPINGS	MOBIL DTE 15M	80	L	PROPER INTERVAL
49	L/D COMPRESSOR (CRYOSTAR / CM300-45)	2	SUMP TANK	MOBIL DTE 15M	320	L	PROPER INTERVAL
		2	OIL COOLER, PUMPS, FILTERS, PIPINGS	MOBIL DTE 15M	80	L	PROPER INTERVAL
50	VACUUM PUMP (MPRI / P100-SV)	2	CYLINDER L.O.	MOBIL DTE AA	20	L	2000 HRS
		2	FLEX I BOX BHD. SEAL	MOBIL THERM 603	1	L	2000 HRS
51	GLYCOL HEAT RESERVE TANK (DSME / HULL TANK)	1	RESERVE TANK	GLYCOL SOLARICE 701	6000	L	PURCHASED BY SHIPYARD (H.P.D.T)
52	PACKAGE TYPE AIR-COND FOR ECR (CENTURY CORPORATION / MP-G7.5 HF3)	1	COMPRESSOR	MOBIL EAL ARCTIC 32	* 4	L	-
53	PACKAGE AIR-COND. FOR W/S & NO.1 SWBD RM. (CENTURY CORPORATION / MP-G15 HF3)	1	COMPRESSOR	MOBIL EAL ARCTIC 32	* 8	L	-

NO.	EQUIPMENT (MAKER/TYPE)	Q'TY	APPLICATION POINT	KIND OF LUB. OIL	AMOUNT (PER SET)	UNIT	REMARK OR CHANGE INTERVAL
54	MANUAL HYD. REM. CONT. SYS (BY CONTROLS, INC. / T12/20/24)	1	TRANSMITTER, ACTUATOR, PIPINGS	MOBIL DTE 13M	3	L	BA001
		1	TRANSMITTER, ACTUATOR, PIPINGS	MOBIL DTE 13M	2.5	L	FW212
		2	TRANSMITTER, ACTUATOR, PIPINGS	MOBIL DTE 13M	2.5	L	RS002/3
55	PACKAGE TYPE AIR-COND. FOR NO.2 SWBD RM. (CENTURY CORPORATION / MP-G10 HF3)	1	COMPRESSOR	MOBIL EAL ARCTIC 32	* 4	L	
56	VALVE REMOTE CONTROL SYSTEM (AMRI-SEIL / -)	1	OIL TANK FOR POWER UNIT	MOBIL DTE 11M	1500	L	PROPER INTERVAL
		1	ACCUMULATORS	MOBIL DTE 11M	563	L	PROPER INTERVAL
		1	PIPE & TUBE	MOBIL DTE 11M	2300	L	PROPER INTERVAL
57	INERT GAS GENERATOR (SMIT GAS / K150 D-LP)	2	GEAR FOR AIR BLOWER	MOBIL DTE BB	15	L	PROPER INTERVAL
		2	MOTOR FOR AIR BLOWER	MOBIL GREASE XHP 222	2	L	PROPER INTERVAL
		1	SUMP TANK FOR COOLING UNIT	MOBIL EAL ARCTIC 100	50	L	PROPER INTERVAL
		1	MOTOR FOR COOLING UNIT	MOBIL GREASE XHP 222	2	L	PROPER INTERVAL
		1	MOTOR FOR DRYER	MOBIL GREASE XHP 222	2	L	PROPER INTERVAL
58	DECK MACHINERY (KOCKS / HIGH PRESSURE)	7	GEAR CASE	MOBIL GEAR 627	130	L	FOR MOORING WINCH
		7	DRUM/CLUTCH, BAND BRAKE, PED/GEAR CASE BEARING	MOBIL GREASE XHP 222	7	KG	FOR MOORING WINCH
		2	GEAR CASE	MOBIL GEAR 627	130	L	FOR ANCHOR WINDLASS
		2	CABLE LIFTER, CLUTCH, BAND BRAKE, BEARING	MOBIL GREASE XHP 222	7	KG	FOR ANCHOR WINDLASS
		2	OPEN GEAR AT CABLE LIFTER	MOBILTAC 375 NC	5	KG	FOR ANCHOR WINDLASS
		1	TANK FORWARD	MOBIL DTE 13M	2900	L	FOR POWER PACK
		1	TANK AFT	MOBIL DTE 13M	2900	L	FOR POWER PACK
		1	IN PIPE LINE	MOBIL DTE 13M	1500	L	
59	BOW THRUSTER (BRUNVOLL / 6415 MOLDE)	1	GEAR HOUSING/PROPELLER	MOBIL GEAR 626	750	L	
		1	PROPELLER SHAFT SEALING SYSTEM	MOBIL GEAR 626	10	L	
		1	THRUSTER GRAVITY TANK	MOBIL GEAR 626	190	L	
		1	IN PIPE LINE	MOBIL GEAR 626	72	L	
60	FIRE WIRE REEL (YOUNGNAM MARINE MACHINERY IND. CO., LTD. / 0000)	2	WINCH	MOBIL GEAR 630	0.8	L	SIX MONTHS
		2	WIRE ROPE	MOBIL ARMA 798	* 0.5	L	OCCASIONALLY
		2	BEARING	MOBIL GREASE XHP 222	* 0.1	L	OCCASIONALLY
		2	OIL SET	MOBIL DTE 13M	* 0.4	L	SIX MONTHS
61	EM'CY TOWING SYSTEM (SAEJIN IND. LTD. / ETS-4000FS-SJ)	1	WINCH	MOBIL GEAR 630	* 3.6	L	SIX MONTHS
62	AIR CAPSTAN (YOUNGNAM MARINE MACHINERY / PNEUMATIC MOTOR DRIVEN TYPE & SUPPORTING TYPE)	4	WINCH	MOBIL GEAR 630	* 1.3	L	SIX MONTHS
		4	WIRE ROPE	MOBIL ARMA 798	* 1	L	OCCASIONALLY
		4	BEARING	MOBIL GREASE XHP 222	* 0.2	L	OCCASIONALLY
		4	OIL SET	MOBIL DTE 13M	* 0.7	L	SIX MONTHS
63	PILOT ROPE LADDER REEL (YOUNGNAM MARINE MACHINERY / FIXED PNEUMATIC MOTOR DRIVEN REEL)	2	WINCH	MOBIL GEAR 630	* 0.8	L	SIX MONTHS
		2	WIRE ROPE	MOBIL ARMA 798	* 0.5	L	OCCASIONALLY
		2	BEARING	MOBIL GREASE XHP 222	* 0.1	L	OCCASIONALLY
		2	OIL SET	MOBIL DTE 13M	* 0.4	L	SIX MONTHS

NO.	EQUIPMENT (MAKER/TYPE)	Q'TY	APPLICATION POINT	KIND OF LUB. OIL	AMOUNT (PER SET)	UNIT	REMARK OR CHANGE INTERVAL
64	ACC. LADDER (SAMGONG CO. LTD. / SWING OUT TYPE)	2	REDUCTION GEAR BOX WITH BRAKE SYSTEM	MOBIL GEAR 630	* 3	L	
		2	OILER FOR AIR MOTOR	MOBIL DTE 13M	* 0.15	L	
65	EM'CY CARGO P/P DAVIT (YOUNGNAM MARINE MACHINERY / FIXED RADIAL SLEWING TYPE)	1	WINCH	MOBIL GEAR 630	* 1.3	L	SIX MONTHS
		1	WIRE ROPE	MOBIL ARMA 798	* 1	L	OCCASIONALLY
		1	BEARING	MOBIL GREASE XHP 222	* 0.2	L	OCCASIONALLY
		1	OIL SET	MOBIL DTE 13M	* 0.7	L	SIX MONTHS
66	STEERING GEAR ROOM DAVIT (YOUNGNAM MARINE / FIXED BOOM TYPE)	1	WINCH	MOBIL GEAR 630	* 1.3	L	SIX MONTHS
		1	WIRE ROPE	MOBIL ARMA 798	* 1	L	OCCASIONALLY
		1	BEARING	MOBIL GREASE XHP 222	* 0.2	L	OCCASIONALLY
		1	OIL SET	MOBIL DTE 13M	* 0.7	L	SIX MONTHS
67	BOSUN STORE DAVIT (YOUNGNAM MARINE / FIXED BOOM TYPE)	1	WINCH	MOBIL GEAR 630	* 1.3	L	SIX MONTHS
		1	WIRE ROPE	MOBIL ARMA 798	* 1	L	OCCASIONALLY
		1	BEARING	MOBIL GREASE XHP 222	* 0.2	L	OCCASIONALLY
		1	OIL SET	MOBIL DTE 13M	* 0.7	L	SIX MONTHS
68	SMALL EQUIP'T HANDLING DAVIT (TOUNGNAM MARINE / FIXED RADIAL SLEWING TYPE)	4	WINCH	MOBIL GEAR 630	* 1.3	L	SIX MONTHS
		4	WIRE ROPE	MOBIL ARMA 798	* 1	L	OCCASIONALLY
		4	BEARING	MOBIL GREASE XHP 222	* 0.2	L	OCCASIONALLY
		4	OIL SET	MOBIL DTE 13M	* 0.7	L	SIX MONTHS
69	CARGO MACHINERY DAVIT (YOUNGNAM MARINE / FIXED RADIAL SLEWING TYPE)	1	WINCH	MOBIL GEAR 630	* 1.3	L	SIX MONTHS
		1	WIRE ROPE	MOBIL ARMA 798	* 1	L	OCCASIONALLY
		1	BEARING	MOBIL GREASE XHP 222	* 0.2	L	OCCASIONALLY
		1	OIL SET	MOBIL DTE 13M	* 0.7	L	SIX MONTHS
70	F.O DAVIT (YOUNGNAM MARINE / FIXED BOOM TYPE)	1	WINCH	MOBIL GEAR 630	* 1.3	L	SIX MONTHS
		1	WIRE ROPE	MOBIL ARMA 798	* 1	L	OCCASIONALLY
		1	BEARING	MOBIL GREASE XHP 222	* 0.2	L	OCCASIONALLY
		1	OIL SET	MOBIL DTE 13M	* 0.7	L	SIX MONTHS
71	INJURED PERSON DAVIT (YONGNAM MARINE / PORTABLE TYPE)	1	WINCH	MOBIL GEAR 630	* 1.3	L	SIX MONTHS
		1	WIRE ROPE	MOBIL ARMA 798	* 1	L	OCCASIONALLY
		1	BEARING	MOBIL GREASE XHP 222	* 0.2	L	OCCASIONALLY
		1	OIL SET	MOBIL DTE 13M	* 0.7	L	SIX MONTHS
72	HOSE HANDLING CRANE (HYDRALIFT / ELECTRO-HYDRAULIC TYPE)	2	HYDRAULIC SYSTEM	MOBIL DTE 13M	800	L	EVERY YEAR
		2	SLEW/WINCH/TRAVEL GEAR BOX	MOBILFLUIED 424	2.5	L	FIRST : 200 R.H, SECOND : 500R.H OR EVERY YEAR
		2	GENERAL GREASE POINT	MOBIL GREASE XHP 222	2.5	KG	EVERY SECOND MONTH
		2	SPHERICAL BEARING IN PIVOT, MAIN JIB, MAIN HYD. CYL	MOBIL GREASE XHP 222	2.5	KG	ONE MONTH
		2	OPEN GEAR: SLEW PINION/RING, RACK/PINION DRIVE	MOBILTAC 375 NC	17	KG	KEEP WELL GREASED AT ALL TIMES.
		2	STEEL WIRE	MOBIL ARMA 798	2.5	KG	KEEP WELL GREASED AT ALL TIMES.
		2	TELESCOPIC JIB WITH NYLATRON SLIDING PADS	MOBILTAC 375 NC	2.5	KG	DO NOT USE GREASE WITH MOLYBDENUM ADDITIVES.

NO.	EQUIPMENT (MAKER/TYPE)	Q'TY	APPLICATION POINT	KIND OF LUB. OIL	AMOUNT (PER SET)	UNIT	REMARK OR CHANGE INTERVAL
73	LIFE BOAT (HARDING / TOTALLY ENCLOSED)	1	ENGINE	MOBIL DELVAC 1	4.8	L	200 HOURS
		1	STEERING PUMP	MOBIL DTE 13M	4	L	WHEN REQUIRED
74	RESCUE BOAT (HARDING / OUTBOARD PETROL)	1	ENGINE	MOBIL OUTBOARD PLUS	0.4	L	WHEN REQUIRED
75	LIFE BOAT DAVIT (DONGWOO MACHINERY / HINGED GRAVITY TYPE)	2	ENCLOSED GEARS	MOBIL GEAR 630	18	L	
		2	WIRE ROPE	MOBIL ARMA 798	5	L	
		2	BEARINGS(GREASE)	MOBIL GREASE XHP 222	2	KG	
76	RESCUE BOAT DAVIT (HARDING / SINGLE ARM)	1	HYDRAULIC SYSTEM	MOBIL DTE 13M	55	L	6-12 WEEKS
77	FLOAT TYPE LEVEL GAUGINE SYSTEM (HENRI SYSTEM / 806 LEVEL GAUGE)	4	GAUGE HEAD	MOBIL DTE 13M or MOBIL DTE 11M	3.75	L	
78	PROVISION CRANE (HYDRALIFT / PORT:MCV-1800-12-18.5, STBD:MCV 1610-12-14)	2	HYDRAULIC SYSTEM	MOBIL DTE 13M	800	L	EVERY YEAR
		2	SLEW/WINCH/TRAVEL GEAR BOX	MOBILFLUIED 424	2.5	L	FIRST:200 R.H., SECOND:500 R.H./EYERY YEAR
		2	GENERAL GREASE POINT	MOBIL GREASE XHP 222	2.5	KG	EVERY SECOND MONTHS
		2	SPHERICAL BEARINGS IN POVIT, MAIN JIB/HYD. CYL.	MOBIL GREASE XHP 222	2.5	KG	ONE MONTH
		2	OPEN GEAR:SLEW(PINION/RING), RACK AND PINION DRIVE	MOBILTAC 375 NC	17	KG	KEEP WELL GREASED AT ALL TIMES
		2	STEEL WIRE	MOBIL ARMA 798	2.5	KG	KEEP WELL GREASED AT ALL TIMES
		2	TELESCOPIC JIB WITH NYLATRON SLIDING PADS	MOBILTAC 375 NC	2.5	KG	DO NOT USE GREASE WITH MOLYBDENUM ADDITIVES.

9.4 List of Motors and Fans

Fan and Motor List

NO.	DESCRIPTION	FAN				MOTOR						REMARK
		Q.TY	TYPE	AIR VOL. m^3/h	RPM	TYPE	KW	RPM	RATING AMP.	STARTING AMP.	BEARING NO	
1	BOILER FORCED DRAFT	2	TACS-1145	1,900/1,190	1,194/894	M2BA 400LKB 6/8	360/155	1,194/894	604/288	-	-	-
2	BOILER SEAL AIR FAN	2	CTB-E-MD 2-68	240	3500	MLA-112M	3.7	3500	6.25	-	6306ZZ / 6206ZZ	-
3	BOIL-OFF LEAK GAS EXTRACTION EXH.	2	ADW-560/280	4,500	1,704	EH 100 M4	1.5	1,704	3.2	18.9	6206ZZ X 2	IP-56, Eex-dIIC-T6
4	BOSUN STORE SUP.	2	AQ-710/330	19,000	1,726	5RN112M4	4.6	1,726	8.7	56	6306ZZ X 2	IP-56
5	BOW THRUSTER ROOM SUP.	1	AQ-630/380	12,000	1,726	5RN112M4	4.6	1,726	8.7	56	6306ZZ X 2	IP-56
6	CO2 ROOM EXH.	1	ADW-500/280	5,000	1,698	4AP 90L-4	1.75	1,698	3.5	16.5	-	HI-PRES
7	COMPRESSOR ROOM EXH.	2	MXDN-1000/410	48,000	1,764	EH180L4	22	1,764	40	252	6310ZZ / 6311Z	IP-56,Eex-d-IIC-T4
8	EM'CY FIRE PUMP ROOM EXH.	1	ADW-315/C9	960	3,404	4AP 80 -2	1.25	3,404	2.6	12.3	-	HI-PRES
9	FWD.PUMP ROOM EXH.	1	AQ-710/380	13,000	1,726	5RN112M4	4.6	1,726	8.7	56	6306ZZ X 2	IP-56
10	GALLEY EXH.	1	ADW-500/330	4,330	1,698	4AP 90L-4	1.75	1,698	3.5	16.5	-	HI-PRES
11	GALLEY SUP.	1	ADW-400/230	2,165	1,674	4AP 80-4	0.9	1,674	2	7.2	-	HI-PRES
12	GLAND EXHAUST FAN	1	BHM5	420	1,730	NIK	3.7	1,730	6.7	-	6206ZZCM / 6207ZZCM	NISHISHBA
13	HOSPITAL EXH.	1	CK 250C	810	2,645	-	0.22	2,645	1	5	-	HI-PRES
14	INCINERATOR ROOM SUP.	1	ADW-560/280	6,000	1,698	4AP 90L-4	1.75	1,698	3.5	16.5	-	HI-PRES
15	LIFT M/C ROOM EXH.	1	ADW-315/C9	500	1,620	4AP 71-4	0.42	1,620	1.2	3.4	-	HI-PRES
16	MESS/SERVICE ROOM EXH.	1	CNA-400	4,185	1,200	4AP 80-4	0.9	1,674	2	7.2	-	HI-PRES
17	MOTOR ROOM SUP.	2	AQ-800/380	21,000	1,726	5RN112M4	4.6	1,726	8.7	56	6306ZZ X 2	IP-56
18	NO.1 ENGINE ROOM EXH.	1	AQ-1250/500	102,000	1,170	XC200L06	25	1,170	43.3	250	6312ZZ	IP-55
19	NO.2 ENGINE ROOM EXH.	1	AQ-1250/500	102,000	1,170	XC200L06	25	1,170	43.3	250	6312ZZ	IP-55
20	NO.1 ENGINE ROOM SUP.	1	AQ-1400/578	102,000/75,852	1,190/885	4RN250M-8,6B3	38.0/16.0	1,190/885	69.2/36.7	519.0/202.0	6315C3 X 2	IP-56
21	NO.2 ENGINE ROOM SUP.	1	AQ-1400/578	102,000/75,852	1,190/885	4RN250M-8,6 B3	38.0/16.0	1,190/885	69.2/36.7	519.0/202.0	6315C3 X 2	IP-56
22	NO.3 ENGINE ROOM SUP.	1	AQ-1400/578	102,000/75,852	1,190/885	4RN250M-8,6 B3	38.0/16.0	1,190/885	69.2/36.7	519.0/202.0	6315C3 X 2	IP-56
23	NO.4 ENGINE ROOM SUP.	1	AQ-1400/578	102,000/75,852	1,190/885	4RN250M-8,6 B3	38.0/16.0	1,190/885	69.2/36.7	519.0/202.0	6315C3 X 2	IP-56
24	PAINT STORE EXH.	1	ADW-315/C9	700	1,668	E 71 B4	0.37	1,668	0.9	3.2	-	HI-PRES
25	PIPE DUCT EXH.	1	MXDN-900/380	25,000	1,764	EH160L4	15	1,764	27.3	185.3	6309ZZ X 2	IP-56,Eex-d-IIC-T4
26	PURIFIER ROOM EXH.	1	AQ-560/330	6,000	1,710	5RN90L04	1.75	1,710	3.5	17.8	6205ZZ X 2	IP-55
27	SANITARY SPACE & CHANGE ROOM EXH.	1	CNA-500	7,909	1,500	4AP 100L-4	3.5	1,720	6.6	37.4	-	HI-PRES
28	SIDE PASSAGE EXH.	2	MXDN-900/380	35,000	1,764	EH160MB4	11	1,764	21	140.7	6309ZZ X 2	IP-56,Eex-d-IIC-T4
29	STEERING GEAR ROOM SUP.	1	AQ-800/330	20,000	1,725	5RN112M04	4.6	1,725	8.9	59	6306ZZ X 2	IP-56
30	WELD AREA EXH.	1	ADW-400/C6	600	1,670	5RN80M04	0.86	1,670	2.0	8.6	6204ZZ X 2	IP-55

Pump and Motor List

	DESCRIPTION	PUMP				MOTOR						MAKER
		Q'TY	TYPE	CAP (m^3/h)	PRESSURE	TYPE	KW	RPM	RATING AMP.	STARTING AMP.	BEARING NO.	
1	AUX. LO PUMP	2	SAG200	210	0.44 MPag	NTIKK	55	1,800	-	-	6313ZZ / 6217CM	P : SHINKO, M : NISHISHIBA
2	CARGO MACH.COOL.FWPUMP	2	-	-	-	-	7.5	-	-	-	6208ZZCM / 6308ZZCM	-
3	VACUUMPUMP FOR BALLAST PUMP	3	-	-	-	-	3.7	-	-	-	6206ZZCM / 6207ZZCM	-
4	BALLAST PUMP	2	GVD500-2M	3,000	-	-	355	900	-	-	7318DB / 6226C3	P : SHINKO, M : NISHISHIBA
5	BILGE PUMP	2	GVD200MS	240	-	NTIKK	30	1,800	-	-	6212ZZ / 6313ZZ	P : SHINKO, M : NISHISHIBA
6	BOILER FUEL OIL PUMP	2	GH-R2T-342	-	-	-	-	-	-	-	-	-
7	CENTRAL COOL.FW PUMP	2	GVD300-2M	780		-	90	1,800	-	-	6218C3 / 6315CM	SHINKO
8	DO PURI. FEED PUMP	1	ACE025N3NVBP	2	0.196 MPag	WU-DA90SF-D-2	1.75	3,440	3.4	20.4	-	IMO
9	DO TRANSFER PUMP	1	ACF080K4IRBO	30	0.4 MPag	-	12.7	1,760	-	-	6207-2ZC3 / C2 6309-2ZC3/P/n 189520	IMO
10	D/G ENGINE DO SERVICE PUMP	1	ACE038K3NVBP	2.3	0.7 MPag	--	2.5	1,700	-	-	6205-2Z / 6206-2Z / P/N 189316	IMO
11	DRAIN PUMP	1	EVZ100MH	54	-	-	30	1,800	--	-	6212ZZ / 6313ZZ	SHINKO
12	EM'CY FEED W. PUMP	1	HLX6	6	-	-	30	1,200	-	-	6212ZZ / 6315ZZ	SHINKO
13	EM'CY FIRE PUMP	1	GVP160-2MS	72	-	-	55	1,800	-	-	6313ZZ / 6217	P : SHINKO, M : NISHISHIBA
14	ENGINE ROOM BILGE PUMP	1	-	10	0.4 MPag	-	3.7	-	-	-	6208ZZCM / 6308ZZCM	-
15	FW GEN.SW PUMP	2	SHQ65M/GVP100M	9/60	0.34 MPag	NTIKK	3.7/11	-	-	-	6210ZZ / 6310ZZ	P : SHINKO, M : NISHISHIBA
16	DOMESTIC F.W COOL. CIRC. PUMP	2	-	5	-	-	0.75	-	-	-	6204ZZCM	-
17	FW HYDROPHORE PUMP	2	-	8	0.6 MPag	-	5.5	-	-	-	6208ZZCM / 6308ZZCM	-
18	FWD HFO TRANS. PP	2	ACE090K4NVBO	50	0.39 MPag	WU-DA180ME-D-4	21.3	1,765	36	270	-	IMO
19	FIRE & G.S. PUMP	2	GVP160-2M	150	-	NTIKK	75	1,800	-	-	6315 / 6218C3	P : SHINKO, M : NISHISHIBA
20	GLYCOL W.CIRC.PUMP	2	-	-	-	-	7.5	-	-	-	6208ZZCM / 6308ZZCM	-
21	HFO TRANSFER PUMP	2	ACF 090K4IRBO	50	0.4 MPag	-	17.3	1,760	-	-	6207-2ZC3 / C2 6309-2ZC3/P/N 189520	IMO
22	HOT W.CIRC.PUMP	2	-	2	0.5 MPag	-	0.4	-	-	-	6203ZZCM X 4	-
23	JOCKEY PUMP	1	-			-	11	-	-	-	6208ZZCM / 6310ZZC3	-
24	LO PURI. FEED PUMP	2	ACE025N3NVBP	2.1	0.25 MPag	-	1.75	3,440	-	-	6205-2Z / 6203-2Z / P/N 190245	IMO
25	LO TRANSFER PUMP	1	ACE032N3NVBP	5	0.4 MPag	-	3.5	3,470	-	-	6205-2Z / 6206-2Z / P/N 189316	IMO
26	MAIN COND. VACUUM PUMP	2	SLPH75330+SGPV53	12.7	-	NTIKK	75	1,750	53	-	6312ZZCM / 6218C3	NISHISHIBA
27	MAIN CONDS PUMP	2	GVC130-2M	110	-	-	60	1,800	-	-	6313ZZCM / 6217CM	SHINKO
28	MAIN COOL. SW PUMP	2	GVD	900	-	NTIKK	90	1,800	-	-	6315ZZ / 6218C3	P : SHINKO, M : NISHISHIBA
29	MAIN SW CIRC. PUMP	3	CVN850M	7,200/3,600	-	NTIKE	185	450	-	-	7322DB / 6228C3	P : SHINKO, M : NISHISHIBA
30	MAIN TUBINE LOPUMP	1	M/T DRIVEN GEAR	210/190	0.44 MPag	-	-	-	-	-	-	-
31	SLUGE PUMP	1	AEB1E100	5	0.34 MPag	SK20F/AL/100L-4	2.53	1,690	6.9	33	-	IMO
32	STERN TUBE LO TRANSFER PUMP	2	ACE025N3NVBP	2	0.3 MPag	-	1.75	3,440	-	-	6205-2Z / 6203-2Z / P/N 190245	IMO