MACHINERY OPERATING MANUAL

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Issue and Update Control

This manual is provided with a system of issue and update control.

Controlling documents ensures that:

- Documents conform to a standard format;
- Amendments are carried out by relevant personnel;
- Each document or update to a document is approved before issue;
- A history of updates is maintained;
- Updates are issued to all registered holders of documents;
- Sections are removed from circulation when obsolete.

Document control is achieved by the use of the footer provided on every page and the issue and update table below.

In the right hand corner of each footer are details of the pages section number and title followed by the page number of the section. In the left hand corner of each footer is the issue number.

Details of each section are given in the first column of the issue and update control table. The table thus forms a matrix into which the dates of issue of the original document and any subsequent updated sections are located.

The information and guidance contained herein is produced for the assistance of certificated officers who by virtue of such certification are deemed competent to operate the vessel to which such information and guidance refers. Any conflict arising between the information and guidance provided herein and the professional judgement of such competent officers must be immediately resolved by reference to BP Shipping Technical Operations Office.

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Mechanical Symbols

Stop Valve	Electric Motor Driven	Y-Type Strainer	F B — Foam Box
Gate Valve	Pneumatic Piston Actuator	Steam Trap With Strainer and Drain Cock	Not Connected Crossing Pipe
Butterfly Valve	Solenoid Actuator	Sounding Head With Filling Cap	Connected Crossing Pipe
Screw Down Non-Return Valve	Pneumatic Diaphragm Actuator	Hopper Without Cover	Branch Pipe
Lift Check Non-Return Valve	Pneumatic Diaphragm Actuator With Hand Wheel	Air Vent Pipe	Blind (Blank) Flange
Swing Check Valve	Spring	Sounding Head With Self - Closing Sampling Cock	Spectacle Flange (° Open • Shut)
Hose Valve	Float	Flow Meter	Orifice
3-Way Valve	Reciprocating Pump	Observation Glass	Spool Piece
Regulating Valve	Centrifugal Pump	Deck Stand (Manual)	Glass Level Gauge
Needle Valve / 'V' Port Valve	Rotary (Gear, Screw, Mono) Type Pump	Deck Stand (Hydraulic)	Overboard Discharge
Self-Closing Valve	Hand Pump	Manometer	Air Vent (With Flame Screen)
Emergency Shut-off Valve	Eductor (Ejector)	Filter Regulating Valve With Strainer	
Safety / Relief Valve	Rose Box	Suction Bellmouth	
P1 P2 — Pressure Reducing Valve	Mud Box	Water Line	
2-Way Cock	Tank Penetration	Float Type Air Vent (With Flame Screen)	
3-Way Cock (L-Type/T-Type)	Discharge/Drain	Flexible Hose Joint	
Hand Operated (Locked Shut) Hand Operated (Locked Open)	Simplex Strainer	Air Horn	
Air Motor Driven	Duplex Strainer With Changeover Cock	H B — Fire Hose Box	

Colour Scheme

- LNG Liquid
- LNG Vapour
- Inert Gas
- Spray Line
- Superheated Steam
- Desuperheated Steam
- Exhaust Steam
- Condensate/Distilled Water
- Fresh Water
- Fresh Water (Jacket Cooling Water)
- Sea Water/Glycol/Nitrogen
- Heavy Fuel Oil
- Marine Diesel Oil
- Air
- Lubricating Oil/Hydraulic Oil
- Bilges
- Fire Main/CO_2
- Refrigerant Gas
- Refrigerant Liquid
- Electrical Signal
- Instrumentation

Electrical and Instrumentation Symbols

I/P	Current to pressure converter		Solenoid valve	OOO	Pushbutton (start/stop/running)			Air Circuit Breaker
I/P	Pressure to current converter	M	Motor operated valve		Pushbutton switch (alternative)			
C/P	Control panel	J	NWT joint box		Pushbutton switch (alternative)			
UPS	Uninterruptible Power Supply	J J	WT joint box 2 glands (4 glands)	O O	Pushbutton (start/stop)			
	Rectifier	HS	Humidistat	BL	Bell			
	Battery	WT	Water transducer		110 Central meter			
	Space heater (element type)	AMS	Alarm monitoring system		Rectifier equipment			
TG	Turbine generator		Overcurrent relay		Making contact	Auxiliary relay contact		
DG	Diesel generator		Normally Open switch		Breaking			
EG	Emergency generator		Normally Closed switch		Making contact	With time limit in closing		
M	AC induction motor	10A	Fuse		Breaking			
GM	Governor motor	RL	Indicator lamp		Making contact	With time limit in opening		
	Earth	D-D	Relay coil		Breaking			
	Transformer	BZ	Buzzer		Making contact	Flicker relay		
	Power supply unit	SIG RB	Whistle relay box		Breaking			
LD	Liquid sensor	GJB/XX	Group junction box xx (xx = location)	O	Emergency stop pushbutton box			
ZBK	Zener barrier box		Resistor	Trip	Automatic Trip			
LM	Limit switch		Variable resistor		Vacuum Circuit Breaker			

CP	Capacitance
CI	Compound Indication
CO_2	CO_2 Meter
O_2	O_2 Meter
DP	Differential Pressure
DPAH	Differential Pressure Alarm (High)
DPS	Differential Pressure Switch
DPX	Differential Pressure Transmitter
DPI	Differential Pressure Indicator
DTAH	Differential Temperature Alarm (High)
EM	Electromagnetic Flow Meter
FAL	Flow Alarm (Low/Non)
FOC	Flow Controller
FX	Flow Transmitter
FI	Flow/Frequency Indication
FS	Flow Switch
FSL	Flow Slowdown (Low/Non)
FLG	Float Type Level Gauge
HY	Hydrazine Detector/Meter
H_2O	Hydrometer
LAH	Level Alarm (High)
LAVH	Level Alarm (Very High)
LAEH	Level Alarm (Extremely High)
LAHH	Level Alarm (High High)
LAL	Level Alarm (Low)
LOC	Level Controller
LCH	Level Controller (High Alarm)
LCL	Level Controller (Low Level)
LCG	Local Content Gauge
LI	Level Indication
LIAL	Level Alarm/Indicator (Low)
LIAH	Level Alarm/Indicator (High)
LIAHL	Level Alarm/Indicator (High/Low)
LR	Level Recorder
LS	Level Switch
MS	Microswitch
MC	Motor Control and Indication
MI	Motor Indication (Run/Normal)
OAH	Oil Content Alarm (High)
OI	Oil Content / O_2 Indicator
PAH	Pressure Alarm (High)
PAL	Pressure Alarm (Low)
PIAL	Pressure Alarm/Indicator (Low)
PIAH	Pressure Alarm/Indicator (High)
PIAHL	Pressure Alarm High/Low Indicator
PICAHL	Pressure Alarm High/Low Indicator/Control
POT	Proportional Position Indicator
PX	Pressure Transmitter
POC	Pressure Controller
PR	Pressure Recorder
PI	Pressure Indication
PS	Pressure Switch
PSH	Pressure Shutdown
PSL	Pressure Slowdown
PH	PH Detector/Meter
RI	RPM Indicator
RCO	RPM Counter
RX	Revolution Transmitter
RC	Revolution Controller
SAH	Salinity Alarm (High)
SI	Salinity Indication
SX	Salinity Transmitter
SM	Smoke Indication
SMX	Smoke Transmitter
TR	Temperature Recorder
TOC	Temperature Control
TI	Temperature Indication
TIAH	Temperature Alarm/Indicator (High)
TIAL	Temperature Alarm/Indicator (Low)
TIAHL	Temperature Alarm High/Low Indicator
TS	Temperature Switch
TT	Temperature Transmitter
TSH	Temperature Shutdown (High)
TSL	Temperature Shutdown (Low)
VX	Vacuum Transmitter
VS	Vacuum Switch
VA	Vacuum Alarm
VSH	Vibration Shutdown
VI	Viscosity Indication
VC	Valve Control
VAH	Viscosity Alarm (High)
VAHL	Viscosity Alarm (High/Low)
VAL	Viscosity Alarm (Low)
XA	Binary Contact
XSH	Other Shutdown
XSL	Other Slowdown
ZI	Position Indication
ZS	Limit Switch

XXX	Function is Locally Available
XXX XXXX	Functions are Available in Control Room
XXX XXXX	Functions are Available on a Local Panel
H XXX XXXX L	Letters outside the circle of an instrument symbol indicate whether high (H), high-high (HH), low (L) or low-low (LL) function is involved O = Open C = Closed

PRINCIPAL MACHINERY PARTICULARS

Main Boilers

Maker:	Kawasaki Heavy Industries
Type:	UME 65/50
Model:	Mono wall natural circulation boiler
Maximum evaporation:	65,000kg/h
Normal evaporation:	50,000kg/h
Steam condition:	5.88mPa superheated steam at 525°C

Safety Valve Settings

Drum high set:	7.546mPa
Drum low set:	7.448mPa
Superheater:	6.370mPa
Economiser:	9.433mPa
Fuel oil consumption:	3,601kg/h at normal evaporation
No. of burners:	3

Forced Draught Fans

Maker:	Osaka Blower Co.
Type:	TACS - 1140
No. of sets:	2
Capacity:	1,280 and 960m^3/min at 1,194 and 895 rpm
Motor:	270kW and 115kW

Air Heaters

Maker:	Kawasaki Heavy Industries
Type:	Extended tubular - steam heated
Temperature rise:	38°C to 130°C

Economisers

Maker:	Kawasaki Heavy Industries
Type:	Spiral finned, extended surface

Seal Air Fans

Maker:	Taiyo Elect. Co. Ltd
No. of sets:	2
Type:	Horizontal centrifugal
Capacity:	7m^3/min x 600mmAq (6kPa) at 50C

Boil Off Gas Extraction Fans

Maker:	Hi-Pres
No. of sets:	2
Type:	Horizontal centrifugal AQ 560
Capacity:	4,300m^3/h at 40mmAq

Boiler Main Feed Water Pumps

Maker:	Coffin Turbo Pump Incorporated
No. of sets:	2
Type:	DEB-16
Power:	608kW
Drive:	Superheated steam
Steam conditions:	5.733MPa at 520°C
Exhaust pressure:	225.4kPa
Capacity (normal):	180m^3/h at 865mth
Maximum speed:	7,411 rpm
Overspeed trip:	8,200 rpm
Sentinel valve:	343kPa
Back pressure trip:	411kPa
Back pressure alarm:	343kPa
Operating oil pressure:	274.4kPa
Low oil pressure alarm:	205.8kPa
Low pressure trip:	171.5kPa
High oil temperature trip:	80°C
Vibration alarm:	7.1mm/s
Vibration trip:	11.2mm/s

Boiler Auxiliary Feed Water Pump

Maker:	Shinko Industries Ltd
No. of sets:	1
Type:	Horizontal centrifugal 10 stage DK80-10MHC
Capacity:	55m^3/h at 850mth
Motor:	250kW

Low Pressure Steam Generator

Maker:	Donghwa Precision Industries Ltd
Type:	BKU
Heating surface:	94.19m^3
Shell steam pressure:	784kPa
Coil steam supply:	9880kg/h
Output:	8,500kg/h

Main Steam Turbine

Maker:	Kawasaki Heavy Industries
Type:	AU - 400 Cross compound impulse 10 stage HP turbine, 8 stage LP turbine with 2 stage astern turbine located in LP turbine exhaust
Output:	39,500PS (29,050kW) at MCR 33,580PS (24,700kW) at NCR
HP turbine speed:	5,075 rpm at MCR
LP turbine speed:	3,350 rpm at MCR
Propeller speed:	90 rpm at MCR / 85.3rpm at NCR
Steam condition:	5.733MPa and superheated at 520°C
Direction of rotation:	Clockwise, looking from aft
Astern maximum continuous speed:	63 rpm (not to exceed two hours)
Critical speed:	72 rpm
Steam bleed off:	HP: HP turbine 5th stage IP: Crossover pipe LP: LP turbine 3rd stage

Main Gearing

Type:	Tandem articulated, double reduction, double hellical

Main Condenser

Maker:	Kawasaki Heavy Industries
Main condenser:	Single pass surface cooling with dump steam chamber
Cooling surface:	3,710m^2
Tube size:	Diameter 19mm, thickness 0.7mm
Condenser vacuum:	722mm Hg, 5.07kPa at a sea temperature of 27°C

Scoop System

Maker:	Omnical Marine Boilers
Sea water flow:	205,000m^3/h at 100% MCR
Scoop inlet diameter:	1,800mm
Scoop outlet diameter:	1,800mm

Vacuum Pumps

Maker:	Kawasaki Heavy Industries
No. of sets:	2
Type:	Nash water sealed, rotary
Capacity:	12.7m³/h at suction vacuum 3.99kPa (730mmHq)
Motor:	30kW at 900 rpm

Gland Steam Condenser

Maker:	Showa Industries Co. Ltd
No. of sets:	1
Type:	Horizontal shell and tube
Cooling surface area:	25m²

Gland Steam Exhaust Fan

Maker:	Nissin Giken Co. Ltd
No. of sets:	1
Type:	BEM 3Y Horizontal centrifugal
Capacity:	7m³/minute at -300mmAq
Motor:	1.5kW at 3,600 rpm

Dehumidifier

Maker:	Mirsui Zosen Machinery
No. of sets:	1
Type:	M-120 Hunters Honeycomb Desiccant
Capacity:	50m³/h at 200Pa process air
Electrical load:	1.3kW maximum

Stern Tube System

Stern Tube

Maker:	Kobelco
Bush:	Aft - L1,700mm x d790mm Forward - L650mm x d792mm
Seal:	DX-850

Lubricating Oil Pumps

Maker:	Taiko Kikai
No. of sets:	2
Type:	NHG - 2MT
Capacity:	2.0m³/h at 196kPa
Motor:	0.70kW

Lubricating Oil Cooler

Maker:	Alfa Laval
Type:	M6-MFM plate type
Capacity:	2m³/h at 46.2°C to 40°C

Aft Stern Tube Seal Tank Lubricating Oil Supplement Pump

Maker:	Taiko Kikai Industries
No. of sets:	1
Type:	Horizontal gear NHG - 0.3m
Capacity:	0.2m³/h at 149kPa
Motor:	0.4kW at 1,200 rpm

Turbine Generators

Steam Turbine

Maker:	Shinko Industries
No. of sets:	2
Type:	RG92-2
Capacity:	3450kW x 8,145 rpm
Steam inlet pressure:	5.77MPa
Temperature:	520°C
Exhaust pressure:	-94.7kPa

Alternator

Maker:	ABB Industries
Type:	AMG 630 M 4 L
Output:	4,313kVA, 3,450kW, 6,600V, 60Hz, 1,800 rpm

Diesel Generator

Engine

Maker:	Watsila
No. of sets:	1
Type:	9R32LNE
Capacity:	3,770kW x 720 rpm

Alternator

Maker:	ABB Industries
Type:	AMG 900 SM 10 LSEA
Output:	4,313kVA, 3,450kW, 6,600V, 60Hz, 720 rpm

Water Heater

Maker:	Watsila
Type:	KVE
Capacity:	11m³/h

Emergency Diesel Generator

Maker:	SsangYong Heavy Industries
No. of sets:	1
Type:	KTA 38 DMGE
Output:	850kW at 1,800 rpm

Alternator

Maker:	Leroy Somer
Type:	LSA 50.1 M6 brushless
Output:	1,062.5kVA, 440V, 60Hz,

Steering Gear

Maker:	Samsung - Hatlapa
Type:	R4ST 700H, 4 cylinder, 3 variable displacement pumps (A4VG)
Motors:	3 x 55kW

Auxiliary External Desuperheater

Maker:	ABB Industry K.K.
Type:	VO-600
Capacity:	10,000kg/h

Fresh Water Generators

Maker:	Alfa laval
No. of sets:	2 - 1 set condensate cooled, 1 set sea water cooled
Type:	VSP-36-125CC, VSP-36-1255WC
Capacity:	60 tonnes/day each

Condensate Pumps

Maker:	Alfa Laval
No. of sets:	2
Type:	Centrifugal PWF2040
Capacity:	3.03m³/h at 26mth

Distillate Pumps

Maker:	Alfa Laval
No. of sets:	2
Type:	Centrifugal PWF2040
Capacity:	2.5m³/h at 39mth
Motor:	1.3kN at 3,430 rpm

Coolers

Auxiliary Condenser

Maker:	Donghwa Precision Industries Ltd
Type:	Shell and tube, vacuum 600mmHg (-78.9kPa)
Cooling surface area:	590m^2

Engine Room Drains Cooler

Maker:	Donghwa Precision Industries Ltd
Type:	Shell and tube
Cooling surface area:	4.5m^2, outlet temperature 80°C

Central Fresh Water Coolers

Maker:	Alfa Laval
No. of sets:	2
Type:	Plate M30-MF
Capacity FW:	1,050m^3/h, 41.1°C to 36°C

Main Turbine Lubricating Oil Cooler

Maker:	Alfa Laval
No. of sets:	1
Type:	Plate type M20-MFM
Capacity LO:	210m^3/h, 54.2°C to 45°C

Heaters

Deaerator

Maker:	Donghwa Precision Industries Ltd
Type:	Direct contact, horizontal
Storage capacity:	20m^3 at 196.14kPa (2.0kg/cm^2)
Feed capacity:	Max. 117,250kg/h, normal 96,000kg/h at 132.9°C

Low Pressure Feed Water Heater

Maker:	Donghwa Precision Industries Ltd
Type:	Shell and tube
Heating surface area:	65m^3, 92,000kg/h, 36°C to 102°C

Low Pressure Steam Generator Feed Water Heater/ Drains Cooler

Maker:	Donghwa Precision Industries Ltd
Type:	Shell and tube
Surface area:	4.44m^2

High Pressure Feed Water Heater

Maker:	Donghwa Precision Industries Ltd
Type:	Shell and tube
Heating capacity:	133°C to 145°C at 119,000kg/h max feed flow
Heating surface area:	45.8m^3

Boiler Fuel Oil Heater

Maker:	Donghwa Precision Industries Ltd
No. of sets:	2
Type:	Shell and tube
Capacity;	10.5m^3 at 50°C to 135°C

Calorifier

Maker:	Kang Rim
Type:	Vertical - electric and steam
Capacity:	2m^3/h, 12,000kcal/h, 150kW

Distilled Water Pumps

Main Condensate

Maker:	Shinko Industries
No. of sets:	2
Type:	Vertical centrifugal EVZ 130 - 2M
Capacity:	130m^3/h at 110mth
Motor:	75kW at 1,800 rpm

Auxiliary Condensate

Maker:	Shinko Industries
No. of sets:	2
Type:	Vertical centrifugal EVZ 130M
Capacity:	85m^3/h at 110mth
Motor:	55kW at 1,800 rpm

Condensate/Drain

Maker:	Shinko Industries
No. of sets:	2
Type:	Vertical centrifugal EVZ 100MH
Capacity:	40m^3/h at 100mth
Motor:	30kW at 1,800 rpm

Low Pressure Steam Generator Feed Water

Maker:	Shinko Industries
No. of sets:	2
Type:	Horizontal centrifugal SHQ50M
Capacity:	11m^3/h at 110mth
Motor:	11kW at 3.600 rpm

Auxiliary External Desuperheater Feed Water Supply

Maker:	Shinko Industries
No. of sets:	2 and 1 spare
Type:	Horizontal centrifugal SHQ50M
Capacity:	2m^3/h at 125mth
Motor:	7.5kW at 3.600 rpm

Fresh Water Pumps

Central Fresh Water Cooling

Maker:	Shinko Industries
No. of sets:	3
Type:	Vertical centrifugal SVS 300M
Capacity:	530m^3/h at 30mth and 680m^3/h at 27mth
Motor:	75kW at 1,800 rpm

Cargo Machinery Fresh Water Cooling

Maker:	Shinko Industries
No. of sets:	2
Type:	Vertical centrifugal SVS 125-2M
Capacity:	80m^3/h at 40mth
Motor:	18.5kW at 1,800 rpm

Cold Domestic Fresh Water

Maker:	Shinko Industries
No. of sets:	2 and 1 spare
Type:	Vertical centrifugal VJ50M
Capacity:	10m^3/h at 70mth
Motor:	7.5kW at 3,600 rpm

Hot Domestic Fresh Water Circulating

Maker:	Shinko Industries
No. of sets:	2 and 1 spare
Type:	Horizontal centrifugal HJ 40M
Capacity:	2m^3/h at 10mth
Motor:	0.75kW at 1,800 rpm

Fresh Water Transfer

Maker: Shinko Industries Ltd
Type: Vertical, centrifugal SVS 100M
Capacity: 70m³/h at 15mth
Motor: 5.5kW at 1,800 rpm

Sea Water Pumps

Ballast Pumps

Maker: Shinko Industries Ltd
No. of sets: 3
Type: Vertical, centrifugal with self-priming of No.3
Model: GVD500-2M (No.s 1 and 2 pumps)
GVD500-2MS (No.3 pump)
Capacity: 3,000m³/h at 50mth
Motors: NTIKE-FCT5-6P type, 6,600V, 580kW, 1,200 rpm

Main Sea Water Circulating Pump

Maker: Shinko Industries
No. of sets: 1
Type: Vertical centrifugal CVF 1000LM
Capacity: 10,000m³/h and 5,000m³/h at 5mth and 8mth
Motor: 220kW at 360 rpm

Auxiliary Sea Water Circulating Pump

Maker: Shinko Industries
No. of sets: 1
Type: Vertical centrifugal CVF 1000LM
Capacity: 10,000m³/h and 5,000m³/h at 5mth and 8mth
Motor: 220kW at 360 rpm

Main Sea Water Cooling Pumps

Maker: Shinko Industries
No. of sets: 2
Type: Vertical centrifugal SVS 400M
Capacity: 1,300m³/h at 20mth
Motor: 110kW at 1,200 rpm

Fresh Water Generator Ejector Pumps

Maker: Shinko Industries
No. of sets: 2
Type: Vertical centrifugal SVS 125-2M
Capacity: 90m³/h at 40mth
Motor: 18.5kW at 1,800 rpm

Fire Fighting Pump

Maker: Shinko Industries
No. of sets: 1
Type: Vertical centrifugal RVP200-2MS self-priming
Capacity: 180m³/h at 120mth
Motor: 132kW at 1,800 rpm

Fire Jockey Pump

Maker: Shinko Industries
No. of sets: 1 and 1 spare
Type: Horizontal centrifugal SHQ 50MM
Capacity: 2m³/h at 120mth
Motor: 7.5kW at 3,600 rpm

Water Spray (Engine Room) Pump

Maker: Shinko Industries
No. of sets: 1
Type: Vertical centrifugal KV 350K
Capacity: 1,200m³/h at 90mth
Motor: 450kW at 1,800 rpm

Water Spray (Steering Gear Room) Pump

Maker: Shinko Industries
No. of sets: 1
Type: Vertical centrifugal RVP200-2MS self-priming
Capacity: 350m³/h at 90mth
Motor: 150kW at 1,800 rpm

Bilge, Fire and General Service Pumps

Maker Shinko Industries
No. of sets: 2
Type: Vertical centrifugal RVP200-2MS self-priming
Capacity: 245m³/h and 150m³/h at 35mth and 120mth
Motor: 45kW and 150kW at 1,800 rpm

Fuel Oil Pumps

Boiler Fuel Oil Supply Pumps

Maker: Taiko Kikai Industries
No. of sets: 2
Type: Horizontal gear - MSES-15XA
Capacity: 13m³/h and 2.94MPa at 25.8cSt
Motors: 30kW at 1,800 rpm

Engine Room Heavy Fuel Oil Transfer Pump

Maker: Taiko Kikai Industries
No. of sets: 1
Type: Horizontal gear - VG-100MA
Capacity: 100m³/h at 490kPa
Motors: 37kW at 900 rpm

Forward Heavy Fuel Oil Transfer Pumps

Maker: Taiko Kikai Industries
No. of sets: 2
Type: Vertical horizontal gear - VG-100MA
Capacity: 100m³/h at 490kPa
Motors: 37kW at 900 rpm

Diesel Oil Transfer Pump

Maker: Taiko Kikai Industries Ltd
No. of sets: 1
Type: Horizontal gear NGH - 15MA
Capacity: 15m³/h at 393kPa
Motor: 5.5kW at 1,200 rpm

MGO Transfer Pump

Maker: Taiko Kikai Industries Ltd
No. of sets: 1
Type: Horizontal gear NGH - 4MA
Capacity: 3m³/h at 245kPa
Motor: 1.5kW at 1,200 rpm

Diesel Oil Treatment Filter

Maker:	C.C. Jensen A/S
No. of sets:	1
Type:	CJC offline filter separator
Model:	PTU1 27/108 MZ-EPWY

Supply Pump

Maker:	Baier and Koppel
Type:	MZ-11-4
Model:	Beka-motor gear pump

Lubricating Oil Pumps and Systems

Main Turbine Lubricating Oil Supply Pump

Maker:	Taiko Kikai Industries Ltd
No. of sets:	1
Type:	LBS-190KH main turbine driven
Capacity:	210m^3/h at 390kPa

Main Turbine Auxiliary Lubricating Oil Supply Pumps

Maker:	Shinko Industries
No. of sets:	2
Type:	Vertical centrifugal SAF150-2
Capacity:	180m^3/h at 45mth, discharge pressure 401kPa
Motor:	45kW at 1,800 rpm

Main Lubricating Oil Filters

Maker:	Nikura Kogyo Co. Ltd
No. of sets:	1 including bypass simplex oil strainer and sludge collector
Type:	LSAS-200A automatic backflushing, 50 micron

Lubricating Oil Transfer Pump

Maker:	Taiko Kikai Industries Ltd
No. of sets:	1
Type:	Horizontal gear NHG - 5MT
Capacity:	5m^3/h at 392kPa
Motor:	2.2kW at 1,200 rpm

Lubricating Oil Purifier Supply Pump

Maker:	Taiko Kikai Industries Ltd
No. of sets:	2
Type:	Horizontal gear NHG - 4MT
Capacity:	3.6m^3/h at 245kPa
Motor:	1.5kW at 1,200 rpm

Lubricating Oil Purifier

Maker:	Alfa Laval
No. of sets:	2
Model:	MOPX 205T
Capacity:	3.6m^3/h at 70°C

Lubricating Oil Purifier Heater

Maker:	Donghwa Precision Industries
No. of sets:	2
Capacity:	3.6m^3/h at 30°C to 90°C
Heating surface area:	1.8m^3

Compressed Air System

Starting Air Compressor

Maker:	J.P. Sauer & Son
No. of sets:	2
Model:	WP33L
Type:	Piston - electric motor driven
Capacity:	38m^3/h at 2.94MPa
Motor:	8.6kW at 1,750 rpm

Emergency Air Compressor

Maker:	J.P. Sauer & Son
No. of sets:	1
Model:	WP15L
Type:	Piston - diesel engine driven
Capacity:	15.5m^3/h at 2.94MPa
Diesel engine rated:	5kW at 1,500 rpm

Control and General Service Air Compressor

Maker:	J.P. Sauer & Son
No. of sets:	3
Model:	SCK 101- 13M60wk
Type:	Screw - electric motor driven
Capacity:	8.3m^3/h at 1,176kPa
Motor:	86kW at 3,560 rpm

Starting Air Receiver

Maker:	Kangrim
No. of sets:	2
Model:	AR300708N
Capacity:	1m^3 and 0.5m^3
Relief valve setting:	3.234MPa

Emergency Air Receiver

Maker:	Kangrim
No. of sets:	1
Model:	AR303436N
Capacity:	0.5m^3
Relief valve setting:	3.234MPa

Control Air Receiver

Maker:	Kangrim
No. of sets:	1
Model:	AR121724N
Capacity:	5m^3
Relief valve setting:	1,274kPa

General Service Air Receiver

Maker:	Kangrim
No. of sets:	1
Model:	AR121724N
Capacity:	5m^3
Relief valve setting:	1,274kPa

Control Air Dryers

Maker:	Tamrotor Marine Compressors
No. of sets:	2-comprising running and standby chambers
Type:	Hankinson Desiccant
Model:	DK 420
Capacity:	300m^3/h at dew point -40°C and 882kPa

Bilge System

Bilge Pump

Maker:	Taiko Kikai Industries
No. of sets:	1
Type:	Vertical reciprocating VPS - 10
Capacity:	10m^3/h at 40mth
Motor:	3.7kW at 1,200 rpm reduced to 76 rpm

Oily Water Separator

Maker:	Hamworthy KSE
No. of sets:	1
Type:	H.S5MK11
Capacity:	5m^3/h

Oil Content Monitor

Maker:	Deckma Hamburg GmbH
Type:	OMD-11
Alarm point:	15 ppm

Sludge Transfer Pump

Maker:	Taiko Kikai Industries. Ltd
No. of sets:	1
Type:	Horizontal mono HNP - 401
Capacity:	5m^3/h at 343kPa
Motor:	2.2kW at 1,200 rpm reduced to 290 rpm

Water Monitoring and Treatment Systems

Marine Growth Prevention

Maker:	Korea Cathelco
No. of sets:	2 - comprising 3 anode tanks
Type:	Ionised system
SW flow:	22,000m^3/h for scoop and main SW circulating 1,500m^3/h for auxiliary SW cooling

Feed Water Measuring Unit

Maker:	Aqua net
No. of sets:	1
Type:	AQ300 45/48
Position:	Main boiler feed water/port and starboard boilers/ LPSG feed/LPSG drum

Chemical Injection Pumps

Maker:	Aqua net
No. of sets:	5
Types:	4HP - main boilers 3LP - LPSG 2LP - FW cooling system 1LP - FW generator

Salinometer

Maker:	Aqua net
No. of sets:	4
Model:	AQ500
Positions:	Deaerator, main condensate, atmospheric drain tank, auxiliary condenser

Oil Content Meter

Maker:	Korea CMR
No. of sets:	1
Type:	402SD80
Position:	Observation drain tank

Rehardening Filter

Maker:	Se-Won Industries
No. of sets:	1
Type:	SWM 5.0
Capacity:	5m^3/h
Position:	FW generator discharge to domestic tanks

Steriliser

Maker:	Kangrim Industries Ltd
No. of sets:	1
Model:	LF15SEDN - 1
Type:	Steam and electric
Capacity:	2.0m^3/h, 12,000kCal/h, 150kW

Steriliser

Maker:	Jowa AB
No. of sets:	1
Type:	AG - S
Capacity:	6m^3/h
Position:	FW generator discharge to domestic tanks

Fresh Water Cartridge Filter

Maker:	Jowa AB
No. of sets:	2
Type:	20µ - synthetic material
Capacity:	5m^3/h
Position:	FW hydrophore discharge to domestic water system

Grease Extractor Filter

Maker:	Misuzu Sangyo Co. Ltd
No. of sets:	1
Type:	W80GS
Capacity:	40m^3/h
Position:	Atmospheric drain tank discharge to main condensate system

Main Feed Magnetic Filters

Maker:	Heinrich Heine
No. of sets:	1
Type:	MASI M14/38
Capacity:	150m^3/h at 10 bar

Sewage Treatment Plant

Maker:	Jonghap
No of sets:	1
Model:	JMC Bio-Aerob -18
Type:	Biological oxidation and discharge
Capacity:	45 persons/day
Discharge pump:	0.3m^3/min at 25mth
Air blower:	20m^3/h
Dosing pump:	1.92 litres/h at 10 bar

Inert Gas Plant

Maker:	Smit Gas System
No. of sets:	1
Capacity:	14,000Nm^3/h

Dehumidifier Dryers

Maker:	A. Hak Apparatenbouw b.v.
No. of sets:	2
Capacity:	14.2m^3
Pessure:	0.35 bar at 150°C
Type:	Desiccant

Refrigeration Plant

Maker:	Grasso
Type:	KMRC 612
Refrigerant:	R404A
Motor:	160kW

Inert Gas Generator Air Blower Units

Maker:	Naaykens
Type:	M
No. of sets:	1
Capacity:	1.94m^3/second at 20°C at 31.5kW

Inert Gas Generator MGO Supply Pump

Maker:	Danfoss
Type:	KSN 2000R

Nitrogen Generator

Maker:	Air Products
No. of sets:	2
Capacity:	90Nm^3/h
Buffer tank capacity:	23m^3

Incinerator

Maker:	Teamtec AS
No. of sets:	1
Type:	OGS 400C
Capacity:	500,000kcal/h

Flue Gas Fan

Capacity:	9,500m^3/h
Motor:	8.6kW at 1,760 rpm - belt drive to fan

Waste Oil Pump

Maker:	PCM Pumps
Type:	M110 F4
Motor maker:	Leroy Somer
Capacity:	0.3kW

Waste Oil Circulating Pump

Maker:	Uniblock
Type:	40-131/0222 NE-W5-GF
Capacity:	6m^3/h at 210kPa

PRINCIPAL PARTICULARS OF CARGO EQUIPMENT AND MACHINERY

Main Cargo Pumps

Maker:	Ebara
Type:	12EC-24
No. of sets:	8 (2 per cargo tank)
Capacity:	Rated at 1,700m^3/h at 155mth
Motor rating:	465.1kW
Motor speed:	1,780 rpm
Starting method:	Direct on line
No. of stages:	1

Spray/Stripping Pumps

Maker:	Ebara
Type:	2EC-092
No. of sets:	4 (1 per cargo tank)
Capacity:	Rated at 50m^3/h at 145mth
Motor rating:	18kW
Motor speed:	3,560 rpm
Number of stages:	2

Emergency Cargo Pumps

Maker:	Ebara
Type:	8ECR-12
No. of sets:	1
Capacity:	Rated at 550m^3/h at 155mth
Motor rating:	171kW
Motor speed:	3,560 rpm
Starting method:	Direct on line
No. of stages:	1

Ballast Pump

Maker:	Shinko Industries
No. of sets:	3
Model:	GVD500-2M (No. 1 and 2 pumps) GVD500-2MS (No.3 pump self-priming)
Capacity:	3,000m^3/h at 50mth
Motors:	NTIKE-FCT5-6P type, 6,600V, 580kW, 1,200 rpm

Ballast Stripping Eductor

Maker:	Kiwon Industrial Co.
No. of sets:	1
Capacity:	300m^3/h
Driving pressure:	1.176MPa

High Duty Compressors

Maker:	Cryostar
Type:	CM 400/55
No. of sets:	2
Capacity(mass flow):	39,666kg/h
Suction volume:	26,000m^3/h
Suction temperature:	-140°C
Suction pressure:	3kPaG or 103kPaA
Discharge pressure:	100kPaG or 200kPaA
Discharge temperature:	Approximately -111.5°C
Compressor rotor speed:	11,200 rpm
Motor power:	666.6kW at 3,580 rpm

Low Duty Compressors

Maker:	Cryostar
Type:	CM 300/45
No. of sets:	2
Capacity:	12,569kg/h
Suction volume:	8,000m^3/h
Suction temperature:	-140°C
Suction pressure:	6kPaG or 106kPaA
Discharge pressure:	100kPaG or 200kPaA
Discharge temperature:	Approximately -105.5°C
Compressor rotor speed:	22,000 rpm
Motor speed:	Variable
Motor power:	280kW at 3,580rpm

LNG Vaporiser

Maker:	Cryostar
Type:	65-UT-38/34-5.4
No. of sets:	1
Capacity(mass flow):	23,111kg/h
Outlet/inlet volume:	13,090/51m^3/h at LNG discharge
Heating:	Steam at 784kPa

Forcing Vaporiser

Maker:	Cryostar
Type:	34-UT-25/21-3.6
No. of sets:	1
Capacity(mass flow):	7,356kg/h maximum
Outlet/inlet volume:	4,211/16m^3/h
Heating:	Steam at 784kPa

Mist Separator

Maker:	Cryostar
Type:	VMS-10/12-1000
No. of sets:	1
Total mass flow:	7,356kg/h maximum

Boil-Off/Warm-Up Heaters

Maker:	Cryostar
Type:	65-UT-38/34-3.2
No. of sets:	2
Capacity mass flow:	23,596kg/h maximum
Outlet/inlet volume:	29,022/9,224m^3/h
Heating:	Steam at 784kPa

Glycol Water Heater

Maker:	Donghwa
Type:	Beu 250 - 1530
Capacity:	23,000kg/h glycol water
Heating:	Steam at 784kPa

Glycol Water Pump

Maker:	Shinko Industries
Type:	SVP 100M
No. of sets:	2
Capacity:	30m^3/h at 45mth
Motor:	11kW at 1,800 rpm

Nitrogen Generator

Maker:	Air Products
Type:	Prism Alpha N_2 plant
Capacity:	2 x 90Nm^3/h at 97% N_2
Dew point:	N_2 - 70°C at atmospheric pressure

Inert Gas / Dry Air Generator

Maker:	Smit Gas
Type:	Gln 14,000 - 0.25 BUFD
No. of sets:	1
Capacity:	14,000Nm^3/h
Discharge pressure:	25kPa

Air Blower

Maker:	Robushi CRB 150/D/LP
Type:	Roots K-150 D-LP
No. of sets:	2
Motor:	185kW at 1,800 rpm

R-404a Refrigerant Dryer

Maker:	Grasso
Type:	KMRC 612
No. of sets:	1
Motor:	185kW at 1,800 rpm

Absorption Dryer

Maker:	Smit Systems
Type:	Regenerative active alumina
Capacity:	14,000m^3/h

Regenerative Dryer

Maker:	Smit Systems
Type:	Jevi
Heater:	310kW

Fuel Pump

Maker:	SAFAG
Type:	NV BHR.G.DC-3
Capacity:	2m^3/h
Motor:	2.5kW

O_2 Analyser

Maker:	Smit Systems
Type:	OPSISA 02 0000

Dew Point Meter

Maker:	Panametrics
Type:	MTS 5/4 (4 - 29mA)
Capacity:	14,000m^3/h

Safety Valves

Cargo Tanks

Maker:	Fukui Seisakusho Co. Ltd
Model:	PSL - MD13 - 131 - LS1(B)
Type:	10 x 12 Porv
Capacity:	27,770Nm^3/h
Set pressure:	25kPa
No. of sets:	8 plus 1 spare

Primary Inter Barrier Space

Maker:	Fukui Seisakusho Co. Ltd
Model:	PSL - MD13 - 131 - S1(B)
Type:	2 x3 Porv
Capacity:	450Nm^3/h
Set pressure:	3kPa
No. of sets:	8 plus 1 spare

Secondary Insulation Space

Maker:	Fukui Seisakusho Co. Ltd
Model:	PSL - MD13 - 131 - S1(B)
Type:	2 x3 Porv
Capacity:	486Nm^3/h
Set pressure:	3kPa
No. of sets:	8 plus 1 spare

Deck Equipment

Hose Handling Cranes

Maker:	MacGregor-Hägglunds Cranes AB
No. of sets:	2
Type (port/starboard):	HH630-1525/HH400-1025
SWL (port/starboard):	15,000/10,000kg
Radius maximum:	25m
Radius minimum:	5.0m
Hoisting speed No Load:	0 to 25m/min
Hoisting speed at SWL:	0 to 12m/min
Slewing sector:	360°
Slewing speed(port/starboard):	0 to 0.6/0 to 0.7 rpm
Luffing (port/starboard):	100/115 seconds
Lifting height:	46m
List/trim:	5° list / 2° trim
Weight of crane (port/starboard):	32.5/25 tons approximately

Provision and Engine Room Cranes

Maker:	MacGregor-Hägglunds Cranes AB
No. of sets:	2
Type (port/starboard):	GP 160-0518/GP 250-1018
SWL (port/starboard):	5,000/10,000kg
Radius maximum:	18m
Radius minimum:	3.6m
Average hoisting speed (port/starboard):	20/12m/min
Slewing sector:	265°
Slewing speed (port/starboard):	0 to 1.6/0 to 1.0 rpm
Luffing (port/starboard):	40/75 seconds
Lifting height (port/starboard):	46/40m
List/trim:	5° list / 2° trim
Weight of crane (port/starboard):	10.9/15.1 tons approximately

Cargo Machinery Handling Crane

Maker:	MacGregor-Hägglunds Cranes AB
No. of sets:	1
Type:	GP 100-0609
SWL:	6,000kg
Radius maximum:	9m
Radius minimum:	2m
Average hoisting speed:	16m/min
Slewing sector:	360°
Slewing speed:	0 to 1.5 rpm
Luffing:	30 seconds
Lifting height:	38m
List/trim:	5° list / 2° trim
Weight of crane:	8.2 tons approximately

Lifeboats

Maker:	Schat-Harding
No. of sets:	2
Model:	MCB24
Dimensions (L x B x H):	7.46m x 2.9m x 2.96m
Number of persons:	45
Weight:	Light load (including loose equipment) 3,850kg
	Total davit load for lowering 7,225kg
Engine maker:	SAAB
Model:	L3.139LB
Engine type:	Diesel, fresh water cooled
Rating:	29hp
Starting system:	Electric motor
Speed:	6 knots
Fuel tank capacity:	210 litres, 24 hours duration at 6 knots

Lifeboat Davit

Maker:	Schat-Harding
No. of sets:	2
Type:	VIP 8/W 120 L
SWL:	7,848kg
Hoisting speed:	0 to 5.9m/min
Lifting height:	47m
Davit and winch weight:	5,140kg
Bowsing:	Tandweil Wandlier winch

Rescue Boat

Maker:	Norsafe AS
Type:	Diesel jet fast rescue boat
Model:	Merlin 6.15m
Length overall:	6.25m
Beam:	2.4m
Depth:	1m
Capacity:	6 persons (up to 15 persons in an emergency)
Boat weight:	1,450kg
Full weight (3 persons):	1,725kg
Lifting arrangement:	Off-load rescue boat hook
Propulsion:	144hp inboard diesel engine with waterjet
Engine maker:	Steyr
Speed with 15 persons:	8 knots
Speed with 3 persons:	28 knots
Range with 3 persons:	110 nautical miles (4 hours)

Rescue Boat Davit

Maker:	Schat-Harding
No. of sets:	1
Type:	SA3.5/W 50 RS
SWL:	3,433.5kg
Overside reach:	1.561m
Hoisting speed:	0 to 20m/min
Lifting height:	40m
Davit and winch weight:	3,000kg

Liferafts

Maker:	Viking Lifesaving Equipment Ltd
Type:	4 x 25 person manual launch
	1 x 6 person manual launch
Total weight:	183kg each (25 person manual launch)
	77kg each (6 person manual launch)

Mooring Winches

Maker:	Friedrich Kocks Gmbh
Model:	CEH 5530

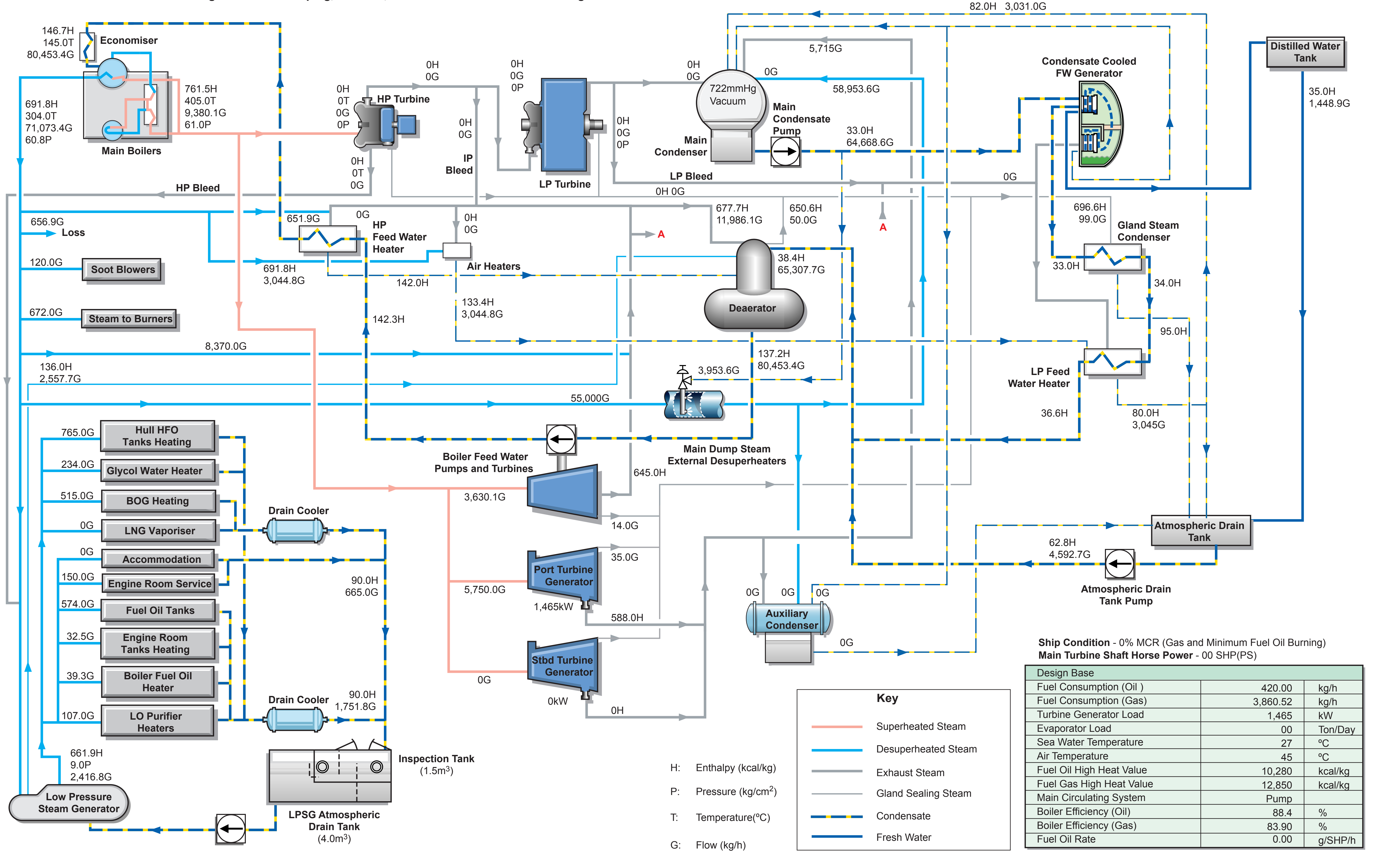
Combined Anchor Windlass/Mooring Winches

Maker:	Friedrich Kocks Gmbh
Model:	CEH 1908

Air Driven Capstans

Maker:	Shin Myung Tech Co. Ltd
No. of sets:	4
Winding load:	1000kg
Winding speed:	25m/minute
Weight:	450kg

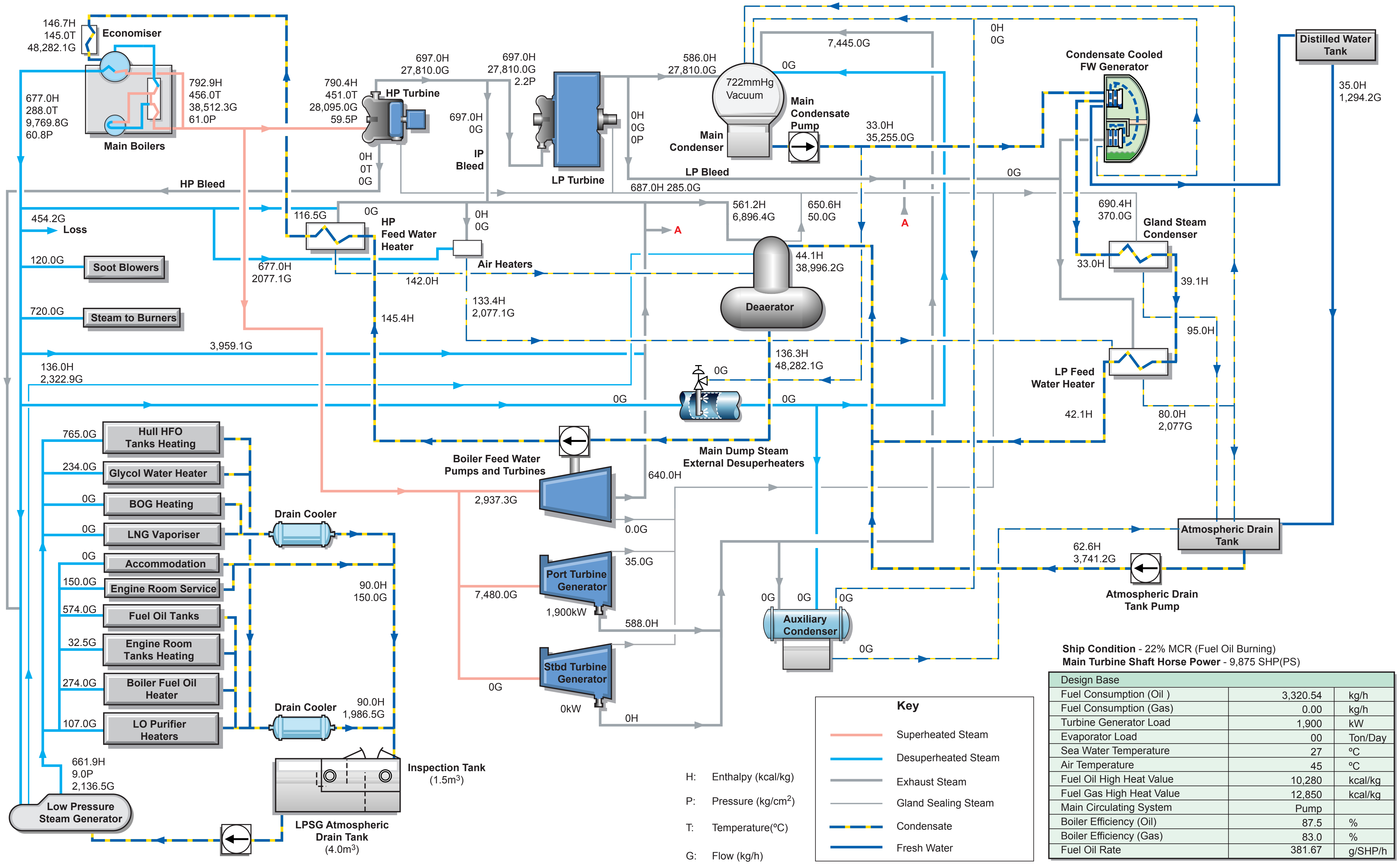
Illustration Heat Balance and Flow Diagram at Port Dumping, 0% MCR, Gas and Minimum Fuel Oil Burning



Ship Condition - 0% MCR (Gas and Minimum Fuel Oil Burning)
Main Turbine Shaft Horse Power - 00 SHP(PS)

Design Base		
Fuel Consumption (Oil)	420.00	kg/h
Fuel Consumption (Gas)	3,860.52	kg/h
Turbine Generator Load	1,465	kW
Evaporator Load	00	Ton/Day
Sea Water Temperature	27	°C
Air Temperature	45	°C
Fuel Oil High Heat Value	10,280	kcal/kg
Fuel Gas High Heat Value	12,850	kcal/kg
Main Circulating System	Pump	
Boiler Efficiency (Oil)	88.4	%
Boiler Efficiency (Gas)	83.90	%
Fuel Oil Rate	0.00	g/SHP/h

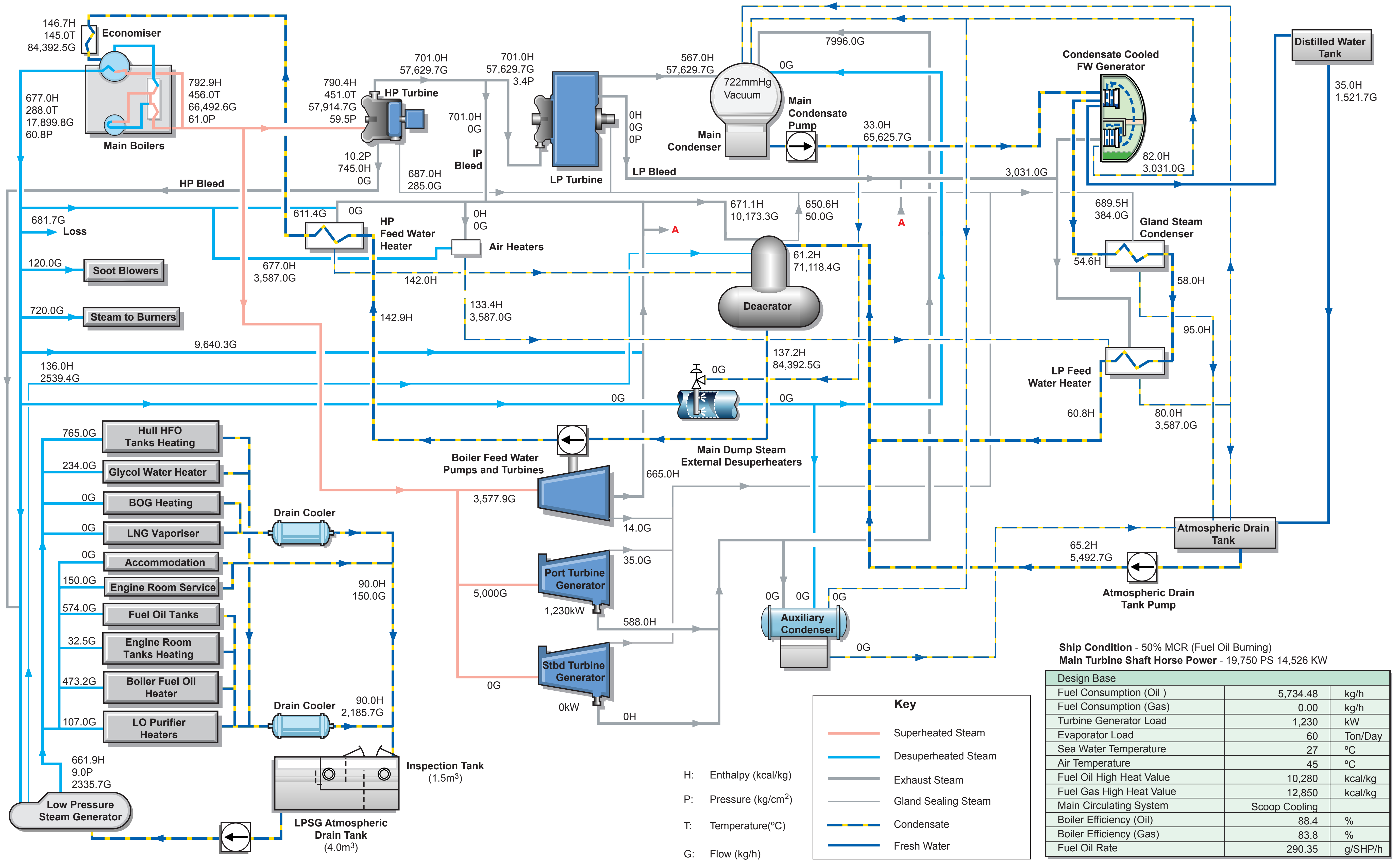
Illustration Heat Balance and Flow Diagram at Manoeuvring (Full Ahead), 22% MCR and 100% Fuel Oil Burning



Ship Condition - 22% MCR (Fuel Oil Burning)
Main Turbine Shaft Horse Power - 9,875 SHP(PS)

Design Base		
Fuel Consumption (Oil)	3,320.54	kg/h
Fuel Consumption (Gas)	0.00	kg/h
Turbine Generator Load	1,900	kW
Evaporator Load	00	Ton/Day
Sea Water Temperature	27	ºC
Air Temperature	45	ºC
Fuel Oil High Heat Value	10,280	kcal/kg
Fuel Gas High Heat Value	12,850	kcal/kg
Main Circulating System	Pump	
Boiler Efficiency (Oil)	87.5	%
Boiler Efficiency (Gas)	83.0	%
Fuel Oil Rate	381.67	g/SHP/h

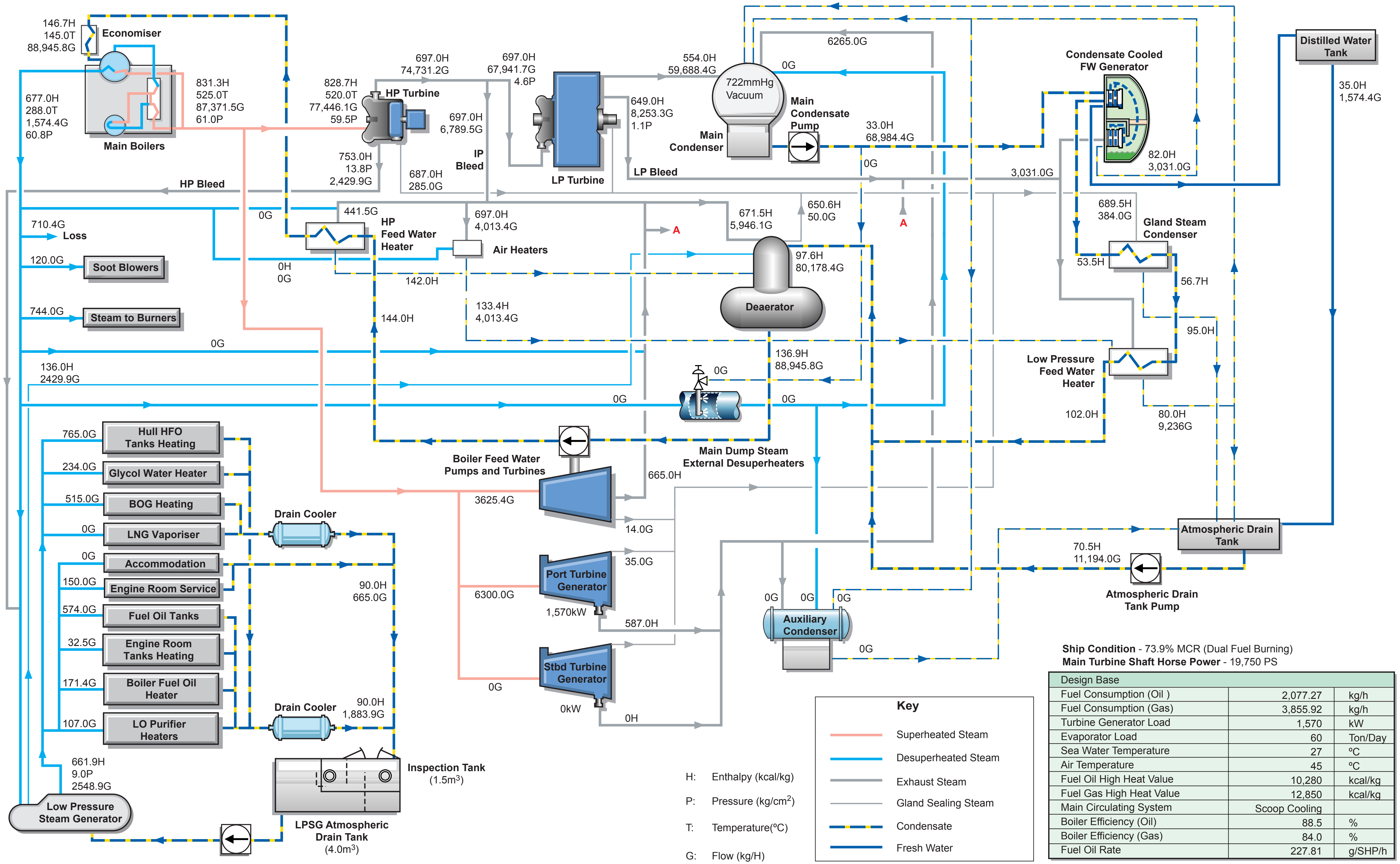
Illustration Heat Balance and Flow Diagram at Laden Voyage, 50% MCR and 100% Fuel Oil Burning



Ship Condition - 50% MCR (Fuel Oil Burning)
Main Turbine Shaft Horse Power - 19,750 PS 14,526 KW

Design Base		
Fuel Consumption (Oil)	5,734.48	kg/h
Fuel Consumption (Gas)	0.00	kg/h
Turbine Generator Load	1,230	kW
Evaporator Load	60	Ton/Day
Sea Water Temperature	27	ºC
Air Temperature	45	ºC
Fuel Oil High Heat Value	10,280	kcal/kg
Fuel Gas High Heat Value	12,850	kcal/kg
Main Circulating System	Scoop Cooling	
Boiler Efficiency (Oil)	88.4	%
Boiler Efficiency (Gas)	83.8	%
Fuel Oil Rate	290.35	g/SHP/h

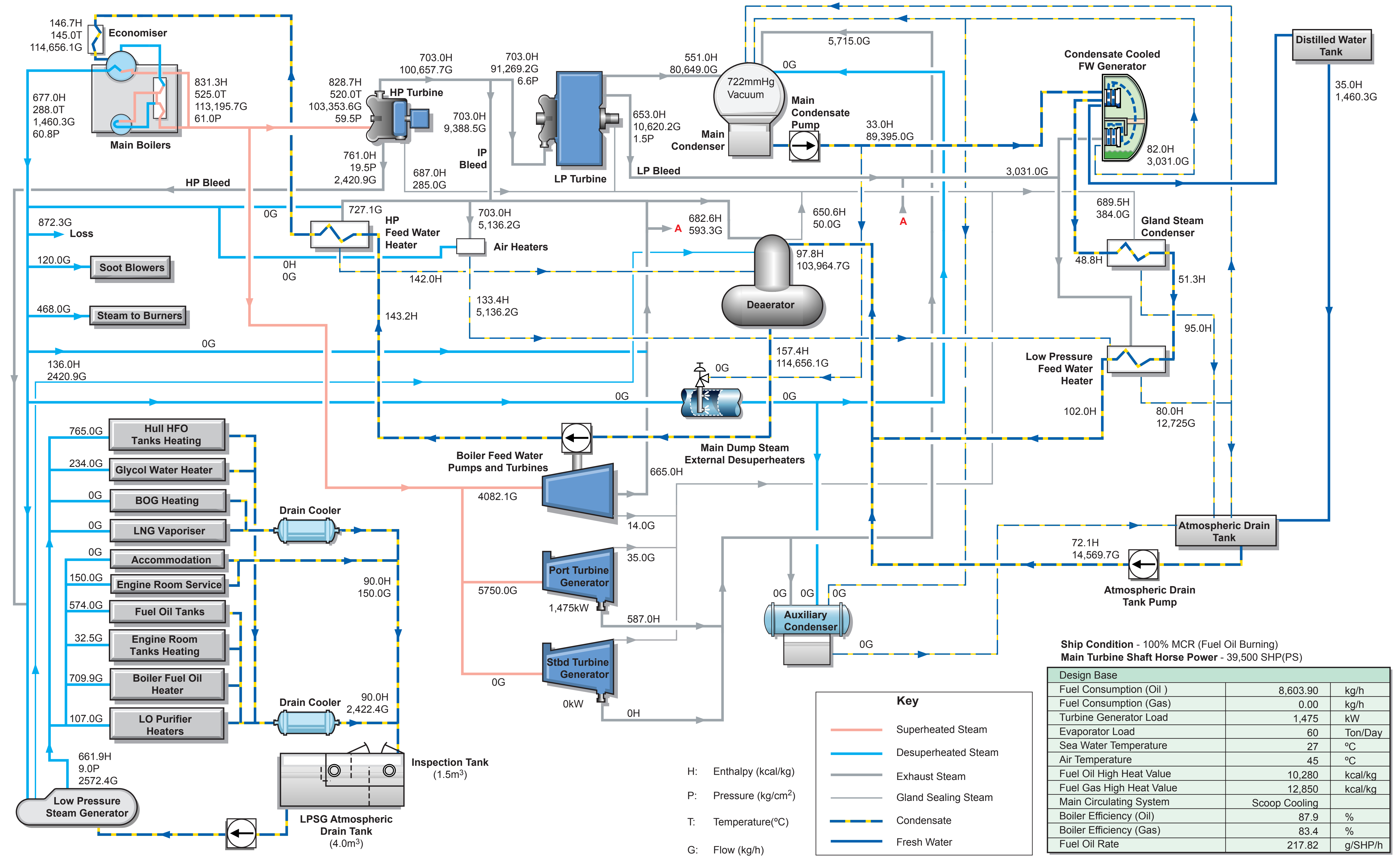
Illustration Heat Balance and Flow Diagram at Laden Voyage, 73.9% MCR and Dual Fuel Oil Burning



Ship Condition - 73.9% MCR (Dual Fuel Burning)
Main Turbine Shaft Horse Power - 19,750 PS

Design Base		
Fuel Consumption (Oil)	2,077.27	kg/h
Fuel Consumption (Gas)	3,855.92	kg/h
Turbine Generator Load	1,570	kW
Evaporator Load	60	Ton/Day
Sea Water Temperature	27	ºC
Air Temperature	45	ºC
Fuel Oil High Heat Value	10,280	kcal/kg
Fuel Gas High Heat Value	12,850	kcal/kg
Main Circulating System	Scoop Cooling	
Boiler Efficiency (Oil)	88.5	%
Boiler Efficiency (Gas)	84.0	%
Fuel Oil Rate	227.81	g/SHP/h

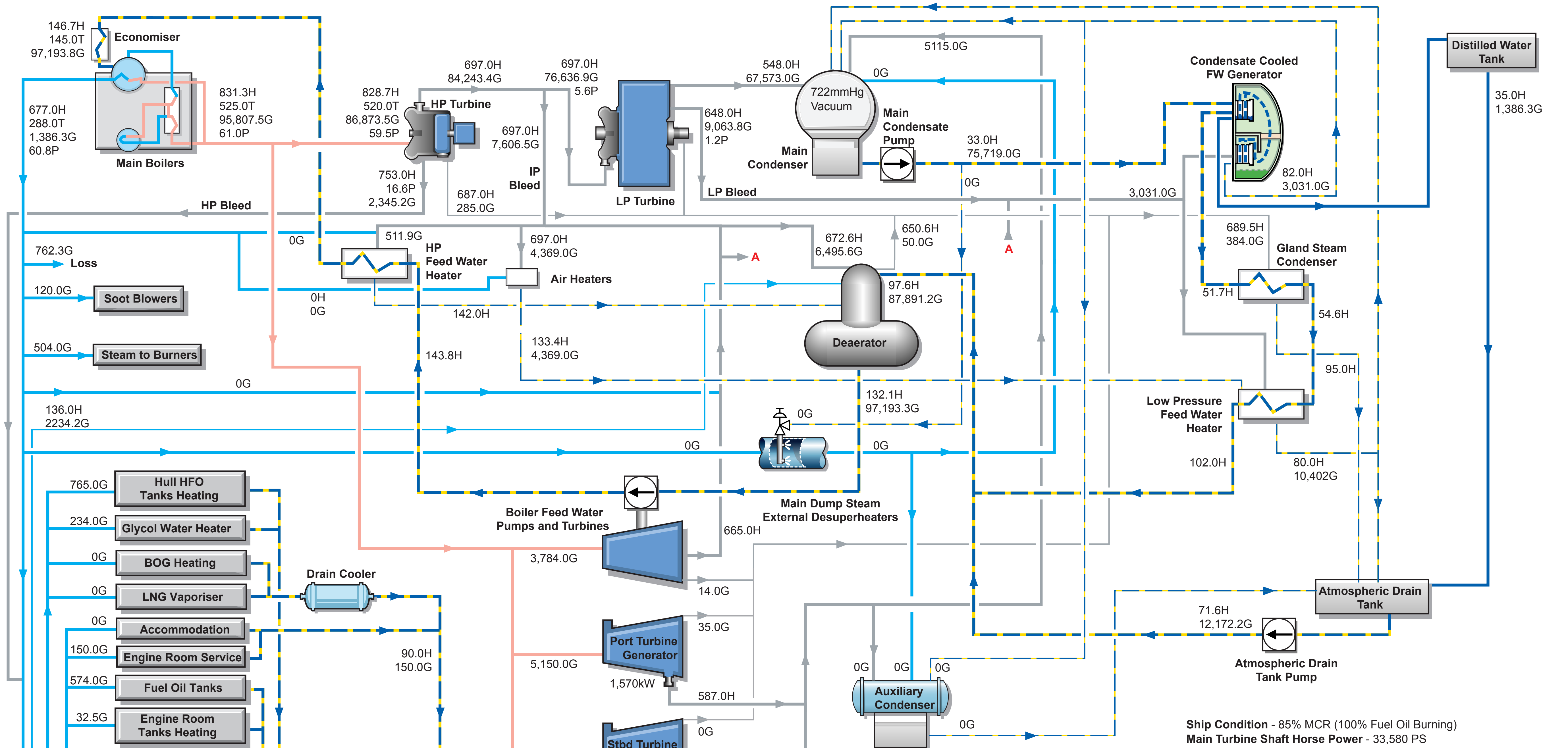
Illustration Heat Balance and Flow Diagram at Laden Voyage, 100% MCR and 100% Fuel Oil Burning



Ship Condition - 100% MCR (Fuel Oil Burning)
Main Turbine Shaft Horse Power - 39,500 SHP(PS)

Design Base		
Fuel Consumption (Oil)	8,603.90	kg/h
Fuel Consumption (Gas)	0.00	kg/h
Turbine Generator Load	1,475	kW
Evaporator Load	60	Ton/Day
Sea Water Temperature	27	ºC
Air Temperature	45	ºC
Fuel Oil High Heat Value	10,280	kcal/kg
Fuel Gas High Heat Value	12,850	kcal/kg
Main Circulating System	Scoop Cooling	
Boiler Efficiency (Oil)	87.9	%
Boiler Efficiency (Gas)	83.4	%
Fuel Oil Rate	217.82	g/SHP/h

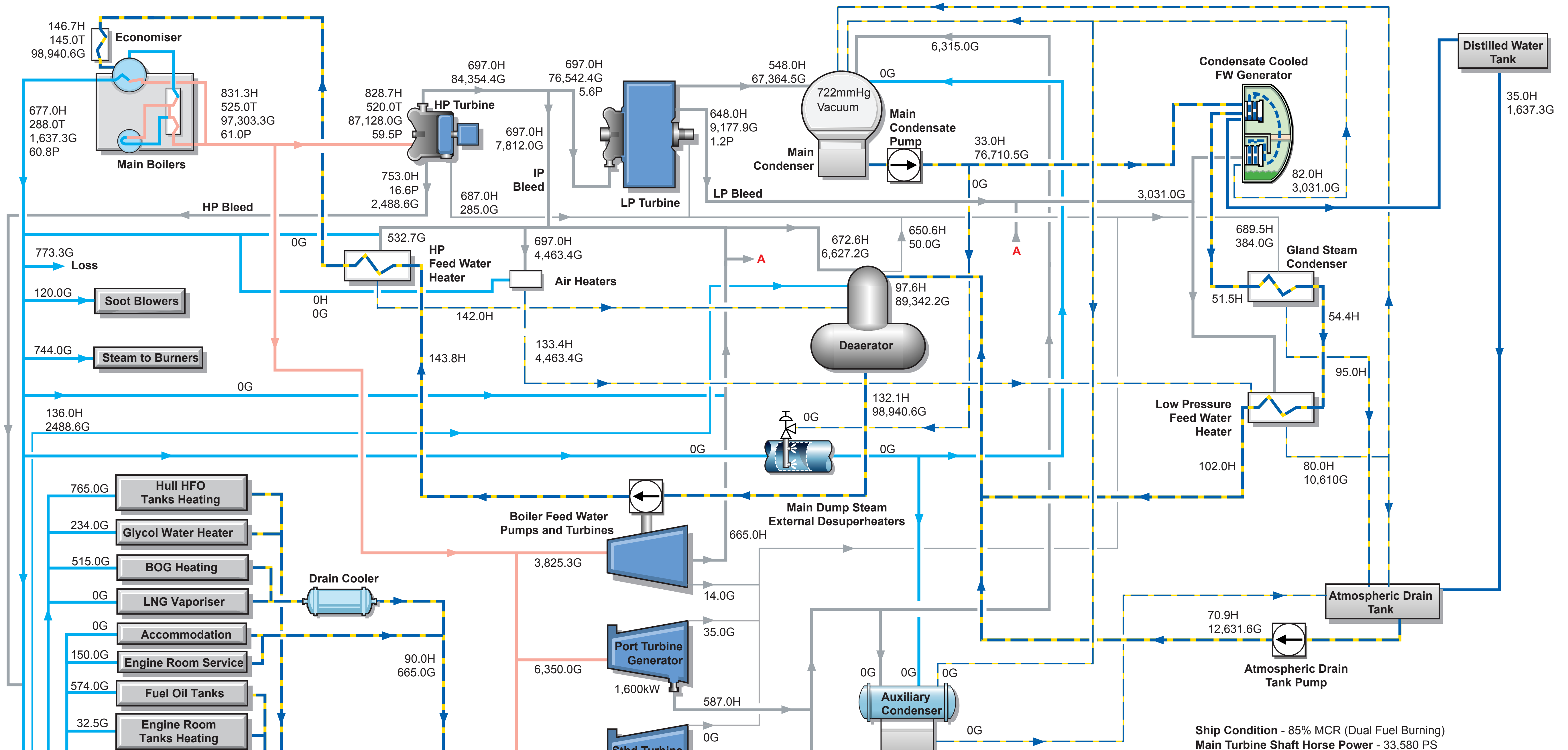
Illustration Heat Balance and Flow Diagram at Laden Voyage, 85% MCR and 100% Fuel Oil Burning



Ship Condition - 85% MCR (100% Fuel Oil Burning)
Main Turbine Shaft Horse Power - 33,580 PS

Design Base		
Fuel Consumption (Oil)	2,077.27	kg/h
Fuel Consumption (Gas)	3,855.92	kg/h
Turbine Generator Load	1,570	kW
Evaporator Load	60	Ton/Day
Sea Water Temperature	27	°C
Air Temperature	45	°C
Fuel Oil High Heat Value	10,280	kcal/kg
Fuel Gas High Heat Value	12,850	kcal/kg
Main Circulating System	Scoop Cooling	
Boiler Efficiency (Oil)	88.5	%
Boiler Efficiency (Gas)	84.0	%
Fuel Oil Rate	227.81	g/SHP/h

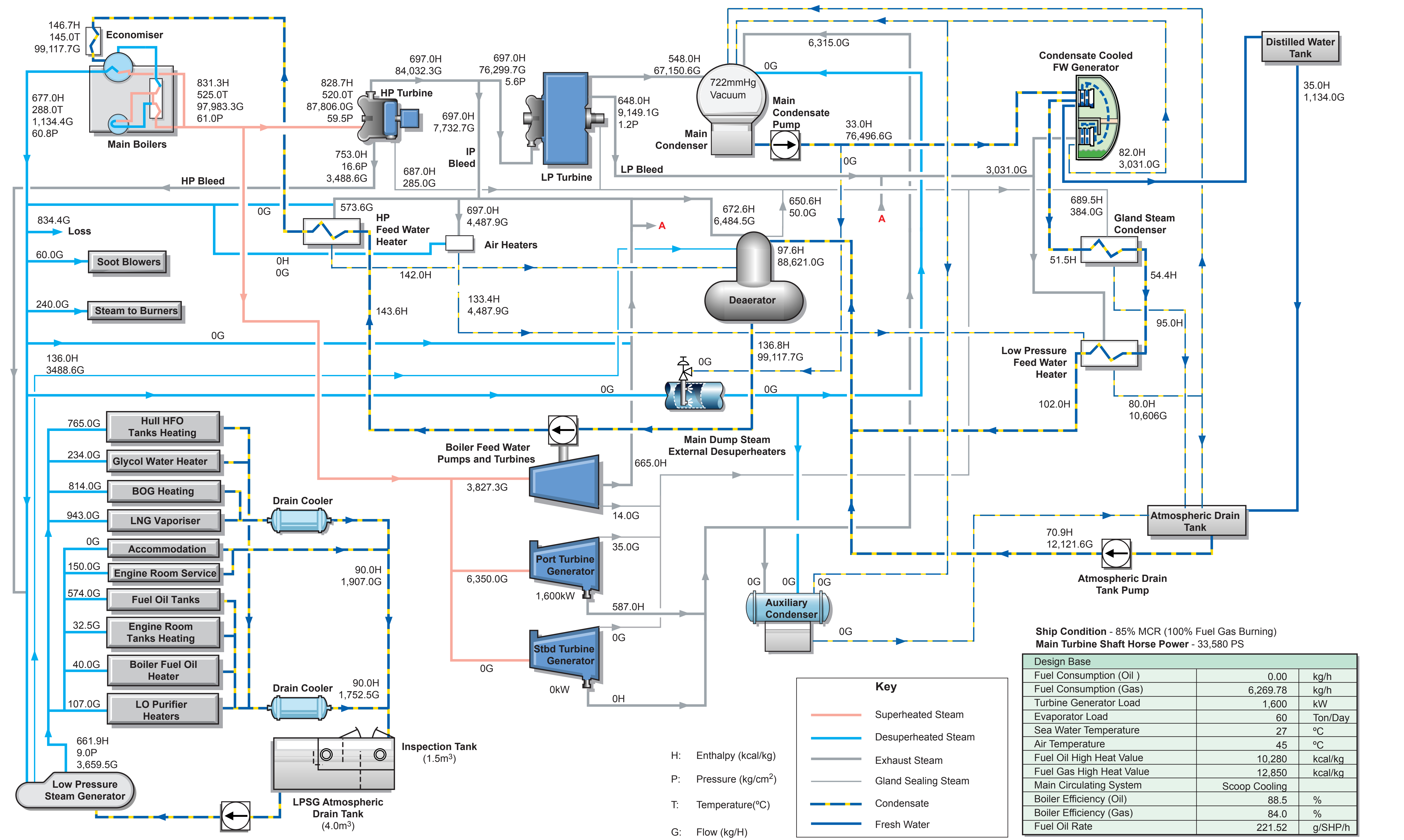
Illustration Heat Balance and Flow Diagram at Laden Voyage, 85% MCR and Dual Fuel Burning



Ship Condition - 85% MCR (Dual Fuel Burning)
Main Turbine Shaft Horse Power - 33,580 PS

Design Base		
Fuel Consumption (Oil)	2,823.29	kg/h
Fuel Consumption (Gas)	3,855.92	kg/h
Turbine Generator Load	1,600	kW
Evaporator Load	60	Ton/Day
Sea Water Temperature	27	ºC
Air Temperature	45	ºC
Fuel Oil High Heat Value	10,280	kcal/kg
Fuel Gas High Heat Value	12,850	kcal/kg
Main Circulating System	Scoop Cooling	
Boiler Efficiency (Oil)	88.5	%
Boiler Efficiency (Gas)	84.0	%
Fuel Oil Rate	220.31	g/SHP/h

Illustration Heat Balance and Flow Diagram at Laden Voyage, 85% MCR and 100% Gas Fuel Burning



Ship Condition - 85% MCR (100% Fuel Gas Burning)
Main Turbine Shaft Horse Power - 33,580 PS

Design Base		
Fuel Consumption (Oil)	0.00	kg/h
Fuel Consumption (Gas)	6,269.78	kg/h
Turbine Generator Load	1,600	kW
Evaporator Load	60	Ton/Day
Sea Water Temperature	27	ºC
Air Temperature	45	ºC
Fuel Oil High Heat Value	10,280	kcal/kg
Fuel Gas High Heat Value	12,850	kcal/kg
Main Circulating System	Scoop Cooling	
Boiler Efficiency (Oil)	88.5	%
Boiler Efficiency (Gas)	84.0	%
Fuel Oil Rate	221.52	g/SHP/h

INTRODUCTION

General

Although the ship is supplied with shipbuilder's plans and manufacturer's instruction books, there is no single handbook which gives guidance on operating complete systems as installed on board, as distinct from individual items of machinery.

The purpose of this manual is to fill some of the gaps and to provide the ship's officers with additional information not otherwise available on board. It is intended to be used in conjunction with the other plans and instruction books already on board and in no way replaces or supersedes them.

Information pertinent to the operation of the vessel has been carefully collated in relation to the systems of the vessel and is presented in three on board volumes consisting of CARGO and DECK OPERATING MANUAL, MARINE OPERATIONS MANUAL and MACHINERY OPERATING MANUAL.

The Cargo Operating Manual and the Machinery Operating Manual are designed to complement MARPOL 73/78, ISGOTT and Company Regulations.

The vessel is constructed to comply with MARPOL 73/78. These regulations can be found in the Consolidated Edition, 1991 and in the Amendments dated 1992, 1994 and 1995.

Officers should familiarise themselves with the contents of the International Convention for the Prevention of Pollution from Ships

Particular attention is drawn to Appendix IV of MARPOL 73/78, the form of Ballast Record Book. It is essential that a record of relevant ballast operations are kept in the Ballast Record Book and duly signed by the officer in charge.

In many cases the best operating practice can only be learned by experience. Where the information in this manual is found to be inadequate or incorrect, details should be sent to the BP Shipping Technical Operations Office so that revisions may be made to manuals of other ships of the same class.

Safe Operation

The safety of the ship depends on the care and attention of all on board. Most safety precautions are a matter of common sense and good housekeeping and are detailed in the various manuals available on board. However, records show that even experienced operators sometimes neglect safety precautions through over-familiarity and the following basic rules must be remembered at all times.

1. Never continue to operate any machine or equipment which appears to be potentially unsafe or dangerous and always report such a condition immediately.

2. Make a point of testing all safety equipment and devices regularly. Always test safety trips before starting any equipment. Test as per requirements of BPS QA system.

3. Never ignore any unusual or suspicious circumstances, no matter how trivial. Small symptoms often appear before a major failure occurs.

4. Never underestimate the fire hazard of petroleum products, especially fuel oil vapour.

5. Never start a machine remotely from the control room without checking visually if the machine is able to operate satisfactorily. Auto standby machinery should be checked by observation during duty rounds.

In the design of equipment and machinery, devices are included to ensure that, as far as possible, in the event of a fault occurring, whether on the part of the equipment or the operator, the equipment concerned will cease to function without danger to personnel or damage to the machine. If these safety devices are neglected, the operation of any machine is potentially dangerous.

Description

The concept of this Machinery Operating Manual is to provide information to technically competent ship's officers, unfamiliar to the vessel, in a form that is readily comprehensible and thereby aiding their understanding and knowledge of the specific vessel. Special attention is drawn to emergency procedures and fire fighting systems.

The manual consists of a number of parts and sections which describe the systems and equipment fitted and their method of operation related to a schematic diagram where applicable.

The first part of the manual details the machinery commissioning procedures required to bring the vessel into varying states of readiness, from bringing the vessel to a live condition through to securing plant for dry dock.

The second part details ship's systems, providing a technical description, system capacities and ratings, control and alarm settings and operating details.

Part three provides similar details for the vessel's main machinery control system.

Part four gives operational emergency procedures for the use of essential machinery.

Part five details the emergency fire fighting systems incorporated on the vessel, providing information on their operation and system capacities.

The valves and fittings identifications used in this manual are the same as those used by the shipbuilder.

Illustrations

All illustrations are referred to in the text and are located either in the text when sufficiently small or above the text on a separate page, so that both the text and illustration are accessible when the manual is laid face up.

Where flows are detailed in an illustration these are shown in colour. A key of all colours and line styles used in an illustration is provided on the illustration. Details of colour coding used in the illustrations are given in the illustration colour scheme.

Symbols given in the manual adhere to international standards and keys to the symbols used throughout the manual are given on the symbols pages.

Notices

The following notices occur throughout this manual:

WARNING
Warnings are given to draw reader's attention to operations where DANGER TO LIFE OR LIMB MAY OCCUR.

CAUTION
Cautions are given to draw reader's attention to operations where DAMAGE TO EQUIPMENT MAY OCCUR.

(**Note:** Notes are given to draw reader's attention to points of interest or to supply supplementary information.)

PART 1: MACHINERY COMMISSIONING OPERATIONAL OVERVIEW

Part 1: Machinery Commissioning Operational Overview

1.1 To Bring Vessel Into Live Condition

Note: This procedure assumes that the main turbine and the main condenser are not readily available

Dead Ship Condition

Shore Supply Available

Establish shore supply.	2.12.4

No Shore Supply Available

Prepare the emergency generator for operation. If necessary fill the emergency diesel generator fuel tank from drums.	2.11.3
Start the emergency generator and supply emergency and main switchboards through the respective breakers.	2.11.3 2.12.6

Supply main and emergency lighting throughout the vessel, together with necessary ventilation.	2.12.3
Put the generator air start system into operation. Start up the main diesel generator and place in parallel with emergency generator.	2.9.3 2.11.2
Put the central sea water system into operation. Put the central fresh water cooling system into operation.	2.3.2 2.4.1
Put the control and GS air systems into operation.	2.9.1 2.9.2
Put the fire detection system into operation.	5.9
Unload and shutdown emergency diesel generator.	2.11.3
Fill a boiler to 80mm below the normal water level, using the drain pumps.	3.3.3
Fill the condensate system - drains tank, deaerator and main condenser.	2.2.1
With a burner in a boiler, supply diesel oil to the burner using atomising air.	2.6.3
Start the boiler forced draught fan. With all required vents and drains open, begin to flash up the boiler. Ensure that the furnace is adequately purged prior to ignition. (**Note:** The boiler should be flashed up manually from the local control station.) If the boiler has been shut down for a long period, use a low fuel pressure to ensure heat and boiler pressure rise slowly.	3.3.3
Open the boiler stop valves to: The superheated steam system. The desuperheated steam system. The exhaust steam systems. The LP steam ranges. Open steam supply from emergency external desuperheater. Start desuperheater spray pumps. Ensure all steam line drains are open. Open the valves to the heating coils of one FO settling tank, placing the coil drains to the contaminated drains system.	3.3.3 2.1.1 2.1.2 2.1.3 2.1.5 2.1.4 2.1.5 2.2.2
Shut the drum vent when steam issues from it, at approximately 100 - 150kPa. Open the steam inlet and drains to one fuel oil heater and allow the fuel temperature to rise slowly.	3.3.3 2.1.5

Recirculate DO around the fuel rail until its temperature reaches approximately 70°C. Change the burner over to HFO and shut down the diesel oil supply.	3.3.3
As the steam pressure rises, use the electric feed pump to maintain the boiler water level. With the boiler now being fired on HFO, the fuel pressure will require adjusting to maintain a steady and safe pressure rise rate. Raise HFO temperature steadily.	3.3.3
Start the auxiliary sea water circulating pump to supply the auxiliary condenser. When the boiler pressure is at approximately 1.50kPa, ensure that 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 go either to the deaerator or dump to the auxiliary condenser.	2.3.1 2.2.1 2.2.3 2.2.4
Put the auxiliary condenser condensate and main drain system into operation. Start one main vacuum pump, line up to the auxiliary condenser and commence raising vacuum. Raise steam on the LPSG and put the system in use, isolating the emergency external desuperheater.	2.11.5
At approximately 3.0MPa, start up a turbine generator. The exhaust will dump to the auxiliary condenser. Unload the emergency diesel generator and parallel the turbine generator with the main diesel generator.	2.11.1 2.12.5 2.12.6
Having warmed through and drained the atomising steam system, change the burner atomising to steam. Isolate the atomising air supply.	3.3.3 2.6.3
With the boiler superheater being circulated, and steam being supplied to the feed pump and turbine generator, all the boiler drains and vents can now be closed in. Continue to raise steam pressure, with fuel and air under the control of the IAS. Check each system is now operational and gradually change over all control systems to automatic and/or remote. Ensure systems and components that have been used are put back on standby condition or isolated e.g. electric feed pump, emergency diesel generator etc.	3.3.3
Ensure that the IAS has taken the control of the boiler out of the flashing ramp to the normal control mode. The boiler should now be providing normal steam pressure to the turbine generator / main feed pump / and fuel oil heating etc. Unload and shutdown the main diesel generator.	3.3.2 2.11.2
Start up all the remaining auxiliaries - refrigeration units / air conditioning units / fans not in use / galley and accommodation supplies etc.	
(**Note:** If the vessel is in dry dock, or alongside a shore installation, electrical power may be 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

1.2 To Prepare Main Plant for Operation (Raising Steam)

One Boiler in Operation and Auxiliary Plant Operational

Open the vents on the steam drum and superheater, and the drains on the desuperheater and superheater, on the non-operational boiler.	2.1.1
Fill the boiler to approximately 80mm below the normal operating level, using the auxiliary feed pump on the auxiliary feed system, with suction and recirculation from the dearator. Ensure careful use of the filling valve and closely monitor the deaerator and boiler water levels.	3.3.3
Fit flashing up HFO size atomiser tips to the burners. Commence circulating fuel oil through the main fuel rail to raise the temperature.	3.3.3
Start a forced draught fan. Open atomising steam to the burners. Supply steam to the air heater. Reset all boiler trips. Place the boiler controls on manual and local in the IAS.	3.3.3
Allow the fuel temperature to rise to approximately 90°C. Purge the boiler furnace. When the purge sequence is completed, flash the boiler and adjust the air and fuel to the minimum for good combustion. (**Note:** The length of time the boiler has been out of operation governs the amount of time to allow for raising steam. The longer the unit has been off line, the greater the number of flashes and soaks should be allowed, before continuous firing.)	3.3.3
Slowly raise the steam pressure. At approximately 100 - 150kPa and with steam emitting from the steam drum vent, close the vent valve.	3.3.3
Continue to raise the steam pressure, closing in the various drains as required to maintain good drainage without excessive water loss.	3.3.3
Isolate the auxiliary feed line to normal condition and line up the main feed line from the main feed pump. Maintain water level control on manual.	3.3.3
At approximately 4.9MPa, open up the desuperheated system main valve bypass valve. Allow the pressure to increase to that of the in-use boiler and float the boiler on-line by opening the main valve and closing the drains and the bypass valve.	3.3.3
Before opening the superheater valves, ensure the line drains to the in-use main feed pump and turbine generator are open. When the superheated temperature approaches the in-use boiler, Slowly open the superheater system stop valves.	3.3.3
Close all drains and vents. Ensure that the IAS has normal control of combustion and level control, and the firing ramp has reset. The plant is now operating with two boilers, one turbine generator and one main feed pump, with exhausts and dumps to the auxiliary condenser.	3.3.2
Ensure that all drains from the main condenser sea water pipes are closed. Start the main SW circulating pump to the main condenser, ensuring all valves on the system are open.	2.3.1
Check all main turbine LO system lines are satisfactory, with the LO cooler drain valves closed. Ensure that the level in the main sump is correct. Start one main LO pump and allow the system to circulate. Check all sight glasses on bearings and gearing for oil flow. Ensure the LO gravity tank is overflowing.	2.7.1
Start the stern tube and shaft seal LO system.	2.7.2

Start the main turbine turning gear.	3.4.1
Crack open the main turbine gland steam make-up bypass valve and allow the turbine to warm through slowly.	2.1.6
Open the central fresh water cooling system to the main turbine LO cooler.	2.4.1
Open the gland steam make-up and spill inlet and outlet valves. Adjust the controller set steam pressure.	2.1.6
Start the gland condenser exhaust fan.	2.1.6
Open the suction / discharge / casing vent to one of the main condensate pumps. Fill the main condenser to a working level from a distilled tank. Start the main condensate pump.	2.2.1. 2.14.3.
Open the valves for the sea water cooling supply to one vacuum pump cooler. Open the air inlet valve to vacuum pump diffuser from the main condenser. Start the vacuum pump and start raising the main condenser vacuum.	2.3.2 2.2.1

When the main condenser vacuum approaches the auxiliary condenser vacuum, open either the main or auxiliary condensate suction valve, depending on which pump is selected as the in use unit. Stop the standby pump.	
The plant is now operating with both boilers, all exhaust dumps to the main condenser and both main condensate and atmospheric drains condensate systems in use. The main turbine has its vacuum raised with gland steam in use. The main turbine and stern tube LO systems are in use. The main turbine is being turned with the turning gear.	
Ensure all the exhaust and drain systems are transferred from the auxiliary to the main condenser. Isolate and shut down the auxiliary condenser and associated condensate system.	
Place all pumps in use to remote start and their second pumps to standby conditions, with all required valves open.	
When the auxiliary condenser has cooled down, shut down the SW cooling system and stop the auxiliary circulating pump.	

Main Plant Ready For Operation

1.3 To Prepare Main Plant for Manoeuvring from In Port Condition

Two Boilers in Operation.
Main Condenser Vacuum Raised.
Main Turbine Turning Gear in Operation.
Bypass valve on main turbine stop valves on both boilers adjusted to maintain a pressure of 200kPa on the main steam line.

Prepare and run up the second turbine generator. Place the second generator on the main switchboard in parallel with the generator in use.	2.11.1 2.12.2
Ensure that the diesel generator is on standby and ready to run, should it be required.	2.11.2
Once loading arms are confirmed as disconnected, commence raising the main steam line pressure to the main turbine by slowly opening the bypass valve on both boiler main turbine stop valves.	2.2.1
When the deck officer is available on the bridge, proceed with following test: With the main turbine controls on manual-stop, move the telegraph lever to all its points, and prove the turbine room control unit follows and answers the bridge unit.	3.4.2
Check and inspect the steering gear systems, ensuring the LO levels and hydraulic oil levels are correct. As each unit is tested, check all movements of the rams and rudder are satisfactory and as required. Maintain contact with the bridge as these tests are undertaken. (**Note:** When steering gear tests are completed, to prevent the pumps delivering in the same mode for long periods and risk overheating the unit, ensure the deck officer alters the rudder angle regularly to overcome this.)	2.10
Open the main boilers superheated steam stop valves to the main turbine are open once the main steam line pressure is at normal.	2.1.1
Disengage the turning gear.	
Advise the bridge that the main turbine will be operated and confirm that the propellor area is clear.	
Close the warming through steam valve.	2.7.1
At the emergency manual manoeuvring valve position, turn the main turbines in the ahead and astern directions a couple of times and confirm all equipment is in good order.	
Set the emergency manual manoeuvring valve back to the neutral position and reset the main turbine trip.	
With the manoeuvring controls in manual mode, from the ECR with some attendance at the turbine side, operate the control to allow main steam into the turbine and rotate ahead at approximately 5 revolutions per minute. Repeat for astern movement. While the above is being undertaken, the main turbine is checked to ensure it turns satisfactorily in both directions.	
Test the main turbine trip from the manual stations at the bridge, ECR and turbine side.	

Reset the main turbine trips and confirm that the control oil and lubricating oil pressures are normal.	
Using the controls in manual mode, repeat the ahead and astern movements to warm through the turbine to a superheat temperature approaching that of the boiler.	3.4.2
After the turbine has been warmed through, turning in the manual mode, place the controls in automatic mode, with the telegraph in stop position, and allow the engine to continue to warm through on the auto-spin program.	3.4.2
As required by international rules, ensure all the information concerning the above being carried out is recorded along with the times at which each section is completed.	
Inform the bridge that the main engines are ready for use.	
At standby, put the main turbine controls to bridge control mode and monitor their response as manoeuvring proceeds.	3.4.2

The Main Turbine is Now Ready to Put to Sea

1.4 To Change Main Plant from Manoeuvring to Full Away

Vessel Is Manoeuvring On Bridge Control

Bridge informs the ECR that the vessel is full away on passage, and indicates as such by moving the telegraph to full sea revolutions.	
Manually change over the operating mode switch from manoeuvring mode to normal mode.	
Record the following: Time Main engine revolution counter reading Fuel oil counter reading Fuel oil service tank levels Diesel oil service tank level Fuel and gas oil bunker tank levels Gas flow meter reading	
Confirm that the astern guard valve is closed, the main turbine drains are automatically closed and the main feed water pump automatic recirculating valve is closed .	
Allow the main engine revolutions to increase as per the timed program, which will open the manoeuvring valve a set amount over a period of time until it is fully open. This will take approximately 40 minutes from full ahead manoeuvring revolutions to full sea revolutions.	3.4.2
The main scoop inlet valve opens and the main sea water circulating pump stops. With the scoop system in use, ensure that the main condenser temperature and vacuum are maintained.	2.3.1
Put the boiler firing controls to the required firing mode in the IAS, whereby gas boil-off may be used in conjunction with fuel oil if this is available.	2.6.3
Confirm the automatic stop of the main turbine standby auxiliary LO pump and that all LO pressures remain normal.	
Pump the contents of the bilge tank overboard through the oily water separator unit. Note that MARPOL regulations apply.	2.8.1
Evaporators may be used to fill the fresh and the distilled water tanks as long as the ship is in permitted waters. Run up and use these units as required.	2.14.1
Change to BOG burning only if required or remain on dual fuel burning.	

Remove one turbine generator from the main switchboard, allow it to run light for a few minutes to cool down. (**Note:** It is possible to test the turbine generator trips while the unit is in this condition.)	2.12.2
Stop and isolate the off load turbine generator. With the turning gear engaged allow the generator to rotate with the electric LO pump in use until cool.	2.11.1
Ensure that the live steam make-up valves close and the main turbine bleed steam valves open as the main turbine revolutions increase.	
Check that the changeover of the LPSG heating steam, from live to HP bleed, has occured.	
Confirm with the bridge that the boilers may be sootblown and proceed as appropriate.	
When full sea speed has been achieved, make final adjustments to the plant to give optimum performance at the required speed. Refer to the heat balance diagrams.	
The vessel is now at Full Away conditions, on bridge control.	

Vessel Is Full Away On Bridge Control

1.5 To Change Main Plant from Full Away to Manoeuvring Conditions

The Vessel Is At Full Revolutions On Bridge Control

Approximately 2 hours before manoeuvring operations are to commence, run up the standby turbine generator. (**Note:** Trips may be tested at this time. When the unit is up to speed, parallel with the unit already on the main switchboard.)	2.11.1. 2.12.2
Approximately 1 hour before manoeuvring operations are to commence, request the Bridge to bring the telegraph position to standby full ahead rpm gradually on the telegraph vernier over 40 minutes. The revolutions will be at the standby full ahead.	3.4.2
As the main turbine rpm reduces, ensure that the following occurs: As the bleed steam pressures reduce, ensure the automatic valves close and the make-up valves open as required.	
If the main boilers are on BOG burning only, change to dual fuel burning on both.	
Ensure that the main circulating pump starts, the valve opens and the scoop valve closes. This ensures the correct amount of cooling water to the main condenser is maintained as the vessel's speed drops.	
As the main turbine revolutions reduce, the operating mode select switch will automatically change over to manoeuvring mode.	
At manoeuvring rpm, the astern guardian valve opens, the turbine drains open and the feed pump recirculating valve opens.	
As the turbine rpm continues to fall, the main condensate recirculation valve will open. This allows condensate to return to the main condenser hot well, ensuring a level is maintained for the condensate pumps.	
Shut down the evaporators, unless only distilled water is required to be manufactured.	2.14.1
When the bridge notifies the engine room of end of passage, record the following: Time Main engine revolution counter Fuel oil counter Fuel oil settling tank levels Diesel oil service tank level Fuel and diesel oil bunker tank levels Distilled and FW tanks levels Gas meter reading	
The main turbines are now ready for movements via bridge control.	

The Plant Is Prepared For Manoeuvring

1.6 To Secure Plant at Finished with Engines

The Vessel Is Manoeuvring On Bridge Control

When all movements of the main turbine are completed, the bridge will transfer the control of the main turbines to the engine room and place the telegraph at FWE.	
Although the telegraph is indicating FWE, the turbine controls are still on automatic, and as such the turbine will turn on the auto-spin steam system. This system allows the main turbine to rotate ahead and astern at approximately 5 rpm, preventing the turbine from sitting in one position for a prolonged period of time which may cause the rotor to sag.	
Close the main turbine steam stop valve from the boilers and open the warming through line.	3.4.2
Switch the auto-spin system off. Put the main turbine to manual and from the ECR evacuate the main steam line pressure to approximately 490kPa, using the main turbine ahead and astern manoeuvres and then trip the turbine.	3.4.2
Engage and start the turning gear.	3.4.2
The main turbine is now stopped and turning slowly with warming steam on line. Unless the turbine is to be shut down for repairs or another specific reason, this is the condition the plant is normally left in while awaiting port operations.	
Crack open the main turbine stop valve bypass valves and maintain a pressure of approximately 200kPa when in port.	2.1.1
Ensure the boilers are firing on dual fuel if possible when in port, thus preventing gas being vented to the atmosphere.	2.6.3

The Engine Room is now Ready for Cargo Operations

1.7 To Secure Plant for Dry Dock

Vessel Is at Finished With Engines And In a Live Condition

Take one of the turbine generators off load, allow it to run light for a few minutes before stopping it. Allow the turbine to rotate on the turning gear while the unit cools down. Close the steam inlet and exhaust valves. Close the gland steam make up and spill valves.	2.12.2 2.11.1
Start up the diesel generator and place on the switchboard in parallel with the in-use turbine generator.	2.11.2 2.12.2
Ensure the main turbine boiler steam stop and warming through valves are shut.	2.1.1
Shut down the evaporators.	2.14.1
Shut down the purifiers.	2.7.3
Trip one boiler.	3.3.2
Close the superheated and desuperheated steam master and intermediate valves and open the superheated steam vent valve. Close the main feed water valves, put the feed control to manual.	2.1.1 2.1.2 2.2.4
Isolate the fuel oil and steam valves at the burner rail. Stop the FD fan and close the vanes. Shut off the steam to the air heater.	2.6.3 3.3.3 2.1.4
Allow the shut down boiler pressure to fall away, opening the drum vent when the pressure is approximately 200kPa.	2.1.1
Shut off the steam supply to the in-use boiler fuel oil heater. When the fuel temperature falls to approximately 90°C, open the fuel supply to the boiler fuel pump from the diesel oil service tank and close all valves from the heavy fuel oil service tanks. Change the atomising steam supply over to atomising air supply, from the general service air system, to the in-use boiler.	2.1.5 2.6.3 2.6.3
As diesel oil is used throughout the system, the HFO will be replaced by the diesel oil. This will be required in preparation for the flash-up cycle when no heat will be available for the HFO. Allow the DO to flow through both fuel heaters, and through the recirculation rail at the burner manifolds on both boilers.	2.6.3
Shut down the LPSG system.	2.2.2
Allow the diesel generator to take the entire switchboard load and take the in-use turbine generator off load. Stop the turbine generator, close all steam/exhaust and gland steam valves. Allow it to rotate on the turning gear while cooling.	2.12.5 2.12.2 2.11.1
Trip the in-use boiler, allowing the main feed pump to run and use up the steam while maintaining the boiler level. Stop the in-use main feed pump and close all valves. Close all superheater and desuperheater valves and open the superheater vent valve. Place all boiler controls to manual.	3.3.3 2.2.4 2.1.1
Stop the in-use vacuum pump, and close all valves. Crack open main condenser vacuum breaking valve. The main condenser vacuum will now fall.	2.2.1
Shut the gland steam make-up and spill valves to the main turbine. Stop the gland exhaust fan.	2.1.6
With the boiler shut down, there should be no more drains returning to the atmospheric drains tank. Shut the deaerator outlet valve to the main feed pump suction. Shut the in-use distilled tank outlet valve to the make-up line.	2.2.4 2.14.3

Stop the in-use main condensate pump. Close the main condensate recirculating valve, to prevent any water returning to the main condenser.	2.2.1
Stop the refrigeration and air conditioning units, and wait for the shore cooling water supply before restarting.	2.13
When the main condenser has cooled, the sea water circulating pump can be stopped and all valves closed.	2.3.1
Stop the main turbine turning gear after approximately 6 hours. Stop the main turbine LO pump. Stop and isolate the stern tube seal LO systems.	3.4.1 2.7.1 2.7.2
Isolate and take off standby all the non-running pumps and machinery.	
Trip the main diesel generator from the switchboard, allow it to run light to cool down before stopping. Start the emergency diesel generator to supply the lighting, ventilation, central SW and FW cooling systems to cool down the main diesel generator and air compressors.	2.12.2 2.11.2 2.11.3
Stop the in-use central sea water cooling pump and the central fresh water cooling pump.	2.3.2 2.4.1
Stop the control and general service air compressors. Stop the air dryers.	2.9.2
The main plant is now shut down.	
When the dockyard has connected the electrical supply to the shore breaker, the emergency generator can be tripped from the emergency switchboard and the shore supply breaker put on.	2.12.4 2.12.6

The Plant is Now Secure in Dry Dock and On Shore Power

Part 2: Ship's Systems

2.0 Location Plans

Illustrations

2.0 LOCATION PLANS

Illustration 2.0a Engine Room Floor Plan

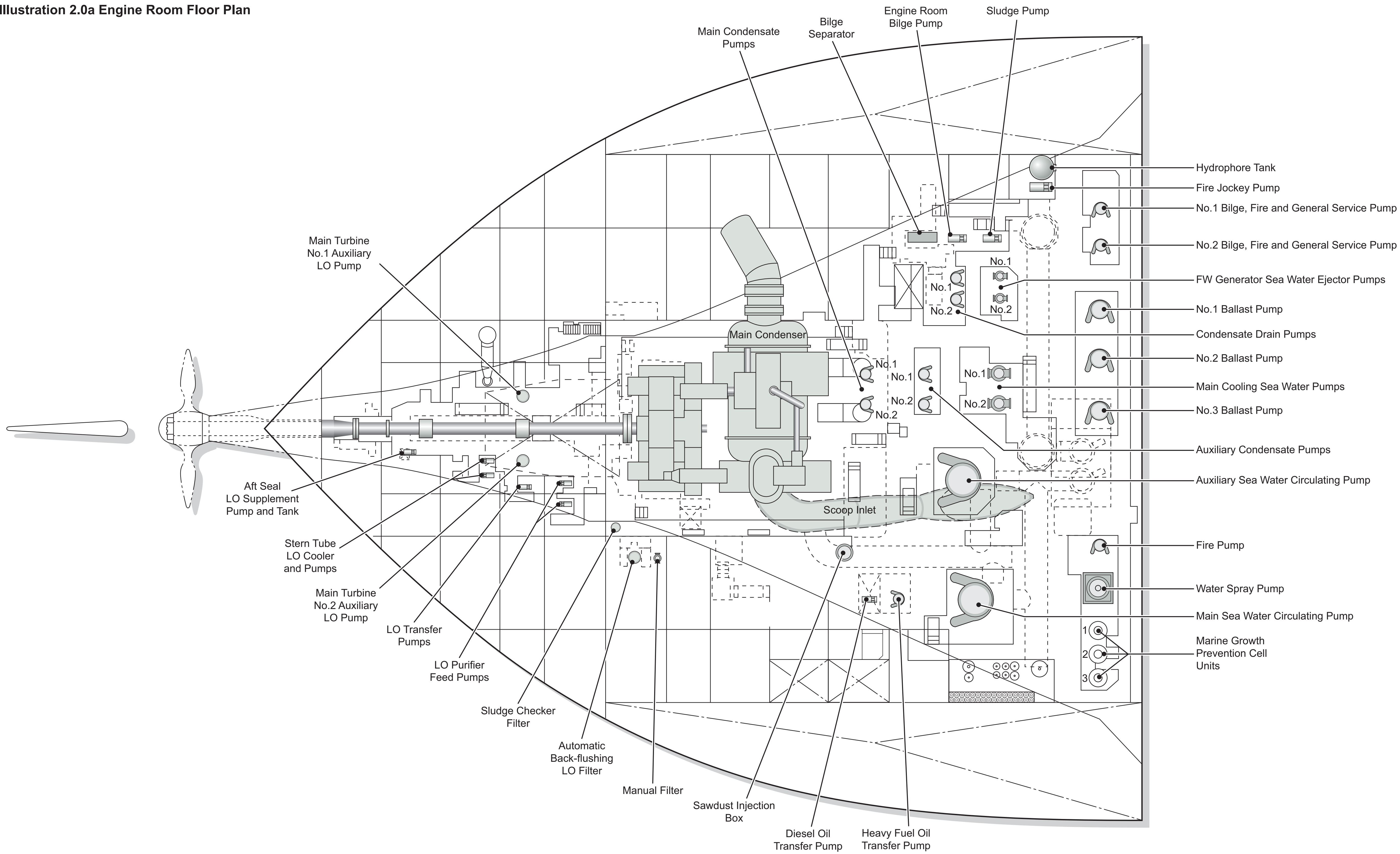


Illustration 2.0b Engine Room 4th Deck Plan

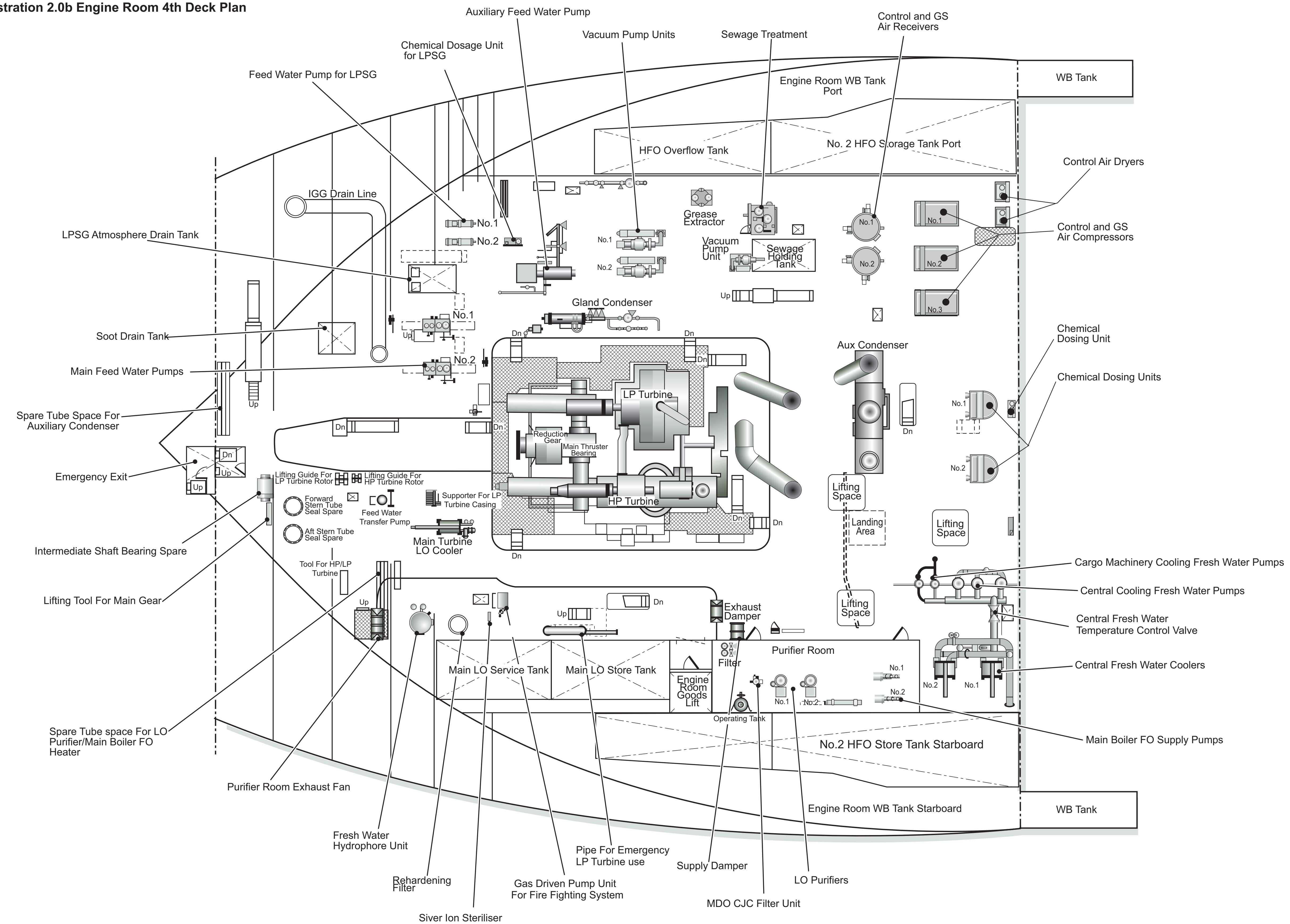


Illustration 2.0c Engine Room 3rd Deck Plan

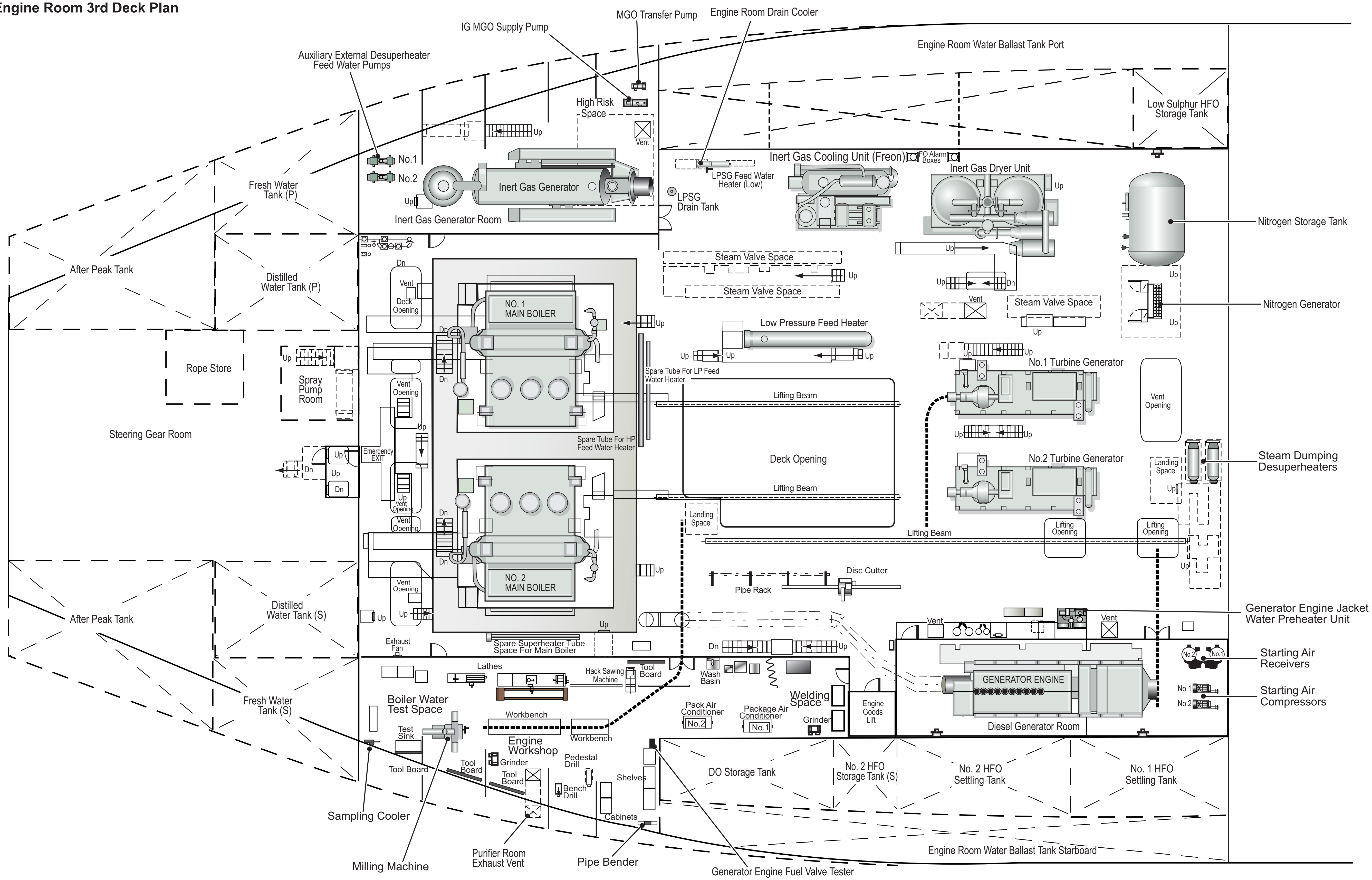


Illustration 2.0d Engine Room 2nd Deck Plan

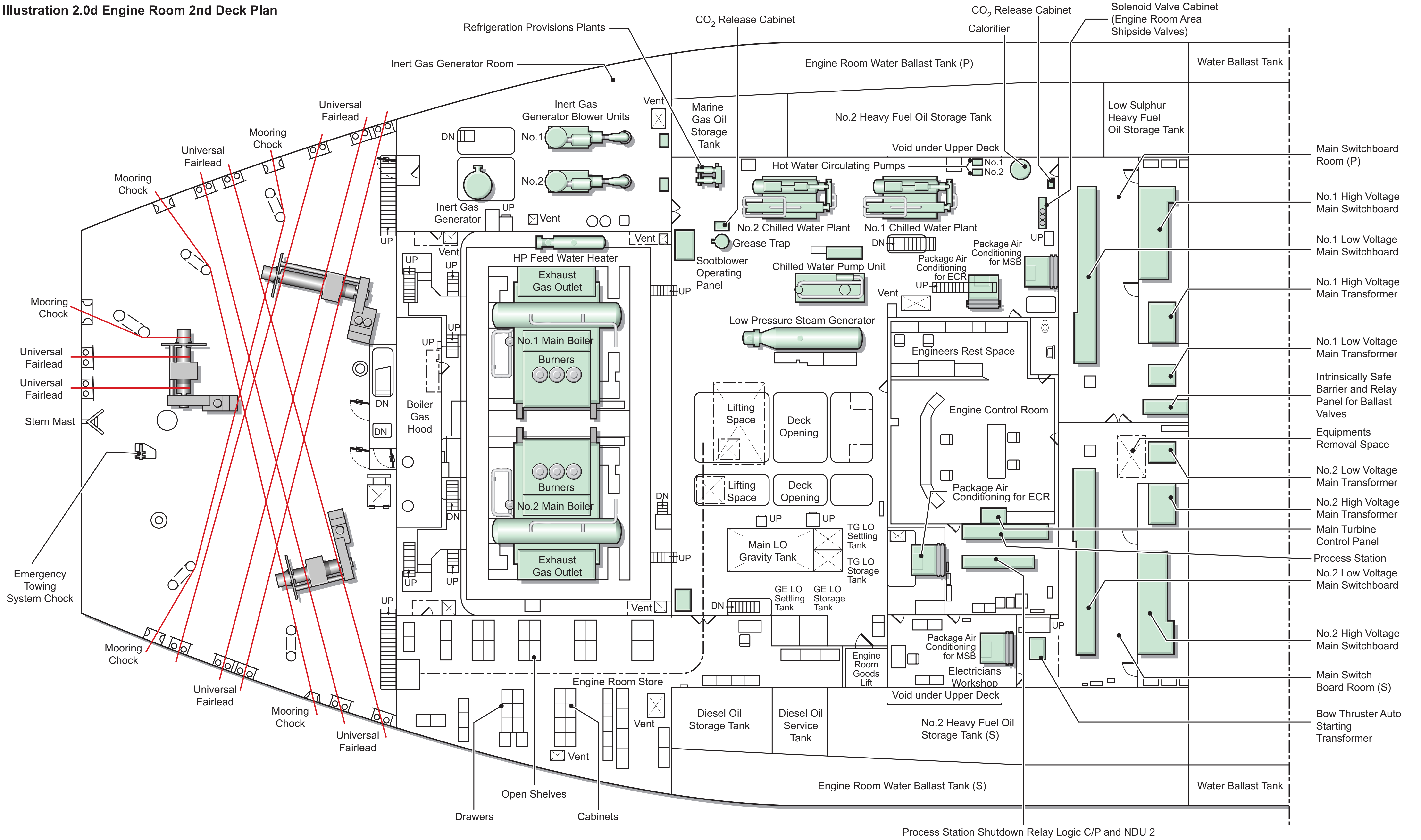
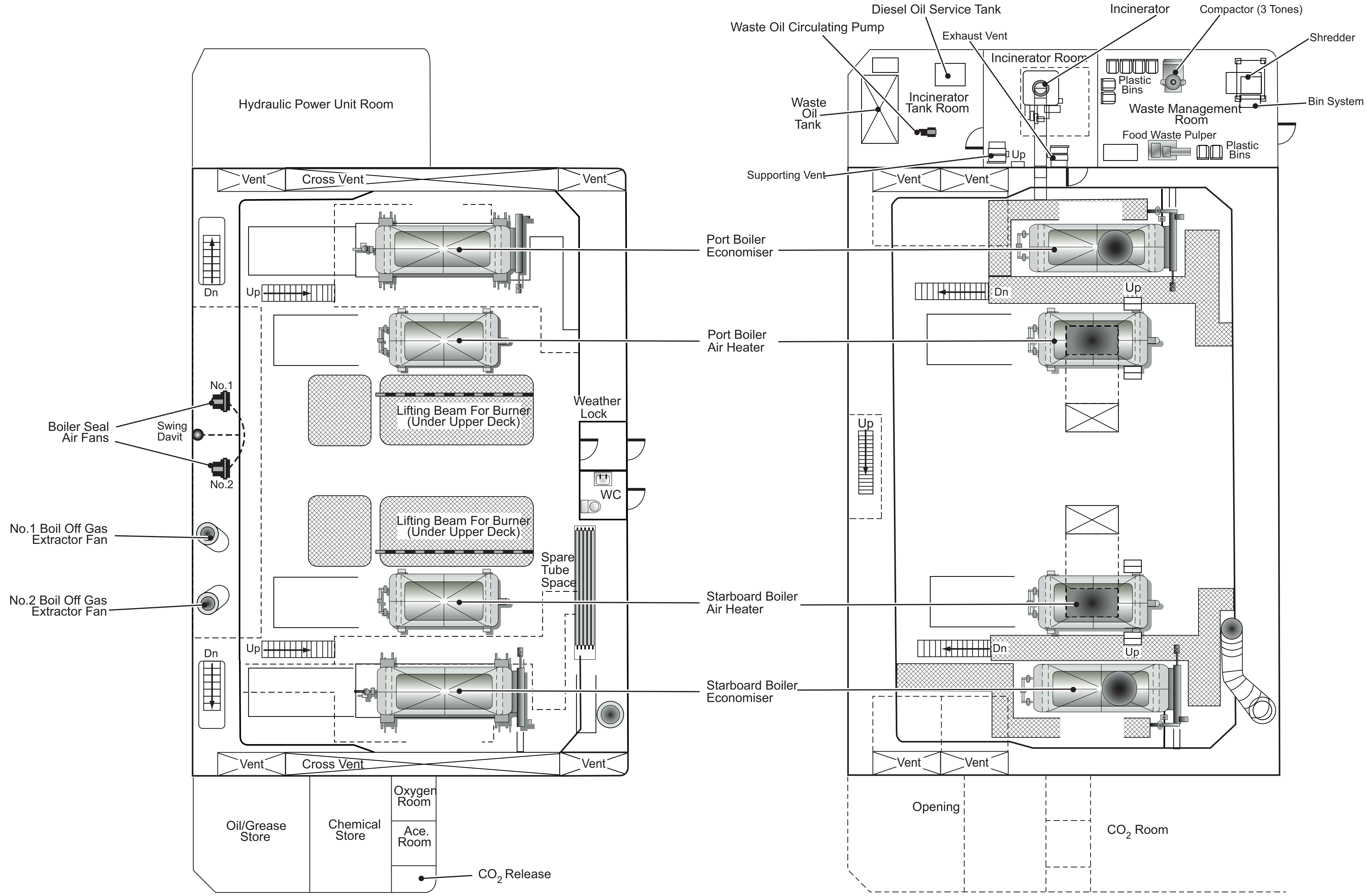
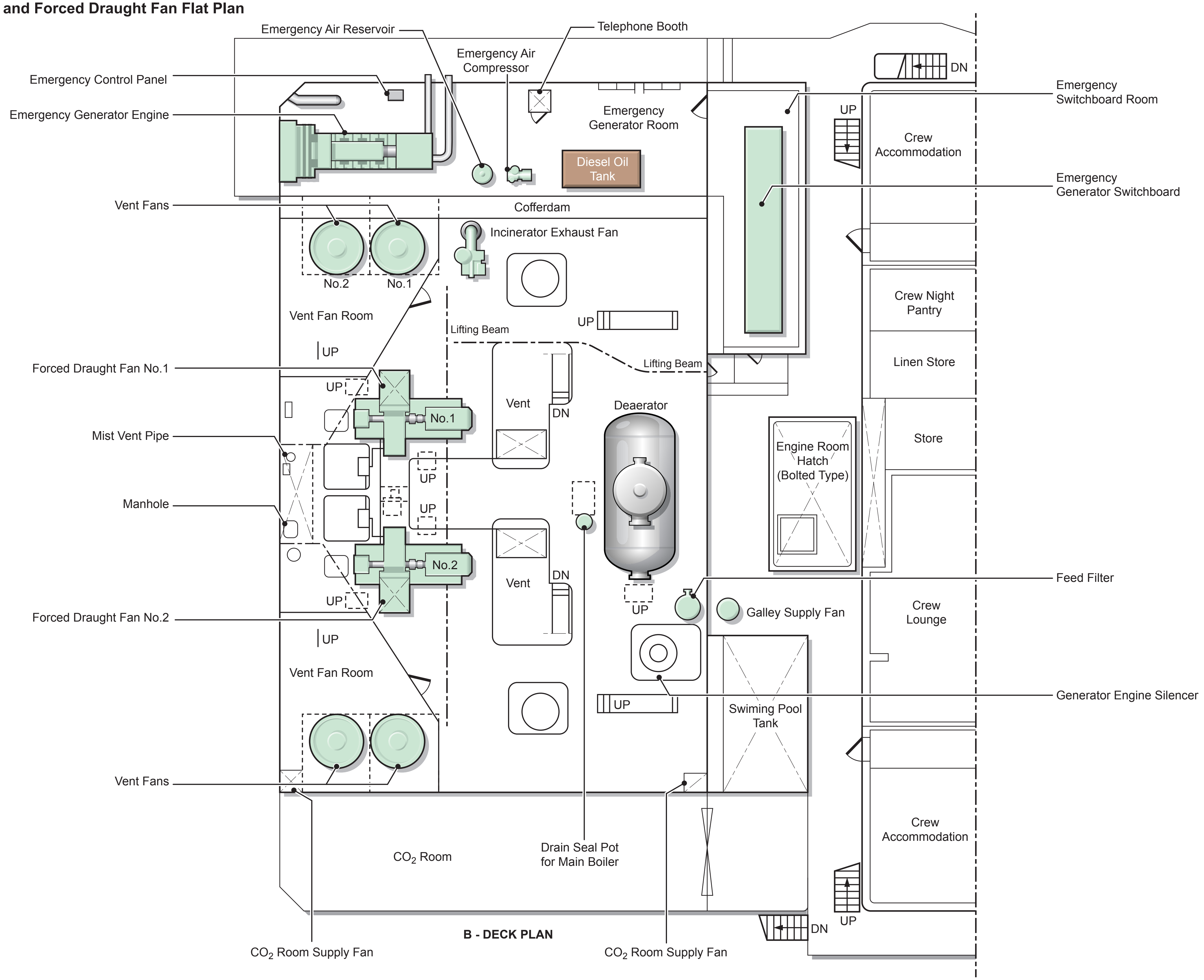


Illustration 2.0e Economiser and Air Heater Flat Plan



Upper Deck Plan **A Deck Plan**

Illustration 2.0f Deaerator and Forced Draught Fan Flat Plan



2.0g Tank Capacity Tables 1

CARGO TANKS				(Specific Gravity = 0.47)	
Compartment	Between Frames	Capacities		Centres of Gravity	
		100% Full	98.5% Full	L.C.G. From Aft Peak (M)	V.C.G. Above B.L. (M)
		M^3	M^3		
No. 1 Cargo Tank (Centre)	122 - 135	24566.1	24197.6	209.592	17.373
No. 2 Cargo Tank (Centre)	105 - 121	39426.9	38835.5	168.593	16.275
No. 1 Cargo Tank (Centre)	88 - 104	39426.9	38835.5	122.518	16.275
No. 1 Cargo Tank (Centre)	72 - 87	35049.3	34523.6	78.823	16.277
Total		138469.2	136395.2		

FRESH WATER TANKS					(Specific Gravity = 1.000)	
Compartment	Between Frames	Capacities - 100% Full		Centres of Gravity		
		Metres^3	Tonnes	L.C.G. From Aft Peak (Metres)	V.C.G. Above B.L. (Metres)	Max. Moment of Inertia (Metres^4)
Distilled Water Tank (Port)	7 - 16	227.5	227.5	9.182	17.778	71.0
Distilled Water Tank (Starboard)	7 - 16	229.1	229.1	9.200	17.797	71.0
Domestic FW Tank (Port)	7 - 16	195.5	195.5	9.569	18.053	90.0
Domestic FW Tank (Starboard)	7 - 16	195.5	195.5	9.569	18.053	90.0
Total		849.2	849.2			

FUEL OIL TANKS					(Specific Gravity = 0.95)	
Compartment	Between Frames	Capacities		Centres of Gravity		
		100% Full	95% Full	L.C.G. From Aft Peak (M)	V.C.G. Above B.L. (M)	Max. Moment of Inertia (M^4)
		M^3	Tonnes			
No.1 Heavy Fuel Oil Storage Tank (Centre)	136 - 164	5104.5	648.3	-70.282	16.108	16.108
No.1 Heavy Fuel Oil Storage Tank (Port)	35 - 71	1165.7	648.3	-70.282	16.108	16.108
No.2 Heavy Fuel Oil Storage Tank (Starboard)	42 - 71	802.4	925.4	109.310	18.999	18.999
No.1 Heavy Fuel Oil Settling Tank (Starboard)	61 - 71	210.9	920.0	109.341	19.000	19.000
No.1 Heavy Fuel Oil Settling Tank (Starboard)	50 - 61	226.2	497.5	-74.943	16.108	16.108
Low Sulphur Heavy Fuel Oil Tank (Port)	65 - 71	221.1	497.5	-74.943	16.108	16.108
Total		7730.8	4629.2			

MISCELLANEOUS TANKS					
Compartment	Between Frames	Capacities - 100% Full	Centres of Gravity		
		M^3	L.C.G. From Aft Peak (M)	V.C.G. Above B.L. (M)	Max. Moment of Inertia (M^4)
Heavy Fuel Oil Overflow Tank (Port)	42 - 54	89.8	39.277	13.044	40.0
Bilge Holding Tank (Port)	62 - 71	96.3	53.614	1.604	278.0
Separated Bilge Oil Tank (Port)	54 - 62	33.1	46.400	1.958	112.0
Clean Drain Tank (Port)	50 - 62	67.8	45.745	1.583	156.0
LO Purifier Sludge Tank (Starboard)	51 - 56	5.8	45.800	9.064	1.0
Bilge Primary Tank (Port)	58 - 62	15.5	48.000	6.120	4.0
Stern Tube LO Drain Tank (Centre)	20 - 22	3.6	16.835	3.022	1.0
Engine Room Aft Bilge Well (Centre)	16 - 19	9.2	14.030	3.095	13.0
Engine Room Mid Bilge Well (Port)	37 - 39	2.3	30.435	2.027	1.0
Engine Room Mid Bilge Well (Starboard)	37 - 39	2.3	30.435	2.027	1.0
Engine Room Forward Bilge Well (Port)	65 - 68	4.3	53.334	1.977	5.0
Engine Room Forward Bilge Well (Starboard)	65 - 68	4.3	53.334	1.977	5.0
Total		334.3			

2.0g Tank Capacity Tables 2

WATER BALLAST TANKS				(Specific Gravity = 1.025)		
Compartment	Between Frame	Capacities		Centres of Gravity		
		M^3	Tonnes	L.C.G. From Aft Peak (M)	V.C.G. Above B.L. (M)	Max. Moment of Inertia (M^4)
Fore Peak Tank	172 - F.E.	913.0	926.5	262.436	12.279	777.0
Forward W.B. Tank (Port)	136 - 164	1965.4	1994.4	239.095	11.681	1418.0
Forward W.B. Tank (Starboard)	136 - 164	1968.9	1994.4	239.079	11.665	1418.0
No.1 W.B. Tank (Port)	121 - 136	5933.8	6021.3	206.224	10.317	10717.0
No.1 W.B. Tank (Starboard)	121 - 136	5933.8	6021.3	206.224	10.317	10717.0
No.2 (F) W.B. Tank (Port)	113 - 121	2687.0	2726.6	179.359	8.565	11035.0
No.2 (F) W.B. Tank (Starboard)	113 - 121	2687.0	2726.3	179.359	8.565	11035.0
No.2 (A) W.B. Tank (Port)	104 - 113	3053.9	3099.0	156.397	8.479	12893.0
No.2 (A) W.B. Tank (Starboard)	104 - 113	3053.9	3099.0	156.397	8.479	12893.0
No.3 (F) W.B. Tank (Port)	96 - 104	2719.9	2760.0	133.360	8.482	11480.0
No.3 (F) W.B. Tank (Starboard)	96 - 104	2719.9	2760.0	133.360	8.482	11480.0
No.3 (A) W.B. Tank (Port)	87 - 96	3055.2	3100.3	110.323	8.482	12896.0
No.3 (A) W.B. Tank (Starboard)	87 - 96	3055.2	3100.3	110.323	8.482	12896.0
No.4 W.B. Tank (Port)	71 - 87	4969.8	5043.1	78.032	8.772	19843.0
No.4 W.B. Tank (Starboard)	71 - 87	4969.8	5043.3	78.032	8.772	19843.0
Engine Room W.B. Tank (Port)	35 - 71	1726.1	1751.6	43.275	14.552	398.0
Engine Room W.B. Tank (Stbd)	35 - 71	1726.1	1751.6	43.275	14.552	398.0
Aft Peak Tank	A.E. - 16	1670.8	1695.4	3.797	15.277	15956.0
Stern Tube C.W. Tank	9 - 16	56.7	57.6	11.285	4.209	15.0
Total		54,866.2	55,675.6			

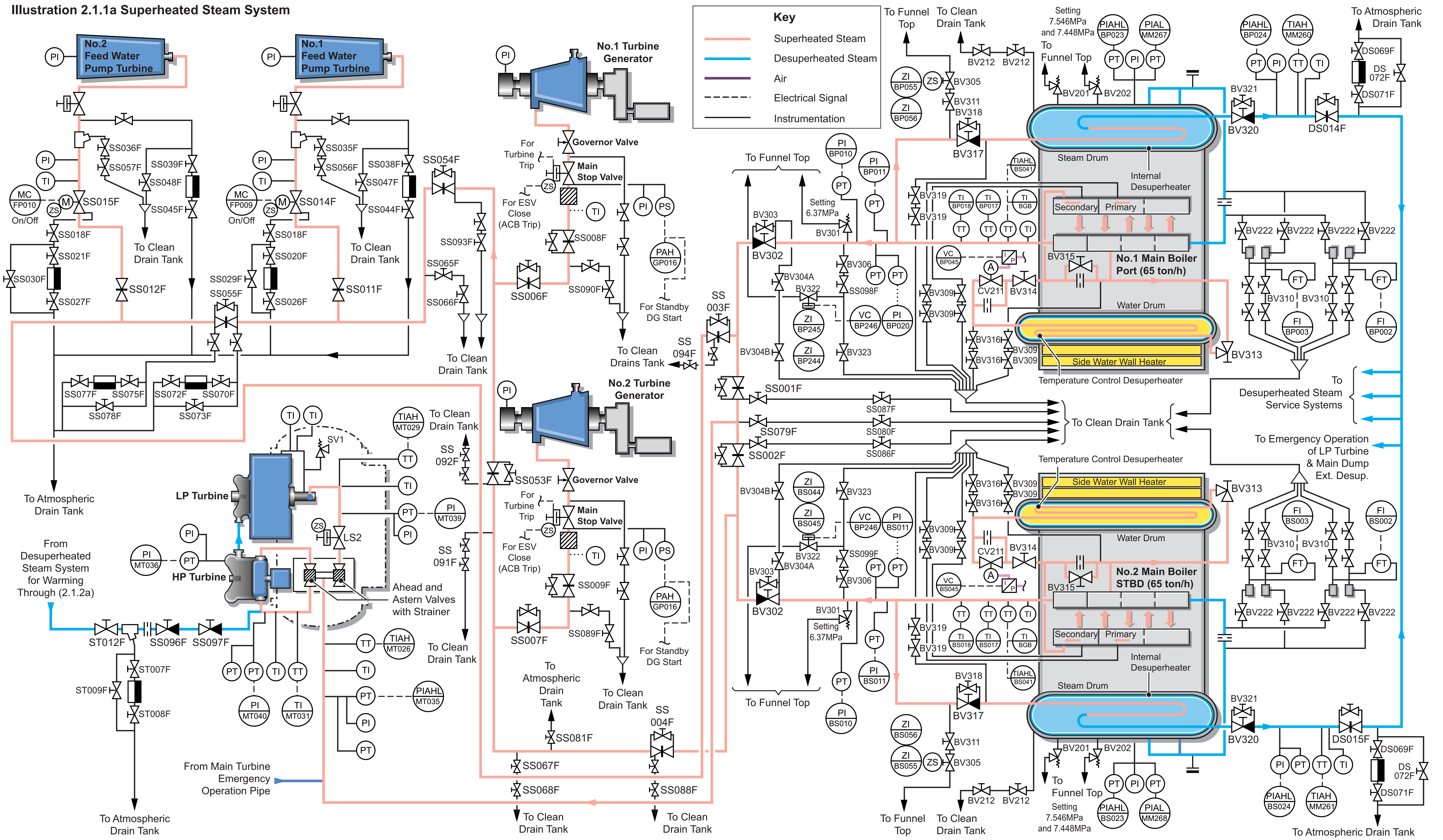
DIESEL OIL TANKS				(Specific Gravity = 0.90)		
Compartment	Between Frames	Capacities		Centres of Gravity		
		100% Full	95% Full	L.C.G. From Aft Peak (M)	V.C.G. Above B.L. (M)	Max. Moment of Inertia (M^4)
		M^3	Tonnes			
Diesel Oil Storage Tank (Starboard)	35 - 46	286.6	245.1	32.035	19.382	30.0
Diesel Oil Service Tank (Starboard)	42 - 46	55.3	47.3	35.211	23.500	12.0
Gas Oil Storage Tank (Port)	35 - 43	105.2	89.9	31.245	23.501	21.0
Total		447.1	382.3			

LUBRICATING OIL TANKS				(Specific Gravity = 0.900)		
Compartment	Between Frames	Capacities		Centres of Gravity		
		100% Full	98% Full	L.C.G. From Aft Peak (M)	V.C.G. Above B.L. (M)	Max. Moment of Inertia (M^4)
		M^3	Tonnes			
Main LO Storage Tank (Starboard)	39 - 47	73.8	65.1	34.400	11.880	19.0
Main LO Settling Tank (Starboard)	31 - 39	73.8	65.1	28.000	11.880	19.0
Main LO Sump Tank (Centre)	26 - 36	76.0	67.1	24.810	2.497	24.715
Main LO Gravity Tank (Starboard)	39 - 45	39.4	34.8	33.600	22.811	82.0
Generator Engine LO Storage Tank (Starboard)	44 - 46	8.0	7.9	36.000	22.664	6.0
Generator Engine LO Settling Tank (Starboard)	42 - 44	8.0	7.0	34.400	22.664	1.0
Generator Turbine LO Storage Tank (Starboard)	45 - 47	6.6	5.8	36.800	22.811	1.0
Generator Turbine LO Settling Tank (Starboard)	45 - 47	6.6	5.8	36.800	22.811	
LO Storage Tank (Starboard)	-6 - -4	1.8	1.6	-5.414	20.598	
Total		294.0	259.3			

2.1 Steam Systems

Illustrations

Illustration 2.1.1a Superheated Steam System



2.1 STEAM SYSTEMS

2.1.1 SUPERHEATED STEAM SYSTEM

Boiler Details

Maker:	Kawasaki Heavy Industries Ltd
No. of sets:	2
Model:	UME 65/50 two drum water tube natural circulation
Maximum evaporation:	65,000kg/h
Normal evaporation:	50,000kg/h
Steam condition:	5.88MPa superheated steam at 525°C
Safety valve settings:	Drum 7.546mPa and 7.448MPa
	Superheat outlet 6.370MPa

All the steam requirements for the vessel are generated in the two main boilers. Steam from the steam drum passes to the primary superheater section through an orifice where the pressure drop is measured and converted to a signal for steam flow, which serves as a function of the IAS/boiler management system.

The steam flows through the primary section of the superheater and then to the secondary superheater section. Taking steam from the primary superheater and leading it through the temperature control desuperheater, situated in the water drum regulates the outlet temperature of the superheated steam. The control valve CV221 regulates the outlet from the desuperheater to the secondary superheater depending on the outlet temperature of the steam leaving the boiler. To ensure that there is always a 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 SS001F and SS002F interconnect both boilers, where a common line supplies the main turbine. Each boiler has an auxiliary machinery stop valve SS003F and SS004F which supplies a ring main, which in turn supplies the two boiler feed water pumps and both generator turbines. The circuit is designed to supply the auxiliary machinery from either side of the ring main giving greater flexibility for maintenance and safety. For example, if it is required to work on the port main feed pump motorised main stop valve SS014F, then by shutting ring main section isolation valves SS055F and SS054F and isolation valve SS011F, double steam isolation is maintained. Warming through bypass valves are provided at all the principal stop valves.

Steam from the superheater outlet is led to the internal desuperheater, situated in the steam drum via valve BV317, from where it is distributed to the various steam services via valves BV320 and DS014F/DS015F.

Services Supplied from the Superheat Steam System

The following machinery is operated form the superheat steam system:

- Port and starboard main feed water pump turbines
- Port and starboard generator turbines
- The main turbine

Procedure for Putting the Superheated Steam System into Service

It is important when bringing any steam system into service to slowly raise the temperature of the pipes, valves and joints. Heating the various parts of the system too quickly can lead to thermal distortion and damage to joints and packings.

The system must be carefully drained of any water during this warming process to prevent 'steam hammer' or 'water hammer' taking place. Mechanical damage can be caused to the surrounding materials. For this reason any water is to be removed from the system before the pressure and temperature are increased.

The pressure must be increased gradually to allow expansion of the components to take place at a rate that will not lead to material failure. Any sudden increase in pressure can send shock waves throughout the system which are very likely to cause damage.

The superheated steam system has been arranged to allow each section to be warmed though, drained and pressurised at a controlled rate. The boiler main superheat stop valves and the intermediate valves have drains and warming through bypass valves. In principle the section or sections of line to be put into service should have all drains along the line open when shutting down the system and should be found in the same condition prior to commencing warming through. With the section main stop valve closed the bypass valve should be gradually, partially opened. This admits a controlled quantity of steam at low pressure to enter the system. The expansion of the steam across the valve requires some of its internal energy to be used thus lowering its temperature.

As the steam pressure builds and the water is driven from the system the drains can be closed in. Similar actions should be taken with the machinery being put into service so that the steam system and the machinery are being drained and gradually warmed though.

The time taken and the rate of increase of the pressure in the system are dependant upon the length of the system, the materials and types of jointing and the machinery being prepared. Where temperature and pressure gauges are fitted the increase can be monitored and controlled. Great care must be taken, safety being the governing factor.

When sufficient drainage and warming through has taken place the system should be at a similar pressure and temperature to the steam supply with the drains closed in to allow sufficient flow to keep the system clear of water and the bypass valve fully opened. The main section stop valve can now be carefully opened giving due consideration to the pressure and temperature increase that may take place. With the stop valve fully open the drains and bypass valves can now be closed. The drain valves should be closed when the system is in use with a steam flow demand.

The procedure for bringing the superheated steam system into operation is described in detail in section 3.3.3 Boiler Operating Procedures.

Alarms

Tag	Description	Low
MM267	No.1 boiler main steam outlet pressure	5.3MPa
MM268	No.2 boiler main steam outlet pressure	5.3MPa

Intergrated Automation System Control

The IAS does not have any control on this system, it only monitors the pressure and temperatures, as illustrated in the mimic below.

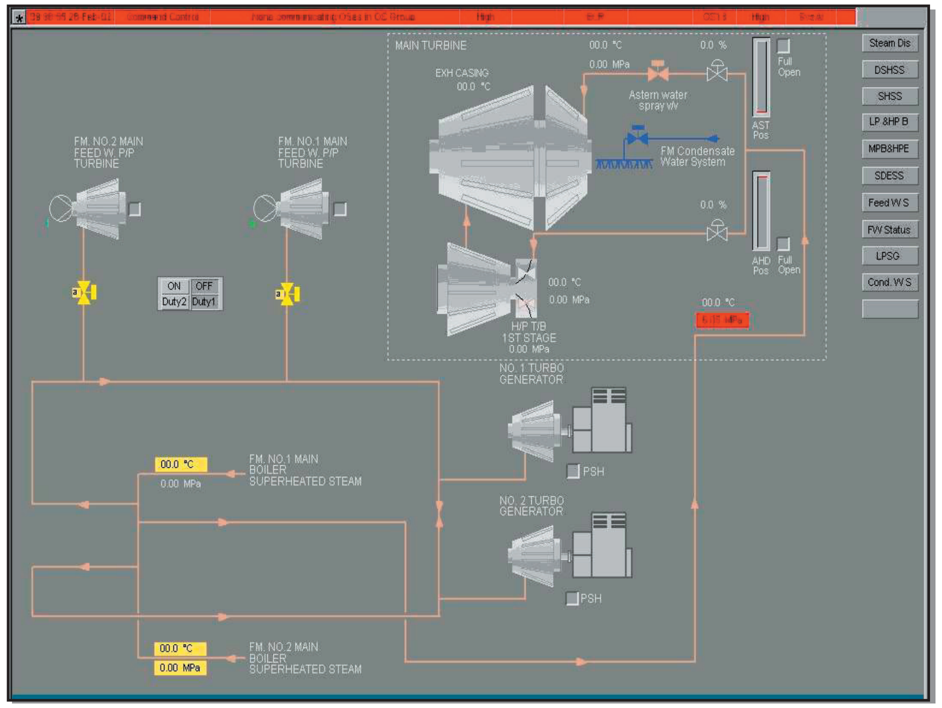
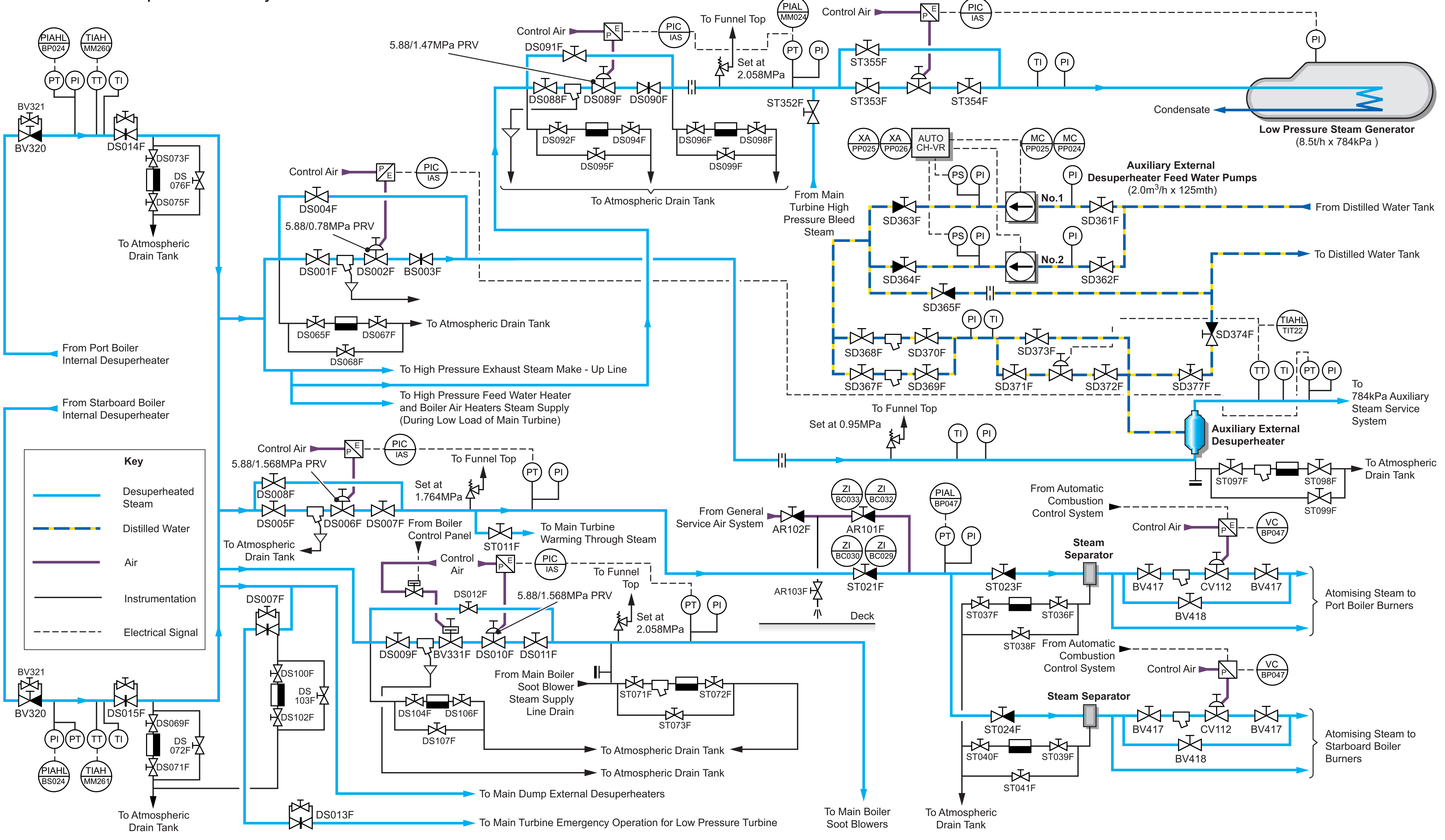


Illustration 2.1.2a Desuperheated Steam System



2.1.2 DESUPERHEATED STEAM SYSTEM

Internal Desuperheaters

Superheated steam from the outlet of each boiler is led to an internal desuperheater fitted in the steam drum of each boiler. Passing the steam through the internal superheater allows a heat exchange to take place between the superheated steam entering the desuperheater, and the saturated steam/water within the steam drum. Consequently the heat given up by the previously superheated steam is recovered and no loss of energy should result. The desuperheated steam exits the internal desuperheater and is led to the desuperheated steam system through a primary and a secondary stop valves BV320 and DS014F/DS015F. Both boilers feed a common range from which the steam is branched away to the auxiliary services.

Systems Supplied from the Main Desuperheated Steam System

- The main turbine emergency steaming connection to the LP turbine
- The main dump steam external desuperheater
- The 5.88/1.568MPa reducing valve DS006F which supplies

  The main turbine warming up steam

  The boiler atomising steam
- The boiler sootblower system through a 5.88/1.568MPa reducing valve DS010F
- The high pressure exhaust steam make-up valve through reducing valve DS062F 5.88/0.2MPa
- The low pressure steam generator heating steam supply through reducing valve DS089F 5.88/1.47MPa
- The high pressure feed water heater steam supply through reducing valve DS081F 5.88/0.41MPa
- The boiler steam air heaters
- The 5.88/0.784MPa auxiliary steam system through reducing valve DS062F

External Desuperheater

An external desuperheater is provided after the 5.88/0.784MPa reducing valve, where the steam temperature is reduced to 180°C, before supplying the auxiliary services. One of two external desuperheater feed water pumps supplies the desuperheater via a temperature control valve at a rate of 2.0m³/h. The pumps take suction from the distilled water tank and return the recirculating water to the same tank.

The recirculating water is constantly bled from the pump delivery through an orifice. This ensures that during times of low spray water demand, there will always be a flow through the pump ensuring that no damage occurs due to overheating.

Procedure for the Operation of the External Desuperheater

a) Fill the distilled water service tank.

b) Ensure that the instrument and gauge valves are open and instrument air is supplied to the control units.

c) Open both external desuperheater feed water pump suction valves SD361F and SD362F.

d) Open the both pump discharge valves SD363F and SD364F.

e) Open the pump's recirculating valve SD365F.

f) Open one of the discharge filters inlet and outlet valves, either SD368F and SD370F or SD367F and SD369F, after ensuring that the filter is clean.

g) Open the inlet and outlet valves of the temperature control valve SD371F and SD372F ensuring that the bypass valve SD373F is closed.

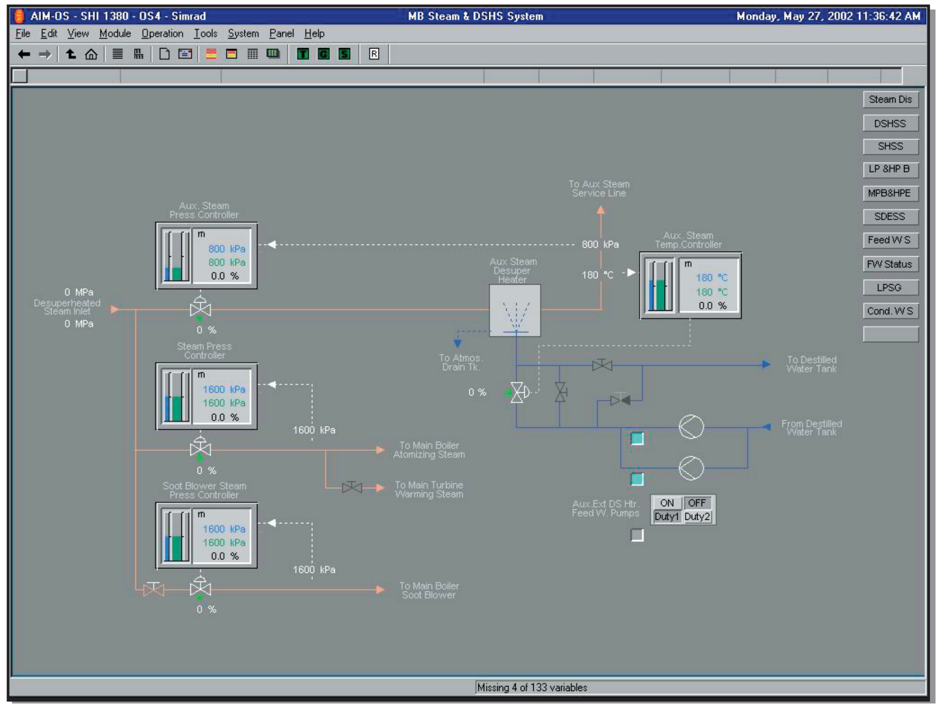
h) Open the inlet and outlet valves for the automatic drain trap of the desuperheater ST097F and ST098F.

i) Start one of the feed water pumps and put the other one on standby.

j) Start supplying steam to the 784kPa steam system by partially opening the steam reducing control valve DS002F inlet and outlet valves DS001F and DS003F.

k) Ensure the spray water control valve opens when the steam temperature reaches the set point of 180°C.

l) Fully open the steam reducing control valve inlet and outlet valves DS001F and DS003F when the steam reducing control valve takes control.



Intergrated Automation System Control

The IAS controls the pressure from the desuperheated steam system to the boiler burner atomising steam system, the sootblower system and the main turbine warming through steam system. The pressure and temperature of the auxiliary steam system is also controlled, via temperature and pressure transmitters positioned on the auxiliary external desuperheater outlet pipe and the two feed water pumps with a duty/standby logic.

General Procedure for Putting the Desuperheated Systems into Operation

It is important when bringing any steam system into service to slowly raise the temperature of the pipes, valves and joints. Heating the various parts of the system too quickly can lead to thermal distortion and damage to joints and packings.

The system must be carefully drained of any water during this warming process to prevent ‘steam hammer’ or 'water hammer' taking place. Mechanical damage can be caused to the surrounding materials. For this reason any water is to be removed from the system before the pressure and temperature are increased.

The pressure must be increased gradually to allow expansion of the components to take place at a rate that will not lead to material failure. Any sudden increase in pressure can send shock waves throughout the system which are very likely to cause damage.

The desuperheated steam systems have been arranged to allow each section to be warmed though, drained and pressurised at a controlled rate. The boiler primary and secondary desuperheater stop valves BV320F and DS014F/DS015F have drains and warming through bypass valves. In principle the section or sections of line to be put into service should have all drains along the line open when shutting down the system and should be found in the same condition prior to commencing warming through. With the section main stop valve closed the bypass valve should be gradually, partially opened. This admits a controlled quantity of steam at low pressure to enter the system. The expansion of the steam across the valve requires some of its internal energy to be used thus lowering its temperature.

As the steam pressure builds and the water is driven from the system the drains can be closed in. Similar actions should be taken with the machinery being put into service so that the steam system and the machinery are being drained and gradually warmed though. The time taken and the rate of increase of the pressure in the system are dependant upon the length of the system, the materials and types of jointing and the machinery being prepared. Where temperature and pressure gauges are fitted the increase can be monitored and controlled. Great care must be taken, safety being the governing factor.

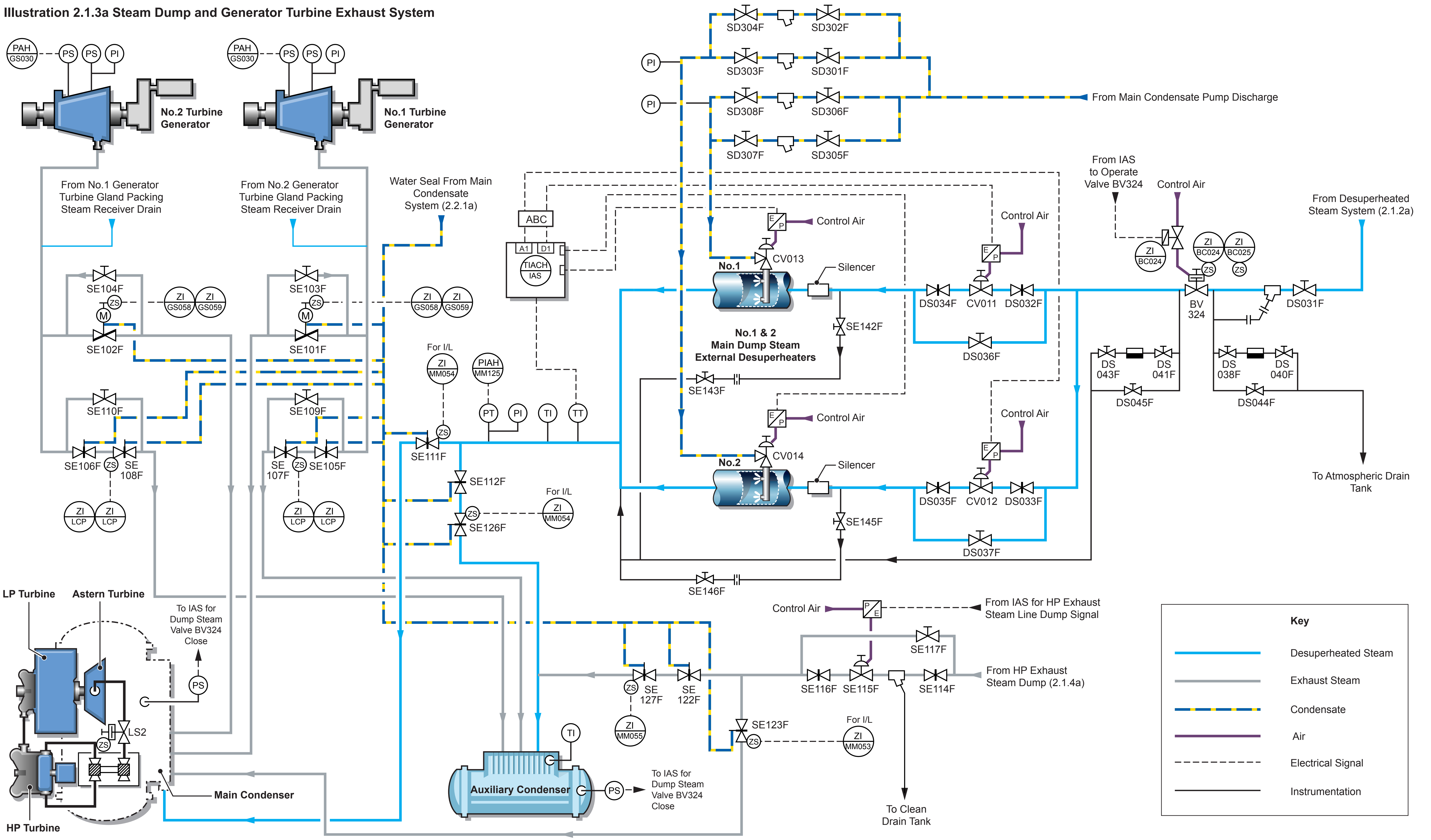
When sufficient drainage and warming through has taken place the system should be at a similar pressure and temperature as the steam supply with the drains closed in to allow sufficient flow to keep the system clear of water and the bypass valve fully opened. The primary, secondary or section stop valve can now be carefully opened giving due consideration to the pressure and temperature increase that may take place. With the primary, secondary or section stop valve fully open, the bypass valves can now be closed and the drain valves closed when there is a system demand and steam flow.

Alarms

Tag	Description	High
MM260	No.1 boiler desuperheater outlet temperature	380°C
MM261	No.2 boiler desuperheater outlet temperature	380°C
PP025	No.1 auxiliary external desuperheater FW pump discharge pressure control	1100kPa
PP026	No.2 auxiliary external desuperheater FW pump discharge pressure control	1100kPa

5.88MPa to 0.784MPa PRV DS062F and 5.88MPa to 0.412MPa PRV DS081F

Illustration 2.1.3a Steam Dump and Generator Turbine Exhaust System



2.1.3 STEAM DUMP AND GENERATOR TURBINE EXHAUST SYSTEM

Dump Steam Desuperheaters

The main boilers burn excess boil-off gas, which is produced from the cargo. If the boil-off gas produced exceeds the requirements for normal steam production, the excess steam produced is dumped to the main condenser via the main dump external desuperheaters. The spray water for the desuperheater sprays is supplied from the main condensate/drain pump discharge. The desuperheaters can discharge to the auxiliary 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 integrated automation system (IAS). The piston valve BV324 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. The dump will control any excess steam pressure generated during these periods.

High Tank Pressure

If the demand of steam is not sufficient to consume the entire 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 will depend on the position of the main turbine manoeuvring valves and the cargo tank pressure. The dump signal from the cargo tank pressure is inhibited when burning fuel oil only. Steam to the desuperheater is supplied via a main piston valve, each desuperheater has its own control valve CV011 and CV012. The main piston valve BV324 will close if excess pressure is detected at the main condenser or the auxiliary condenser. All valves that are subject to the main and auxiliary condenser vacuum have water sealed glands.

Procedure for the Operation of the Dump Steam Desuperheaters

a) Ensure that the instrument and gauge valves are open and instrument air is supplied to the control units.

b) Open the inlet and outlet valves DS038F, DS040F, DS041F and DS043F of the line drain traps before and after the piston valve BV324F.

c) Ensure that the spray control valves Cv013 and CV014 are in the CLOSED position.

d) Supply spray water from the main condensate pump or from the drains pump. Open the inlet and outlet valves of one water supply filter on each desuperheater, after ensuring that it is clear.

Position	Description	Valve
Open	Root valve from main condensate pump	SD222F
or		
Open	Root valve from drains pump	SD220F
Open	No.1 desuperheater spray water valves	SD306F, SD308F
		or SD305F, SD307F
Open	No.2 desuperheater spray water valves	SD302F, SD304F
		or SD301F, SD303F

e) Open one of the desuperheater discharge valves SE111 or SE112F and SE126F to the main condenser.

f) Open the steam supply valve DS031F to the desuperheaters.

g) Open the control valve inlet and outlet valves on each desuperheater.

Position	Description	Valve
Open	No.1 desuperheater control valve isolation	DS032F, DS034F
Open	No.2 desuperheater control valve isolation	DS033F, DS035F

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

High Pressure Exhaust Dump Steam System

The high pressure exhaust system utilises exhaust steam from the main feed water pumps, and the main turbine medium pressure bleed, to supply steam for the following:

- Feed heating at the dearator
- Fresh water generator heating steam
- Main turbine and alternator turbine gland packing steam

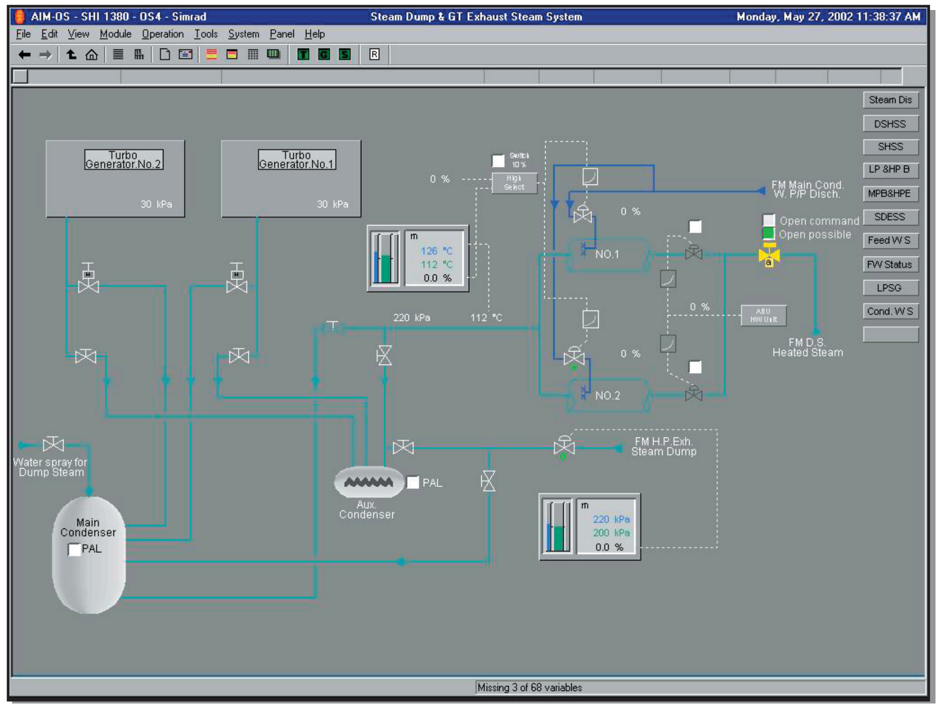
On occasions it is possible for this supply of steam to exceed the demand particularly during large changes of plant load. Excess pressure from the HP exhaust steam system is dumped to the main condenser. If the main condenser is shut down, the excess pressure can be diverted to the auxiliary condenser. This system is controlled from the IAS which operates valve SE115F to regulate the pressure in the system. Valve SE123F dumps the steam to the main condenser and valves SE122F and SE127F dump it to the auxiliary condenser.

CAUTION

Do not open both the dump to the main condenser and the dump to the auxiliary condenser at the same time if the main condenser is under normal vacuum. Doing so will cause a sudden loss of vacuum within the main condenser and subsequent trip of the main engine.

Generator Turbine Exhaust Steam System

Both generator turbines exhaust to the main condenser through independent pipelines. If the main condenser is unavailable, the exhaust can be diverted to the auxiliary condenser. Operation of this system is described as part of the procedure for starting the turbine generators (see section 2.11.2 Turbine Generators)



Intergrated Automation System (IAS) Control

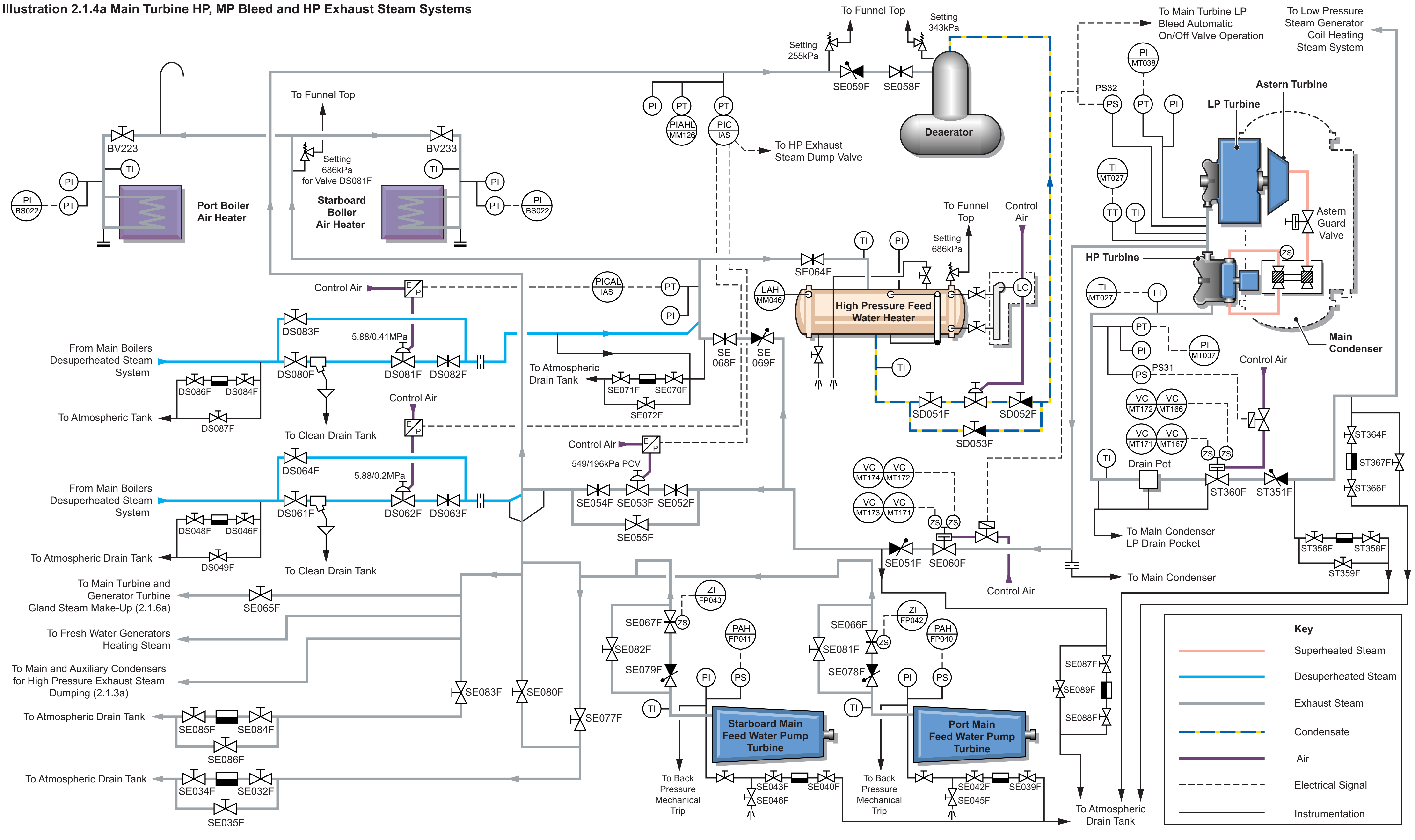
The steam dump valves are controlled from the Automatic Boiler Control (ABC) System and the water spray valves are controlled by the ABC and IAS. There is one spray valve for each dump valve which prevents high temperature steam entering the main condenser. The spray valves receive the same control signal from the ABC as the dump valves. A separate temperature controller will control the dump steam temperature and a high selector will select the highest output from the steam dump control signal and the temperature control signal.

(**Note:** The dump valve BV324 will close if the the main condenser SW outlet temperature reaches 70°C or the vacuum falls to 600mmHg.)

Alarms

Tag	Description	Low Alarm
MM125	Dump steam outlet pressure	100kPa

Illustration 2.1.4a Main Turbine HP, MP Bleed and HP Exhaust Steam Systems



2.1.4 MAIN TURBINE HIGH PRESSURE AND MEDIUM PRESSURE BLEED AND HIGH PRESSURE EXHAUST STEAM SYSTEMS

High Pressure Bleed System

High pressure (HP) bleed steam is bled from the main turbine at the fifth stage of the HP turbine. The bleed off valve ST360F opens automatically by a signal from the pressure switch located at the bleed off point. The normal bleed steam pressure of 1.47MPa joins the LP steam generator heating steam supply system, also supplied by the boiler internal desuperheater. The HP steam supply joins the desuperheated steam supply before the LP steam generator heating steam control valve. The bleed valve opens at a pressure of 1.0MPa and closes at 0.9MPa

Medium Pressure Bleed System

MP bleed steam is bled from the crossover pipe between the HP and LP turbines. The bleed steam valve SE060F opens automatically at a signal from the pressure switch located at the bleed off point. This signal also opens the LP bleed valve ST076F.

The bleed line is continually drained to the main condenser via an orifice situated before the automatic bleed valve. The bleed valve SE060F opens at a pressure of 0.29MPa and closes at a pressure of 0.192MPa. The normal bleed steam pressure is 2.2MPa at NCR. The steam supplies the high pressure exhaust system through a reducing valve set at 180kPa and also directly at MP bled pressure to the following services:

- Heating steam to the HP feed water heater
- Port and starboard boiler steam air heaters

Operation of the High and Medium Pressure Bleed Systems

The bleed valves can be opened or closed from the machinery console, but automatic operation will normally be selected. All drain traps' isolating valves on the system should be opened. Valves SE052F and SE054F, the HP exhaust make up regulating valve isolators, require opening to allow the MP bleed to supply the HP exhaust system.

High Pressure Exhaust System

The MP bleed system and the feed pump turbine exhaust normally supply the HP exhaust system. The system is intended to operate at a pressure of approximately 198kPa. If the pressure drops to 180kPa make up steam is supplied from the main boiler desuperheater outlet via reducing valve DS062F.

If the pressure rises to 220kPa the excess pressure is dumped to the main or auxiliary condensers. This function is controlled from the IAS system.

The HP exhaust system provides the steam to the following services:

- Fresh water generator heating steam
- Main turbine and generator turbine gland packing steam
- Deaerator heating steam

Procedure for the Operation of the High Pressure Exhaust Steam System

The main turbine is in the stopped condition and the feed pump exhaust is supplying the HP exhaust system.

a) Ensure that the instrument and gauge valves are open and that instrument air is supplied to the control units.

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

c) Slowly open the inlet and outlet valves DS061F and DS063F, of the reducing valve DS062F from the main boiler desuperheater system until the control valve takes over.

d) Supply steam to services as required.

e) Put the MP bleed valve SE060F into automatic operation.

f) Ensure that the bleed valve opens at the correct pressure when running the turbine up to full speed.

CAUTION
Due to the small band of operation between the make-up pressure and the dump pressure, ensure that the make-up control valve is not open at the same time as the dump valve.

Intergrated Automation System (IAS) Control

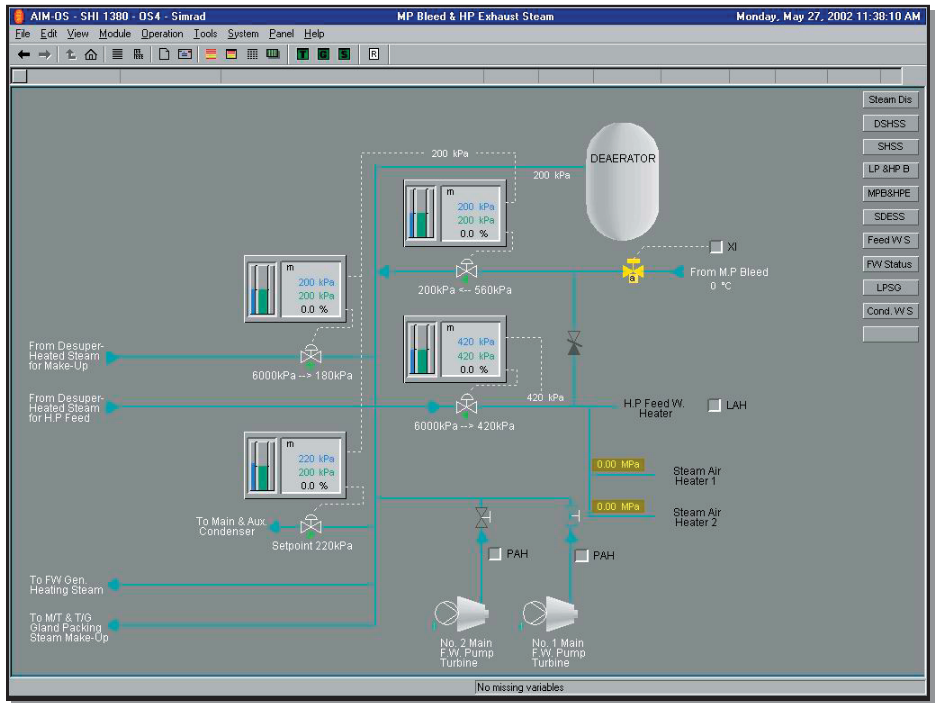
The IAS controls the pressure in the deaerator by controlling the pressure from the main turbine MP bleed (506kPa) to 180kPa by using a PID controller. If the deareator pressure is lower than 180kPa another controller, set at 180kPa will take over and supply steam from the desuperheated steam system. If the deareator pressure exceeds 200kPa a third controller will open the exhaust dump valve to the main condenser.

The HP feed water heater receives heating steam from the MP bleed system at 560kPa and if the pressure is lower than 420kPa a PID controller, set at 420kPa, will take over and supply steam from the desuperheated steam system.

The main turbine HP bleed valve are controlled via the IAS when switched to the REMOTE position. The valve can be operated manually from an operater station or, when in the AUTO position, opened/closed by the signal from to the pressure transmitter PS31 situated on the HP bleed pipe.

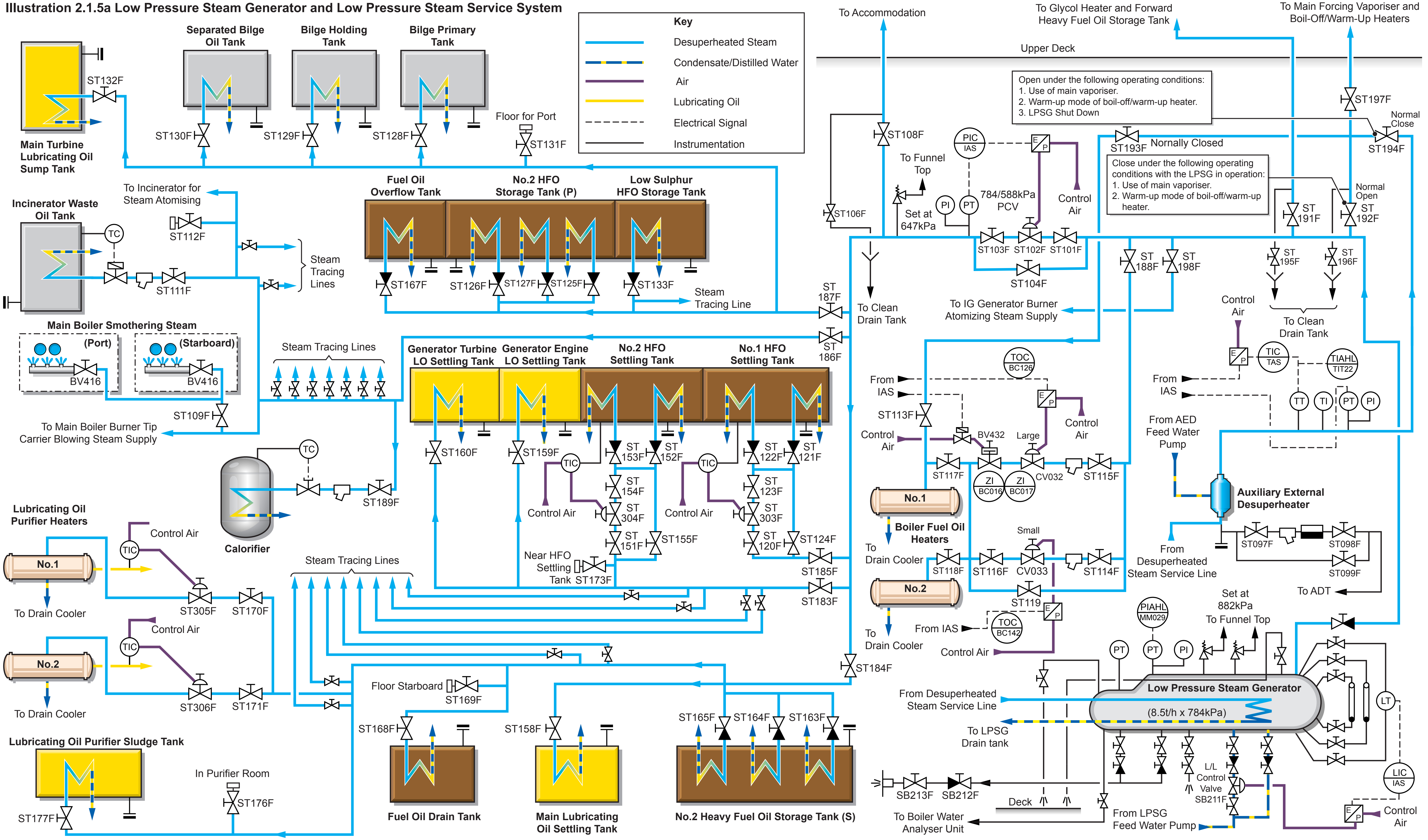
Alarms

Tag	Description	Low low Alarm	Low Alarm
MM123	HP FW heater and SAH pressure control		350kPa
MM126	HP exhaust steam pressure	160kPa	280kPa



549kpa to 194kPa Pressure Reducing Valve SE053F

Illustration 2.1.5a Low Pressure Steam Generator and Low Pressure Steam Service System



2.1.5 LOW PRESSURE STEAM GENERATOR AND LOW PRESSURE STEAM SERVICE SYSTEM

Low Pressure Steam Generator

Manufacturer:	Donghwa Precision Ind. Co. Ltd
Heating steam:	1.47Mpa, 9,880kg/h, 202°C
Output steam:	784kpa, 8,500kg/h, 174.5°C
Feed water:	1.28Mpa, 8,500kg/h, 124°C

The low pressure steam service system is supplied from the low pressure steam generator (LPSG). This system supplies all the heating needs of services from which there could be a risk of feed water contamination. Such an event can occur for example, if a heating coil within a fuel tank were to rupture. Fuel oil entering the coil will be returned to the feed system and if not detected in time could enter the boiler. The effects of this happening in a high pressure boiler can lead to carry over of water and the oil into the steam system and will require the boiler to be shut down and cleaned. Using the LPSG keeps the systems separate and any contamination will only affect the LPSG which is easier to deal with.

The boiler fuel oil heaters and all LP steam services can be supplied directly from the 784kPa desuperheated system if the LPSG is shut down. This connection is also used to supply the main LNG vaporiser and warm up heater when used in the warm up mode when the LPSG is still in use.

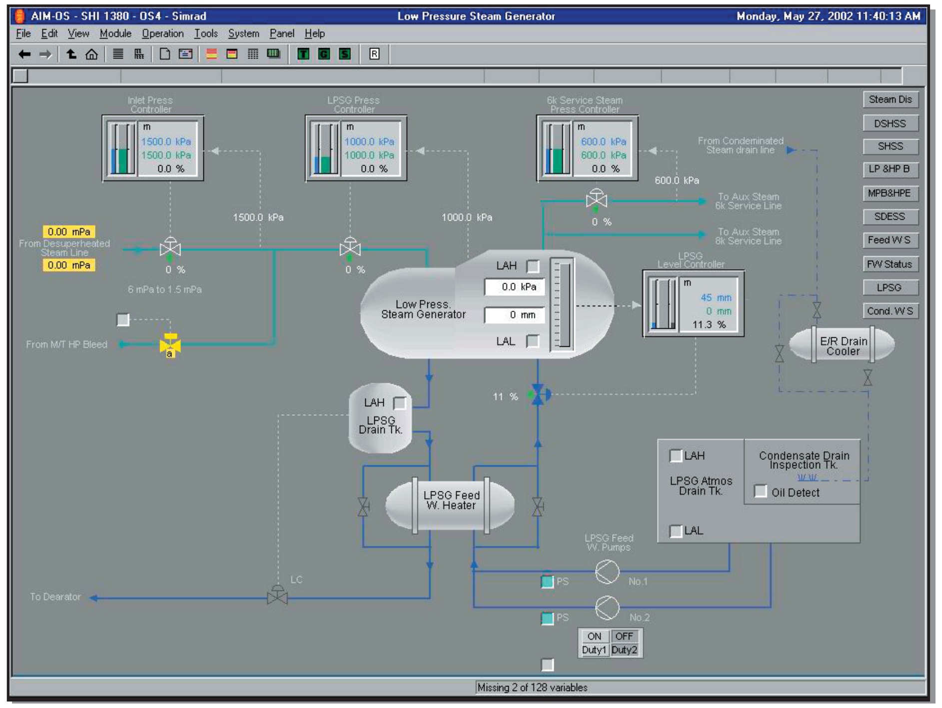
The heating steam to the LPSG heating coil is supplied from the main boilers desuperheated steam system via 5.88/1.47MPa reducing valve DS089F or from the main turbine HP bleed when sufficient. Control of the heating coil steam is by the IAS which compares the output set point pressure with the actual output pressure and adjusts the heating steam accordingly (see illustration 2.2.2b).

The drains from the heating coil pass into the LPSG drain tank with a level controller which, by maintaining a condensate level in the tank, has the effect of ensuring that the heating steam gives up its latent heat of evaporation before leaving the coil. The condensate passes to the LPSG feed water heater and gives up further energy to the feed water. From the LPSG feed water heater the condensate is returned to the deaerator (see illustration 2.2.2b).

The LPSG is protected by two safety valves set at 862.74kPa.

Intergrated Automation System (IAS) Control

The IAS controls the output to the 600kPa heating steam system.



Procedure to Put the Low Pressure Steam Generator into Service

Prior to starting the LPSG its dedicated feed water system should be put into service. An initial dose of chemicals in accordance with the manufacturer's recommendations should be added to the water used to fill the unit. The unit should be filled to just below its normal working level to allow for expansion during initial heating. The LPSG feed water system and its operation is described in section 2.2.2 LPSG Feed Water and Contaminated Feed System.

With the LPSG filled to the level described above:

a) Ensure that the instrument and gauge valves are open and instrument air is supplied to the control units.

b) Ensure that the IAS is set for an output pressure of 882kPa.

c) Ensure that the 5.88/1.47MPa range is operational (see section 2.1.2 Desuperheated Steam System).

(**Note:** The desuperheated steam system should be warmed through in conjuction with warming through the heating coil steam, by cracking open the PCV inlet and outlet valves DS088F and DS090F and allowing this pressure to stabilise at 1.47MPa, whilst warming through heating steam, as per procedure f. Experience has shown that operating the 5.88/1.47MPa range without a flow of steam to the LPSG coil will result in lifting of the system relief valve, which is set at 2.05MPa.)

d) Open the drum vent valve.

e) Prepare the LPSG drains system for operation by positioning the valves as follows:

Position	Description	Valve
Open	Heating coil drains outlet	SD062F
Open	Drain tank outlet	SD063F
Open	LPSG feed water heater inlet and outlet valves	SD064F SD065F
Open	LPSG drain tank level control valve inlet and outlet	SD067F SD068F
Open	LPSG drains to deaerator, valve at deaerator	SD270F

f) With the LPSG heating steam controller isolating valves ST353F and ST354F closed, crack open the steam controller bypass valve ST355F. Carefully admit steam to the heating coil giving due consideration to good steam system practice.

Once the shell pressure is indicated and steam flow to the heating coil is established, open fully the PCV inlet and outlet valves DS088F and DS090F, ensuring the pressure is maintained at 1.47MPa.

The steam raising process should take approximately one hour during which time the steam supply to the coil is gradually increased.

g) When the LPSG pressure reaches about 49kPa and steam is issuing from the drum vent, close the vent valve.

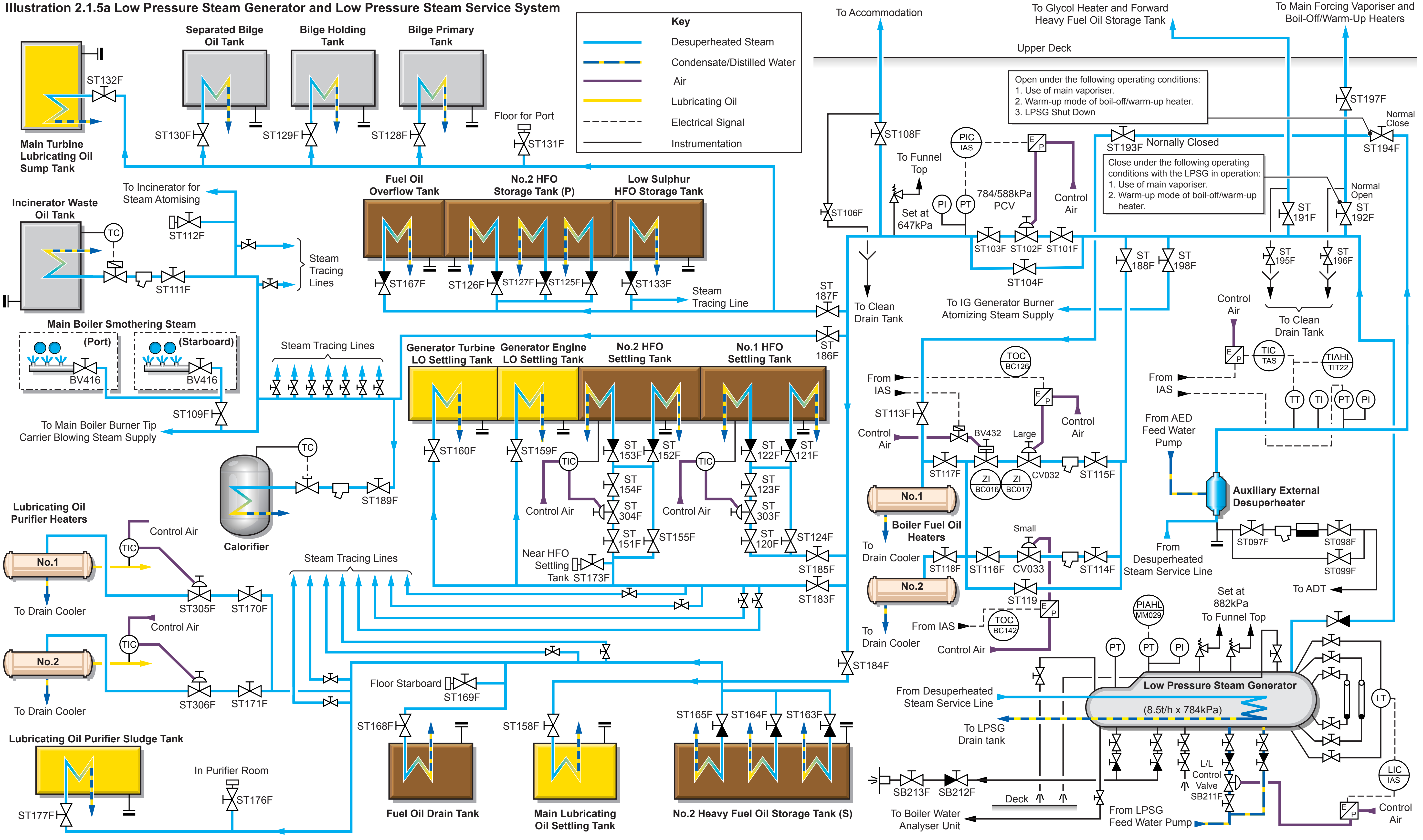
h) As the LPSG approaches 784kPa slowly open the heating control isolating valves ST353F and ST354F and close the bypass valve ST355F.

The steam pressure is being controlled by the IAS and therefore the steam to the heating coil will be regulated automatically through the following stages.

i) Slowly open the LPSG main steam stop and warm through the low pressure steam system.

j) When the LPSG is supplying the low pressure steam system at normal pressure, the IAS control of the boiler fuel oil heating is set to automatic temperature control and conditions are stable, change over the heating steam supply to the main boiler fuel oil heaters as follows:

Illustration 2.1.5a Low Pressure Steam Generator and Low Pressure Steam Service System



Position	Description	Valve
Open	Boiler fuel oil heater regulator inlet and outlet valves	ST115F ST114F, ST116F
Open	Boiler fuel oil heating steam root valve	ST188F
Close	Boiler fuel heating backup supply root valve	ST193F
Close	Boiler fuel heating backup supply secondary valve	ST113F

(**Note:** Ensure the LPSG is supplying steam to the cargo machinery room by opening valve ST192F and closing the external desuperheater supply valve ST194F. When the LPSG is supplying the cargo machinery, ensure that the condensate is returning to the condensate inspection tank by closing valve SD131F and opening valve SD130F. When the auxiliary external desuperheater is in use, valve SD131F must be open and valve SD130F closed.)

Services Supplied from the Low Pressure Steam System

The output steam pressure from the LPSG is 785kPa. The services supplied at this pressure are:

- Boiler fuel oil heaters
- Main vaporiser and forcing vaporiser
- Boil off gas/warm up heaters
- Glycol heater
- Forward HFO tank heating
- Inert gas generator atomising steam
- 588kPa reducing valve

The 588kPa reducing valve supplies the following services:

- Accommodation services
- Steam connection points for sea chest clearing
- Port and starboard HFO storage tanks
- HFO overflow tank
- HFO drain tank
- Incinerator atomising steam
- LO purifier sludge tank
- Trace heating system
- LO purifier heaters
- Generator LO settling tanks.
- Main LO settling tank
- HFO settling tanks
- Calorifier
- Boiler burner cleaning
- Boiler smothering steam
- Incinerator waste oil tank
- Bilge primary tank
- Low sulphur HFO storage tank
- Bilge holding tank
- Separated oil bilge tank
- Main LO sump tank

The 588kPa system is protected by a safety valve set at 647kPa.

Procedure for the Operation of the Low Pressure Steam System

a) Ensure that the instrument and gauge valves are open and instrument air is supplied to the control units.

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

c) Open the inlet valve ST101F for the 784kPa to 588kPa reducing valve.

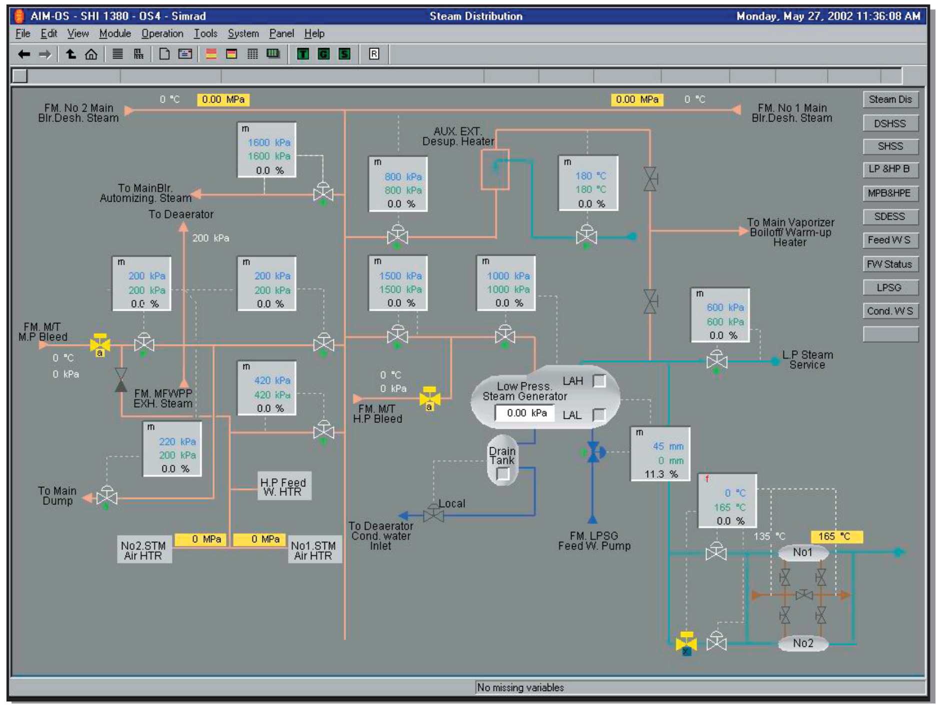
d) If possible open some of the 588kPa services such as tank heating.

e) Partially open the outlet valve ST103F for the reducing valve and allow the system to warm through.

f) Slowly open the outlet valve until the reducing valve takes control, then open fully.

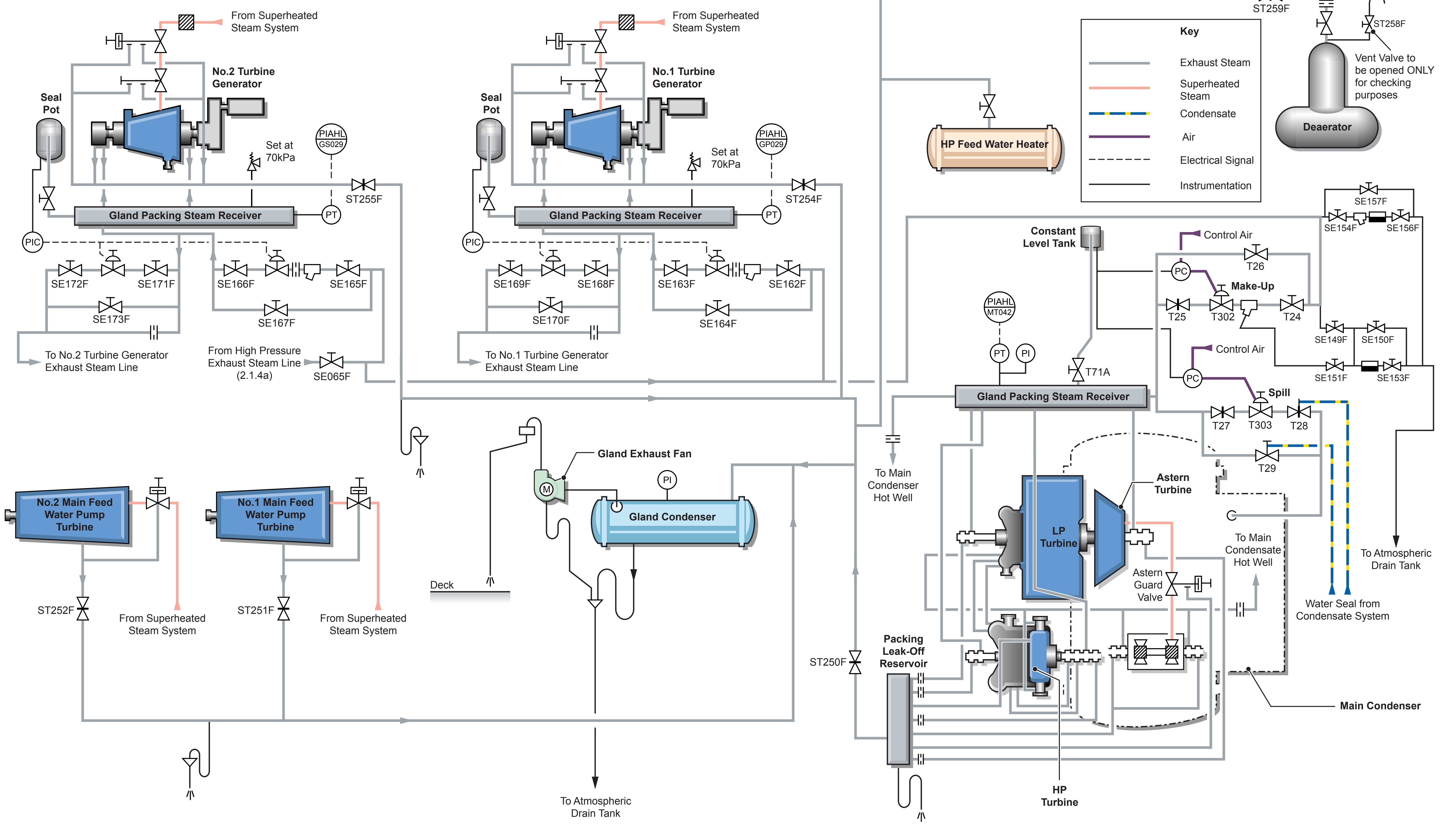
Alarms

Tag	Description	Low Alarm	High Alarm
MM029	LPSG steam pressure	490kPa	863kPa



784kpa to 588kPa Pressure Reducing Valve ST104F

Illustration 2.1.6a Gland Steam Packing and Leak-Off System



2.1.6 GLAND STEAM PACKING AND LEAK OFF SYSTEM

Gland Steam Condenser

Manufacturer:	Showa Ind. Co. Ltd
Heating steam:	1.275MPa
Temperatures:	Shell 250°C, tube 80°C
Surface:	$25m^3$

Principle of Gland Steam

Steam for the gland sealing for both generator turbines and the main turbine is supplied from the HP exhaust steam system.

Labyrinth type seals are used at the end of the turbine rotors to prevent the steam in these regions from leaking to atmosphere and more importantly, to prevent air from entering the turbine where the internal pressure is less than atmospheric. The seals are formed by radially slotting sections of labyrinths into the packing rings, which themselves are likewise slotted radially into the turbine upper and lower casings. The peak and trough edges of these labyrinths are located adjacent to corresponding square radial grooves machined into the rotor shaft. The clearances between the labyrinth edges and rotor are minimised to reduce steam leakage between the inner (high gland steam pressure) areas and outer (low gland steam pressure) areas. Adequate axial clearance between the rotor and labyrinths allow for the designed axial movement and expansion between the rotor and the casing.

Steam is supplied to the glands from a gland packing steam receiver mounted underneath the turbine. Where the turbine internal steam pressure is higher than the pressure in the gland housing, steam will enter the series of diaphragms from the turbine, as well as supplying the gland steam receiver and is effectively throttled across each stage causing its pressure to drop. The packing steam receiver is connected to the inner sections of the glands so that the steam supplied will pass outwards and is led away from the outer glands to the packing steam leak-off reservoir and from there to the gland steam condenser.

Where the pressure in the gland housing is greater than the internal turbine pressure at the shaft exit point, the steam available from the gland steam receiver will be drawn through the gland, effectively sealing it and preventing the ingress of air. The gland steam receiver releases excess steam through a control valve to the flash chamber or receives steam from a make-up controller supplied from the HP exhaust range. The need for the steam to make-up or spill changes with the turbine load, i.e. at high load the steam will generally be spilt out of the system and at low loads the packing steam will need to be made up.

Gland Steam Condenser

The gland steam condenser is a horizontal, straight tube type with the gland exhaust fan mounted on top. It has cooling tubes through which the main and/or auxiliary condensate is passed to act as the cooling medium. Turbine gland leakage steam and air is collected in the gland steam condenser. Air and non-condensible gases are drawn out and exhausted by the fan. The gland steam leak-off condensate passes through a loop seal and drains to the atmospheric drains tank.

The loop seal is designed to allow the gland steam leak-off condensate to successfully drain to the ADT without losing the low vacuum created in the gland steam condenser shell by the gland steam exhaust fan.

Main Turbine Gland Steam System

Packing steam is normally controlled by two air operated control valves. In the case of low packing steam pressure, the make-up valve opens and supplies the packing steam to the glands. In the 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 20kPa.

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

The main turbine manoeuvring valve glands and extra nozzle valve glands also drain to the packing steam leak-off reservoir.

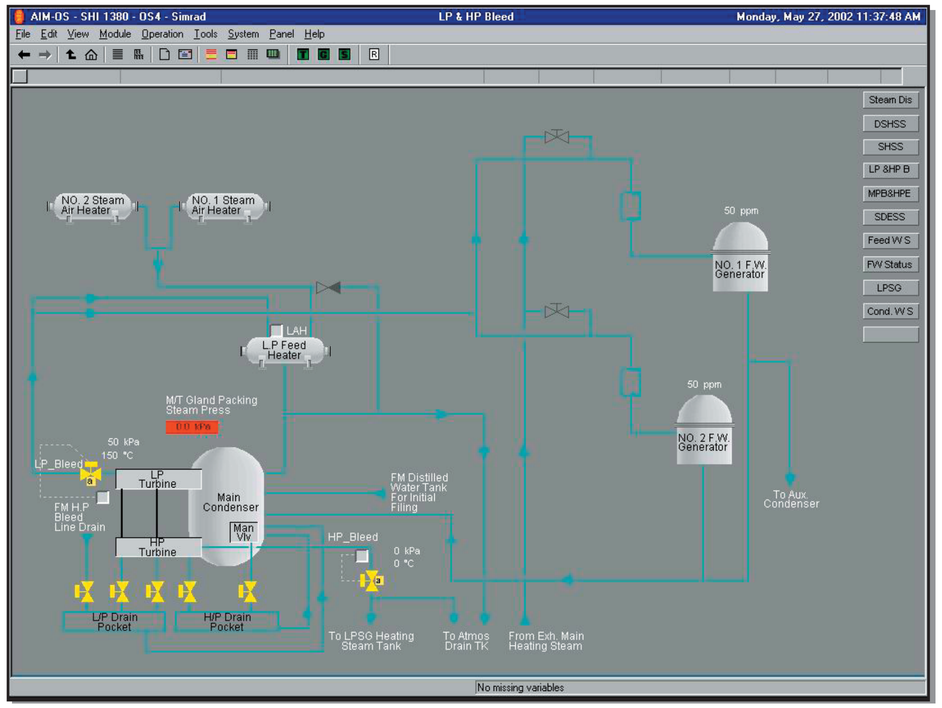
Procedure to Put the Main Turbine Gland Steam System into Operation

Prior to bringing the gland steam system into operation ensure that all the drain trap isolating valves are open, the main turbine LO system is in use and the turning gear is operating.

a) Ensure that the supply from the HP exhaust steam system is available. Carefully open the supply valve SE065F to the gland steam system.

b) Ensure that the main and/or auxiliary condensate system is operating and cooling water supplied to the gland steam condenser. Start the gland steam condenser fan.

c) Open the packing steam leak-off outlet valve ST250F to the gland steam condenser.



d) Set the gland steam packing steam pressure controller to the desired pressure of 20kPa.

e) Open the gland steam make-up and spill control outlet valves T25 and T28.

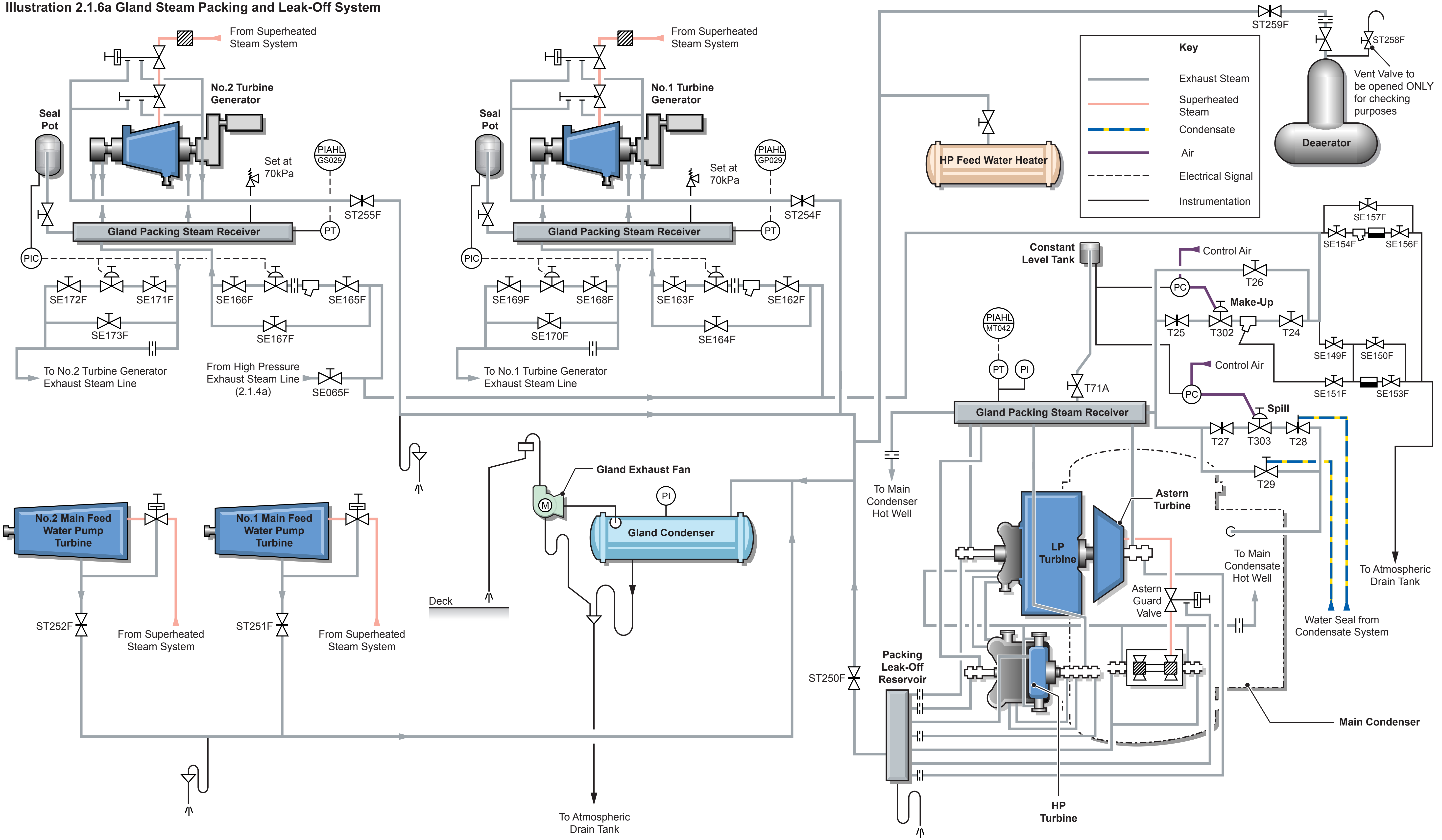
f) Slowly open the gland steam make-up control valve inlet isolating valve T24.

g) Slowly open the gland steam spill control valve inlet isolating valve T27.

Generator Turbines Gland Steam System

The generator turbine gland sealing is supplied in a similar manner, with desired pressure maintained in the gland packing steam receiver by make-up and spill valves. 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, valve glands and nozzle valves are drawn to the gland condenser.

Illustration 2.1.6a Gland Steam Packing and Leak-Off System



Procedure to Put the Generator Turbine Gland Steam System into Operation

Prior to bringing the generator gland steam system into operation ensure that all the drain trap isolating valves are open, the turbine generator LO system is in use and the turbine is turning on the turning gear.

a) Ensure that the supply from the HP exhaust steam system is available. Carefully open the supply valve SE065F to the gland steam system.

b) Ensure that the main and/or auxiliary condensate system is operating and cooling water supplied to the gland steam condenser. Start the gland steam condenser exhaust fan.

c) Open the gland steam leak-off valve on the generator concerned, valve ST254F on the port generator and valve ST255F on the starboard generator.

d) Set the gland steam packing pressure controller to the desired pressure at approximately 10kPa.

e) Open the gland steam make-up and spill control outlet valves, valve SE163F and SE169F on the port generator and valve SE166F and SE172F on the starboard generator.

f) Slowly open the gland steam make-up control valve inlet isolating valve SE162F on the port generator and valve SE165F on the starboard generator.

g) Slowly open the gland steam spill control valve inlet isolating valve SE168F on the port generator and valve SE171F on the starboard generator.

Main Feed Water Pumps

The main feed pump turbine shaft glands, control valve steam glands will always be under positive pressure when operating and therefore no make-up steam is necessary. Leak off steam is drawn away from the glands to the gland condenser.

Procedure to Put the Main Feed Pump Gland Leak-off into Operation

Prior to bringing the steam turbine driven pump gland steam system into operation ensure that all the drain trap isolating valves are open.

a) Ensure that the main and/or auxiliary condensate system is operating and cooling water supplied to the gland steam condenser. Start the gland steam condenser fan.

b) Open the gland leak-off valves, ST251F on the port feed pump and ST252F on the starboard feed pump.

The gland leak-off valves should remain open during normal operating conditions so that the off-line feed pump is ready to start immediately.

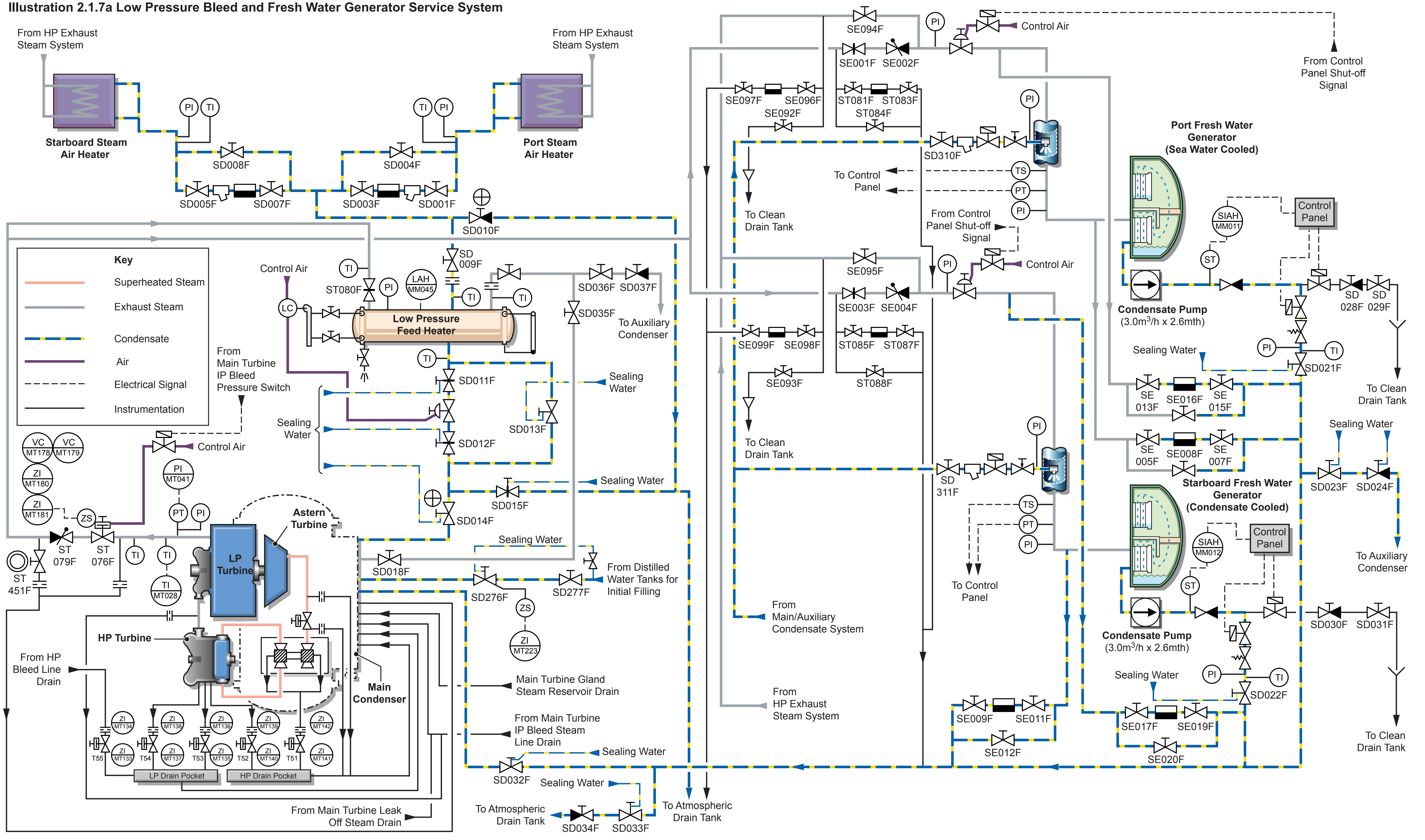
Deaerator and High Pressure Feed Water Heater

Non-condensible gases from the deaerator and the HP feed water heater are drawn to the gland steam condenser.

The deaerator vent valve and isolating valve ST259F to the gland steam condenser should remain open whilst the plant is in operation and the dearator vent valve position varied, depending upon the oxygen readings obtained in the feed water analysis. A separate vent valve ST258F is fitted adjacent to the main vent line and leads to a gooseneck. This is fitted to allow a visual check of the output to be made and is normally closed.

The HP feed water heater vent valve should be open during operation of the heater.

Illustration 2.1.7a Low Pressure Bleed and Fresh Water Generator Service System



2.1.7 LOW PRESSURE BLEED AND FRESH WATER GENERATOR SERVICE SYSTEM

Low Pressure Bleed System

Low pressure (LP) steam is bled from the 3rd stage of the LP turbine. The bleed valve ST076F opens at a pressure of 80kPa and closes at 70kPa. The signal take off point is on the crossover between the HP and LP turbines. The same signal operates the MP bleed valve. The valve can be opened or closed from the ECR console, but automatic operation will normally be selected.

There is no external steam make-up to the the LP feed heater.

The LP bleed steam is supplied directly to the LP feed heater. A control valve on the drain outlet of the heater maintains a constant condensate level in the feed heater. This increases the efficiency of the heater by ensuring that all steam gives up its latent heat of evaporation to the feed water. Further plant efficiency is gained by leading the drains from the boiler air heaters through the LP feed heater, but they can also be diverted directly to either the main condenser or the atmospheric drain tank. The drains from the LP heater are normally directed to the atmospheric drain tank, but may also be directed to the main condenser.

Procedure for Putting the Low Pressure Heater Steam System into Operation

The heating steam supply from the LP bleed to the LP heater should remain ready for operation. Steam will then be supplied when the bleed valve opens under automatic operation.

a) Ensure that all instrumentation, control air and control valves are open. Operate the valves as follows:

Position	Description	Valve
Open	Level transmitter steam and water valves	
Open	Level controller valve inlet and outlet	SD011F, SD012F
Open	Drains to the atmospheric drain tank	SD015F
Open	LP feed heater steam inlet	ST080F
Open	Drains from the boiler steam air heaters	SD009F

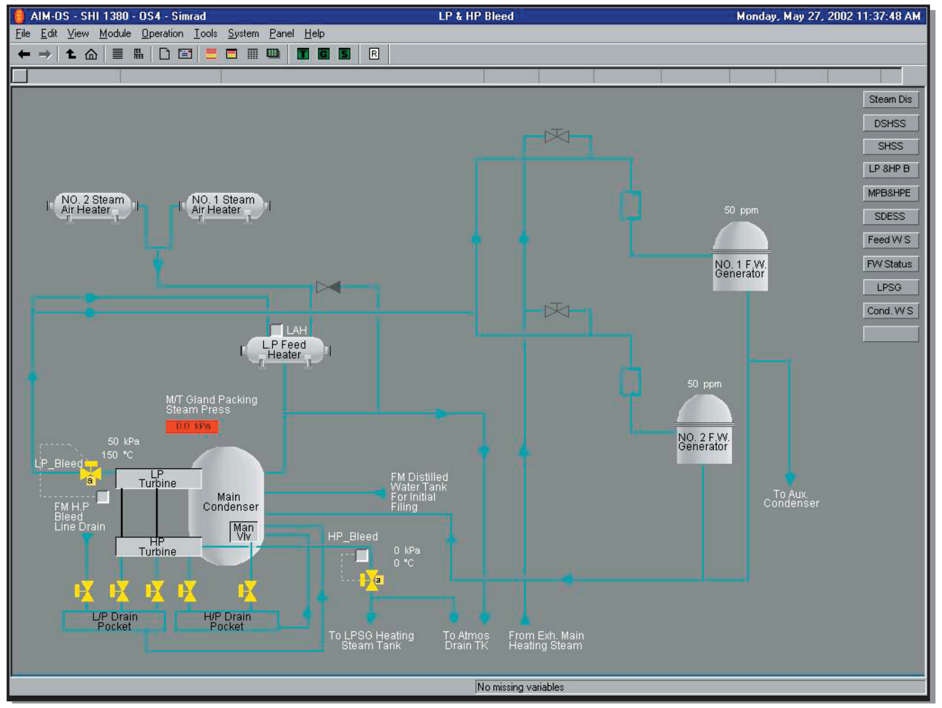
Fresh Water Generator Service System

Steam from the HP exhaust system supplies the fresh water generator feed heaters through their independent desuperheaters. The LP bleed is also able to supply the fresh water generator heating steam systems through isolating valves fitted before the heating steam control valves.

To supply the fresh water generator heating steam from the LP bleed system open valve SE001F for the port fresh water generator and valve SE003F for the starboard fresh water generator and close the corresponding HP exhaust valves, SE094F for the port unit and SE095F for the starboard unit .

Intergrated Automation System (IAS) Control

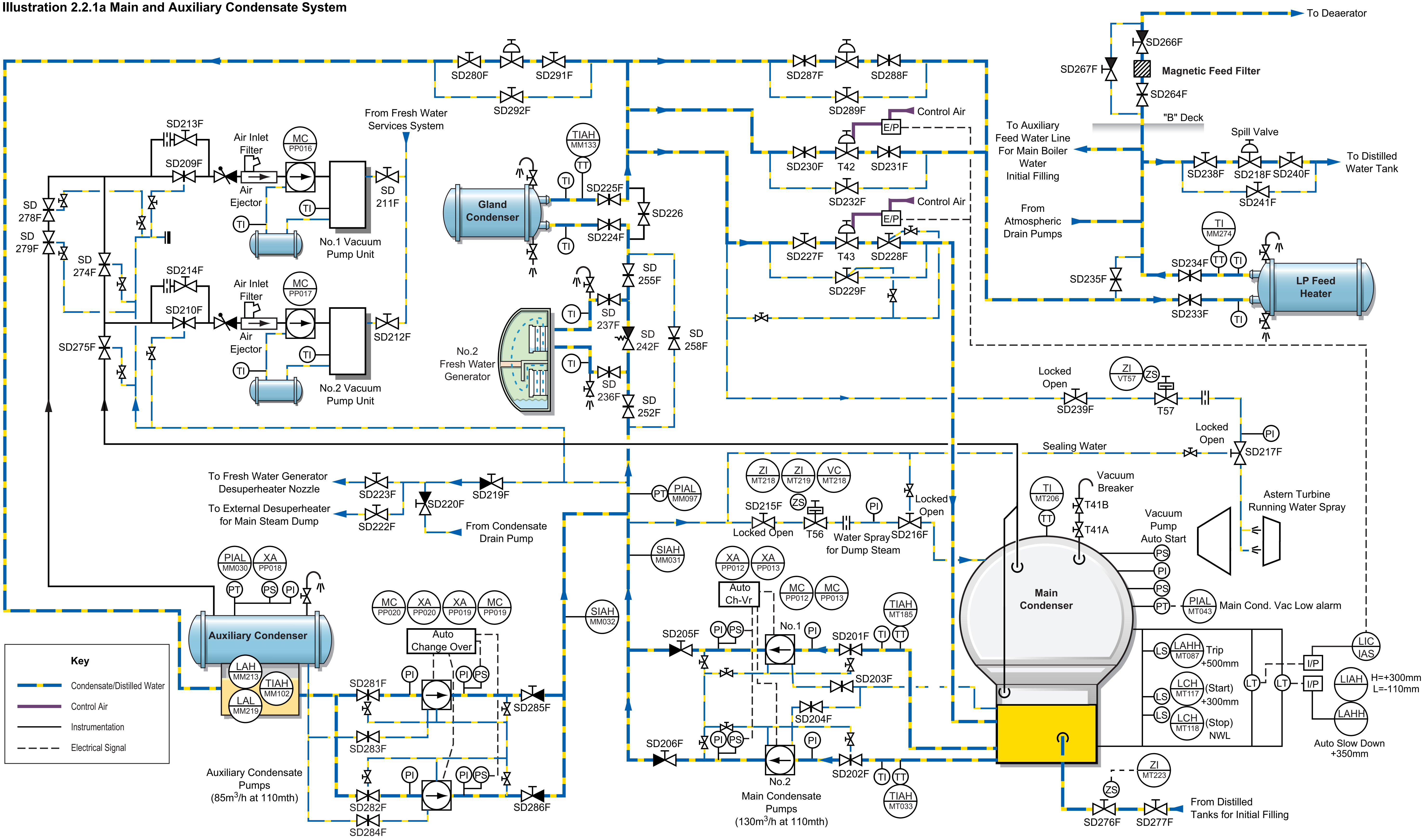
When the main turbine LP bleed valve is switched to the REMOTE position the valve can be opened and closed via the IAS. When in the AUTO position the valve controlled by the output signal from the pressure transmitter PS32.



2.2 Condensate and Feed Water Systems

Illustrations

Illustration 2.2.1a Main and Auxiliary Condensate System



2.2 CONDENSATE AND FEED WATER SYSTEMS

2.2.1 MAIN AND AUXILIARY 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.

Exhaust steam from the main turbines, generator turbines, dump steam and other auxiliaries, is condensed under vacuum in the sea water cooled main condenser. The condensate produced is extracted by one of the two main condensate water pumps, and circulated through various heat exchangers, before entering the deaerator, which is 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 38°C to 137°C. This increase is gained by the use of otherwise waste heat in the condensate cooled FW generator when in use, the gland leak-off condenser, the LP feed heater which is supplied by the LP bleed steam from the main LP turbine, and drains from the boiler steam air heaters. The LP heater having a vent line to either the main or auxiliary condensers.

Exhaust steam from the main feed pumps and IP bleed steam from the main turbine (section 2.1.4), plus make-up boiler desuperheated steam (section 2.1.2), provide the heating steam for the deaerator.

Intergrated Automation System (IAS) Control

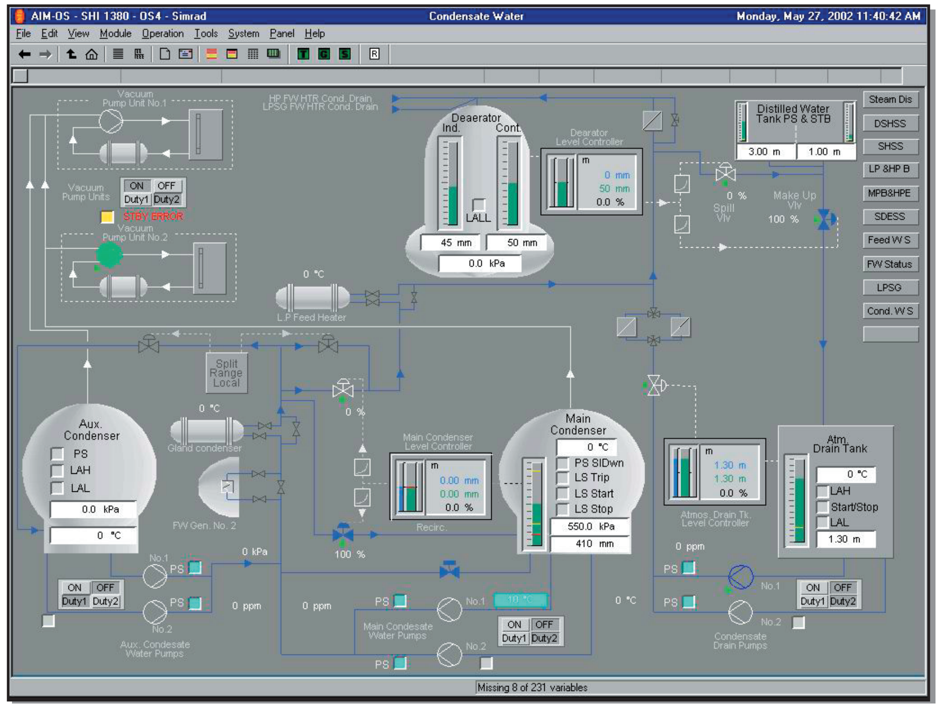
Condensate extraction pumps are provided in a main and standby configuration. The operator must start one of the two pumps from an operator station, then set the other pump to automatic operation. The pump selected for automatic operation will act as standby for the running pump. It will start automatically upon detection of low pressure in the system or if the running pump stops. The standby pump will also start if the main condenser high level switch is activated and will stop when the level returns to normal. Though these pumps are designed to be self-cavitating, the main condenser level is controlled by an automatic recirculating valve T43. This valve is fitted into the line after the gland condenser, ensuring that it has a condensate flow through it at all times.

The two vacuum pumps are on a duty/standby selection. One of the pumps is started from an operator station and the other pump is set to AUTO. The automatic start pump will cut in if a low vacuum is detected in either the main or auxiliary condensers, or the duty pumps stops.

The signal from the condenser level transmitter is compared in a high signal selector, with the output signal operating either level control valve T42, or the recirculation valve T43.

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 there is water in the condenser at all times and that the condensate pumps do not run dry.



The condenser level is alarm monitored, where a high alarm will initiate the automatic start of the standby condensate pump. This pump will also automatically stop when the normal level is regained. Further higher levels will initiate the main turbine automatic slowdown and ultimately the trip functions.

The glands of the 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 main condenser vacuum and have condensate 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 are used to check condensate quality in the combined pump discharge line.
The auxiliary condenser operates under vacuum conditions, the vacuum being produced by the same vacuum pumps as for the main condenser. The auxiliary condenser receives drains from the port and starboard fresh water generator heating coil. Dump and exhaust steam normally directed to the main condenser can also be diverted to the auxiliary condenser. Two auxiliary condensate water pumps, operating on a main and standby configuration similar to the main condenser pumps, extract the condensate which is delivered into the main condensate line.

The condensate level is maintained in the auxiliary condenser in the same manner as in the main condenser, by a control regulating valve responding to the level transmitter.

This system returns condensate water to the auxiliary condenser after heat has been extracted from the gland condenser and from the starboard fresh water generator, or has been passed into the LP feed heater as in the main condenser. Thus the condensate flows through the starboard fresh water generator condenser and extracts heat from the vapour produced from sea water. This condenses the vapour to produce the distillate and heats the condensate thus making for greater plant efficiency.

The condensate discharge continues through the gland steam condenser. This unit condenses the vapour from the following:

- Gland steam leak-off systems of the main feed water pumps, generator turbines and main turbines
- HP feed water heater
- Deaerator

The drains produced flow through a U-tube water seal to the atmospheric drains tank.

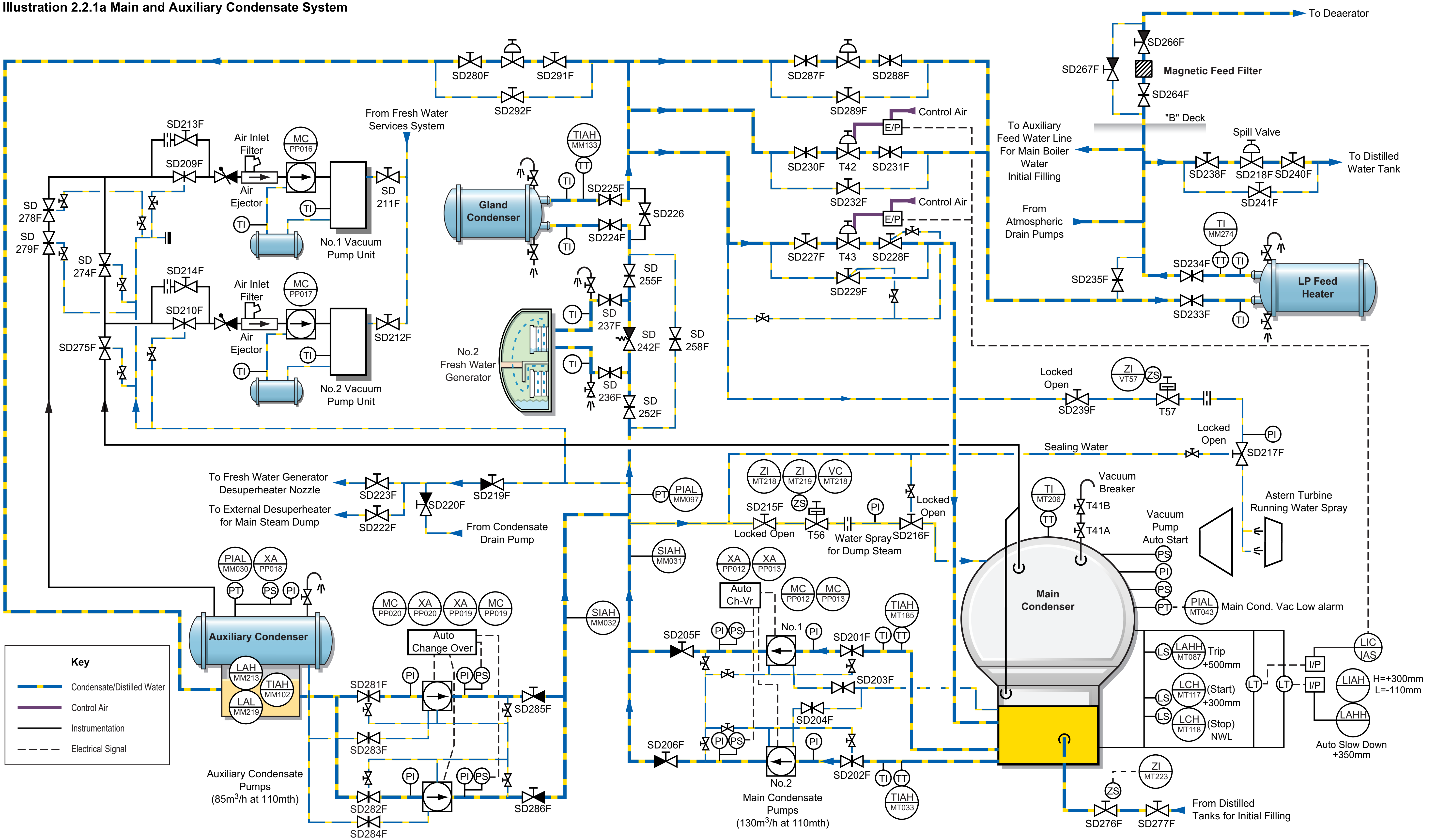
Air and other non-condensibles are extracted from the gland condenser by the gland vapour fan, which discharges to atmosphere.

During some ship operations dump steam is generated by burning excess boil-off gas. This steam is desuperheated and dumped to the main condenser (section 2.1.3). A water curtain is arranged in way of this exhaust to the main condenser, with the spray water for the curtain supplied from the condensate line before the gland steam condenser.

Desuperheating injection water is supplied from the condensate system to the following services:

- No.1 and No.2 dump desuperheaters before the gland condenser
- Main astern turbine steam supply after the gland condenser

Illustration 2.2.1a Main and Auxiliary Condensate System



- Auxiliary steam desuperheater from the distilled water storage tanks
- No.1 and No.2 evaporator steam supply before the gland condenser

Condensate water is also supplied to No.1 and No.2 main vacuum pump valve gland seals.

The condensate continues through the LP feed water heater which is supplied with heating steam from the LP bleed when this is operational and condensate from the main boiler air heater heating steam.

Finally, the condensate reaches the deaerator which is a contact feed water heater, the deaerator feed storage tank, providing a positive inlet head for the main feed water pumps. Non-condensible gases and associated vapours are drawn to the gland steam leak-off condenser, and to the atmosphere via the fan.

The steam cycle is a dynamic system and variations in flow require condensate make-up or dump. The deaerator level is controlled by the spilling (dumping) of excess condensate back to the distilled water tanks at deaerator high level signal, and by accepting make-up to the system from the distilled water tanks via the atmospheric drain tank at low level signal (Section 2.2.3). The unit is also fitted with a high and low level alarms plus a low-low level alarm and inhibit of the automatic start of the standby feed pump.

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

Procedure to Put the Main Condensate System into Operation

To put the main condensate system into use assuming all valves are closed initially:

a) Start the main sea water circulation through the main condenser (section 2.3.1).

b) Check the quality of any condensate already in the condenser. If necessary drain the condensate side of the condenser to the bilge to preclude any risk of feed contamination.

c) Isolate the condenser level control transmitter and alarms from the condenser, drain the lines to prove them clear, and return the transmitter to service.

(**Note:** Ensure that the reference legs and header chambers are topped up and remain so.)

d) Initial filling of the main condenser is by direct supply from the distilled water tanks through filling valves SD276F and SD277F. The bypass valve SD272F around the deaerator make-up control valve will need to be opened if the deaerator is already full. If this is necessary, shut the supply valve SD297F to the atmospheric drain to prevent the tank from overfilling. Refer to section 2.2.3.

e) Bypass the starboard fresh water generator condenser by opening the bypass valve SD258F.

f) Bypass the gland condenser by opening the bypass valve SD226F.

g) Ensure that the main condenser recirculation valve T43 is operational and open the inlet and outlet valves SD227F and SD228F.

h) Ensure that control air is supplied to all control valves in the system. Check that the condenser level transmitter and level gauge are on line.

i) With both condensate pumps isolated, check for rotation by hand.

j) Set up the condensate pump valves as in the table below:

Position	Description	Valve
Open	Port main condensate pump suction	SD201F
Open	Port main condensate pump balance line	SD203F
Open	Port main condensate pump gland sealing valves	
	or	
Open	Starboard main condensate pump suction	SD202F
Open	Starboard main condensate pump balance line	SD204F
Open	Starboard main condensate pump gland sealing valves	

k) Start the pump and check its operation, then open the discharge valve.

Open	Starboard main condensate pump discharge	SD206F
Open	Port main condensate pump discharge	SD205F

l) Set up one main vacuum pump as in the following table, bringing it into operation and raise the condenser vacuum.

Position	Description	Valve
Open	Water supply to header tank	SD211F or SD212F
Open	Seal water supplies	
Open	Vacuum line to main condenser	SD275F, SD210F or SD274F, SD209F, SD275F
Close	Main condenser vacuum breaking valves	T41A, T41B

m) Ensure that the condenser level control valve is operating correctly. When the condenser is holding a normal level, shut the filling supply from the distilled water tank valves SD276F and SD277F.

n) Open the condensate inlet valves SD236F and SD252F to the starboard fresh water generator condenser, vent off the unit, open the outlet valves SD237F and SD255F and close the bypass valve SD258F and the vent valves.

o) Open the feed inlet to the gland condenser SD224F, vent off the unit, open the outlet valve SD225F and close the bypass valve SD226F and the vent valves.

p) Open the feed inlet valve SD233F to the LP feed heater, vent off the unit, open the outlet valve SD234F and close the bypass valve SD235F and the vent valves.

q) Open the master valves SD239F and SD217F for the astern water spray steam and dump steam water spray valves SD215F and SD216F and then lock them open.

(**Note:** Ensure that the main condenser level control discharge valve inlet and outlet valves SD230F and SD231F are open and the bypass valve SD232F is closed.)

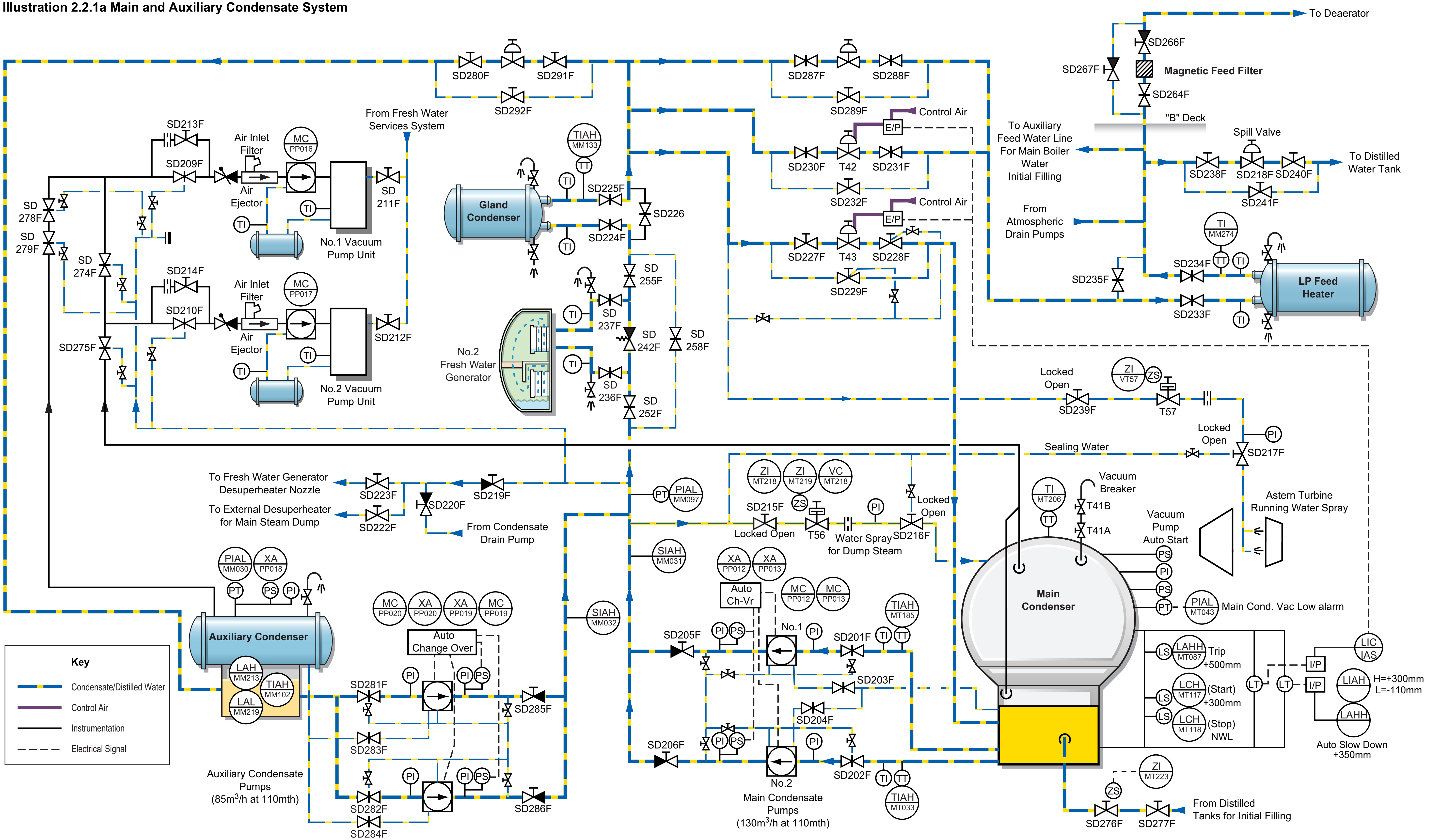
r) Open all valves on the second condensate pump and place it in standby mode. Check that the automatic cut in operation is working.

s) Check all seal water and condensate water lines to ensure that valves open correctly.

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

Put the clean drains system into use by refering to section 2.2.2

Illustration 2.2.1a Main and Auxiliary Condensate System



Procedure to Put the Auxiliary Condensate System into Operation

Assuming that the main condensate system and the clean drains system are operation:

a) Check that the system is ready for use. Start the main sea water circulation through the auxiliary condenser (section 2.3.1).

b) Check the quality of any condensate already in the condenser. If necessary drain the condensate side of the condenser to the bilge to preclude any risk of feed contamination.

c) Isolate the condenser level transmitter and alarms from the condenser, drain the lines to prove them clear, and return the transmitter to service.

(**Note:** Ensure that the reference legs and header chambers are topped up and remain so.)

d) Initial filling of the auxiliary condenser is from the main condensate system through the auxiliary condenser level control valve bypass valve SD292F.

e) Ensure that control air is supplied to all control valves in the system. Check that the condenser level transmitter and level gauge are on line.

f) Open the auxiliary condenser level control valve inlet valve SD291F and outlet valve SD280F.

g) With both auxiliary condensate pumps isolated, check for rotation by hand. Open one of the pump's suction, balance line and gland seal valves.

Position	Description	Valve
Open	Port auxiliary condensate pump suction	SD281F
Open	Port auxiliary condensate pump balance line	SD283F
Open	Port auxiliary condensate pump gland sealing valves	
	or	
Open	Starboard auxiliary condensate pump suction	SD282F
Open	Starboard auxiliary condensate pump balance line	SD284F
Open	Starboard auxiliary condensate pump gland sealing valves	

h) Start the pump and check its operation, then open the discharge valve.

Position	Description	Valve
Open	Port auxiliary condensate pump discharge	SD285F
Open	Starboard auxiliary condensate pump discharge	SD286F

i) Open the vacuum pump valves to the auxiliary condenser SD278F and SD279F and raise the condenser vacuum.

(**Note:** Ensure that the auxiliary condenser level control valve inlet and outlet valves SD287F and SD288F are open and the bypass valve SD289F is closed.)

j) Open all valves on the second auxiliary condensate pump, place it in standby mode. Check that the automatic cut in operation is working.

k) Check all seal water and condensate water lines to ensure that valves open correctly.

l) Continue to raise the auxiliary condenser vacuum and ensure that the level in the condenser stabilises at the normal working level.

Main Feed Water Magnetic Filter

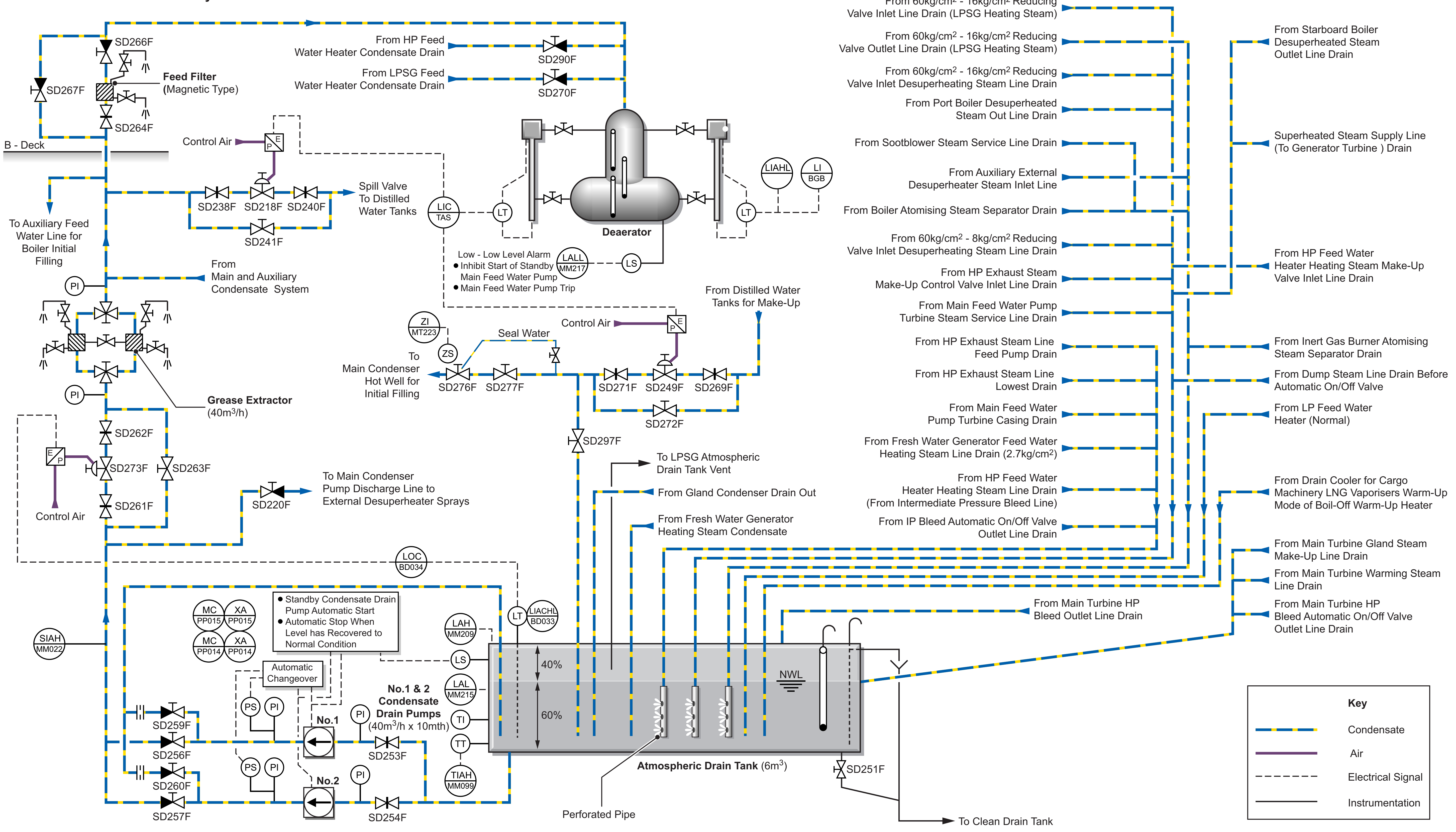
Alarms

Tag	Description	High Alarm
MM030	Auxiliary condemser vacuum pressure	-40kPa
MM031	Main condenser condensate water outlet salinity	5.0ppm
MM032	Auxiliary condenser condensate water outlet salinity	5.0ppm
MM015	Deaerator feed water outlet salinity	5.0ppm
MM102	Auxiliary condenser vaccuum tank temperature	70°C
MM133	Gland condenser outlet temperature	60°C

Tag	Description	Low Alarm
MM097	Main condensate pump discharge pressure	700kPa
PP012	No.1 main condensate pump pressure control	1100kPa
PP013	No.2 main condensate pump pressure control	1100kPa
PP019	No.1 auxiliary condensate pump pressure control	1000kPa
PP020	No.2 main condensate pump pressure control	1000kPa

Tag	Description	Low Alarm	High Alarm
BD033	Atmospheric drain tank level	0.3m	1.6m

Illustration 2.2.2a Clean Drains System



2.2.2 CLEAN DRAINS SYSTEM

Introduction

The system consists of the following drains that are from systems which do not contain hydrocarbon and other contamination:

- 5.88/1.568MPa steam reducing valve to LPSG heating coils
- 5.88/1.568MPa steam reducing inlet valve to desuperheated steam range
- Port and starboard boiler internal desuperheaters outlet pipeline drains
- Sootblowers steam service pipeline drain
- Auxiliary external desuperheater steam inlet pipeline drain
- Fuel oil burners atomising steam separator drain
- IG generator fuel oil burner atomising steam separator drain
- 5.88/0.78MPa steam reducing desuperheater inlet valve pipeline drain
- HP exhaust steam range make-up control valve inlet pipeline drain
- Main feed water pump turbines steam inlet pipeline drain
- Main feed water pump turbines HP exhaust steam pipeline drain
- HP exhaust steam range pipeline lowest point drain
- Main feed water pump turbines casing drain
- Fresh water generator coil heating steam pipeline drain
- HP feed water heater IP bleed heating steam pipeline drain
- HP feed water heater heating steam make-up valve inlet pipeline drain
- IP bleed steam on/off valve outlet pipeline drain
- HP bleed steam on/off valve outlet pipeline drain
- Generator turbines superheated steam supply pipeline drain
- Excess desuperheated steam dump automatic on/off valve inlet pipeline drain
- LP feed water heater condensate outlet pipeline drain
- Cargo machinery drain cooler condensate return pipeline drain
- Main turbines gland steam make-up pipeline drain
- Main turbines warming through steam pipeline drain
- Fresh water generator condensate pumps discharge pipeline drain
- Gland steam condenser and fan casing drain

The returns do not need cooling and go directly to the atmospheric drain tank (ADT), where the condensate drain pumps return the drains to the main condensate system via the grease extraction filters.

Intergrated Automation System (IAS) Control

Condensate drain pumps are provided in a main and standby configuration. The operator must start one of the two pumps from an operator station, then set the other pump to automatic operation. The pump selected for automatic operation will act as standby for the running pump. It will start automatically upon detection of low pressure in the system or if the running pump stops. The standby pump will also start if the main condenser high level switch is activated and will stop when the level returns to normal.

The ADT level is maintained by a level transmitter which supplies the signal to a control valve which controls the pump discharge. The pumps constantly recirculate water back to the ADT, via valves SD259F and SD260F and the orifice plates fitted in the line, which prevent the pumps overheating.

A level switch controls the action of the pumps by automatically starting the standby pump when the tank level rises to a high level. When the level in the tank drops to the normal level, the standby pump automatically stops.

Should the returning clean drains quantity increase, the constant level controller would discharge more condensate to the system and the deaerator water level would rise. Consequently, the deaerator level transmitter would relay a signal to the spill valve SD218F and condensate water would spill back to the distilled tank.

When the water level in the deaerator drops to a preset normal level, the ADT is supplied from the distilled tank via the make-up control valve SD249F.

Procedure to Put the Clean Drains System into Operation

a) Open the distillate make-up line supply from the distilled water tank to be used, the feed make-up valve isolation valves and the supply valve to the ADT, as in the following table:

Position	Description	Valve
Open	Distilled water tank outlet valve	SD352F or SD351F
Open	Feed filter inlet and outlet valves	SD353F, SD355F
Open	Feed make-up valve inlet and outlet	SD269F, SD271F
Open	Feed make-up valve bypass	SD272F
Open	ADT filling valve	SD297F

b) Fill the ADT to normal working level. Close the make-up bypass valve SD272F until the rest of the system is prepared.

c) Place one element of the grease extractor on line. Open the ADT level control valve inlet and outlet valves, the feed filter inlet and outlet valves, the spill back to distilled tank inlet and outlet valves as in the following table:

Position	Description	Valve
Open	Feed filter inlet and outlet valves	SD264F, SD266F
Open	ADT level valve inlet and outlet valves	SD261F, SD262F
Open	Spill back valve inlet and outlet valves	SD238F, SD240F

d) Ensure that control air is supplied to all control valves in the system. Check that the ADT and deaerator level transmitters and level gauges are on line.

e) With both condensate drain pumps isolated, check for rotation by hand. Open one of the pump's suction and leak-off line valves.

Position	Description	Valve
Open	Port condensate drain pump suction	SD253F
Open	Port condensate drain pump leak-off line	SD259F
	or	
Open	Starboard condensate drain pump suction	SD254F
Open	Starboard condensate drain pump leak-off line	SD260F

f) Start the pump and check its operation then gradually open the discharge valve.

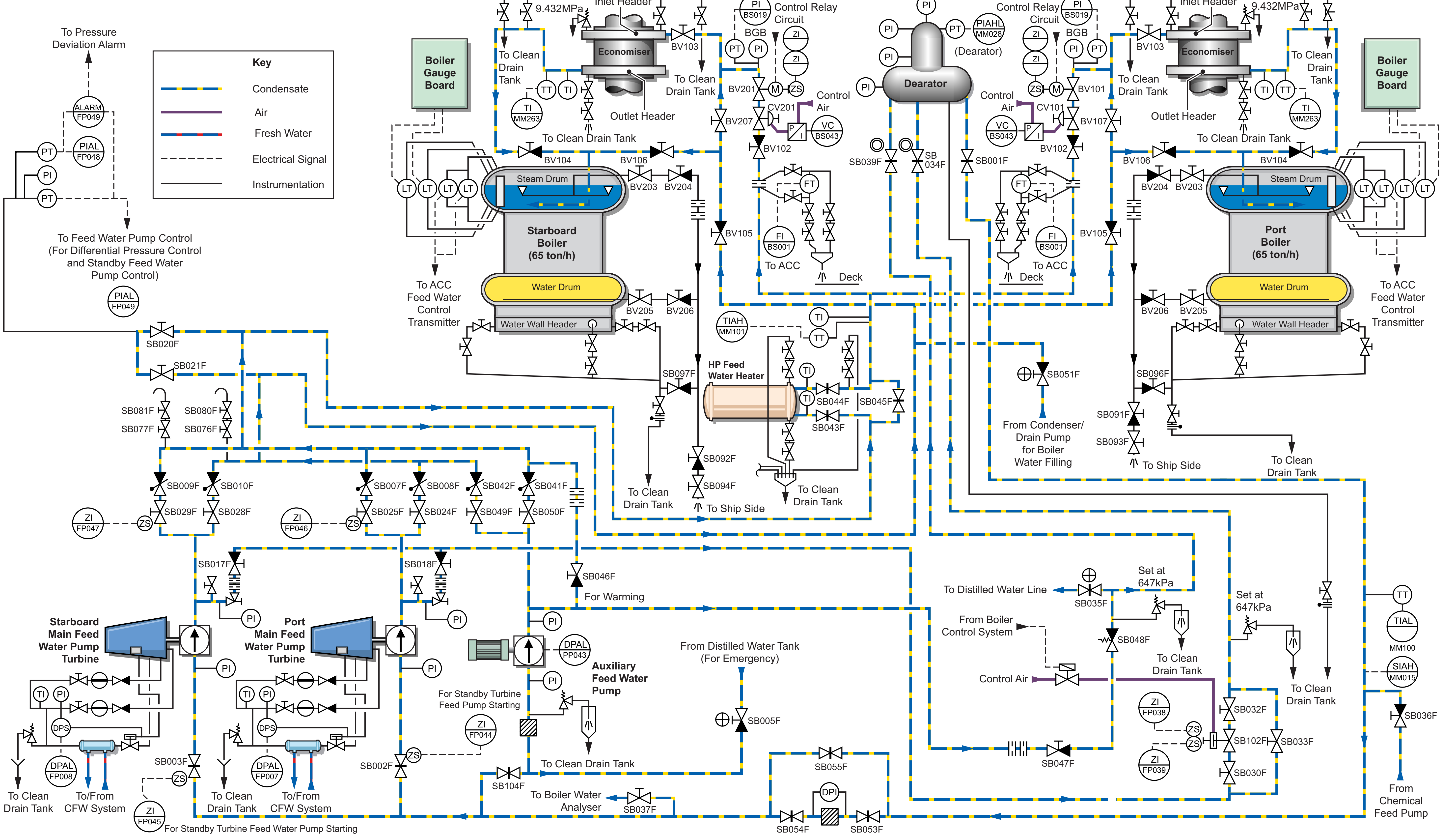
Position	Description	Valve
Open	Port condensate drain pump discharge	SD256F
Open	Starboard condensate drain pump discharge	SD257F

The levels in the ADT and deaerator should stabilise as the system balances itself out.

Alarms

Tag	Description	Low	High
MM022	Condensate drain water outlet salinity		5.0ppm
MM099	Atmospheric drain tank temperature		100°C
PP014	No.1 condensate drain pump pressure control	800kPa	
PP015	No.2 condensate drain pump pressure control	800kPa	

Illustration 2.2.3a Boiler Feed Water System



2.2.3 BOILER FEED WATER SYSTEM

Equipment Specification

Boiler Main Feed Water Pumps

Maker:	Coffin
Type:	Horizontal centrifugal DEB-16
Power:	608kW
Drive:	Superheated steam driven turbine
Steam conditions:	5.733MPa at 520°C
Exhaust pressure:	225.4kPa
Capacity:	140m^3/h at 865mth (extra nozzle valve closed)
	180m^3/h at 865mth (extra nozzle valve open)
Maximum speed:	7,411 rpm
Overspeed trip:	8,200 rpm
Sentinel valve:	343kPa
Back pressure trip:	411.6kPa
Back pressure alarm:	343kPa
Operating oil pressure:	274.4kPa
Low oil pressure alarm:	171.5kPa
Low oil pressure trip:	205.8kPa
High oil temp alarm:	80°C
Vibration alarm:	7.1mm/s
Vibration trip:	11.2mm/s

Boiler Auxiliary Feed Water Pump

Maker:	Shinko Ind. Ltd
No. of sets:	1
Type:	Horizontal centrifugal 10 stage DK80-10MHC
Capacity:	55m^3/h at 850mth
Motor:	250kW

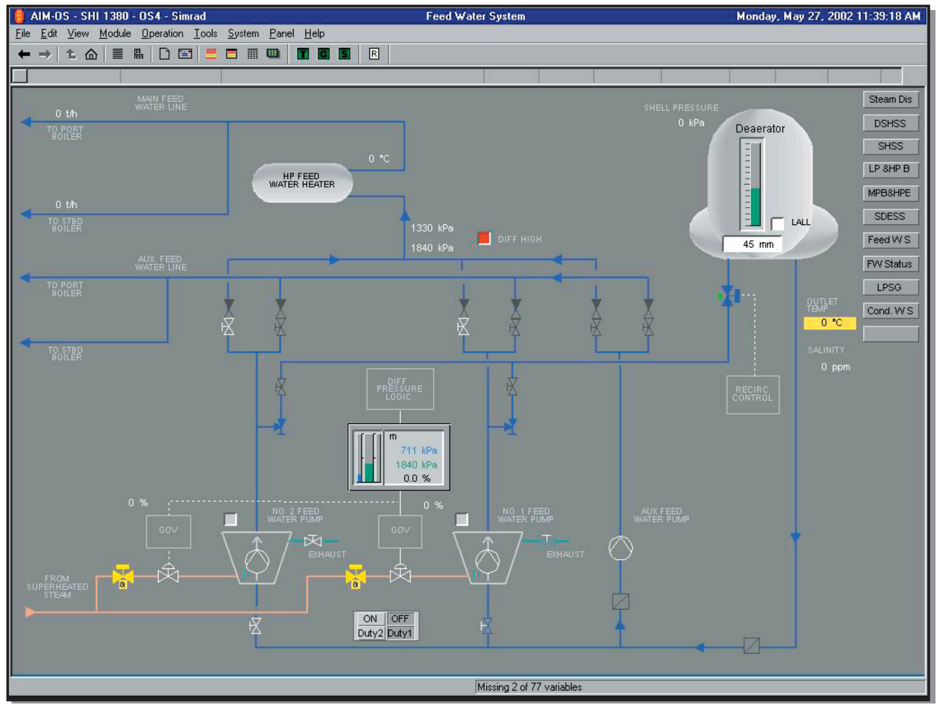
Description of the Main Feed System

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

Feed water from the condensate systems (Section 2.2.1 and 2.2.3), enters the deaerator through the sprayers and mixes with the steam supplied from the HP exhaust system. As the two mediums are mixed (as well as raising the water temperature), the deaerator breaks the water into a fine mist, resulting in the liberation of air and any other non-condensible 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-condensible gases are extracted to atmosphere by the gland steam exhaust fan.

The heated feed water is collected in the deaerator storage tank, 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 location of the deaerator high up 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 dosing 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 SB027F, before entering the feed pump suction manifold.

Two main feed pumps are fitted, with one in use and a second unit on standby. The IAS controls the starting and stopping of the pumps by transmitting a 4-20mA signal to the turbine governor motor according to the feed water differential pressure signal from a PID controller. The standby pump will automatically start and run up should there be a low differential pressure from the duty pump. The electrically driven auxiliary feed pump is started and stopped from the IAS screen, without automatic mode and is primarily for use when starting the plant in an emergency. It can be used if the other two pumps develop a fault but only at low boiler load.

It is estimated that this pump could possibly support the main turbine operating at approximately 25% MCR, ie harbour full ahead condition. The auxiliary feed pump can take suction from the service distilled water tank in an emergency.

The running speed adjustment for the steam flow to the duty feed water pump turbine is controlled via a differential discharge pressure control. This measures and compares the feed pump discharge pressure with boiler steam drum pressure and adjusts the pump speed to maintain a constant differential across the feed regulator.

Discharge pipe configuration from the feed pumps is such that any one feed pump can supply either boiler or any service. Interconnecting pipelines between the pumps, isolated by non-return valves, are arranged to supply two common discharge lines.

The boiler water level control function utilises a three term control. The water level, steam and feed flow inputs are compared and the control output the modulates the boiler feed control valves.

Main Feed Line

The feed water in the discharge line from the pumps passes through the high pressure (HP) feed water heater where its temperature is increased utilising steam from the HP exhaust system. The line divides to supply each boiler separately and passes through an orifice which measures the feed flow to the boiler, utilised in the boiler management system. It then passes through the feed level control valve CV201 or CV101, and the emergency motorised valve BV201 or BV101 which closes at boiler high-high level. After passing through the economiser the feed enters the steam drum of the boiler.

Auxiliary Feed Line

This pipeline is usually used if the main line requires repairs, especially to the feed control valve or the flow orifice plate. The feed water can be directed through the economiser, or bypass it and flow directly into the boiler. Whichever path is chosen, great care must be taken when the auxiliary feed is in use, as the feed valve to the boiler is manually operated and must be attended at all times. The operator must maintain a careful watch on the boiler level in this mode. Under steady load conditions it requires little movement to maintain a steady steam drum water level.

CAUTION

Care should be taken when using the auxiliary feed regulator during fluctuating loads not to overcompensate with movement of the valve. This can lead to the feed pump overspeeding or slowing enough to trip due to low oil pressure.

Main Feed Pump Recirculation Line

An air operated solenoid valve opens to allow the feed pumps to recirculate water back to the deaerator. When the boilers are operating at low loads, this valve will open automatically, allowing water through an orifice on the pump itself, then through the piston valve and into the water chamber at the bottom of the deaerator.

Auxiliary Feed Pump Recirculation Line

The recirculating valve on this pump is manually operated and may be directed to the deaerator when the pump takes suction from there, or the in service distilled water tank, when utilising that supply source.

The main feed recirculation line is either open or closed with no intermediate control. It is provided to ensure that, at low feed flow rates to the boilers, sufficient feed flow can be maintained through the feed pump to prevent damage due to cavitation and overheating.

Boiler Filling Line

The discharge from the condensate pumps for boiler filling is connected to the auxiliary feed line, through valve SB051F, which should normally be locked shut.

Control and Instrumentation

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 flow and water level control via the boiler water feed regulator valves. Each boiler is also fitted with two water level transmitters for the level detector and indicator alarm system. Each transmitter separately detects its own set of alarms.

One level indicator transmitter operates following:

- Boiler high level alarm to IAS
- Boiler low level alarm to IAS
- Boiler high level trip
- Boiler high level signal for main turbine automatic slowdown

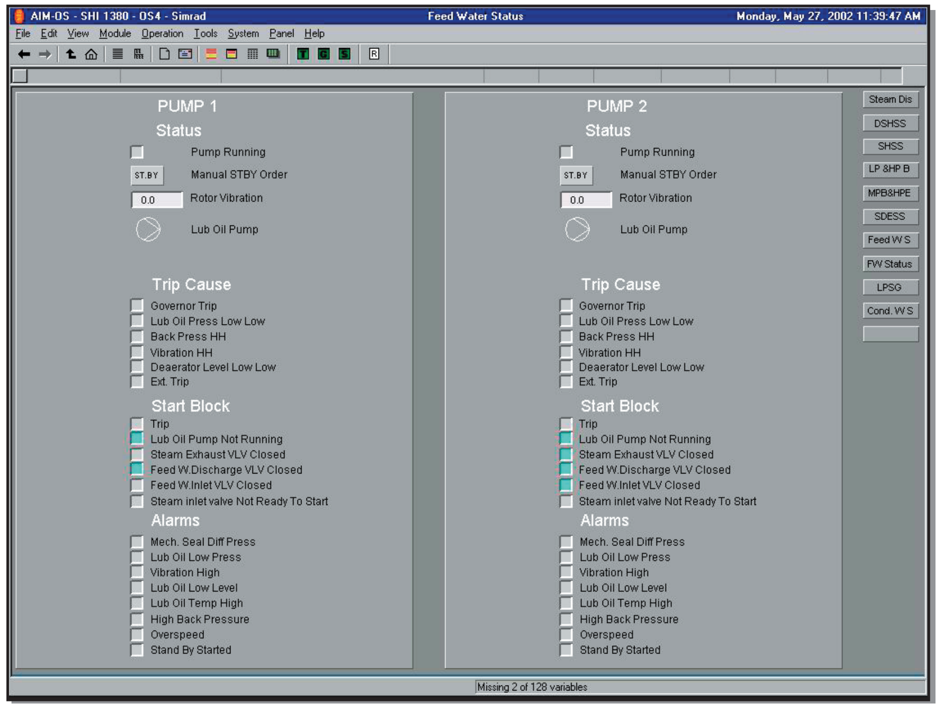
The other level detector transmitter operates following:

- Boiler high level main turbine trip
- Boiler low low level for main turbine automatic slowdown
- Boiler low low level trip
- Boiler high level main turbine interlock
- Boiler high level signal to close motorised feed valve
- Signal to open motorised feed valve

Final feed into the boilers is through the economisers, where the feed temperature is increased to 155°C.

The economisers are placed in the path of the furnace flue gases, in order to extract maximum heat from the waste gas before passing out of the funnel.

Under emergency conditions, the water side of the economiser can be bypassed and feed water supplied directly to the boiler drum. Should this be necessary, steam flow must be restricted. The economiser should be drained and vented.



Description of the Main Feed Water Pumps

The turbine feed pump consists of four main sections:

- Turbine assembly
- Bearing housing assembly
- Governor gear and oil pump assembly
- Pump assembly

The four sections are mounted on a rigid base plate with air spaces in between the main sections to prevent leakage from any part of the assembly into the adjacent section.

The driving steam enters the single stage, impulse, two bucket row, velocity compounded, axial flow turbine through the top of the unit by way of the steam strainer. It then passes through the steam chest and is guided to the nozzle block by means of the steam chest manifold and external nozzle piping.

After expanding through the turbine wheel, the steam exhausts in an axial direction from the upper portion of the turbine casing directly above the turbine end cover.

A single shaft passes through the turbine housing, bearing casing and pump housing. It is supported by two roller bearings located in the bearing casing and a steady bearing of the thrust type, comprising two ball races, located on the outboard end of the pump housing. The pump rotating parts are supported between the roller bearing and the outboard thrust bearing. The turbine wheel is overhung in the turbine housing axially outboard of the roller bearing. The bearing casing additionally serves as an oil reservoir, where the oil temperature maintained throughout the LO system is controlled by a shell and tube type oil cooler, installed independently of the feed pump.

The rolling element type thrust bearing serves its primary function as a steady bearing, there being little thrust with the pump operating under hydraulically balanced conditions. The pump is completely balanced and the small residual thrust is a function of the relatively low exhaust pressure.

The main shaft serves the additional purpose of providing power to the horizontal governor drive shaft through a worm and worm gear. This horizontal shaft is connected to a vertical shaft through a set of spiral mitre gears to drive the centrifugal speed governor and gear type main oil pump.

The main shaft is protected by stainless steel sleeves fitted where it passes through the turbine labyrinth type sealing glands and where it meets the inboard and outboard pump mechanical seals. The shaft sleeves abut tightly one against the other to establish an axial position and clearance of all moving parts.

Control of the feed pump is exercised through operation of the single balanced governor steam valve.

Mechanical Seal Flushing Water

This system is designed to provide flushing water to the pump's mechanical seals. The source of the flushing water supply is at the interstage connection on the pump. The seal flushing water passes through a regulating valve which reduces the pressure to approximately 240kPa above pump suction pressure, or other reference pressure such as the leak-off pressure. The reference line is connected to the regulating valve at one of the reference connection ports. The flushing water then passes though a heat exchanger to remove heat obtained along its path through the system. Upon exiting the cooler, the flushing water enters a pressure cylinder from where it passes through fitted manual valves, flow meters and system check valves before the pump's inboard and outboard mechanical seals.

Seal flushing water flow to the mechanical seals is monitored by one differential pressure switch connected to the reference pressure cavity on the pressure regulating valve and to the body of the pressure cylinder.

Filling and venting is required if the pump has been drained for maintenance. Fill and vent the pump and the entire seal flushing system before operating the pump under any conditions. To effectively accomplish this task, operate the pump at a minimum speed for one to two minutes then stop the pump. Vent the seal flushing system and the feed pump again prior to placing the pump on line.

Pump Discharge Pressure

The constant pressure regulator actuates the oil relay via the main control lever to position the valve in order to maintain the maximum required discharge pressure. However, by monitoring the differential pressure across the feed regulating valve and utilising this value to adjust the pump speed/output by adjusting the constant pressure regulator position, the subdued variations of the pump output are achieved.

The Centrifugal Speed Governor

The centrifugal speed governor trips the oil relay via the main control lever when the rated speed has been exceeded and causes the closing of the balanced governor steam valve. This trips the pump and avoids excessive rotor stresses.

The High Exhaust Back Pressure Trip

The high exhaust back pressure mechanical trip actuates the oil relay via the main control lever, to relieve the oil pressure required to hold the governor balance valve open.

Loss of Lubricating Oil Pressure

Loss of LO oil pressure causes the same action as the high exhaust back pressure mechanical trip.

Pump Assembly

The pump assembly is of the centrifugal type. The feed water enters at the first stage of the unit, travels downward through the suction passages, is directed axially into the impeller and is discharged radially into the nineteen stage diffuser. It is directed by the pump casing to the second stage impeller, through the second stage diffuser and finally out through the pump discharge flange.

Turbine Extra Nozzle Handwheels

Turbine extra nozzle hand valves are provided to permit more efficient operation of the turbine at loads other than the normal design rated load. As mechanical wear takes place in the feed pump between rebuilds, its efficiency drops.

The extra nozzles are provided to allow additional steam to be supplied to bring the pump up to rated output.

They are also used when the steam plant is being operated at higher than normal load or during heavy manoeuvring where the boiler levels are fluctuating rapidly.

Control and Alarm Settings

Point No.	Setting	Description
FP048	5.8MPa	Main feed line pressure low alarm (standby pump auto start)
FP013	205kPa	No.1 main feed pump LO pressure low alarm
FP021	71.5kPa	No.1 main feed pump LO pressure low (pump trip)
	8,200 rpm	No.1 main feed pump overspeed trip
FP040	343kPa	No.1 main feed pump exhaust pressure high
	3.5kg/cm^2	No.1 main feed pump exhaust sentinel valve lift
FP021	411.6kPa	No.1 main feed pump exhaust pressure trip
FP025	205.8kPa	No.2 main feed pump LO pressure low alarm
FP024	171.5kPa	No.2 main feed pump LO pressure low (pump trip)
FP033	8,200 rpm	No.2 main feed pump overspeed trip
FP041	343kPa	No.2 main feed pump exhaust pressure high
	343kPa	No.2 main feed pump exhaust sentinel valve lift
FP033	411.6kPa	No.2 main feed pump exhaust pressure trip
MM028	160/280kPa	Deaerator shell pressure low/high
MM101	160°C	HP feed water heater outlet temperature high
MM100	125°C	Deaerator outlet temperature low

Operating Procedures

Boiler Filling (using the Auxiliary 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 drum and superheater vents fully.

c) Open the pump discharge valve SB049F to the auxiliary feed line, economiser bypass valve BV106 and direct feed valve BV105 slightly to the steam drum. Ensure that the boiler drum feed valve BV104 from the main line is closed.

d) Check that the pump suction valve, from the deaerator SB104 is locked shut, and open the suction valve SB005F from the distilled water tank.

(**Note:** Ensure that the main feed pump discharge valves SB024F and SB028F to the auxiliary feed line are shut and the auxiliary feed pump recirculating valve SB035F to the distilled water tank is opened after closing the recirculating valve SB039F to the deaerator.)

e) Start the pump and commence filling the boiler, ensuring adequate pump back pressure, by throttling valve BV105 and economiser valve BV106. Maintain a careful watch on the local steam drum level gauges until the required level is achieved. Close the direct auxiliary feed valve.

f) Open the feed inlet valve BV103, the economiser outlet valve BV104 and the vent valves BV103 and BV110, ensuring that the unit drain valves are closed. Open the auxiliary feed line valves BV107/207 slightly to the economiser inlet. Continue using the pump until water emerges from the vent BV103, having removed all air from the economiser. Shut BV103 and BV110.

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.

If both boilers are out of service and the plant is being brought on line from cold, then the other way to initially fill them is by using the condensate system, opening valve SB051, which is locked shut, and filling through the auxiliary feed line as described above.

With one boiler in service, filling of the second boiler can be achieved through the use of the auxiliary feed pump taking suction from and recirculation to the deaerator. It is important to carefully monitor the water levels during this operation.

Hydraulic Boiler Test Procedure

a) On the boiler to be tested, open the vents and close all drains. Blank off or gag the superheater and drum safety valves, plus any other items such as instrumentation transmitters, which may be adversely affected by the pressure involved. Once the water level reaches the top of the water level gauge glass, isolate all gauge glasses. Fit the test pressure gauge, ensuring that the boiler is isolated from the main steam systems with both master, intermediate and warming through valves closed.

2.2.3b Boiler Feed Water Pumps Starting Procedure

Check the LO sump for water.

Check LO sump level and top up as necessary.

Open the valves supplying flushing water to the feed pump mechanical seals.

Open the cooling water inlet valves WF019F and WF023F and outlet valves WF020F and WF024F to the LO cooler and the valves to the flushing water cooler.

Set the auxiliary LO pump starter to the REMOTE position.

Open the turbine casing drain, steam chest drain and exhaust line drain.

Open the turbine exhaust valves SB067F and SB066F.

Open the pump feed inlet SB002F and SB003F, discharge SE025F and SE029F and recirculating valves SB017F and SB018F and vent any air from the pump through the vent valve.

On the local panel, check that the auxiliary LO pump starter is not showing 'Abnormal'. Set the feed pump steam inlet valve controller to REMOTE.

Open the turbine supply steam isolating valves SS011F and SS012F.

Reset the turbine trip lever and press the reset button on the local panel, then acknowledge the reset trips at the IAS panel.

Open the gland steam leakoff valves.

On the Feed Water System IAS screen, Click on the pump icon to reveal a command menu. Click on the START button. The LO pump will start and after 30 seconds the steam supply valve SS014F or SS015F opens to start the pump.

On the Feed Water System IAS screen, Click on the pump duty icon ON button to ensure that the running pump is on duty and the standby pump will start in the event of the running pump stopping.

b) Fill the boiler as described above until water appears at the hydraulic test vent. The boiler tubes, both generating and superheater, are now full of water.

c) Replace the hydraulic test vent flange, which is the highest on the boiler, and continue filling with the boiler test pump after stopping the boiler auxiliary feed pump.

d) Build up the hydraulic pressure to the required value, then stop the pump, closing its valves and the boiler supply valve.

e) If the boiler test pump is not available, continue using the auxiliary feed pump with very restricted flow at the boiler. Continuously monitor the auxiliary feed pump for any overheating during this phase.

f) Monitor the test pressure, checking for any signs of decay over a period of time. For safety reasons, close inspection of the boiler while under the test pressure should be avoided. Provided the full test pressure is maintained for a satisfactory period, progressively reduce this pressure by slowly opening the uppermost vent valve.

WARNING

If friction grip plugs are used for sealing purposes, all practical precautions must be taken regarding safety aspects. Reduction in pressure may adversely affect the stability/sealing capability of such plugs. At no time during the application of test pressure should any personnel be allowed to be in direct line of such plugs, and where practicable, protective screening should be arranged.

g) If the pressure falls during testing, or leaks are noted, the test is to be stopped. The boiler should be drained to a suitable level which will allow any repairs to be undertaken. On completion of these repairs, the boiler is to be re-tested.

h) On completion of testing, the boiler can be drained to a suitable level for flashing. Ensure that steam only spaces within the boiler e.g. superheater - are thoroughly drained. Open the drum and superheater vent valves.

i) Remove the gags from the safety valves and open all steam and water legs to the transmitters and water level gauges.

j) Arrange for an initial chemical dosage to the pumped into the boiler.

Procedure to Prepare the Feed Water System for Use and to Start a Turbine Feed Water Pump

a) Start to warm through the main superheater lines to the main feed pumps. Prepare the main and auxiliary feed systems for operation including the electrical feed pump. Line up the valves as follows:

Position	Description	Valve
Open	Deaerator feed outlet valve	SB001F
Open	Feed strainer inlet and outlet valves	SB053F, SB054F
Open	Feed pump suction valves	SB104F, SB002F, SB003F
Open	Feed pump recirculating valves	SB017F, SB018F, SB047F
Open	Feed pump recirculating controller valves	SB030, SB032F
Closed	Feed pump recirculating controller bypass	SB033F
Open	Feed pump recirculating line to deaerator	SB034F, SB039F
Open	Feed pump main feed discharge valves	SB029F, SB025F SB050F
Open	Feed pump auxiliary feed discharge valves	SB028F, SB024F SB049F
Open	HP feed heater bypass valve	SB045F

b) Arrange the boiler feed inlet valves as required (see section 3.3.3 Boiler Operating Procedures).

It is assumed the one boiler is now producing sufficient steam to operate the feed pump.

c) Prepare the feed pumps for use as follows:

- Check the feed pump lubricating oil (LO) sump for water and drain as necessary through the sump drain valve
- Check the LO level on the dipstick and top up as necessary
- Open the valves supplying flushing water to the feed pump mechanical seals
- Open the cooling water inlet valves WF019F and WF023F and outlet valves WF020F and WF024F to the LO cooler and the valves to the flushing water cooler
- Set the auxiliary LO pump starter to REMOTE to run the pump
- Open the turbine casing drain, steam chest drain and exhaust line drain
- Open the turbine exhaust valves SB067F and SB066F
- Open the pump feed inlet SB002F and SB003F, discharge SE025F and SE029F and recirculating valves SB017F and SB018F and vent any air from the pump through the vent valve
- Check that the auxiliary LO pump starter is not showing ‘Abnormal’
- Set the feed pump steam inlet valve controller to REMOTE on the local panel
- Open the turbine steam isolating valves SS011F and SS012F
- Reset the turbine trip lever and press the reset button on the local panel, then acknowledge the reset trips at the IAS panel.
- Open the gland steam leak-off valves

A trip of the feed pump may be caused by:

- Local trip i.e. high back pressure, overspeed, manual trip
- Excessive vibration
- Low/low lubricating oil pressure
- Low/low deaerator level

In the event that a trip condition has existed, the operator must reset the system from the local panel before a start may be attempted. Reset is not possible if the condition still exists.

(**Note:** The lubricating oil pressure will be zero which would normally cause a trip, but the system is arranged to allow a trip reset and pump start before the lubricating oil trip becomes active.)

d) When all the above conditions are met, the operator may request a pump start from the IAS graphic screen. The following sequence is started:

- The IAS checks that the conditions are correct (see above)
- A pulse signal START command is sent to the auxiliary LO pump via a gate which inhibits this signal if a stop or trip command is issued. A timed alarm circuit is initiated to indicate a failure of the pump to start in a predetermined time. In this event, the system sends a ‘Stop’ command to the LO pump starter for safety, and resets the start block thus cancelling the start command. No further action takes place and the starting of the feed pump will be deemed to have failed. This situation will remain until reset by the operator. Under normal conditions i.e. no failure, the LO pump starts.

- Upon receipt of a 'Running' signal from the LO pump (ie LO pressure) and providing the steam inlet valve is not already open, a pulse signal is sent to the controller to initiate the 'Open' command to the steam inlet valve. An alarm is generated if the valve is not fully opened in a predetermined time. In this event, a signal is sent to once more close the steam inlet valve for safety, and resets the start block thus cancelling the start command. No stop command is sent to the auxiliary LO pump in this case because the pump will automatically stop after 60 seconds.
- As the steam inlet valve opens, the feed pump begins to rotate and the internal mechanical LO pump begins to generate LO pressure. Once sufficient pressure is generated as monitored by a pressure switch, a 'Stop' signal is sent to the auxiliary LO pump since it is no longer needed. In the event that the pressure fails to achieve the pressure required after 60 seconds, the auxiliary LO pump is stopped automatically and an alarm is initiated.
- If the sequence proceeds without fault, the steam valve will open fully as monitored by a valve mounted limit switch, at which time the start order is cancelled and the pump is considered to be running. Once the start order is cancelled, the LO trip pressure switch becomes active once more.

(**Note:** If a 'Stop' command is issued at any time or a trip condition occurs, the feed pump is stopped by stopping the auxiliary LO pump (if running) and closing the steam inlet valve.)

With the system now operating normally it is important to make regular checks of the feed pumps, paying particular attention to the following:

- LO level and drainage of water from the sump
- Leakage from the mechanical seals
- Correct flow of cooling water to the mechanical seals
- Off line feed pump is not rotating backwards due to exhaust leakage
- Running unit vibration and noise

Setting the Off-Line Feed Pump to Standby Mode

The system allows the operator to select AUTO (Standby) and in this condition, if any failure occurs on the running pump (except deaerator low-low level, which causes both pumps to stop), the second pump will start automatically.

Prepare the standby feed pump as described above.

In order to select AUTO certain conditions must apply:

- Feed pump suction valve open
- Feed pump exhaust valve open
- Feed pump discharge valve open
- Auxiliary LO pump starter set to REMOTE
- Auxiliary LO pump starter not showing 'Abnormal'
- Feed pump steam inlet valve controller set to REMOTE on the local panel
- Feed pump steam inlet valve controller operable
- Feed pump is not tripped
- The other pump must be running
- The pump to be designated standby must be stopped
- There must not be a current operator 'Start' order
- There must not be a current 'Stop' order
- The deaerator level must not be on low-low

When the above conditions are met, the operator may select AUTO. If any of the above conditions subsequently change, an alarm would be raised and the AUTO condition automatically cancelled. In AUTO condition, if the running pump trips for any reason other than for a deaerator low/low level, or if the differential between the feed pump discharge pressure and the boiler drum pressure becomes too small, and providing that there is no blackout, then a standby start command is issued. The same sequence occurs as for the operator initiated start.

In the event of a blackout, the start will occur when the blackout is cancelled and power is restored.

In the event of a standby start, the AUTO condition is automatically cancelled. Whilst in the AUTO condition, the operator may select START and the pump will start, with the AUTO condition being cancelled.

Similarly, if the operator requests STOP for the standby pump (there would be no reason since the pump is not running) the AUTO condition is cancelled.

If a trip condition occurs for the standby pump, the AUTO condition is cancelled. An automatic transfer from AUTO will generate an alarm and alert the operator.

Local Operation

The feed pumps are normally operated from the engine control room either with manual start and stop or by automatic start.

The auxiliary LO pump and various valves may be operated locally and in each case, the IAS notes the condition and will not allow a start request. In these conditions it is still possible to issue a STOP or TRIP command from the IAS.

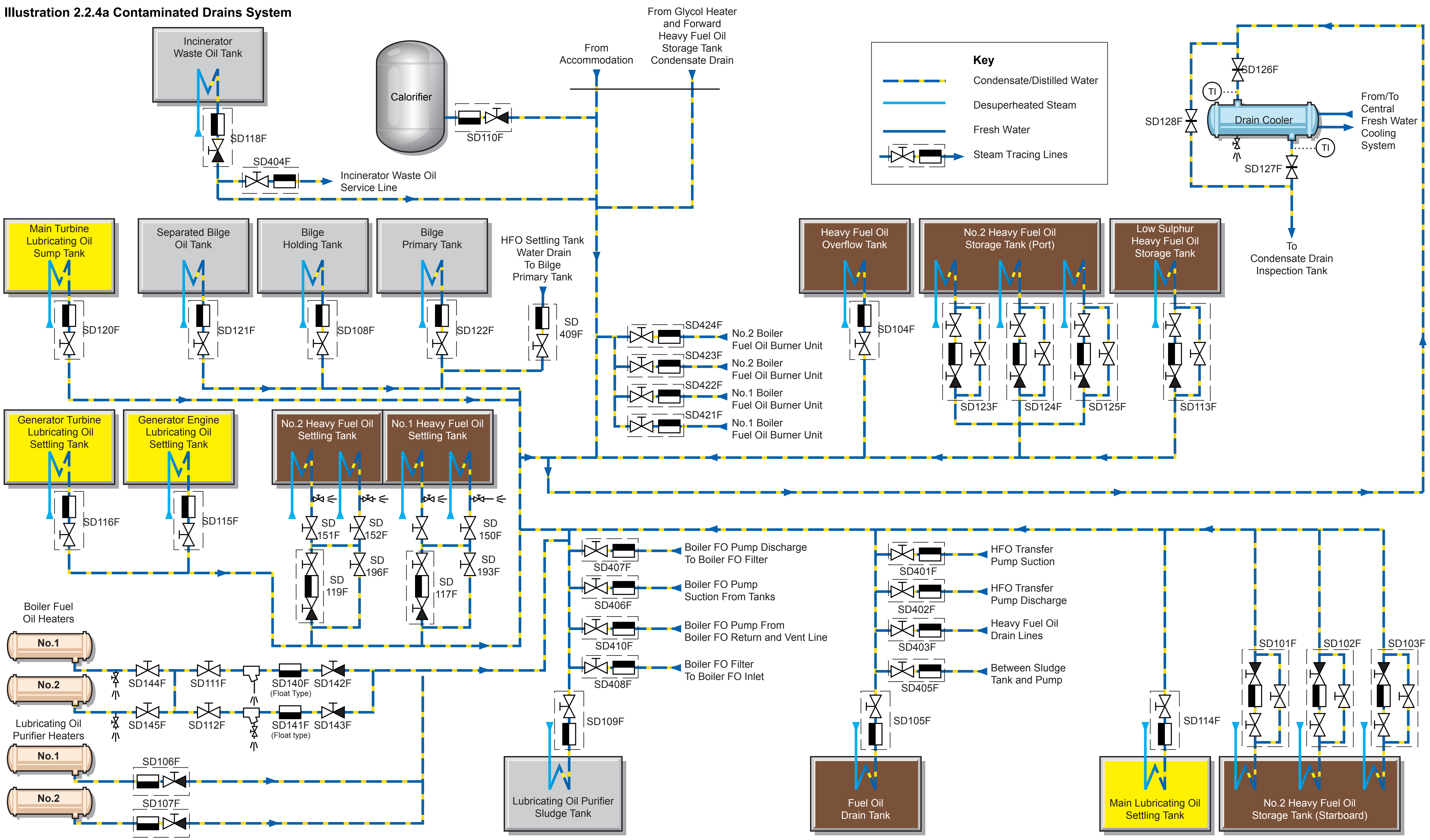
Stopping a Feed Pump

Stopping of a feed pump is normally carried out from the IAS by clicking on STOP. It is good practice to stop a running pump by using or simulating one of the trip devices, which has the advantage of testing the trip and testing the automatic start of the standby pump.

After the pump has stopped, check for water leakage from the mechanical seals, this commonly occurs when the pump is stopped and 'takes up' with the pump running.

Reset the trip device and place the pump in AUTO mode as described above.

Illustration 2.2.4a Contaminated Drains System



2.2.4 LOW PRESSURE STEAM GENERATOR FEED WATER AND CONTAMINATED DRAINS SYSTEM

Contaminated Drains System

The steam system supplying heating to tanks and systems that could be a potential source of contamination is kept separate from the main steam system. Any rupture of a heating coil in a tank may allow the substance within the tank to enter the heating coil and return to the feed system. In a high pressure boiler this would have very serious consequences, oil would cause foaming in the steam drum and lead to carry over into the steam system. Loss of heat transfer would take place due to the lining of oil upon the heating surfaces. Removal and cleaning of the boiler internals would render the boiler out of service for some considerable time with subsequent commercial implications.

This ship is equipped with an independent contaminated feed and steam system to supply these services. The low pressure steam generator (LPSG) supplies steam at 784kPa to the system. The condensate is returned to the LPSG atmospheric drain tank through the engine room drains cooler and the condensate drain inspection tank.

Engine Room Drains Cooler

Maker:	Donghwa Precision Ind. Ltd
Type:	Shell and tube
Cooling surface area:	4.5m^2
Outlet temperature:	80°C

The drains cooler cools the drains returning to the drain tank to prevent it from overheating and boiling over. The cooling medium is supplied from the central fresh water cooling system. A temperature controller throttles the cooling water outlet to maintain a condensate temperature of 60°C. Condensate returning from the separate cargo machinery drains cooler, located in the cargo machinery room, is led directly to the drains tank.

The following heating systems have condensate drainage to the engine room drains cooler:

- Boiler fuel oil heaters
- Main vaporiser
- Boil off gas and warm up heaters
- Glycol heater
- Forward HFO tank heating
- Accommodation services
- Port and starboard HFO storage tanks
- HFO overflow tank
- HFO drain tank
- LO purifier sludge tank
- Trace heating system
- LO purifier heaters
- Generator LO settling tanks
- Main LO settling tank
- HFO settling tanks
- Calorifier
- Incinerator waste oil tank
- Bilge primary tank
- Low sulphur HFO storage tank
- Bilge holding tank
- Separated oil bilge tank
- Main LO sump tank

Condensate Drain Inspection Tank

Whilst the consequences of oil entering the LPSG are not as serious as this happening to the main boilers, it is still an undesirable situation. The returning drains are led from the engine room drain cooler to the condensate drain inspection tank. The drains enter a primary chamber fitted with an observation window and an oil detector. An automatic scumming valve is fitted which is connected to the tank just below the normal water level. In the event of oil being detected by the oil detector, an alarm will be raised and the automatic scumming valve will open. This drains the oil that will be floating on the surface away to the primary bilge tank. Should this situation develop, the LPSG can be kept in service but the distilled water make-up requirement will increase to replace the lost feed. The drain outlet valve from each of the services on the system should be closed in turn until the oil ceases to show up in the inspection tank. This service will then have to be isolated in its entirety until repairs have been made. Full use of the HFO heaters and settling tank heating coil returns test points should be made in the first instance. Manual scumming valves are also provided.

(**Note:** It is important to make regular visual checks of the condensate drain inspection tank. The oil detector should not be relied upon and does not replace the need for good watchkeeping practice. The probes of the oil detector should be cleaned regularly to prevent false alarms.)

Water from the primary stage of the tank passes to the secondary stage through a connection from the bottom of the primary stage, exiting at the water line level of the secondary stage. This ensures that oil floating on the top of the water in the primary stage does not pass to the secondary stage.

An observation window is fitted and a manual scumming valve. Both parts of the tank have drains with which to empty the tank completely.

Water is then led to the LPSG atmospheric drain tank through a sponge filter.

Low Pressure Steam Generator Atmospheric Drain Tank

The atmospheric drain tank part of the LPSG system provides the water supply for the LPSG feed water pumps. Make-up is supplied to the tank from the distilled water tank in service. This replaces any losses in the system and is controlled by a float valve installed at the normal water level of the tank. A bypass valve is fitted for use in the event of a failure of the float valve. Temperature and level alarms are fitted which relay back to the engine control room.

Valves are provided to divert the returns from certain systems capable of being supplied from the main boilers, back to the clean atmospheric drain tank when this is necessary. This situation would arise if the LPSG was out of service, or because of the designed steam demand being greater than the output of the LPSG. The services capable of being supplied this way are:

- LNG vaporiser
- Boil off gas and warm up heaters

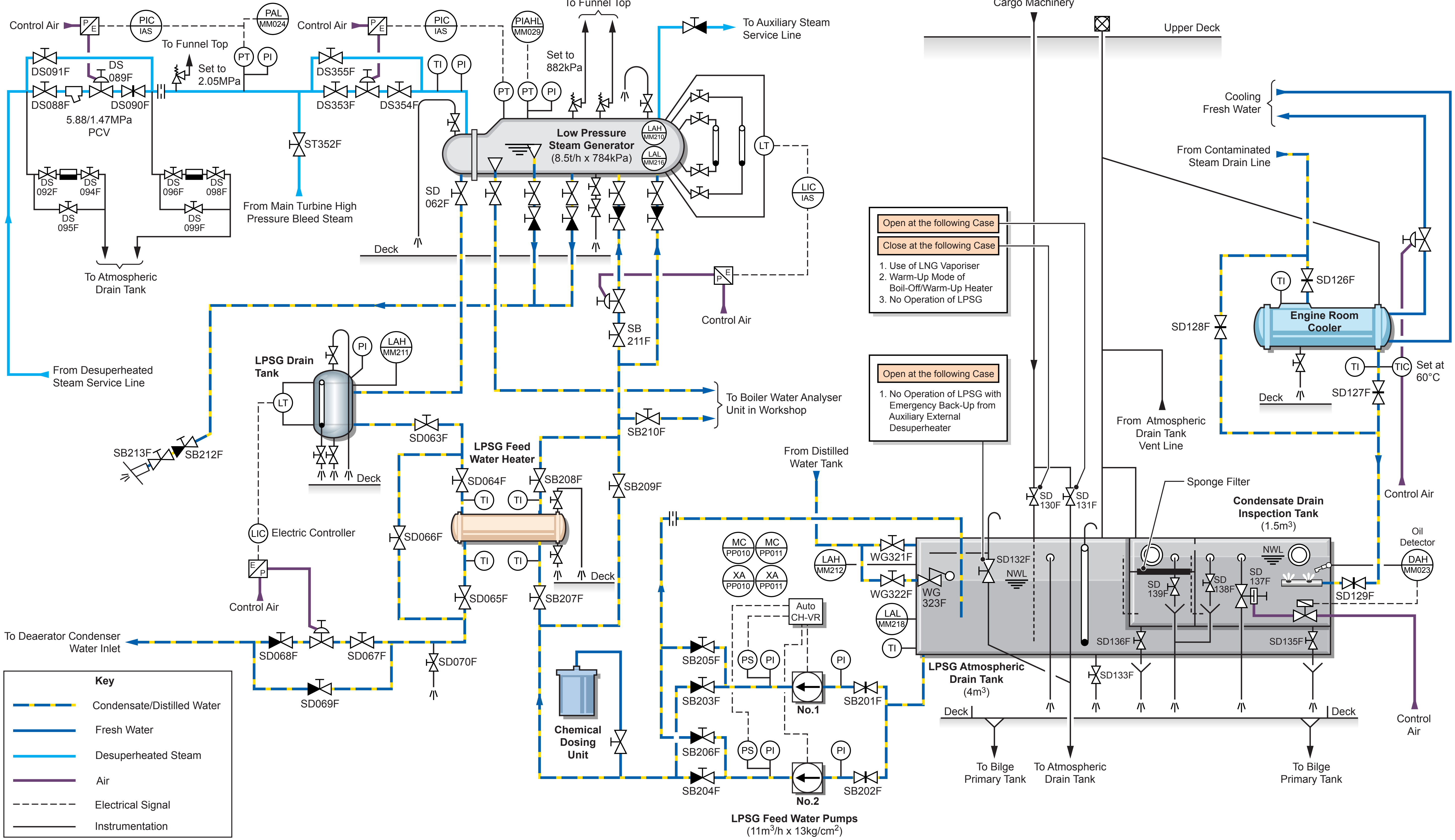
The boiler fuel oil heaters can also be supplied from the auxiliary desuperheated steam system when the LPSG is not available. The condensate will return to the LPSG atmospheric drain tank as usual which gives some protection and detection facilities should contamination occur. When operating in this manner the condensate then needs to be returned to the main feed system and this is achieved by opening valve SD132F. The inlet to this line is set higher than the normal water level to prevent make up water from entering while the LPSG is shut down.

Should the LPSG require to be shut down for an extended period of time, the configuration of the steam piping permits ALL LPSG steam services to be supplied via the auxiliary external desuperheater.

Alarms

Tag	Description	Low
PP010	No.1 FW pump discharge pressure control	1100kPa
PP011	No.2 FW pump discharge pressure control	1100kPa

Illustration 2.2.4b Low Pressure Steam Generator Feed Water System



Procedure to Put the Contaminated Drains System into Operation

Individual services on the system are used as required and the drain trap valves opened to allow the condensate to return to the drains cooler. The temperature of the returns should be checked to ensure that the drain traps are working correctly and not allowing steam to return to the drains system.

a) Supply control air to the oil scumming valve SD137F and the drains cooler temperature control valve.

b) Supply cooling water to the engine room drains cooler from the central fresh water cooling system (see section 2.4.1).

c) Open the condensate inlet valve SD126F into the cooler, the outlet valve SD127F from the cooler and the inlet valve SD129F into the condensate drain inspection tank. Switch ON the oil detector.

d) Open the feed make-up supply from the distilled tank in service by opening valve WG322F to the float valve.

e) If the LNG vaporiser or warm up gas heater are to be used, open valve SD131F and close valve SD130F to divert the drains to the clean atmospheric drains tank.

f) If the boiler fuel oil heaters are being supplied from the emergency desuperheated steam connection, open valve SD132F to allow the drains to return to the clean atmospheric drains tank.

Low Pressure Steam Generator Feed Water System

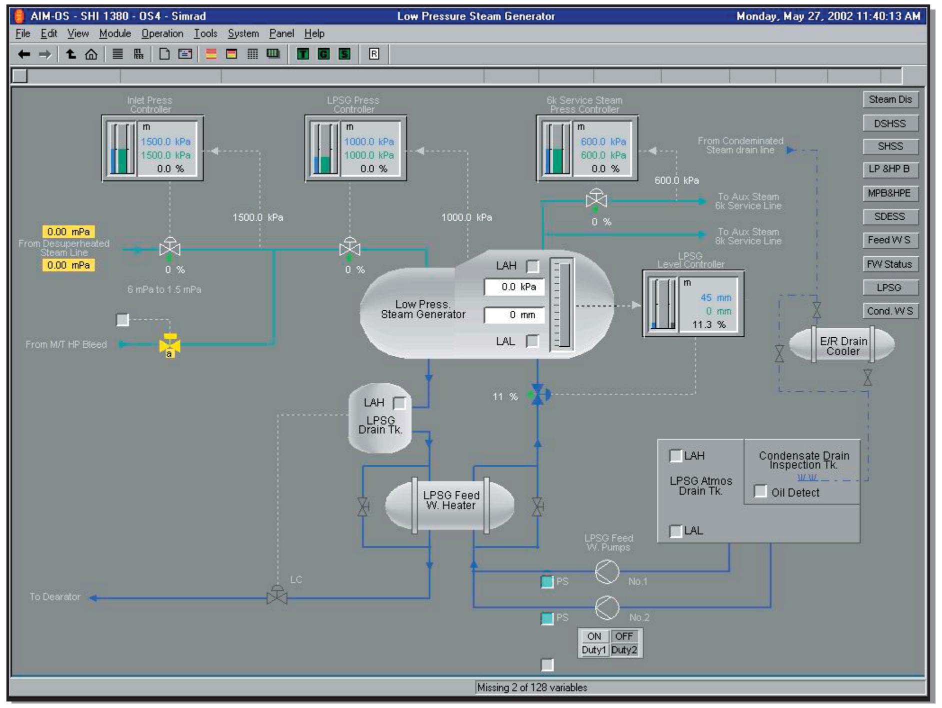
Low Pressure Steam Generator Feed Water Pumps

Maker:	Shinko Industries Ltd
No. of sets:	2
Model:	SHQ50M
Capacity:	$11m^3/h$ at 110mth

Low Pressure Steam Generator Feed Water Heater

Maker:	Donghwa Precision Industries Ltd
Type:	Shell and tube
Heating surface area:	$4.44m^2$

The LPSG feed system enables the returned condensate, plus any make-up added, to be pumped into the LPSG.



Intergrated Automation System (IAS) Control

Two feed pumps are provided operating in a main and standby configuration. The operator must start one of the two pumps from an operator station, then set the other pump to automatic operation. The pump selected for automatic operation will act as standby for the running pump. It will start automatically upon detection of low pressure in the system or if the running pump stops.

Each pump has a leak-off through an orifice to ensure that there is always a flow through the pump even when the level control valve is shut. The discharge line from the pump has a connection from the LPSG chemical dosing unit so that feed chemicals can be injected into the feed water line. The feed water is passed through the LPSG feed water heater. The heating medium is the condensate from the LPSG heating steam coil. The feed water then passes into the LPSG steam drum through the level regulating valve which maintains the water level. This is controlled from the IAS which reads the water level and adjusts the flow accordingly. Two gauge glasses are fitted for visual checking of the level.

If the main turbine load is reduced to below 75% the LPSG coil steam is supplied from the desuperheated steam system and the HP bleed valve is closed.

The LPSG has manual scumming and blow down valves arranged at the water level and just below.

Procedure to Put the Low Pressure Steam Generator Feed System into Operation

a) Supply control air to the LPSG feed regulator valve and ensure that all instrumentation and gauge valves are open.

b) With both feed pumps isolated, check for rotation by hand. Open one of the pump's suction and leak-off line valves.

Position	Description	Valve
Open	No.1 feed pump suction valve	SB201F
Open	No.1 feed pump leak-off valve	SB205F
	or	
Open	No.2 feed pump suction valve	SB202F
Open	No.2 feed pump leak-off valve	SB206F

c) Open the LPSG feed heater bypass valve SB209F.

d) Open the feed regulator inlet isolating valve SB211F, the feed check valve and the primary feed valve.

e) Start the pump and check its operation and gradually open the discharge valves.

Position	Description	Valve
Open	No.1 feed pump discharge valve	SB203F
Open	No.2 feed pump discharge valve	SB204F

f) Ensure that the level control system is reacting correctly and that the steam drum level is maintained at the normal position.

g) If the LPSG is being filled from empty supply an initial dose of chemical treatment in accordance with the supplier's recommendation.

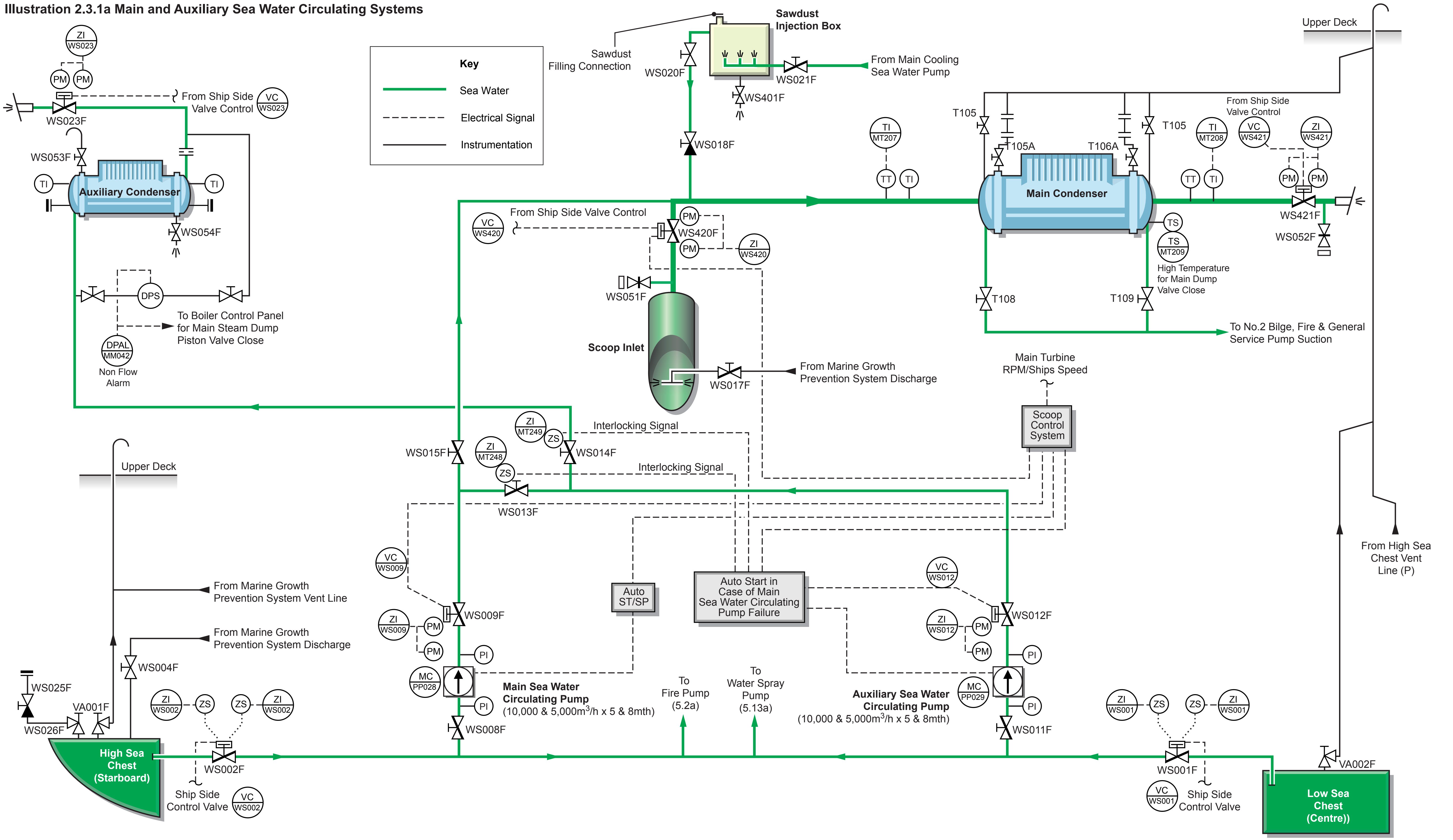
h) Slowly open the LPSG feed water heater inlet valve SB207F. Use the vent valve to bleed off any air in the heater. Slowly open the heater outlet valve SB208F and close the bypass valve SB209F.

i) Open the valves on the off-line pump and place it in standby mode.

2.3 Sea Water Systems

Illustrations

Illustration 2.3.1a Main and Auxiliary Sea Water Circulating Systems



2.3 SEA WATER SYSTEMS

2.3.1 MAIN AND AUXILIARY SEA WATER CIRCULATING SYSTEMS

Equipment

Main Sea Water Circulating Pump

Maker:	Shinko Ind. Ltd
No. of sets:	1
Type:	Centrifugal
Model:	CVF1000LM
Capacity:	10,000m^3/h at 5mth
Motor:	220kW at 360 rpm

Auxiliary Sea Water Circulating Pump

Maker:	Shinko Ind. Ltd
No. of sets:	1
Type:	Centrifugal
Model:	CVF1000M
Capacity:	10,000m^3/h at 5mth
Motor:	220kW at 360 rpm

Scoop Cooling System

Maker:	Omnical-HDW Marine Boilers
Capacity:	21,000m^3/h

Marine Growth Protection System

Maker:	Korea Cathelco
No. of sets:	2 comprising two anode tanks and one controller for the scoop and main circulating system and one anode tank with controller for the central SW cooling system

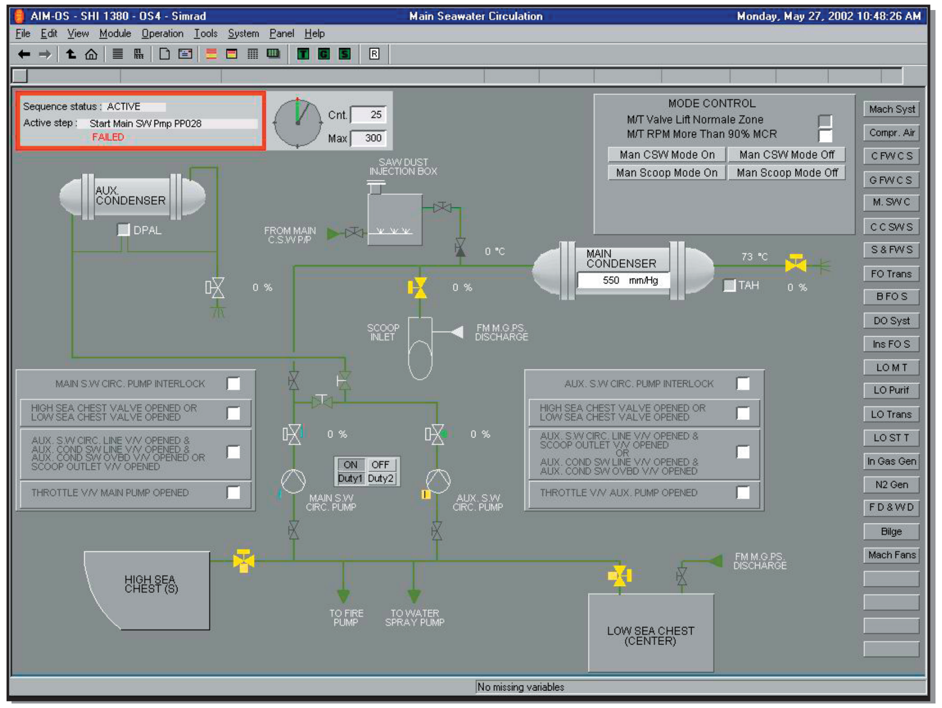
Introduction

The main sea water (SW) circulating system supplies cooling sea water to the main condenser and the auxiliary condenser. Two sea water circulating pumps are provided for circulating sea water, these being designated as the main SW circulating pump and the auxiliary SW circulating pump. The auxiliary SW circulating is normally set to supply sea water to the auxiliary condenser but by means of a crossover valve WS013F, it may also be used to supply sea water to the main condenser when the main SW circulating pump is not available.

The capacity of each pump is not sufficient to supply both the main and auxiliary condensers.

The main SW circulating pump is normally used for supplying sea water to the main condenser but, by means of the crossover valve WS013F, it may be used to supply sea water to the auxiliary condenser.

The auxiliary condenser SW supply valve WS014F from the auxiliary sea water circulating pump and the crossover valve WS013F from the auxiliary sea water pump are interlocked so that both may not be open at the same time. The valve WS013F from the auxiliary sea water pump may only be opened when the auxiliary pump operates in the event of main sea water pump failure.



During normal seagoing operations, when the main turbine is operating at or above 63 rpm, sea water cooling is supplied to the main condenser via the scoop inlet valve WS420F. This system consists of an opening on the flat bottom of the ship's hull and a carefully designed appendage on the main condenser overboard at the forward half circumference of the overboard opening. This appendage creates an eductive effect in way of the main condenser overboard as the vessel passes through the water. The magnitude of this eductive effect increases in proportion to the vessel's speed. The difference in water pressure created between the scoop inlet and overboard causes a flow of sea water through the main condenser, via the inlet valve WF420F and the overboard valve WF421F.

Operation of the main sea water circulation system is controlled by the IAS and it may be operated in manual or automatic modes. The IAS has a Duty/Standby function so that the auxiliary pump will start if there are any failures on the main pump. There is a start interlock on the pumps from the sea chest and overboard valves. If valves WS013F and WS014F are closed it is not possible to start the auxiliary SW circulating pump. The procedures for operating valves and pumps via the IAS graphic screen is covered in section 1.

Manual valves in the system must be opened or closed as required in order to operate a particular item of equipment.

The water scoop has its own sea suction valve WS420F, but the main and auxiliary SW circulating pumps take suction from a suction main which connects to a high and a low sea suction chest by means of valves WS001F and WS002F. These valves may be operated locally or remotely from the IAS screen. The sea chests are provided with connections from the marine growth protection system (MGPS).

In the event of hydraulic power failure the valves can be operated by the following methods:

- Using the individual manually operated pump fitted to the actuator - by turning the indicator to close or open as required and operating the handle
- Using one of the portable emergency hand pumps - by connecting the hoses to the valve actuator cylinder snap-on connections and operating the pump handle

The main condenser inlet from the water scoop and main circulating pump has a connection to a sawdust injection box, which is supplied with water from the central cooling sea water pump via valve WS154F (see section 2.3.2).

The auxiliary condenser is normally supplied with sea water by the auxiliary SW circulating pump and has a remotely operated overboard discharge valve.

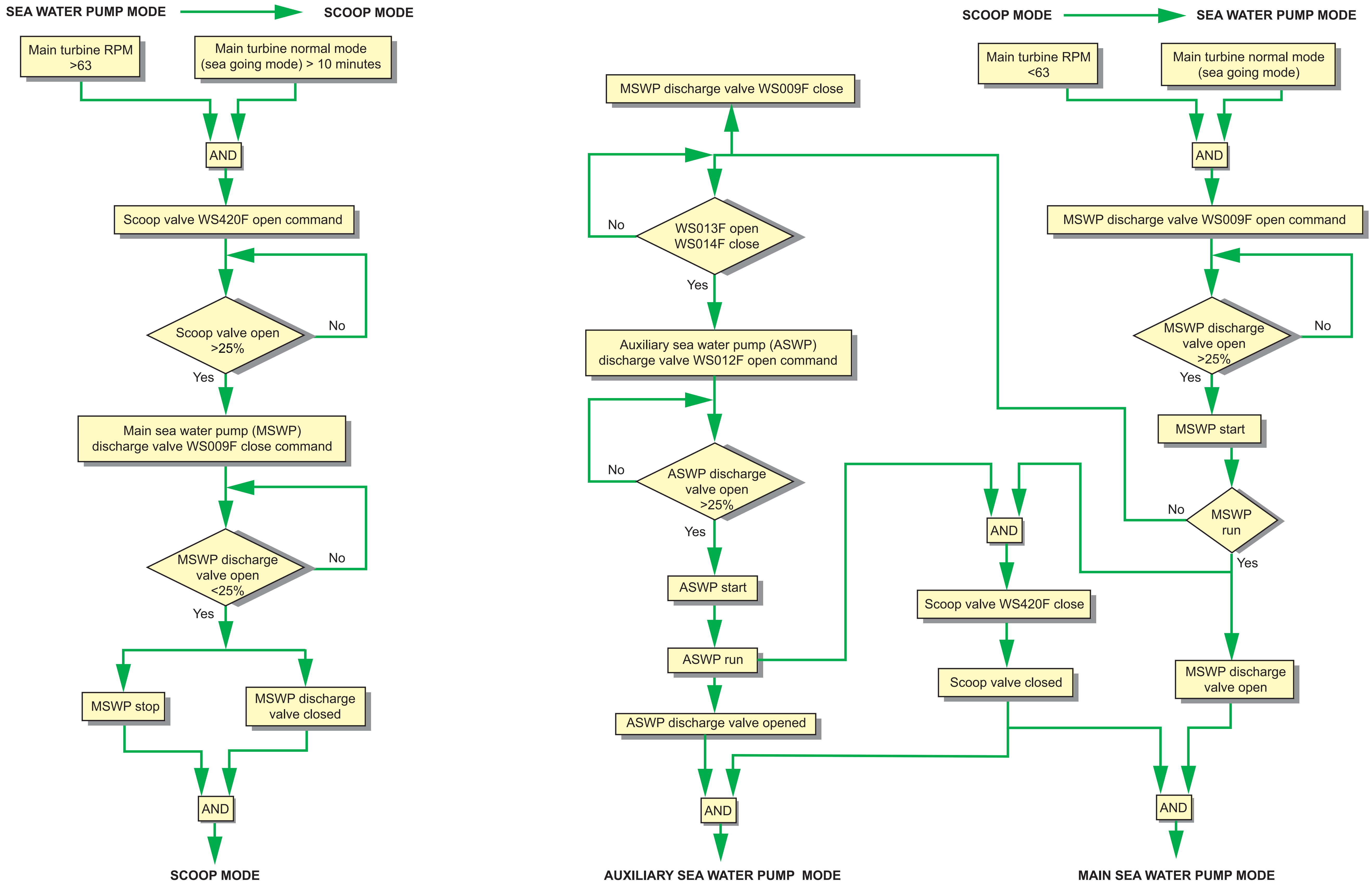
There is full redundancy in the main condenser sea water system in that the main SW circulating pump can supply the main condenser with all necessary sea water and the auxiliary SW circulating pump can replace the main SW circulating pump by supplying sea water to the main or auxiliary condensers if necessary.

System Control

The main sea water circulating system may operate in automatic or manual mode. In addition, the system control may be switched to System Off allowing for individual control of equipment. Selection of system modes is made from the IAS main sea water circulation system graphic screen.

When operating in automatic mode the control system will select the scoop or pump for operation depending upon the speed of the ship. In manual mode the operator may select Scoop Mode and water is supplied to the main condenser from the water scoop, or Pump Mode where water is supplied by the main SW circulating pump. A requirement is that there must be a continuous supply of water to the main condenser when changing between pump and scoop modes. This is achieved by having an overlap on the control of valves and the pump. As the scoop valve opens to allow water to the condenser from the scoop the outlet valve from the main SW circulating pump closes. The pump stops when the pump outlet valve is 25% open.

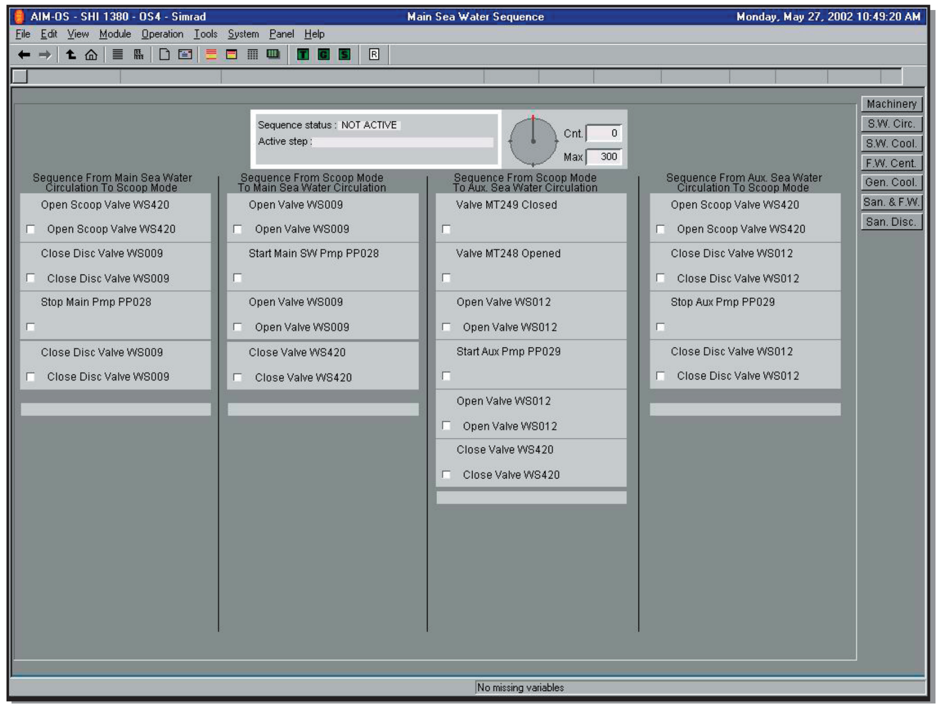
2.3.1b Scoop Changeover Flow Diagram



When changing from scoop to pump operation the pump starts supplying water before the scoop valve closes.

The pump outlet valve will open 25% and then the main SW circulating pump will start; the pump outlet valve will then continue to open until it is fully open.

Only when the pump is operating with its outlet valve fully open will the pump mode indicator be illuminated to show that the system is in pump mode. The scoop valve will then be fully closed.



Present operating modes are displayed on the IAS main sea water circulating system screen with different colours on the indicators.

Automatic Mode

Automatic mode requires the interlock loop to be complete and the interlock loop comprises the following:

- The main SW circulating pump must be in REMOTE and AUTO
- The scoop outlet valve must be in REMOTE and AUTO
- The main condenser outlet valve must be open
- The main SW circulating pump outlet valve must be in AUTO
- Either the high or low sea chest suction valve must be open

If the interlock loop is broken at any time an alarm will sound and the system will change to manual mode.

Sea Water Circulating Mode to Scoop Mode

Changeover from pump mode to scoop mode will take place automatically when in automatic mode provided that the following conditions are satisfied:

- The engine speed is above 65 rpm.
- The telegraph has been in the At Sea position for more than 10 minutes.

The following sequence must occur within a 300 second period otherwise an alarm sounds and the system reverts back to the main circulating pump:

- The IAS will send an open command to the scoop inlet valve WS0420F.
- When the scoop inlet has opened more than 90% a close command is send to the main circulating pump discharge valve WS009F.
- When the valve has closed to the 25% open position the IAS stops the main circulating pump

The system was observed to take 100 seconds for the scoop valve to open, a further 68 seconds for the main circulating pump discharge valve to operate and the pump to stop.

Scoop Mode to Sea Water Circulating Mode

Changeover from scoop to pump mode is carried out automatically when the following conditions are satisfied:

- Engine speed falls below 72 rpm
- The telegraph position is changed from Full Away to Manoeuvring
- During a restart following a blackout

The following sequence occures:

- The IAS will send an open command to the main SW circulating pump discharge valve WS0009F.
- When the valve opens to the more than 25% open position the IAS will start the main circulating pump
- Once the main circulating pump is running the IAS closes the scoop inlet valve WS420F

The system is now in Main Sea Water Circulating Mode.

Should the main SW circulating pump fail, the following sequence occurs:

- The IAS closes the main circulating pump discharge valve WS009F and ensures that the auxiliary condenser SW inlet valve WS014F is closed and the crossover valve WS013F is open
- The IAS opens the auxiliary SW circulating pump discharge valve WS012F
- When the valve reaches the 25% open position the auxiliary SW circulating pump is started
- Once the auxiliary SW circulating pump is running the IAS closes the scoop inlet valve WS420F

The system is now in Auxiliary Sea Water Circulating Mode.

Manual Mode

Manual mode may be selected at any time although change between scoop and pump modes still depends upon the valves and pumps being in their respective remote and automatic modes.

A change from pump mode to scoop mode may be selected manually when the following conditions are met.

- Engine speed is above 81 rpm
- The IAS indicates that manual scoop is available

A change from scoop mode to pump mode may be made at any time when in manual mode.

If the engine speed falls below 81 rpm when in scoop mode and manual mode, an alarm is activated.

If there is a blackout when in manual mode the system automatically reverts to pump mode if it was operating in scoop mode at the time of the blackout. This enables the system to resume operation in pump mode after the electrical power is restored.

System Off

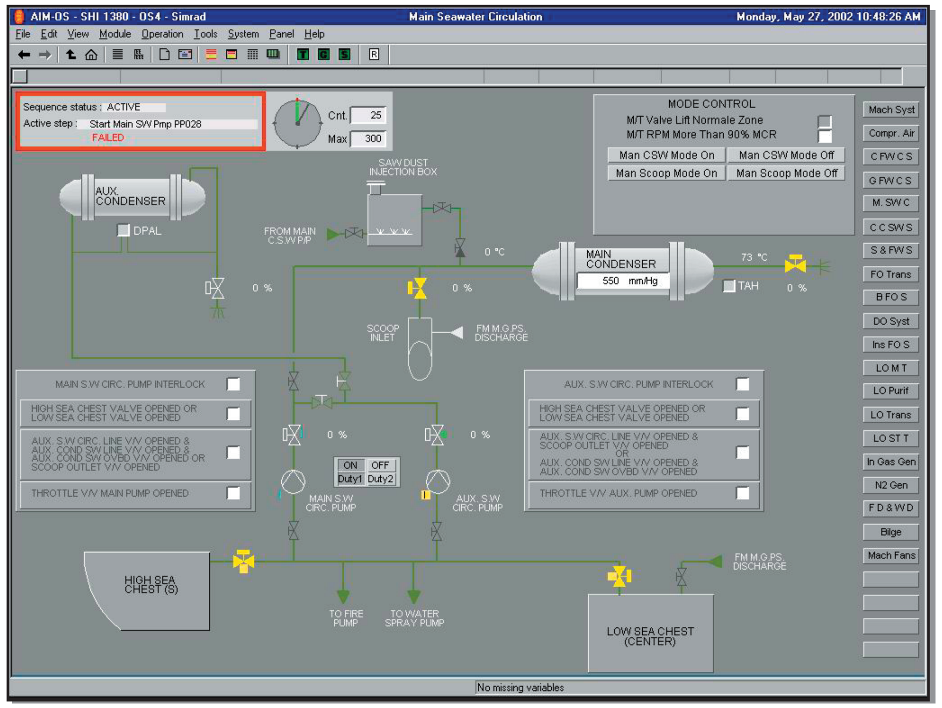
If the system is switched off no automated sequences will be carried out by the system. All valves and the main SW circulating pump may be operated individually from the IAS graphic display screen for the main sea water circulating system.

All alarms still operate when in the system off mode but in the event of a blackout no action is taken when electrical power is restored.

Local Control

All items of equipment associated with the automatic scoop control which can be set to local control can be operated in that mode if required. The main SW circulating pump and scoop outlet valve may be operated in local control as may the auxiliary SW circulating pump. Operation of any item of equipment in local control mode will remove all control from the IAS and this may have an influence on automatic operation of the system if that item is part of the interlock loop.

Control of the main and auxiliary condenser overboard discharge valves and the high and low sea suction valves is manual at all times. These valves are activated from the ship side valve control graphics screen. They may all be closed at any time in an emergency by selecting the Close All Ship Side Valves using the soft key on the graphic display. Normally only one of the sea chest suction valves will be open at any time.



Starting and stopping of the main SW circulating pump may take place remotely or locally in automatic or manual mode. The mode is selected at the main sea water circulating system graphic screen. The pump will start or stop as necessary when changing between pump and scoop modes.

Preparation for the Operation of the Main Sea Water Circulating System

a) Ensure that the high and low sea chests are vented.

b) Ensure all the pressure gauge and instrumentation valves are open and that the instrumentation is reading correctly.

c) At the ship side valve control graphic screen open the desired suction main line valve from the operating sea chest; valve WS002F for the high sea chest on the starboard side or valve WS001F for the low sea chest located in the middle section of the engine room.

d) From the ship side valve control graphic screen open the auxiliary condenser overboard discharge valve WS023F and the main condenser overboard valve WS421F.

e) Open the manual main SW circulating pump suction valve WS008F.

f) Open the manual auxiliary SW circulating pump suction valve WS011F. Check that the crossover valve WS013F is closed.

g) Open the manual supply valve to the main condenser from the main sea water circulating pump WS015F and the manual supply valve to the auxiliary condenser from the auxiliary sea water circulating pump WS014F.

h) Open the main and auxiliary condenser water box vents, leave the main open and close the auxiliary when vented.

The valves are now set to allow the main sea water circulating system to operate.

Procedure for Operating the Auxiliary Condenser Sea Water Cooling System

a) Ensure that the cooling sea water system for the auxiliary condenser is already flooded and that suction is available at the pump.

b) At the main sea water circulating system graphic display, select AUTO operation for the auxiliary SW circulating pump. This will cause the auxiliary sea water pump outlet valve WS012F to be opened 25% before the pump is started.

c) Check that the pump starts and that the auxiliary sea water circulating pump outlet valve opens fully. Check that sea water is flowing through the auxiliary condenser.

For local operation of the auxiliary SW circulating pump LOCAL control is selected at the control switch located on the starter panel on the main switchboard. The pump may be started and stopped at the local position. The auxiliary condenser inlet valve will be opened and closed by the control system in response to starting and stopping of the pump.

Procedure for Automatic Operation of the Main Condenser Sea Water System

(**Note:** All operations in this procedure take place at the IAS Main Sea Water Circulating System graphic display.)

a) Ensure that the sea water system is already flooded and that suction is available at the main SW circulating pump.

b) Select AUTO MODE for the main SW circulation pump operation.

c) Check that the scoop inlet valve is set to AUTO.

d) At the mode panel for the main sea water circulating pump check that AUTO is selected.

e) Provided that the interlock loop is complete the control system will operate to allow circulating sea water to flow through the main condenser, being supplied by the main sea water circulating pump or scoop as appropriate.

If the vessel is in port and being prepared for sea, the engine speed and telegraph position restrictions will not allow for scoop operation and the main SW circulation pump will be started. When the main sea water circulation pump outlet valve is 25% open the main SW circulating pump will be started; the pump outlet valve will continue to open to its full extent

f) Check that the SW circulation system is functioning correctly; when it is the condenser vacuum can be raised.

With the system in AUTO mode the main SW circulating pump will supply cooling water to the main condenser until the conditions for automatic change to scoop mode are satisfied. The change to scoop mode will be made when the engine speed is above 63 rpm and the telegraph has been in the At Sea position for more than 10 minutes.

The change from scoop mode back to pump mode will be made when the engine speed falls below 42 rpm, or when the telegraph is moved to the manoeuvring position from the Full Away position, or during a restart following a blackout.

Procedure for Manual Operation of the Main Condenser Sea Water System

(**Note:** All operations in this procedure take place at the IAS main sea water circulating system graphic display.)

Manual mode may be selected at any time but the associated valves and main SW circulating pump must be in their respective remote and automatic modes.

a) Ensure that the sea water system is already flooded and that suction is available at the main SW circulating pump.

b) At the graphic display check that the main SW circulation pump operation is selected in REMOTE and AUTO modes.

c) At the main sea water circulating system graphic display check that the scoop inlet valve is set for AUTO.

d) At the mode selection panel in the graphic display select MANUAL mode.

When in manual mode it is possible to manually change from scoop to pump mode, and vice versa. To allow the change to scoop mode the engine speed must be above 53 rpm and the Manual Scoop Available indicator in the graphic display screen must be illuminated. The change from scoop to pump mode can be made at any time when in manual mode.

a) To change from pump to scoop mode whilst in manual mode SCOOP MODE must be selected in the display.

b) To change from scoop to pump mode whilst in manual mode PUMP MODE must be selected in the display.

If the engine speed falls below 42 rpm when in scoop mode and manual mode an alarm will be activated.

In the event of a blackout when in manual mode and scoop mode the system will automatically revert to pump mode. In pump mode and manual mode the main SW circulating pump may be started and stopped manually from the graphic display.

Procedure for Manual Operation of the Main Condenser Sea Water System

a) At the mode selection panel in the IAS main sea water circulating system graphic display select SYSTEM OFF.

When System Off is selected no automated operations will be carried out by the control system; there will be no automatic restart after a blackout. All items of equipment, valves and pumps may be operated individually in isolation from all other equipment.

All alarms will still function when in the System Off mode.

Procedure for Local Control of the Main Condenser Sea Water System

Some items of equipment in the main SW circulation system may be operated locally if required. Operation in local control removes all IAS control of the item of equipment. This may have an effect on the operation of the automated parts of the system if that item of equipment is part of the interlock loop.

The main and auxiliary sea water circulating pumps and the pump outlet valve, may be operated in local control.

Local control of pumps and valves is normally only used if the control system fails.

At the pump or valve concerned select LOCAL operation. This removes control of that item from the IAS.

When in local control the item of equipment can only be operated locally. To revert to control from the IAS the operation mode switch for the item of equipment must be turned to the REMOTE position.

(**Note:** The auxiliary SW circulating pump must normally be available for remote start in the event of failure of the main sea water circulating pump.)

Procedure for Operation of the Main Condenser Sea Water System using the Auxiliary Sea Water Circulating Pump

Under normal circumstances the main condenser is supplied with sea water by the scoop or the main SW circulating pump. In the event of failure of the main SW circulating pump, the auxiliary SW circulating pump can supply water to the main condenser.

The auxiliary sea water circulating pump may be manually set to supply the main condenser with sea water as follows:

a) At the mode selection panel in the main sea water circulating system graphic display select SYSTEM OFF.

b) Ensure that the auxiliary SW circulating pump suction valve WS011F is open.

c) Check that the main SW circulating pump discharge valve WS009F is closed. This should occur automatically when the pump is stopped.

d) Open the SW circulating pump interlocked crossover valve WS013F.

e) Ensure that the main condenser overboard discharge valve WS421F is open. Check that either the high sea suction valves WS002F or the low sea suction valve WS001F is open.

g) Select REMOTE at the pump control for the auxiliary SW circulating pump in the system graphic screen and start the pump as required. The pump may also be started locally be selecting LOCAL at the starter panel on the main switchboard.

The Condenser Sawdust System

In the event of condenser tube leakage, sawdust is injected into the main condenser cooling sea water system in order to provide a means by which small leaks may be plugged. The sawdust injection box is supplied with a sea water supply from the central cooling sea water system. Outlet from the sawdust box is to a connection on the scoop sea water supply pipe near the condenser inlet via valve WS018F.

In order to operate the system the sawdust box must be supplied with sawdust and the inlet valve from the cooling sea water system WS021F opened. The outlet valve from the sawdust box WS020F must be opened in order to supply the mixture of sawdust and sea water to the condenser inlet line. The inlet valve to the condenser sea water circulation system WS018F must be opened to supply sawdust to the condenser. The system may be operated when in Scoop or Pump mode.

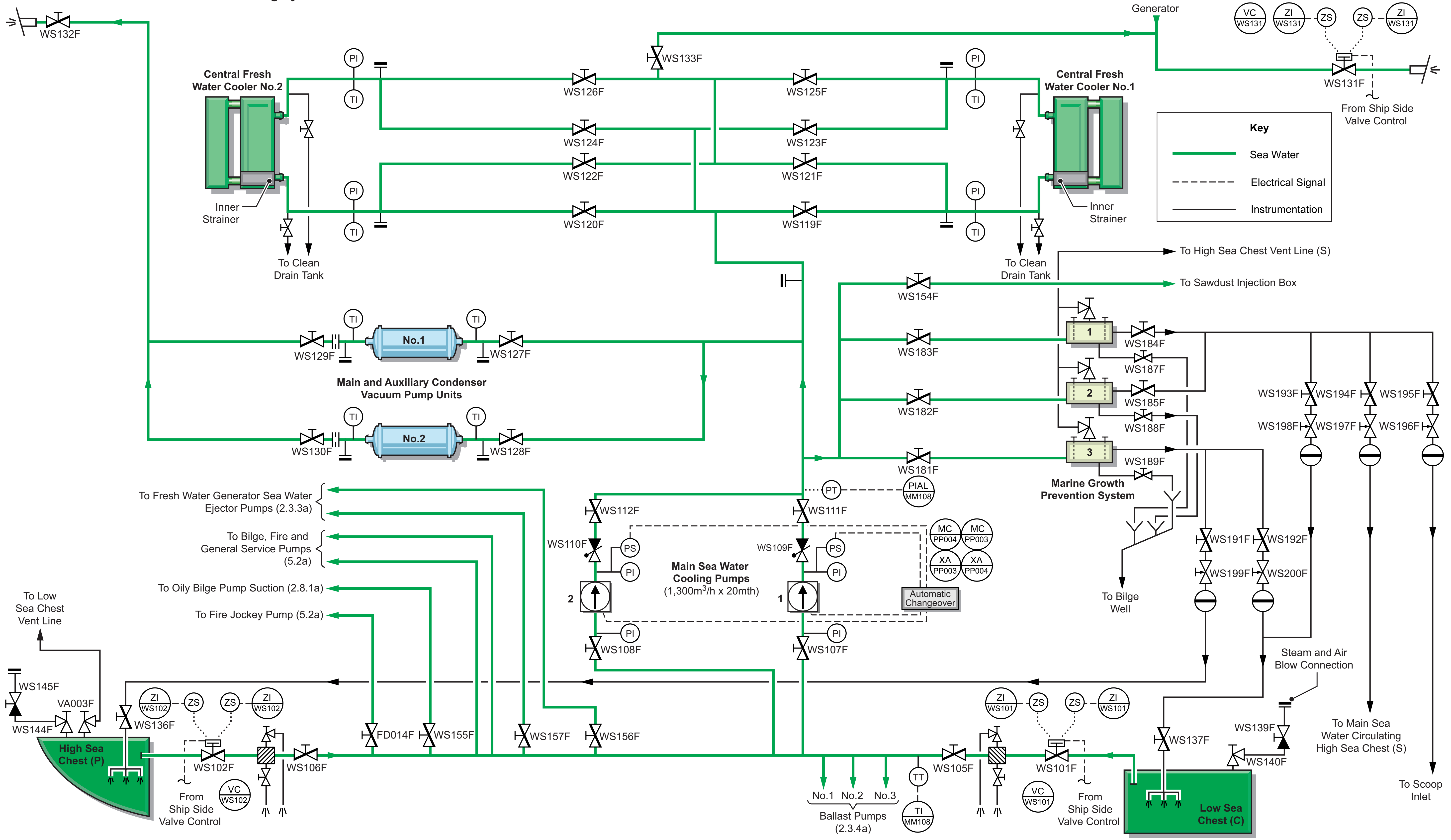
The Sea Water Marine Growth Protection Antifouling System

The sea water system is protected against fouling by the antifouling system. The system protects against marine growth and corrosion by means of anodes. The marine growth protection anodes (MG) are made from copper and the trap corrosion anodes (TC) are made from aluminium.

Three separate MGPS modules are fitted, No.3 serves the central cooling sea water system and supplies treated sea water to the high and low sea chests of that system. No.1 and No.2 MGPS modules supply the scoop sea water inlet and the main sea water circulation system; a branch also allows these units to supply the central cooling sea water system if required. Normally only one unit is operating for the scoop and main sea water circulating systems.

The MGPS modules are supplied with sea water from the central cooling SW system (see section 2.3.2.) and in the module the sea water is dosed with copper and aluminium ions. This treated sea water is then supplied to the sea suction chests. The dosing rate depends upon the current supplied to the anodes and this must be adjusted to suit the sea water flow through the module. The current settings for the MG and TC anodes should be the same and the currents are adjusted by means of the setting knobs on the control panel. Adjustment of current should only be made after consulting the Cathelco operating manual. Incorrect setting of the current can result in inadequate protection against marine growth and corrosion or excessive wastage of the anodes.

Illustration 2.3.2a Central Sea Water Cooling System



2.3.2 CENTRAL SEA WATER COOLING SYSTEM

Main Sea Water Cooling Pump

Maker:	Shinko Ind. Ltd
No.of sets:	2
Type:	Centrifugal
Model:	SVS400M
Capacity:	1,300m³/h at 20mth

Fresh Water Generator Sea Water Ejector Pump

Maker:	Shinko Ind. Ltd
No.of sets:	2
Type:	Centrifugal
Model:	SVS125-2M
Capacity:	90m³/h at 40mth

Introduction

The central sea water cooling system provides cooling water to the two central coolers and the vacuum pump heat exchangers. The system also supplies sea water as required to the main condenser sawdust injection box and the MGPS system. The two main SW cooling pumps take suction from the sea water suction pipe which connects with the high port side and low centreline sea chests.

The two fresh water generator sea water ejector pumps also take suction from the sea water suction header. These pumps provide sea water feed to the fresh water generators and sea water to operate the combined brine/air ejectors.

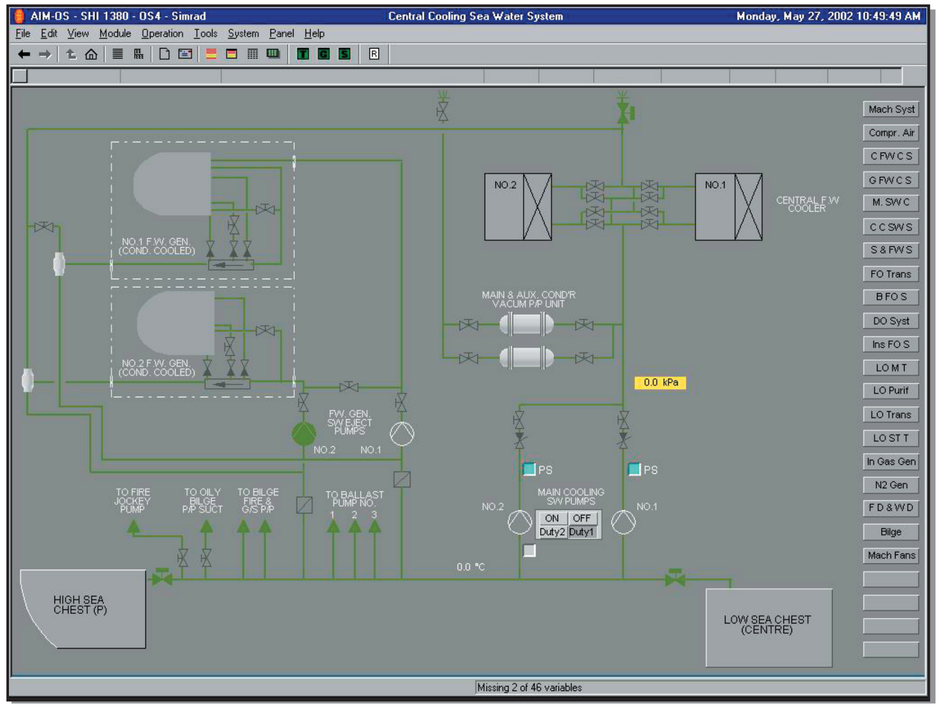
There is no connection between the central sea water cooling system and the main sea water circulating system apart from via the MGPS and sawdust injector.

Sea water supplied to the central fresh water coolers cools the fresh water circulating through these coolers, which is the cooling medium for the central fresh water cooling system (see section 2.4.1).

The two main SW cooling pumps and two central fresh water coolers provide 100% redundancy for the system, only one pump and cooler being required for normal full operation. The pumps are arranged so that one is selected as the duty pump and the other as the standby pump to commence operation should the duty pump fail to maintain the desired cooling sea water flow.

On the loss of the duty pump a low pressure signal is sent to start the standby pump. Selection of duty and standby pumps is made from the IAS via the central cooling sea water system graphic display screen.

The pumps may operate in automatic mode, remote manual mode or local manual mode.



Main Sea Water Cooling Pump Control

Control of the main SW cooling pumps is via the IAS at the display screen where the Duty/Standby selection available. There is a start interlock on the pumps from the sea chest and overboard valves.

Automatic mode allows the standby pump to start upon loss of pressure from the duty pump. Automatic operation selection is indicated on the IAS graphic screen. Manual mode allows the operator to start or stop either pump from the central cooling sea water display graphic.

Automatic Mode

When the standby facility is set to AUTO the standby pump will start automatically upon a start command from the IAS when failure of the duty pump is indicated by the duty pump pressure switch. When in automatic mode a manual start or stop from the IAS is inhibited. When the standby pump starts in auto mode an alarm is generated.

Automatic operation can only be selected if the standby pump is stopped, the starter is set to the REMOTE position, the standby pump is not in an alarm condition and the duty pump is running without alarm and set in the REMOTE position.
The standby facility is forced to the OFF condition if both pumps are running, both pumps are stopped, one pump is in an alarm condition or one pump is set to local. An alarm is generated if the standby facility is forced to the off condition.

Manual Mode

When the standby facility is in the off position both pumps are forced into the manual mode. This allows operation of the pumps remotely from the IAS graphic display. Operation in this condition will be indicated in the graphic screen.

Local manual control may be selected at the IAS graphic screen and this allows the pump to be started and stopped by means of local pushbuttons situated near the pumps themselves.

Local status is displayed on the graphic screen for each pump. Local stop of a pump is always active even when the starter is selected as remote.

If the local stop button is pressed when in remote the pump motor is stopped and the IAS control for the pump is reset to local.

Valve Control

The high and low sea chest valves WS102F and WS101F are controlled from the IAS graphic display screen. Valves may be opened and closed from this screen. An illuminated screen indicator indicates if the valve is open or closed.

Both sea chest suction valves may also be opened and closed locally.

The overboard discharge valve from the main central coolers WS131F may be opened and closed remotely from the ship side valve control graphic display screen. The valve may also be opened or closed locally.

All other valves in the system are manually operated locally and must be set before the system pumps are activated.

Preparation for the Operation of the Central Sea Water Cooling System

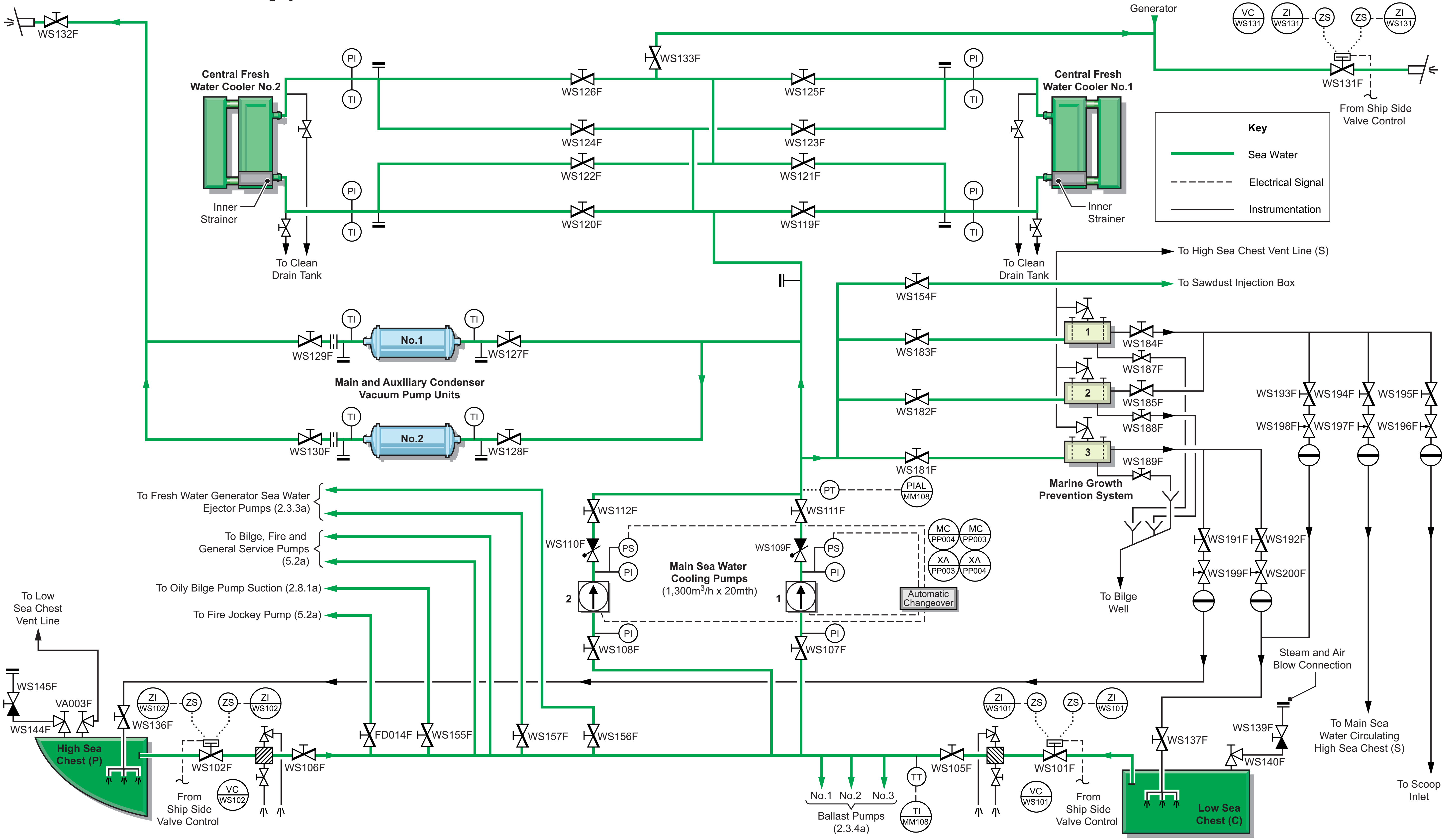
a) Ensure that the high and low sea chests are vented.

b) Ensure all the pressure gauge and instrumentation valves are open and that the instrumentation is reading correctly.

Alarms

Tag	Description	Low Alarm
MM107	Main SW cooling pump discharge pressure	140kPa
PP003	No.1 SW cooling pump outlet pressure control	150kPa
PP004	No.2 SW cooling pump outlet pressure control	150kPa

Illustration 2.3.2a Central Sea Water Cooling System



c) At the ship side valve control graphic screen open the desired central cooling sea suction valve from the operating sea chest, valve WS102F for the high sea chest on the port side or valve WS101F for the low sea chest located in the middle section of the engine room. Open the associated strainer outlet valve manually; WS106F for the high sea chest strainer or WS105 for the low sea chest strainer. vent the selected strainer.

d) From the ship side valve control graphic screen select and open the cooling sea water system overboard discharge valve WS131F.

e) Set the manual valves as in the following table:

Position	Description	Valve
Open	No.1 cooling sea water pump suction valve	WS107F
Open	No.1 cooling sea water pump discharge valve	WS111F
Open	No.2 cooling sea water pump suction valve	WS108F
Open	No.2 cooling sea water pump discharge valve	WS112F
Open	No.1 central FW cooler inlet valve	WS119F
Open	No.1 central FW cooler outlet valve	WS125F
Open	No.2 central FW cooler inlet valve	WS120F
Open	No.2 central FW cooler outlet valve	WS126F
Closed	No.1 central FW cooler back flushing valves	WS121F/ WS123F
Closed	No.2 central FW cooler back flushing valves	WS122F/ WS124F
Throttled	Central FW cooler line outlet valve	WS133F
Open	No.1 vacuum pump heat exchanger inlet valve	WS127F
Open	No.1 vacuum pump heat exchanger outlet valve	WS129F
Open	No.2 vacuum pump heat exchanger inlet valve	WS128F
Open	No.2 vacuum pump heat exchanger outlet valve	WS130F
Open	Vacuum pump heat exchanger overboard discharge valve	WS132F
Close	Sawdust box supply valve	WS154F
Closed	Condenser sawdust box inlet valve	WS021F
Open	MGPS No.3 module supply valve	WS181F
Open	MGPS No.3 module outlet valves to high sea chest	WS191F/WS199F
Closed	MGPS No.3 module drain valve	WS189F
Open	MGPS No.2 module supply valve	WS182F
Open	MGPS No.2 module outlet valve	WS185F
Closed	MGPS No.2 module drain valve	WS188F
Open	MGPS No.1 module supply valve	WS183F
Open	MGPS No.1 module outlet valve	WS184F
Closed	MGPS No.1 module drain valve	WS187F
Open	MGPS No.2 and No.1 module outlet valves to scoop inlet	WS195F/WS196F
Close	MGPS No.2 and No.1 module outlet valves to main SW circulating pump high sea chest	WS194F/WS197F
Closed	MGPS No.2 and No.1 module outlet valves to low chest	WS193F/WS198F
Open	Low sea chest MGPS inlet valve	WS137F
Open	High sea chest MGPS inlet valve	WS136F
Open	Main high sea chest MGPS inlet valve	WS004F
Open	Scoop MGPS inlet valve	WS017F
Open	No.1 FW generator sea water ejector pump suction valve	WS156F
Open	No.1 FW generator sea water ejector pump discharge valve	WS158F
Open	No.2 FW generator sea water ejector pump suction valve	WS157F
Open	No.2 FW generator sea water ejector pump discharge valve	WS159F
Closed	FW generator sea water ejector pump discharge crossover valve	WS160F
Open	No.1 distillation plant SW inlet valve	WS161F
Open	No.1 distillation plant brine outlet valve	WS168F
Open	No.1 distillation thermostatic recirculation valve	WS167F
Throttle	No.1 distillation thermostatic recirculation valve	WS172F
Open	No.2 distillation plant sea water inlet valve	WS162F
Open	Outlet from air separator	WS165F
Open	No.2 distillation plant brine outlet valve	WS169F
Open	No.2 distillation thermostatic recirculation valve	WS170F
Throttle	No.2 distillation thermostatic recirculation valve	WS171F
Open	Outlet from air separator	WS166F
Open	Main overboard discharge valve	WS131F

(**Note:** Valves are indicated in their normal operating position but if an item of equipment is not operating, such as a fresh water distillation plant or a MGPS unit, the valves for that unit may be closed.)

The central sea water cooling system is now set and ready for operation.

(**Note:** If starting the system from a dry state, the pump discharge valves WS111F and WS112F should be throttled in for the initial start.)

Procedure for the Operation of the Auxiliary Sea Water Cooling System

a) Ensure that the system is prepared for operation as described above and that the sea water suction main is flooded.

b) With the system flooded below the waterline, vent all coolers, piping and machinery units via system vent valves prior to starting a pump.

c) At the sea water service system IAS graphic display screen select AUTO mode. Select one of the pumps as the duty pump and start that pump. Select the other pump as the standby pump.

d) Check that pressure is raised in the system and that sea water is flowing to all selected items with their valves open.

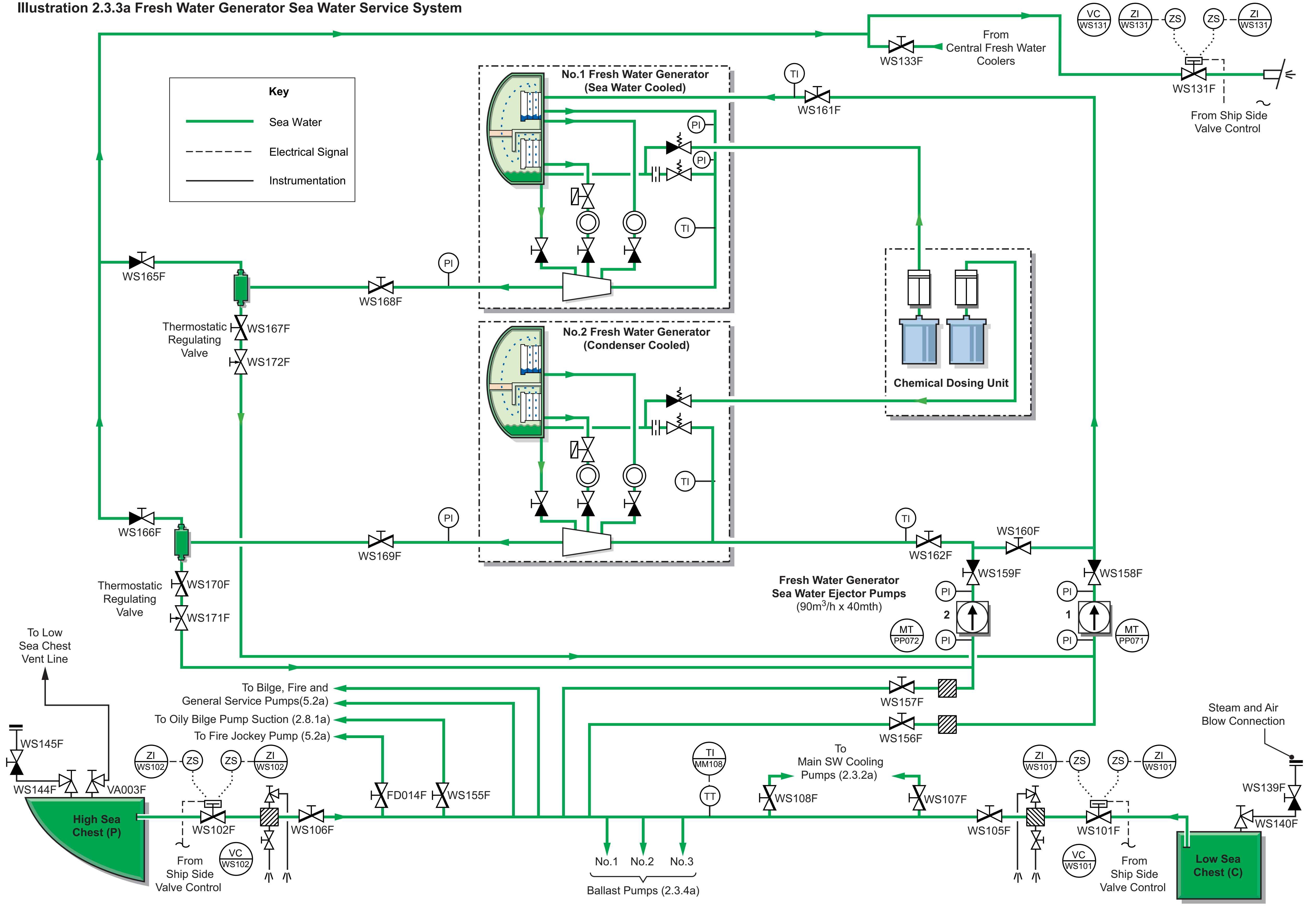
e) Provide electrical power to the MGPS modules and start them operating. Check that the systems are operating correctly by means of the flow indicators and that the correct main condenser suction is receiving treated water depending upon whether the system is in pump or scoop mode.

f) As required start up the distillation plant when the sea water system is operating correctly and when it is safe to do so if the distillate is to be produced for domestic purposes.

Blackout and Hot Start Up

In the event of a blackout the IAS will retain the operating arrangements in force prior to the blackout and will automatically start the assigned duty pump when power is restored. This will be part of the sequential start arrangements. If the duty pump fails to start and the standby pump is still in automatic mode, the standby pump will start. During the blackout the system alarms are inhibited.

Illustration 2.3.3a Fresh Water Generator Sea Water Service System



2.3.3 FRESH WATER GENERATOR SEA WATER SERVICE SYSTEM

Two fresh water distillation plants are fitted, each with a capacity of 60 tons/day. These units generate fresh water by the evaporation of sea water and subsequent condensation of the vapour produced by that evaporation. The units operate at partial vacuum allowing for evaporation at lower temperature and increased efficiency. Low temperature evaporation also reduces salt scale formation and allows for prolonged operation. Operation of the evaporator will be discussed in more detail in section 2.14.1.

Sea water supply to the evaporators provides feed water for evaporation, cooling water for condensing the vapour and driving water for operating the brine/air ejectors which remove brine from the evaporator shell.

Sea water is provided by two distillation plant sea water feed pumps, one for each evaporator. Although each evaporator has its own dedicated pump, these pumps are cross-connected by means of valve WS160F which allows No.1 pump to supply No.2 evaporator or No.2 pump to supply No.1 evaporator.

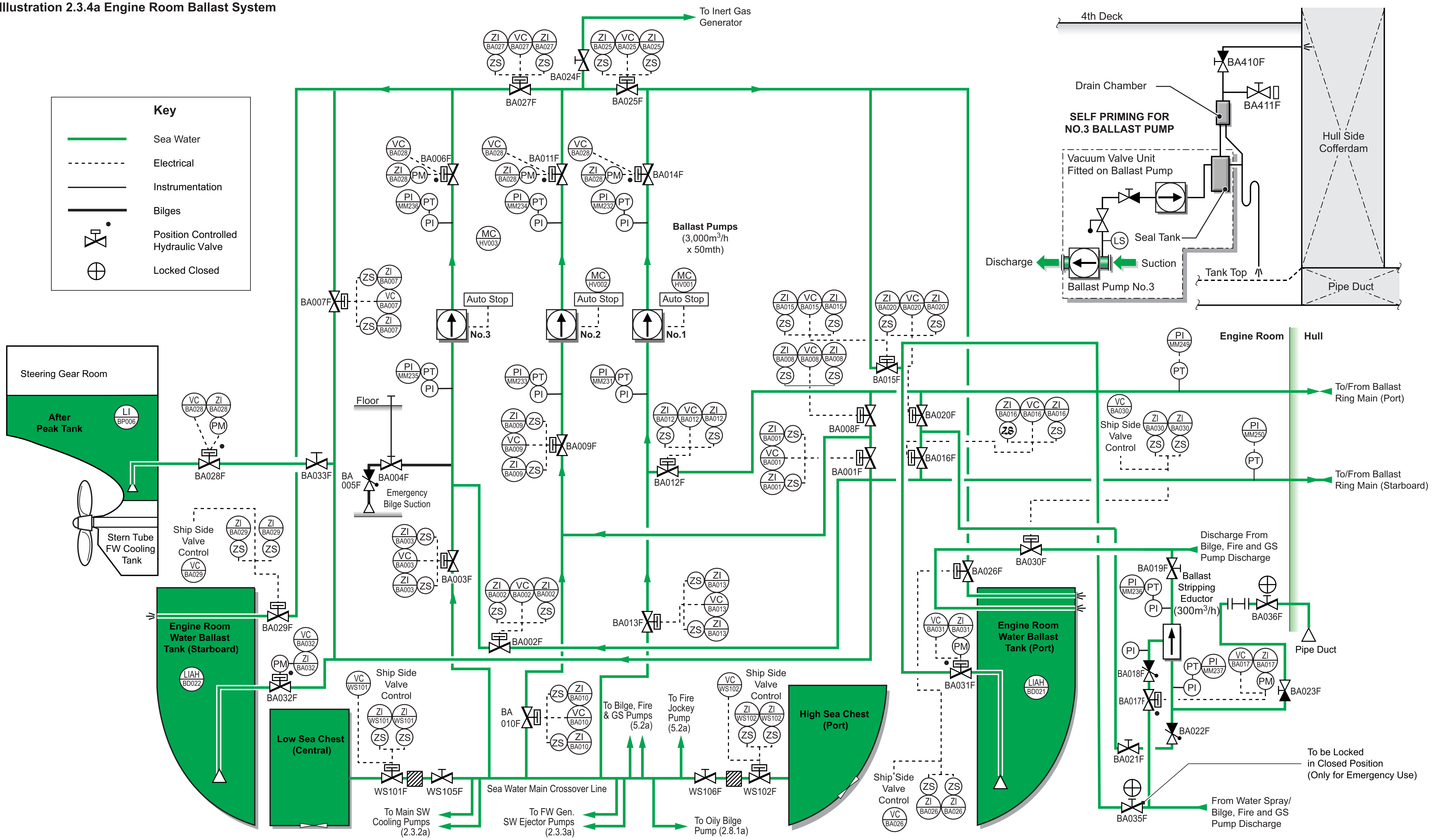
The IAS provides monitoring only for these pumps.

Distillation plant sea water pumps are started and stopped locally and will be operated when the evaporators are put into operation.

In order to prevent foaming in the evaporator and to restrict the formation of scale, a chemical treatment is applied to the feed to the evaporation chamber. This is achieved by means of a chemical dosing unit.

A non-return discharge valve is fitted to the outlet line from each evaporator brine ejector and the discharges pass to a common overboard discharge valve.

Illustration 2.3.4a Engine Room Ballast System



2.3.4 ENGINE ROOM BALLAST SYSTEM

Ballast Pumps

Maker:	Shinko Ind. Ltd
No. of sets:	3
Type:	Vertical, centrifugal with self-priming of No.3
Model:	GVD500-2M (No.s 1 and 2 pumps) GVD500-2MS (No.3 pump)
Capacity:	3,000m^3/h at 50mth

Ballast Stripping Eductor

Maker:	Kiwon Ind.
No. of sets:	1
Capacity:	300m^3/h at 11mth

Introduction

The engine room ballast system consists of the following:

- Aft peak tank
- Port and starboard water ballast tanks
- Three centrifugal pumps, one with a priming pump unit
- Stripping eductor

The three ballast pumps take suction from either the sea water crossover pipe or from all the ballast tanks. In normal service, the port pump, No.1, is connected to all the port tanks and the starboard pump No.3 to all the starboard tanks. No.2 pump can be used on either side and it is also possible to draw from both sides with any single pump. No.3 pump is fitted with a vacuum pump unit and can be used to take suction from an emergency bilge suction, via valve BA005F which is operated locally from an extended spindle on the starboard side of the engine room.

Stripping and final educting is done using the water spray pump as the driving water for the eductor on the 250mm stripping suction to the 600mm ballast main via the valve BA021F. The stripping line discharges through valve BA019F and overboard valve BA030F on the port side.

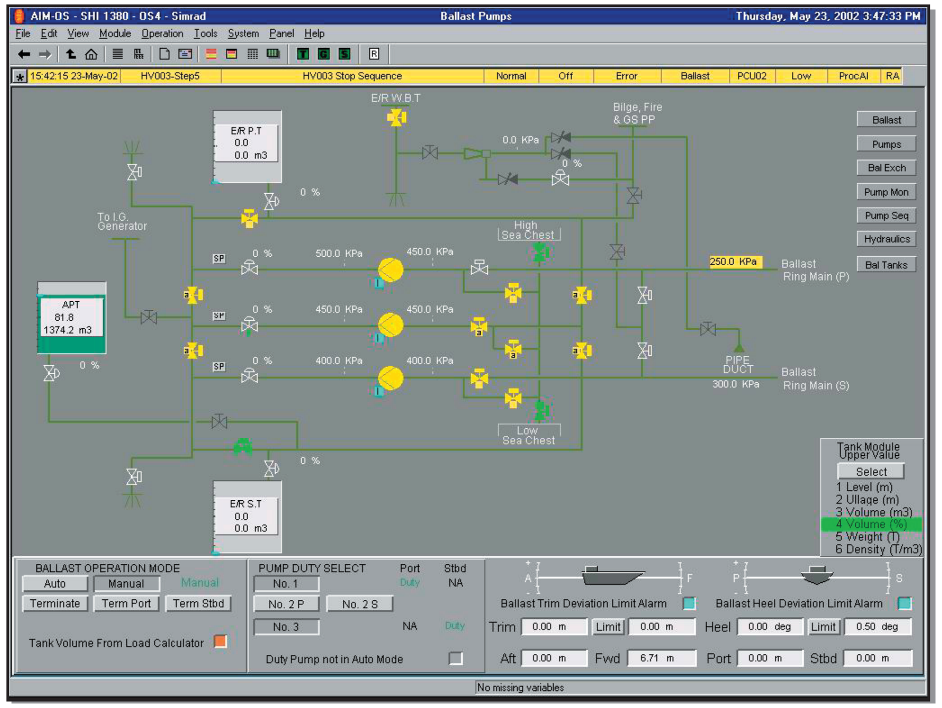
The stripping eductor can also be used in an emergency for pumping out the pipe duct via the 150mm suction line and valves BA023F and BA036F when an emergency spool piece is fitted.

All ballast valves are butterfly valves hydraulically operated, with the exception of some manual valves on the eductor system and the aft peak isolating valve.

The tank main suctions, pump discharge valves and the driving water inlet to the eductor are of the intermediate position controlled type.

The ballast pumps can be stopped locally regardless of the position of the Local/Remote switch. The switch must be in the LOCAL position before the pump can be started locally and a Power Request signal is sent from the switchboard to the IAS PMS before a start is allowed. The IAS has to send a Power Available signal to the switchboard prior to the start signal

(**Note:** There is no interlock between pump start and the suction valve if the pump is started in locally. If the suction valve is closed the IAS will sound an alarm.)



All the ballast valves can be controlled from the cargo control room using the IAS graphic display screens. The same pipes and valves are used both for the filling and emptying of all the ballast tanks.
The ballast pumps are also used to supply sea water to cool the inert gas generator, with No.2 pump being used via valve BA024F.

In the event of an emergency when the ballast and water spray pumps may not available, the engine room ballast tanks can be filled using the bilge, fire and GS pump and discharged overboard using the ballast stripping eductor, with driving water from the bilge, fire and GS pumps.

The ballast system can be operated entirely in automatic mode by clicking on the AUTO button on the IAS screen, however the procedure described below is for a manual operation.

Procedure for Filling the Aft Peak Tank with Sea Water

Description is for using No.3 ballast pump.

a) Ensure that all suction strainers are clear on the sea water suction chests.

b) Ensure that all the pressure gauge and instrumentation valves are open and that the instrumentation is reading correctly.

c) Determine how much sea water is to be pumped into the aft peak tank.

(**Note:** Check that all the ballast system valves are closed.)

d) Manually open the aft peak isolating valve BA033F.

e) At the IAS graphic display screen BALLAST PUMPS, use the trackball to set up the ballast system for sea suction. Select each valve in turn and at the revelant faceplate and click on the OPEN soft key to operate the valve.

Position	Description	Valve
Open	Ballast system discharge valve	BA007F
Open	Aft peak tank filling/emptying valve	BA028F
Open	No.1 ballast pump sea suction valve	BA013F

f) Open the pump discharge valve BA014F 10% before starting the pump.

g) Start the ballast pump by clicking on the START/STOP icon in the IAS graphic display screen to bring up the faceplate and click on the START soft key.

h) At the IAS graphic display screen, monitor the after peak tank level as required.

Stop the pump and close all valves when the aft peak is at the required level.

Procedure for Pumping out the Aft Peak Tank

Description below is for using No.3 ballast pump.

(**Note:** Check that all ballast system valves are closed.)

a) Ensure all the pressure gauge and instrumentation valves are open and that the instrumentation is reading correctly.

b) Manually open the aft peak isolating valve BA033F.

c) At the IAS graphic display screen BALLAST PUMPS, use the trackball to set up the ballast system for pumping out the after peak tank. Select each valve in turn and at the revelant faceplate click on the OPEN soft key to operate the valve.

Position	Description	Valve
Open	Aft peak tank filling/emptying valve	BA028F
Open	No.1 ballast pump suction from ballast tanks	BA012F
Open	Overboard discharge line valve (starboard)	BA029F

d) Open the pump discharge valve BA014F 10% before starting the pump.

e) Start the ballast pump by clicking on the START/STOP icon in the IAS graphic display screen to bring up the faceplate and click on the START soft key.

f) At the IAS graphic display screen, monitor the after peak tank level as required.

Stop the pump and close all valves when the aft peak is at the required level.

Procedure for Filling the Engine Room Water Ballast Tanks

Description below is for using No.1 ballast pump.

a) Ensure that all suction strainers are clear on the sea water suction chests.

b) Ensure that all the pressure gauge and instrumentation valves are open and that the instrumentation is reading correctly.

(**Note:** Check that all the ballast system valves are closed.)

c) Determine how much sea water is to be pumped into the engine room ballast tanks.

d) At the IAS graphic display screen BALLAST PUMPS, use the trackball to set up the ballast system for sea suction. Select each valve in turn and at the revelant faceplate and click on the OPEN soft key to operate the valve.

Position	Description	Valve
Open	No.1 ballast pump sea suction valve	BA013F
Open	Ballast pump system discharge to valve	BA007F
Open	Ballast line valves to port ballast tank	BA027F, BA025F, BA015F

Position	Description	Valve
Open	Starboard ballast tank filling/emptying valve	BA032F
Open	Port ballast tank filling/emptying valve	BA031F

e) Open the pump discharge valve BA014F 10% before starting the pump.

f) Start the ballast pump by clicking on the START/STOP icon in the IAS graphic display screen to bring up the faceplate and click on the START soft key.

g) At the IAS graphic display screen, monitor the after peak tank level as required.

Stop the pump and close all valves when the aft peak is at the required level.

Procedure for Pumping out the Engine Room Water Ballast Tanks using No.1 Ballast Pump

(**Note:** Check that all ballast system valves are closed.)

a) Ensure all the pressure gauge and instrumentation valves are open and that the instrumentation is reading correctly.

b) At the IAS graphic display screen BALLAST PUMPS, use the trackball to set up the ballast system for pumping out the engine room ballast tanks. Select each valve in turn and at the revelant faceplate and click on the OPEN soft key to operate the valve.

Position	Description	Valve
Open	No.3 ballast pump suction from ballast tanks	BA002F
Open	Ballast line valves from port ballast tank	BA001F, BA008F
Open	Starboard ballast tank filling/emptying valve	BA032F
Open	Port ballast tank filling/emptying valve	BA031F
Open	No.3 ballast pump overboard discharge	BA029F

c) Open the pump discharge valve BA014F 10% before starting the pump.

d) Start the ballast pump by clicking on the START/STOP icon in the IAS graphic display screen to bring up the faceplate and click on the START soft key.

e) At the IAS graphic display screen, monitor the after peak tank level as required.

Stop the pump and close all valves when the aft peak is at the required level.

Procedure for using the Ballast Stripping Eductor to Strip Out the Remaining Ballast Water

Description below is for using the water spray pump see Section 5.6.

(**Note:** Check that all ballast system valves are closed.)

a) Ensure all the pressure gauge and instrumentation valves are open and that the instrumentation is reading correctly.

b) Manually open the valves as required in the table below.

Position	Description	Valve
Open	Eductor driving water supply	FD056F
Open	Eductor suction	BA021F
Open	Eductor discharge	BA019F,
Open	Aft peak isolating	BA033F

c) At the IAS graphic display screen BALLAST PUMPS, use the trackball to set up the ballast system for stripping out the engine room ballast tanks. Select each valve in turn and at the revelant faceplate and click on the OPEN soft key to operate the valve.

Position	Description	Valve
Open	Port ballast ring main suction	BA020F
Open	Starboard ballast ring main suction	BA016F
Open	Port ballast tank suction	BA031F
Open	Starboard ballast tank suction	BA032F
Open	Aft peak tank suction	BA028F
Open	Overboard discharge	BA030F
Open/adjust	Eductor driving water supply	BA017F

d) Start the water spray pump by clicking on the START/STOP icon in the IAS graphic display screen to bring up the faceplate and click on the START soft key.

e) At the IAS graphic display screen, monitor the ballast tank levels as required.

Stop the water spray pump and close all valves when the ballast tanks are empty. Ensure the water spray pump is set up on the water spray system on completion of the deballasting operation.

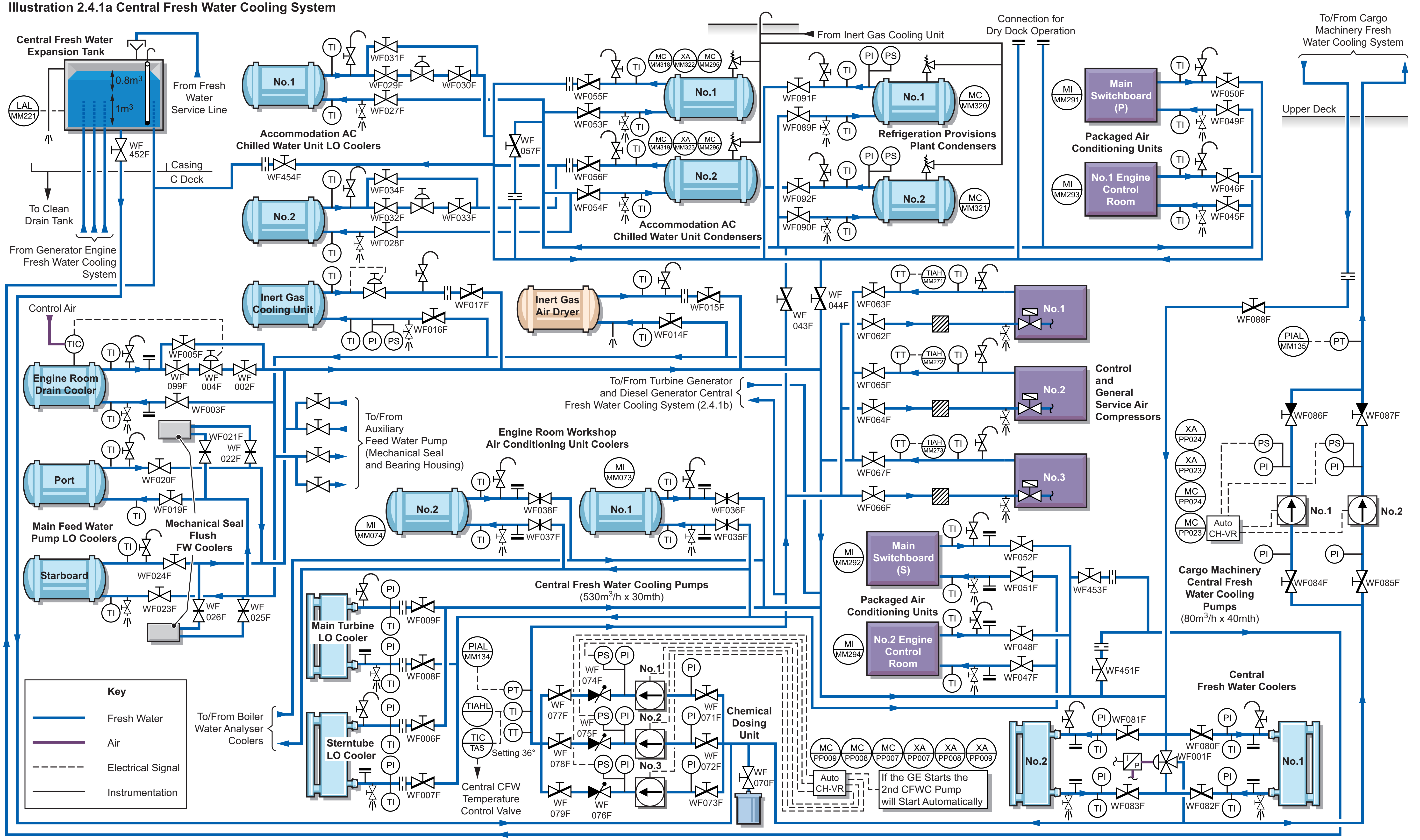
Alarms

Tag	Description	High	High High
MM145 - 153	Ballast pump motor winding temperatures	140°C	145°C

2.4 Centralised Fresh Water Cooling System

Illustrations

Illustration 2.4.1a Central Fresh Water Cooling System



2.4 FRESH WATER COOLING SYSTEMS

2.4.1 CENTRAL FRESH WATER COOLING SYSTEM

Central Fresh Water Cooling Pumps

Maker:	Shinko Ind. Ltd
No. of sets:	3
Type:	Centrifugal
Model:	SVS300M
Capacity:	$530m^3/h$ at 30mth and $680m^3/h$ at 27mth

Cargo Machinery Fresh Water Cooling Pumps

Maker:	Shinko Ind. Ltd
No. of sets:	2
Type:	Centrifugal
Model:	SVS125-2M
Capacity:	$80m^3/h$ at 40mth

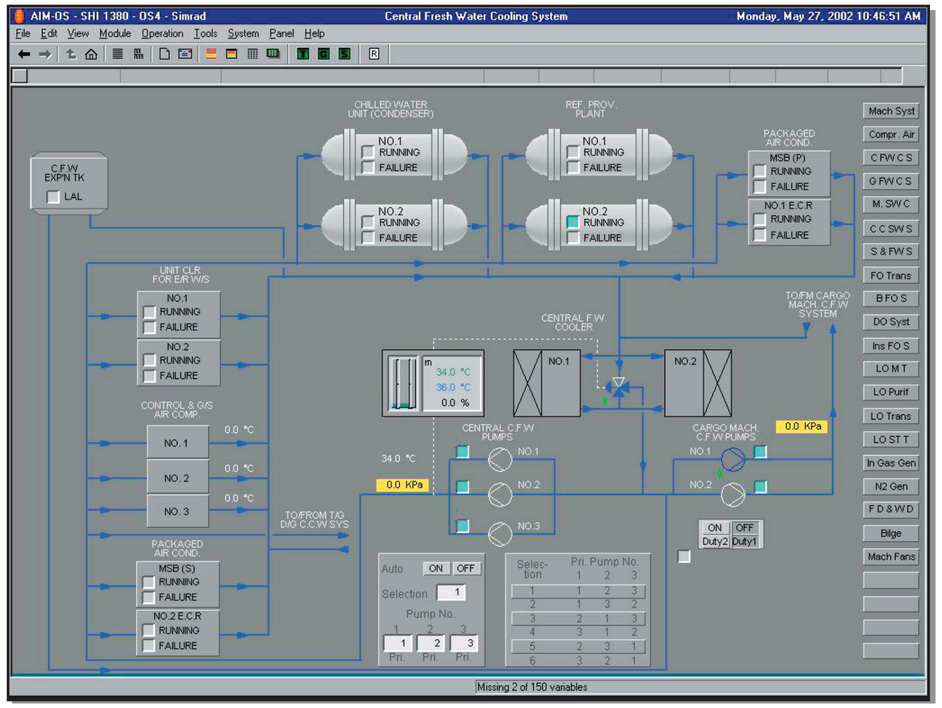
Introduction

The main central fresh water cooling system has three cooling water pumps which supply cooling water to the following:

- Diesel generator and engine
- Turbine generators
- Refrigeration plant
- Engine room workshop air conditioning units
- Main switchboard package air conditioning units
- Engine control room package air conditioning units
- Air compressors
- Chilled water plant LO coolers and condensers
- Auxiliary feed water pump mechanical seals, flushing cooler
- Engine room drain cooler
- Main feed water pump LO and mechanical seal coolers
- Main LO cooler
- Stern tube LO cooler
- Inert gas plant coolers

Two cargo machinery fresh water cooling pumps supply fresh water from the central FW cooling system to the cargo machinery coolers located in the cargo motor room and cargo machinery room. The cargo machinery fresh water cooling system is described in section 2.4.2.

The water in the central FW cooling system is treated to inhibit corrosion by means of a chemical dosing unit located at the main central cooling fresh water pump suction manifold. A main central cooling system expansion tank allows for expansion in the system and make-up should that be required. The expansion tank is fitted with a manually operated supply valve which is fed from the fresh water hydrophore system. This valve is used to maintain the correct level of water in the expansion tank. Any loss of FW in the CFWC system can be monitored from the expansion tank level, allowing for the temperature changes and machinery operations.



The main fresh water cooling pumps are identical and one will be normally set for duty with another set as the standby pump to cut in automatically if the duty pump fails. The duty pump is started when the diesel generator is started and the Low Temperature FW Cooling inlet solenoid valve WF301F is energised to allow cooling water to the diesel generator.

The cargo machinery central cooling fresh water pumps are normally also arranged with one as the duty pump and the other as standby pump.

Valves in the central cooling system are manually set and must be set correctly in order to ensure coolant flow to a particular service. A three-way temperature controlled valve WF001F at the central coolers regulates the flow of fresh water through the central coolers and thus the temperature of the fresh water in the system is maintained at the desired value (36°C).

The main diesel generator is fitted with its own jacket water circulation pump and this is engine driven thus ensuring correct circulation of water through the engine when operating. There is a jacket water preheater which is electrically powered. Two jacket preheating pumps, one duty and the other on standby or shut down, circulate warmed water through the jacket system of the diesel generator engine when it is on standby. This ensures that the standby diesel generator is always available for duty.

Pump Control

Main central cooling fresh water pumps and the cargo machinery central fresh water cooling system pumps may be controlled from the central fresh water cooling system graphic display screen in the IAS or locally at the pumps. They may be selected for standby (auto) mode which means that one pump will be started as the duty pump and the other pumps will be the standby pumps. For normal operation by the IAS in standby mode the pumps must be set to NOR and IAS.

Upon initial start-up the operator starts the selected pump from the IAS or locally. If a pump running signal is not received by the IAS five seconds after the start command a failure alarm is activated. When the duty pump is running the other pumps may be selected as the standby pumps in priority if they are available. This is done at the IAS by setting the pumps to Auto and then selecting the pumps for standby priority at the graphic display screen. Remote operation of a pump allows for control from the IAS graphic screen. Auto may be selected provided that the pump is stopped, is set to NOR and is not tripped, and provided that the other pump is running.

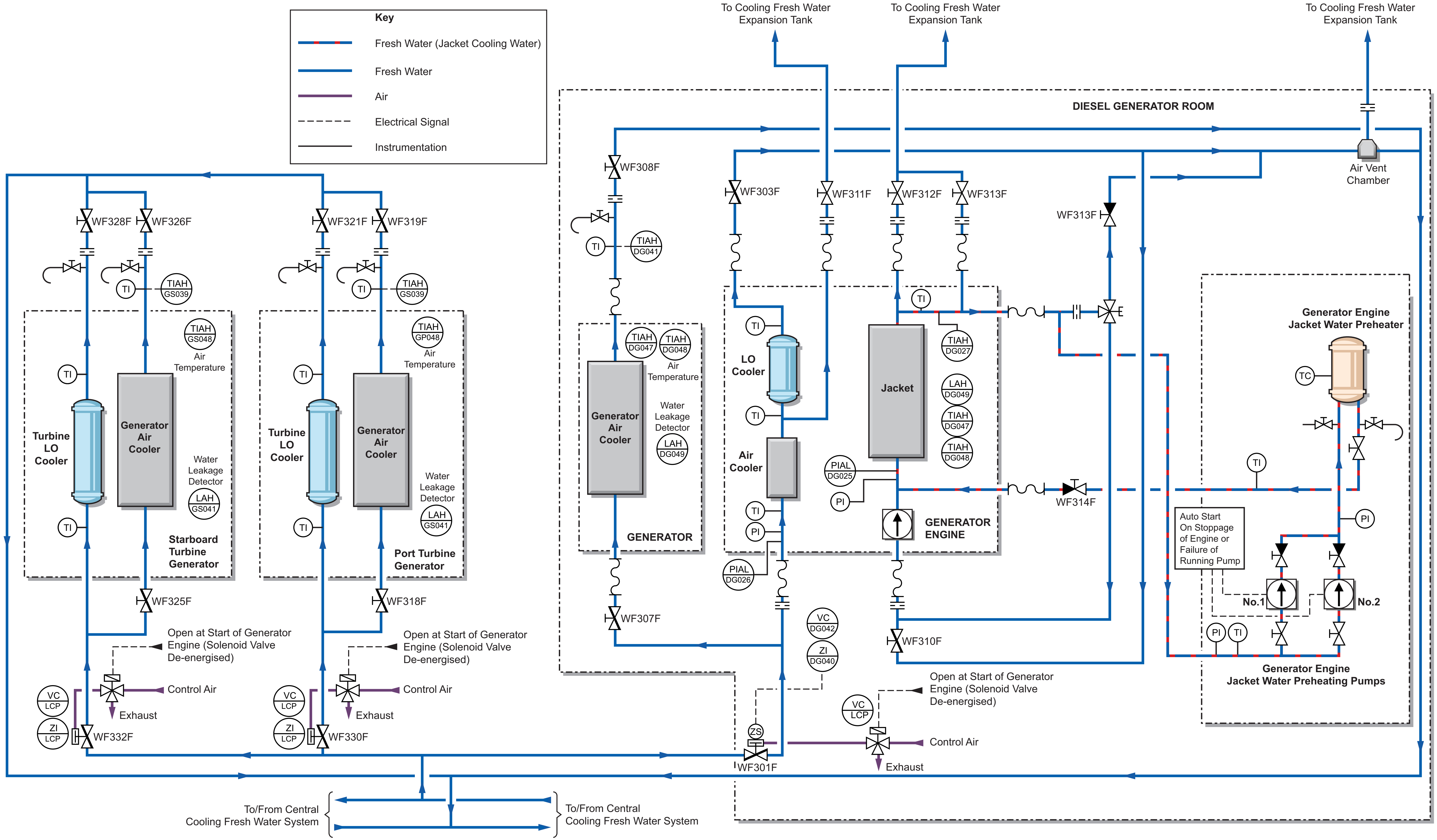
In the event of a running pump tripping or delivering low-low pressure the IAS activates an alarm and sends a start signal to the first standby pump. If a running pump is changed from NOR to LOCK the IAS will activate an alarm and start the standby pump. Visual indication of pump status is given on the IAS graphic screen. If the running pump is changed from IAS to local the changed status is indicated on the IAS graphic screen but no alarm is activated and the standby pump is not started.

Pumps set to manual operation may be controlled locally or remotely from the IAS graphic screen. Pumps not set to remote cannot be started or stopped by the IAS. Pumps may also be selected as tripped or off.

Manual

Pumps may be manually started and stopped from the IAS graphic screen provided that the pump is set to NOR at the local switch and IAS at the main switchboard panel. The IAS activates an alarm if a pump trips or delivers a low discharge pressure when in manual. If a low-low alarm is activated when both pumps are set to manual, the IAS does not start the second pump because it has not been selected as the standby pump, nor will an alarm be activated. If a pump status changes when set to manual the IAS graphic screen will display the new status.

Illustration 2.4.1b Central Fresh Water Cooling for Turbine Generators and Diesel Generator



Local Operation

Each pump main switchboard starter panel has two positions, LOCAL and IAS. The local STOP pushbutton has two positions, LOCK and RUN. Selection of the LOCK position switches the pump off and it cannot be operated from the IAS. An indication of the LOCK selection is displayed at the IAS graphic screen by illumination of the Tripped/Off indicator and the pump icon on the graphic indicated that the pump is not running. The Isolated/Tripped alarm is still operational.

Selection of LOCAL at the main switchboard panel allows the pump to be started or stopped locally at the start pushbuttons and this inhibits the normal start and stop from the IAS. Setting the pump in local control prevents it from being set as the standby pump. The IAS will indicate on the graphic when the pump motor is running or stopped and will show that it is selected for local control. The alarm for Isolated/Tripped is still operational as is the low discharge pressure alarm.

Selection of IAS at the starter inhibits local start of the pump which can then only be started from the IAS graphic for the pump. However, the pump stop from the local position will still operate. The local stop facility is available at all times for all pumps.

Blackout

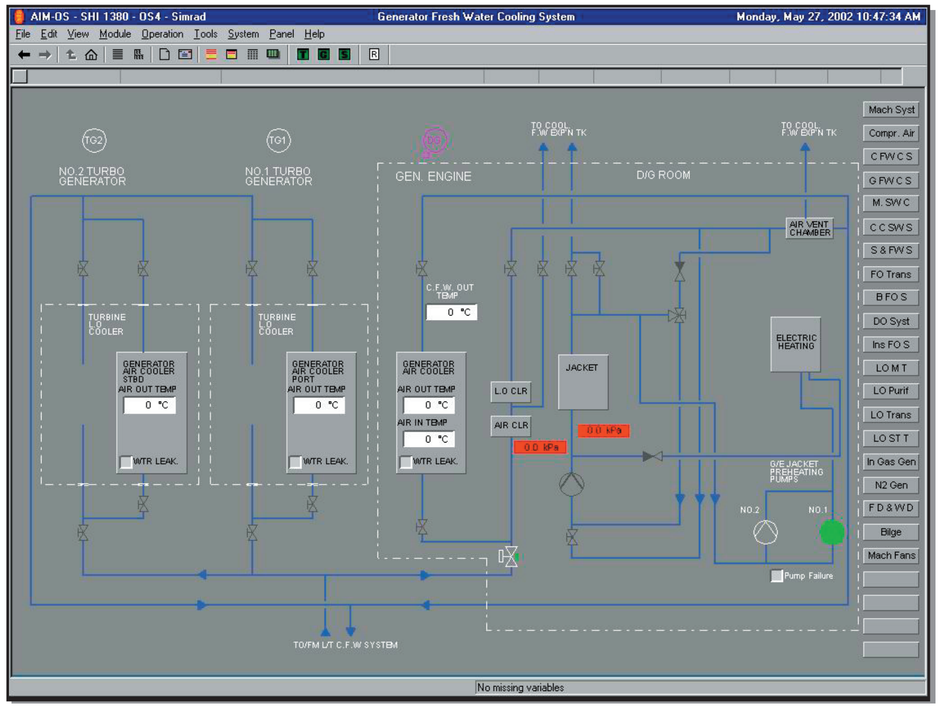
At a blackout the IAS remembers which pump was the duty pump and at the restoration of electrical power the duty pump will be started as part of the sequential start system, provided that the pump is set to remote; if the duty pump fails to start within 5 seconds the standby pump will be started, if it was set to auto before the blackout. Normal alarms resulting from the effects of the blackout are inhibited during the blackout but are restored when the duty pump is started and pressure is restored.

Alarms

Tag	Description	Low	High
MM134	Pump discharge pressure	400kPa	
MM136	Cooler outlet control temperature	32°C	40°C
MM271/2/3	Control and GC compressors CW outlet temperature		45°C
PP008	No.2 central CFW pump pressure control	350kPa	
PP009	No.1 central CFW pump pressure control	350kPa	

Procedure for the Operation of the Fresh Water Cooling System

a) Ensure that the fresh water cooling system is fully charged with water and that all air is vented from the system. Ensure that the central fresh water cooling expansion tank is at the correct level and that the top up supply from the fresh water hydrophore system is available.



b) Ensure all the pressure gauge and instrumentation valves are open and that all instruments and gauges are reading correctly. Ensure that there is a control air supply at the three-way temperature control valve.

c) Set up the valves as shown in the following table:

Position	Description	Valve
Open	System air vent valves	WF451F, WF453F, WF454F
Open	No.1 main central FW cooling pump suction valve	WF071F
Open	No.1 main central FW cooling pump discharge valve	WF077F
Open	No.2 main central FW cooling pump suction valve	WF072F
Open	No.2 main central FW cooling pump discharge valve	WF078F
Open	No.3 main central FW cooling pump suction valve	WF073F
Open	No.3 main central FW cooling pump discharge valve	WF079F
Operational	Three-way central cooler bypass valve	WF001F

Position	Description	Valve
Open	No.1 main central FW cooler inlet valve	WF080F
Open	No.1 main central FW cooler outlet valve	WF082F
Open	No.2 main central FW cooler inlet valve	WF081F
Open	No.2 main central FW cooler outlet valve	WF083F
Open	Diesel generator engine inlet solenoid valve	WF301F
Open	No.1 generator turbine inlet solenoid valve	WF330F
Open	No.2 generator turbine inlet solenoid valve	WF332F

(**Note:** The cooling water supply solenoid valves are opened by the control system when the diesel generator and turbine generators are started.)

Position	Description	Valve
Open	Diesel generator engine air and LO cooler outlet valve	WF303F
Open	Diesel generator engine alternator air cooler inlet valve	WF307F
Open	Diesel generator engine alternator air cooler outlet valve	WF308F
Open	Diesel generator engine outlet valves to expansion tank	WF311F, WF312F
Open	Diesel generator engine jacket valve from heater	WF314F
Open	Diesel generator engine jacket outlet valve	WF313F
Open	Diesel generator engine jacket preheater pump inlet and outlet valves	
Operational	Diesel generator engine jacket temperature control valve	
Open	No.1 turbine generator air cooler inlet valve	WF318F
Open	No.1 turbine generator air cooler outlet valve	WF319F
Open	No.1 turbine generator LO cooler outlet valve	WF321F
Open	No.2 turbine generator air cooler inlet valve	WF325F
Open	No.2 turbine generator air cooler outlet valve	WF326F
Open	No.2 generator turbine LO cooler outlet valve	WF328F
Open	Chemical dosing unit supply valve	WF070F
Open	Supply line valve	WF043F
Open	Return line valve	WF044F
Open	No.1 control and GS air compressor inlet valve	WF062F
Open	No.1 control and GS air compressor outlet valve	WF063F

Position	Description	Valve
Open	No.2 control and GS air compressor inlet valve	WF064F
Open	No.2 control and GS air compressor outlet valve	WF065F
Open	No.3 control and GS air compressor inlet valve	WF066F
Open	No.3 control and GS air compressor outlet valve	WF067F
Open	No.1 control room unit cooler inlet valve	WF045F
Open	No.1 control room unit cooler outlet valve	WF046F
Open	No.2 control room unit cooler inlet valve	WF047F
Open	No.2 control room unit cooler outlet valve	WF048F
Open	Port MSB unit cooler inlet valve	WF049F
Open	Port MSB unit cooler outlet valve	WF050F
Open	Starboard MSB unit cooler inlet valve	WF051F
Open	Starboard MSB unit cooler outlet valve	WF052F
Open	No.1 workshop unit cooler inlet valve	WF035F
Open	No.1 workshop unit cooler outlet valve	WF036F
Open	No.2 workshop unit cooler inlet valve	WF037F
Open	No.2 workshop unit cooler outlet valve	WF038F
Open	No.1 provision refrigeration condenser inlet valve	WF089F
Open	No.1 provision refrigeration condenser outlet valve	WF091F
Open	No.2 provision refrigeration condenser inlet valve	WF090F
Open	No.2 provision refrigeration condenser outlet valve	WF092F
Open	No.1 chilled water unit condenser inlet valve	WF053F
Open	No.1 chilled water unit condenser outlet valve	WF055F
Open	No.2 chilled water unit condenser inlet valve	WF054F
Open	No.2 chilled water unit condenser outlet valve	WF056F
Open	No.1 chilled water unit LO cooler inlet valve	WF027F
Open	No.1 chilled water unit LO cooler temperature control valve inlet valve	WF029F
Open	No.1 chilled water unit LO cooler temperature control valve outlet valve	WF030F
Close	No.1 chilled water unit LO cooler temperature control valve bypass valve	WF031F
Open	No.2 chilled water unit LO cooler inlet valve	WF028F
Open	No.2 chilled water unit LO cooler temperature control valve inlet valve	WF032F
Open	No.2 chilled water unit LO cooler temperature control valve outlet valve	WF033F
Close	No.2 chilled water unit LO cooler temperature control valve bypass valve	WF034F
Throttled	No.2 chilled water unit bypass valve	WF057V
Open	Drain cooler for engine room inlet valve	WF003V
Open	Drain cooler for engine room temperature control valve inlet valve	WF004F
Open	Drain cooler for engine room temperature control valve outlet valve	WF002F
Close	Drain cooler for engine room temperature control valve bypass valve	WF005F
Open	Stern tube cooler inlet valve	WF007F
Open	Stern tube cooler outlet valve	WF006F
Open	Main LO cooler inlet valve	WF008F
Open	Main LO cooler outlet valve	WF009F
Open	No.1 feed water pump turbine LO cooler inlet valve	WF019F
Open	No.1 feed water pump turbine LO cooler outlet valve	WF020F
Open	No.2 feed water pump turbine LO cooler inlet valve	WF023F
Open	No.2 feed water pump turbine LO cooler outlet valve	WF024F
Open	Feed pump seal flush water cooler inlet	WF025F, WF021F
Open	Feed pump seal flush water cooler outlet	WF026F, WF022F
Open	Auxiliary feed pump cooling water supply valves	
Open	Auxiliary feed pump cooling water return valves	
Open	IG cooler unit inlet valve	WF016F
Open	IG cooler unit outlet valve	WF017F
Open	IG dryer inlet valve	WF014F
Open	IG dryer outlet valve	WF015F
Open	Expansion tank inlet line valve	WF454F
Open	No.1 cargo machinery cooling FW pump inlet valve	WF084F
Open	No.1 cargo machinery cooling FW pump outlet valve	WF086F
Open	No.2 cargo machinery cooling FW pump inlet valve	WF085F
Open	No.2 cargo machinery cooling FW pump outlet valve	WF087F

d) At the IAS central fresh water cooling graphic display set the central cooling FW pumps to AUTO.

e) Select and start one main central cooling FW pump as the duty pump.

f) Set the second and third pumps to AUTO and select their priority as the standby pumps.

(**Note:** The duty pump may be started locally but unless the other pumps are set to AUTO they will not act as the standby pumps.)

g) Ensure that there is an electrical supply at the diesel generator preheater.

h) When temperatures in the system are stable individual items of equipment may be operated.

i) Check the system for leaks as temperatures rise.

j) At the IAS fresh water cooling system graphic display set both cargo machinery cooling FW pumps to AUTO.

k) Select and start one cargo machinery cooling FW pump as the duty pump and start that pump.

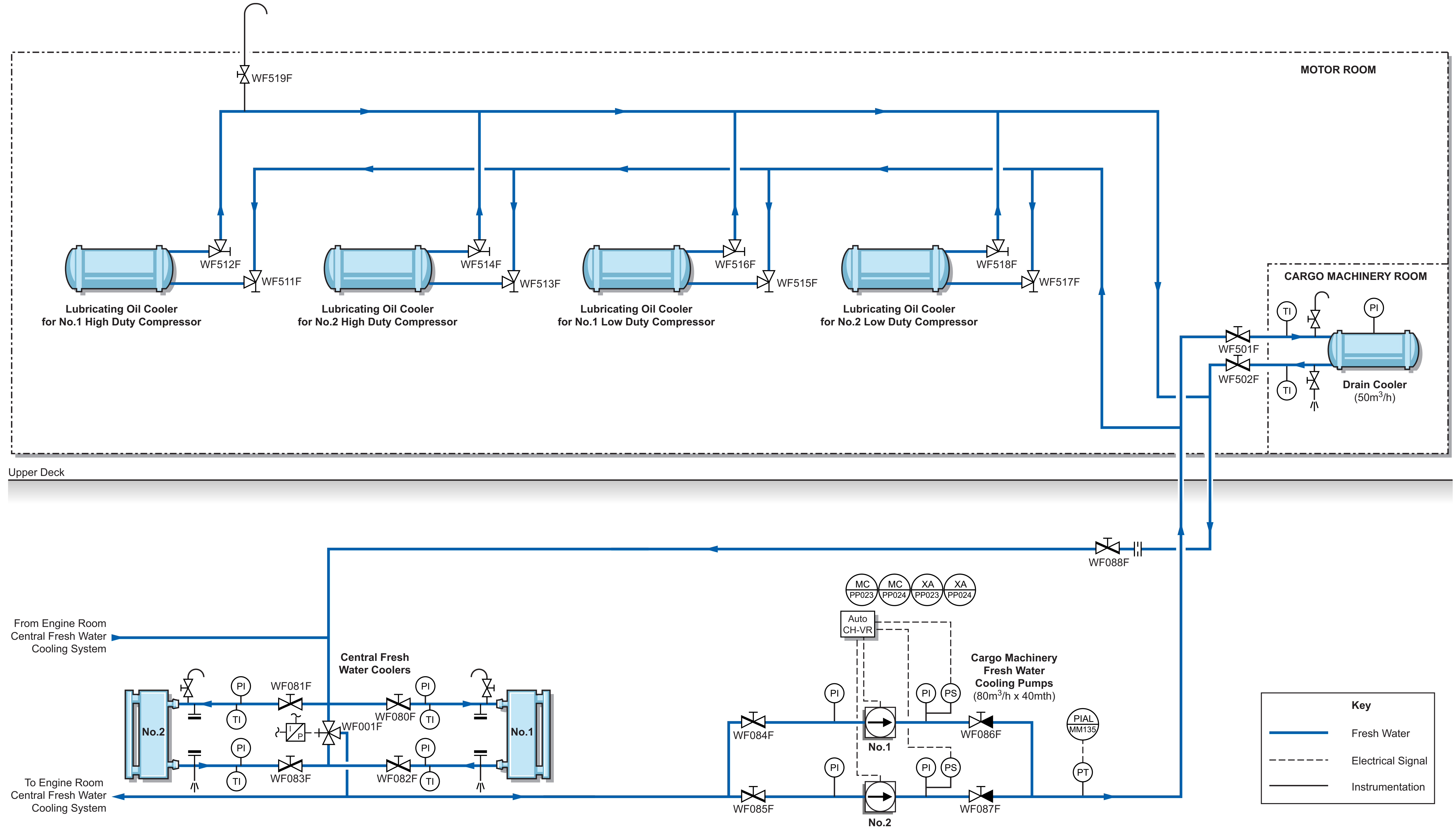
l) Set the second pump to AUTO and it will act as the standby pump.

(**Note:** The duty pump may be started locally but the unless the other pump is set to AUTO it will not act as the standby pump.)

m) Test the water daily and use the chemical dosing system to restore the level of chemicals in the fresh cooling water system to the level recommended

(**Note:** Test more frequently in the case of a loss of FW from the system, determined by the level in the expansion tank, or less likely, an increase in level.)

Illustration 2.4.2a Cargo Machinery Fresh Water Cooling System



2.4.2 CARGO MACHINERY FRESH WATER COOLING SYSTEM

Cargo Machinery Fresh Water Cooling Pumps

Maker:	Shinko Ind. Ltd
No. of sets:	2
Type:	Centrifugal
Model:	SVS125-2M
Capacity:	80m^3/h at 40mth

Introduction

The cargo machinery fresh water cooling system is a subsystem of the central FW cooling system. The cargo machinery coolers are located in the cargo motor room and the cargo machinery room. Four LO coolers in the motor room and a drain cooler in the cargo machinery room are cooled by water from the central FW cooling system. This water is circulated by one of the two cargo machinery cooling FW pumps as mentioned in section 2.4.1.

The cargo machinery FW cooling system uses water from the main central FW cooling system and so no additional treatment for corrosion inhibition is required.

The cargo machinery central cooling fresh water pumps are normally arranged with one pump set as the duty pump and the other as standby pump. The standby pump will start should the duty pump fail to maintain water pressure in the system. The pumps are selected at the IAS system Central Machinery Cooling FW System graphic screen but they may also be operated locally.

The following items of equipment are cooled by water flowing in the cargo machinery FW cooling system:

- No.1 HD compressor LO cooler
- No.2 HD compressor LO cooler
- No.1 LD compressor LO cooler
- No.2 LD compressor LO cooler
- Drain cooler for gas heaters, vaporisers and compressor LO sump heating coils

Pumps may be manually started and stopped from the IAS graphic screen provided that the pump is set to NOR locally and IAS at the main switchboard starter panel. The IAS activates an alarm if a pump trips or delivers a low discharge pressure when in manual.

Procedure for the Operation of the Cargo Machinery Fresh Water Cooling System

a) Ensure that the main central fresh water cooling system is fully charged with water and operating normally. Ensure that the expansion tank is at the correct level and that the top up supply from the fresh water hydrophore system is available.

b) Ensure all the pressure gauge and instrumentation valves are open and that all instruments and gauges are reading correctly.

c) Set up the valves as shown in the following table, assuming that the system is full and isolated:

Position	Description	Valve
Open	No.1 cargo machinery cooling FW pump suction valve	WF084F
Open	No.1 cargo machinery cooling FW pump discharge valve	WF086F
Open	No.2 cargo machinery cooling FW pump suction valve	WF085F
Open	No.2 cargo machinery cooling FW pump discharge valve	WF087F
Open	No.1 HD compressor LO cooler inlet valve	WF511F
Open	No.1 HD compressor LO cooler outlet valve	WF512F
Open	No.2 HD compressor LO cooler inlet valve	WF513F
Open	No.2 HD compressor LO cooler outlet valve	WF514F
Open	No.1 LD compressor LO cooler inlet valve	WF515F
Open	No.1 LD compressor LO cooler, outlet valve	WF516F
Open	No.2 LD compressor LO cooler inlet valve	WF517F
Open	No.2 LD compressor LO cooler, outlet valve	WF518F
Open	Drain cooler for gas heaters etc inlet valve	WF501F
Open	Drain cooler for gas heaters etc outlet valve	WF502F
Crack open	System vent valve	WF519F

d) At the IAS central machinery fresh water cooling system graphic screen set both cargo machinery cooling FW pumps to AUTO.

e) Select and start one cargo machinery cooling FW pump as the duty pump and start that pump, with discharge valve throttled at start and gradually opened fully.

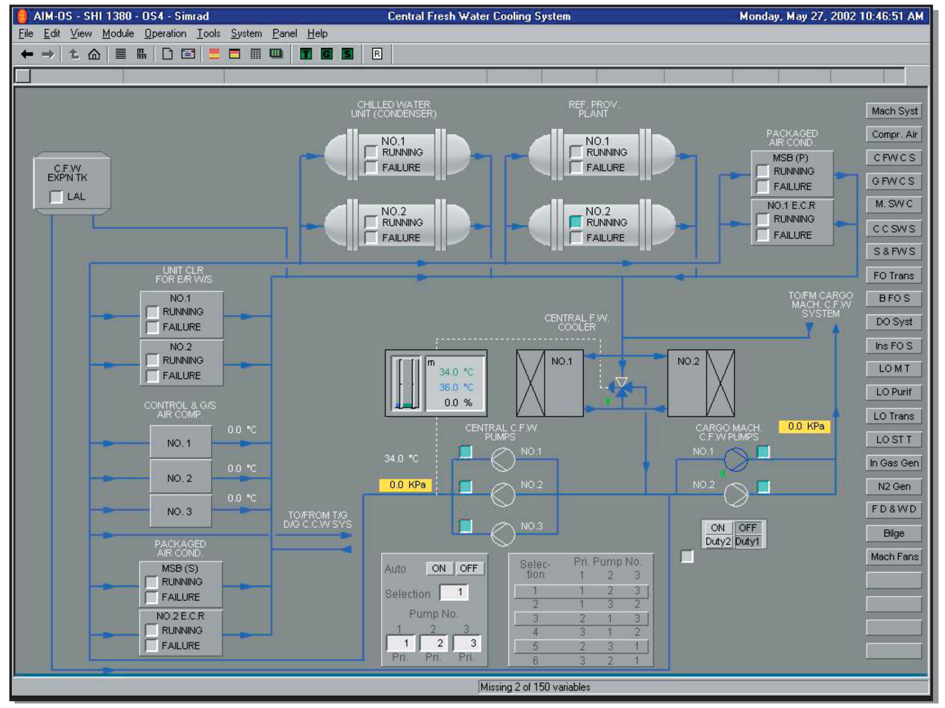
f) If the second pump is available it may be set to AUTO and will act as the standby pump.

(**Note:** The duty pump may be started locally but the unless the other pump is set to remote it will not act as the standby pump.)

g) Check the system for leaks as temperatures rise and close vent valve WF519F.

Alarms

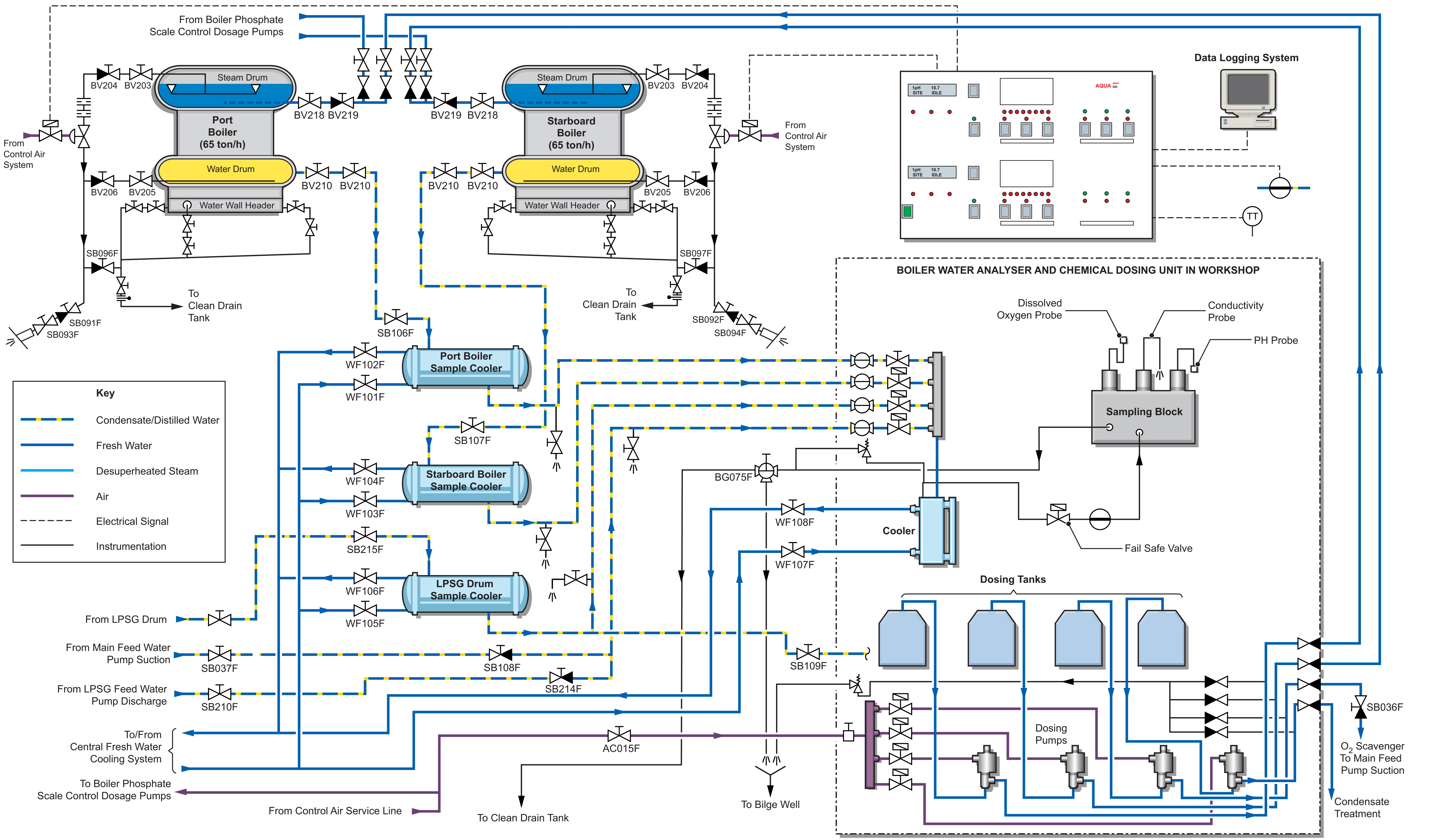
Tag	Description	Low
MM135	Pump discharge pressure	500kPa
PP023	No.1 cargo machinery CFW pump pressure control	400kPa
PP024	No.2 cargo machinery CFW pump pressure control	400kPa



2.5 Boiler Water Sampling and Treatment System

Illustrations

Illustration 2.5a Boiler Water Sampling and Treatment System



2.5 BOILER WATER SAMPLING AND TREATMENT SYSTEM

Maker: AQUA^{net} Inernational Ltd
Models: AQUA^{man} 300 - HP Boiler Water Management System
AQUA^{man} 500 - Salinometer Control Panel

Introduction

Chemical analysis and treatment of feed water is undertaken to prevent corrosion and scale formation in the main boilers and feed system 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 analytical tests must be undertaken in accordance with the detailed instructions given by the chemical supplier and the water characteristics maintained within the ranges specified. Test results are to be recorded in a form that enables trends and the effect of treatment to be monitored. The dissolved solids in the boiler water are controlled by use of scum lines in the steam drum and blowdown valves in the water drum, through which these impurities are discharged overboard. These systems are an integral part of the boiler water treatment.

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

- Port evaporator distillate: Salinity
- Starboard evaporator distillate: Salinity
- Auxiliary condenser outlet: Salinity
- Condensate drains pump discharge: Salinity
- Deaerator outlet: Salinity
- Main condensate pump discharge: Salinity

The main feed water analyser units have permanent sample lines fitted, which are led through coolers to a permanent test meter.

These are fitted for the following:

- Port boiler water drum: Test for pH, conductivity and dissolved O_2
- Starboard boiler water drum: Test for pH, conductivity and dissolved O_2
- Deaerator outlet water: Test for pH, conductivity and dissolved O_2

All the coolers are cooled by the central fresh water cooling system.

Water Specification

Boiler Water

pH at 25°C:	9.6 - 10.3
Conductivity:	less than 400uS/cm
Total dissolved solids:	less than 200ppm
Chlorides:	less than 20ppm
Phosphates:	10 - 20ppm
Silica:	less than 4ppm
Oil:	close to 0ppm

Feed Water

pH at 25°C:	8.0 - 9.0
Total hardness:	0ppm
Oxygen:	0.028ppm
Hydrazine reserve:	0.01 or above

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

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

Low or inadequate dosage of ammonia or neutralising 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 neutralising amine, resulting in a pH in excess of 10, may not be detrimental to the steel in the system, though it is not recommended and system levels should be reduced into the range.

Increase in hardness and/or sodium is a result of sea water contamination and should be rectified as soon as possible. Iron contamination is a result of too low a pH and/or excess dissolved oxygen. If the oxygen level increases, the source of contamination is to be located and rectified as soon as possible and the hydrazine dosage 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 observation tank used to clear any accumulation found in the tank.

Automatic Sample and Analysis Management Unit

The management unit takes samples of the boiler and feed water systems sequentially. The samples pass through a cooler and manifold before flowing through the measurement module and are discharged to the clean drain tank. Each sample is allowed to flow for a period that ensures full flushing of the previous sample. The module contains probes which measure the pH, conductivity and dissolved O_2 of the sample.

The make-up feed water flow from the distilled tank to the atmospheric drain tank is also monitored continuously, via a flow meter, together with the dearator outlet temperature. Flow meters are also fitted on individual feed water lines and are fed to the processor for additional control and monitoring of the feed water/steam production rates.

The controller interprets the analysis of each sample and adjusts the output of the dosing pumps and the automatic surface blowdown valves to maintain the set values required.

The unit operates automatically unless the following conditions apply:

- Manual blowdown required
- Contaminated water alarm requiring system check
- Chemical tank level low

The sample temperature is monitored and the Fail Safe valve will close if the temperature exceeds 55°C. The valve will remain closed until the temperature remains at below 50°C for a period of 10 minutes.

Operating Procedure

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

a) Ensure that the following boiler and feed water chemical injection valves are open:

Description	Valve
Port and starboard boiler chemical injection	BV218 and BV219
Feed water pump suction chemical injection	SB036F

b) Ensure that the dosing pump discharge valves are open to the systems requiring control.

c) Check that the dosing tanks are full with the correct chemical agent and that the suction lances are submerged.

d) Ensure that the following sample coolers inlet and outlet valves are open for supply by the central FW cooling system:

Description	Valve
Port boiler sample cooler	WF101F and WF102F
Starboard boiler sample cooler	WF103F and WF104F
LPSG drum sample cooler	WF105F and WF106F

e) Open the following sample valves on the boilers and the feed water pipelines:

Description	Valve
Port boiler sample	BV210 and BV210
Starboard boiler sample	BV210 and BV210
LPSG drum sample	
LPSG feed water sample	SB210F
Boiler feed water sample	SB037F

CAUTION
Boiler water samples are taken from the water drum and are therefore 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.

f) Open the sample manifold inlet valves.

g) Open the sample drain/test cocks alternately to ensure the pipelines contain sample water.

h) Ensure that there is electrical power to the control panel and switch on the unit.

Sampling will commence in approximately one minute.

i) Press the mode pushbutton switch to the MANUAL position.

j) To test the solenoids, manually operate each inlet valve to the sample manifold.

k) Check the flow indicator rotation from each valve individually and the sample cock to drain. The flow should be towards the sampling block.

l) Switch all manual valve switches to the OFF position.

m) Set the mode switch to the AUTO position.
n) Turn the pump mode switches to the AUTO position.

The green LED light will illuminate, indicating the automatic and normal position.

(**Note:** Do not leave the pumps in the MANUAL mode except when values are low after the first full cycle, in which case, operate in MANUAL mode until all the boiler readings are within range. The feed sample may alarm during this period due to the relatively high initial dosage.)

The unit is now operational and will go through its cycle as programmed. The DISPLAY HOLD pushbutton can be used to stop the display at a desired read out.

If any samples are also to be taken from the analyser unit drain outlets, then clean dry flasks with stoppers are to be used. The flask should be filled to overflowing and sealed to prevent any ingress of oxygen while the flask is standing waiting testing.

Boiler Alkaline Compound Injection Unit

Alkaline treatment and phosphate scale control is 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 an even distribution.

Hydrazine Dosing Unit

The O_2 scavenger dosing unit, which injects hydrazine into the feed water pump suction line from the dearator, should be operated continuously to maintain a constant hydrazine reserve with little fluctuation. The concentration of hydrazine should be varied depending upon the results of the tests.

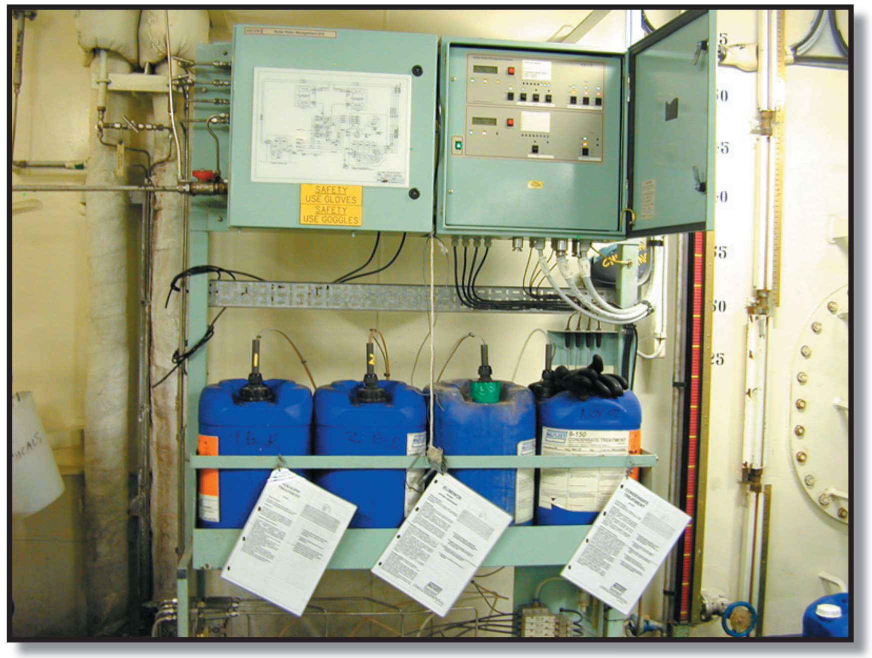
Boiler Blowdown Procedure

When in port, the duty deck officer should be contacted to ensure that the discharge from the ship's side will not be dangerous.

Condensate Treatment

A condensate treatment chemical is injected into the condensate pipeline to protect against CO_2 corrosive attack and reduce iron and copper pickup.

WARNING
Due to the volatile nature of high pressure water at high temperature, it is advisable to never open the water wall header drain valves 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.



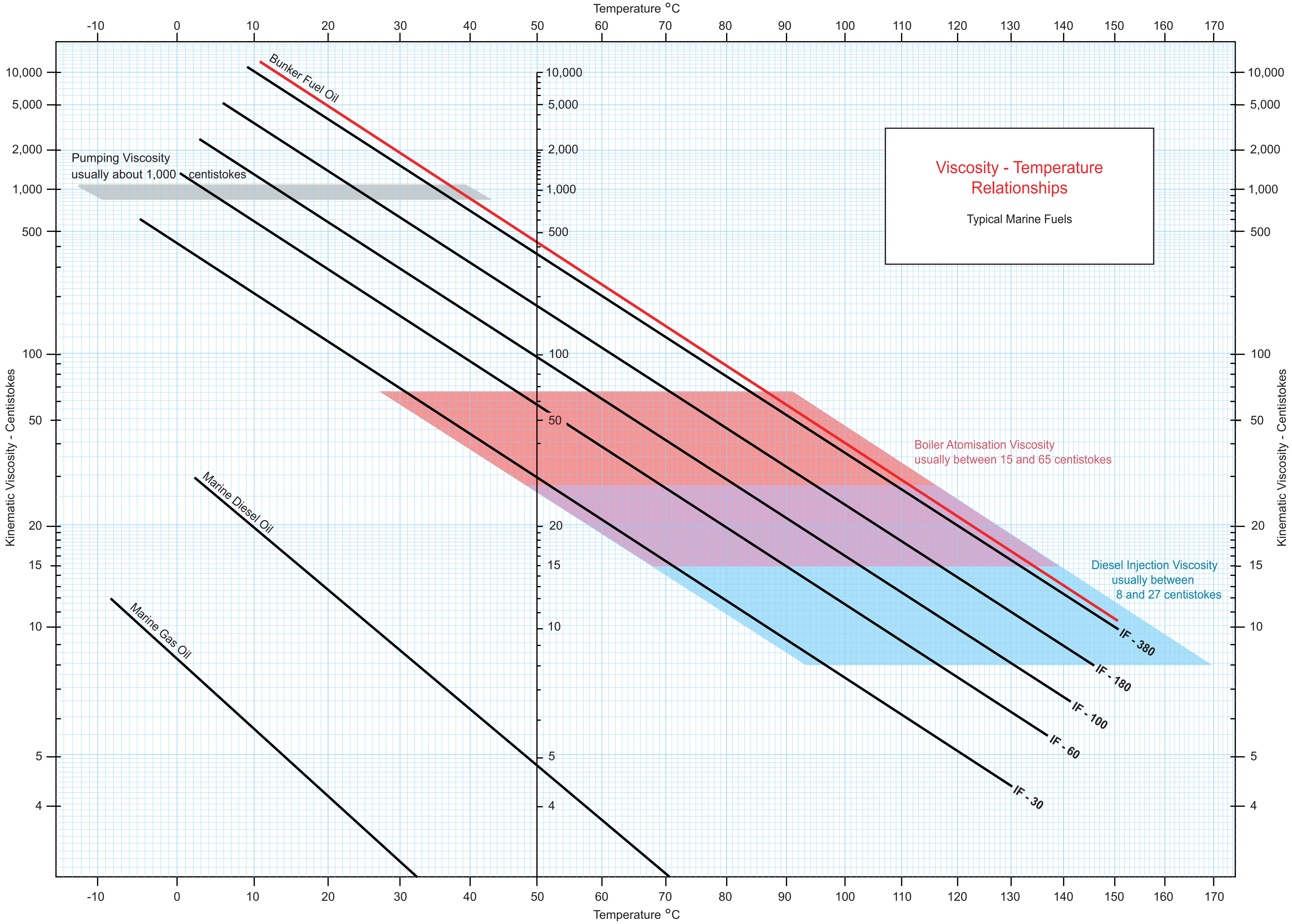
Boiler Water Sample Test Panel in Workshop

Port Boiler Blowdown Valves on Engine Room Floor Level

2.6 Fuel Oil and Fuel Gas Service Systems

Illustrations

Illustration 2.6.1a Fuel Oil Viscosity - Temperature Graph



2.6 FUEL OIL AND FUEL GAS SERVICE SYSTEMS

2.6.1 FUEL OIL BUNKERING AND TRANSFER SYSTEMS

Heavy Fuel Oil Transfer Pump

Maker:	Taiko Kikai Ind. Ltd
No. of sets:	1
Type:	Vertical screw
Model:	VG-100MA
Capacity:	$100m^3/h$ at 490kPa

Diesel Oil Transfer Pump

Maker:	Taiko Kikai Ind. Ltd
No. of sets:	1
Type:	Horizontal screw
Model:	NHG-15MA
Capacity:	$15m^3/h$ at 392kPa

Forward Fuel Oil Transfer Pump

Maker:	Taiko Kikai Ind. Ltd
No. of sets:	2
Type:	Vertical screw
Model:	VG-100MA
Capacity:	$100m^3/h$ at 490kPa

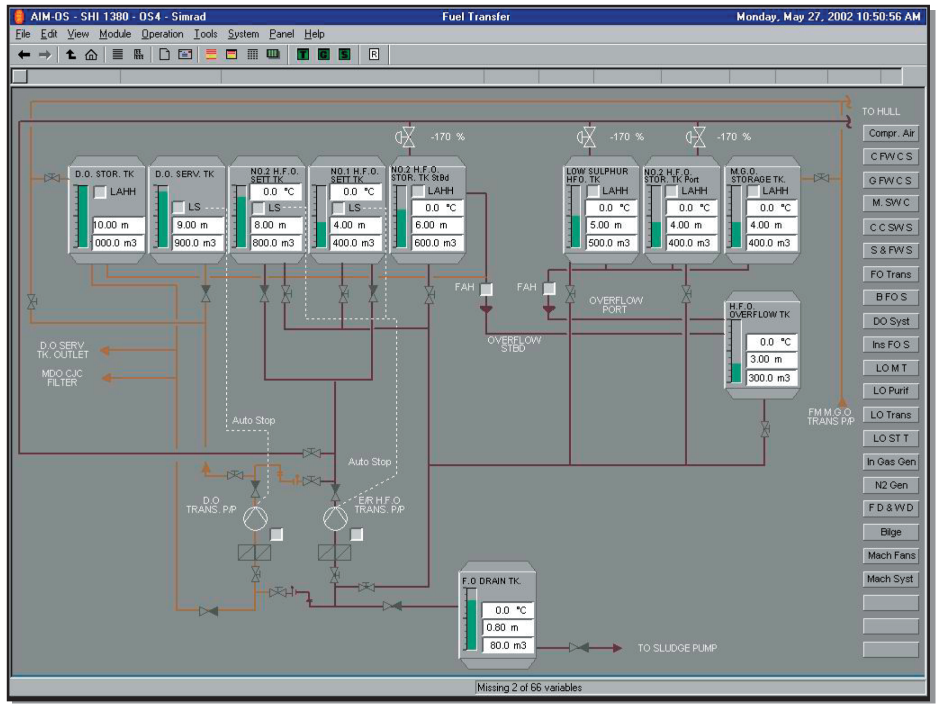
Gas Oil Transfer Pump

Maker:	Taiko Kikai Ind. Ltd
No. of sets:	1
Type:	Horizontal screw
Model:	NHG-4MA
Capacity:	$3.0m^3/h$ at 245kPa

Introduction

Heavy fuel oil, for the boilers is stored in two HFO tanks located at the sides of the engine room, and a forward centre fuel oil tank located forward of the cargo tanks. There is a low sulphur HFO tank located at the port side of the engine room within the port No.2 HFO tank. These bunker tanks are filled from the port and starboard connections adjacent to the cargo manifold. There are also connections to the diesel oil storage tank filling line. From the three bunker FO tanks, one forward and two aft, HFO is transferred to the HFO settling tanks where it is allowed to settle prior to being used in the boilers. Low sulphur heavy fuel oil is supplied directly to the boilers from the low sulphur HFO bunker tank if necessary but it may also be pumped to the settling tanks.

The HFO transfer pump is located on the starboard side of the engine room floor and is used to transfer HFO from the storage tanks to the settling tanks.



The HFO transfer pump may be started and stopped remotely or locally. For local operation the control selector switch at the main switchboard panel must be turned to the LOCAL position and the local switch turned to the NOR position. The pump may then be started and stopped by means of the local pushbuttons. When the main switchboard panel control selector is set to IAS the HFO transfer pump may be started and stopped manually at the IAS graphic screen. The display graphic indicates the operating status of the HFO transfer pump. The HFO settling tanks are fitted with level switches which switch off the HFO transfer pump when the maximum working level in the tank is reached. There is also a long run alarm which is activated if the pump runs for longer than 30 minutes.

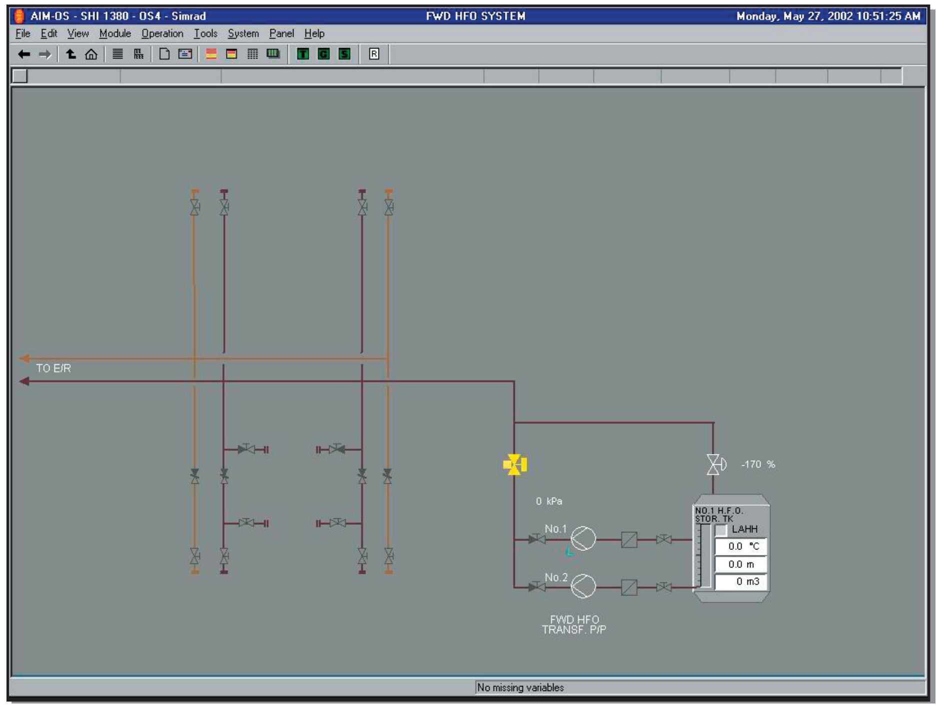
All valves on the HFO bunkering and transfer system are manual except for the HFO storage tank filling valves OF534F (No.2 HFO storage tank port), OF533F (No.2 HFO storage tank starboard), OF532F (low sulphur HFO tank) and OF501F (forward HFO storage). The discharge valve from the forward HFO transfer pumps to the bunker main line, OF511F, is also remotely operated.

The DO storage tank is located in the engine room and it is filled from the DO bunkering line. The HFO and DO bunkering stations are located on the port and starboard sides of the ship adjacent to the cargo manifold. There are forward and aft pipe connections at the bunkering stations.

Sampling valves are located at each bunkering connection and bunkering pipes are drained by means of a portable air driven pump which is connected at the starboard bunkering station.

The aft HFO storage tanks, the DO storage tank and the MGO storage tank overflow to the HFO overflow tank. The HFO settling tanks overflow to No.2 starboard HFO storage tank and the DO service tank overflows to the DO storage tank.

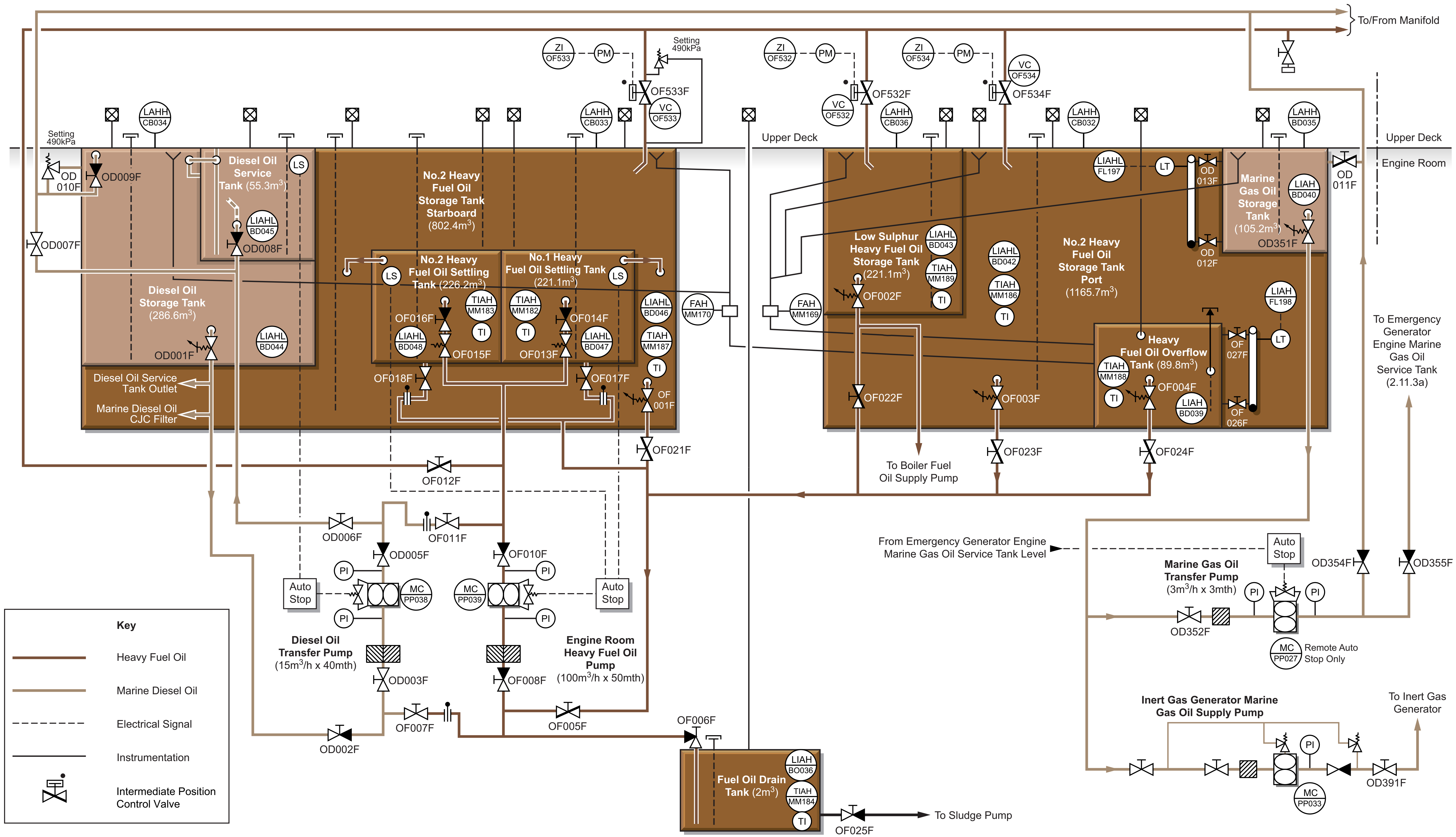
The forward HFO system consists of a centre HFO storage tank located forward of the cargo tanks and above and inboard of the forward water ballast tanks. The forward HFO storage tank is located on the ship's centreline. The tank is filled from the same manifold connections as the aft HFO storage tanks, the filling line running in the under passageway. Two forward FO transfer pumps are used to transfer HFO from the forward storage tank to the aft HFO storage tanks as required. Only one pump is used at any time. The forward FO transfer pumps are located in the forward pump room and may be operated locally or remotely depending upon the setting of the selector switches on the main switchboard panel. In the LOCAL position the pumps may be started and stopped locally by means of the start and stop pushbuttons.



When the forward FO transfer pump control selectors are set to IAS at the main switchboard panel, the pumps may be started and stopped manually at the IAS graphic screen FWD HFO System.

The forward FO transfer pump valves are manually opened and closed but the discharge valve to the bunker transfer line OF511F is remotely operated from the IAS bunker system screen. Tank suction valves for both pumps are of the quick-closing type with trip wire operation from the upper deck.

Illustration 2.6.1b Fuel Oil Bunkering and Transfer System - Engine Room



The forward bunker transfer pump room has a bilge well and a hand pump for draining the well.

Valves at the bunker station on the cargo manifold are manually operated but tank filling valves are controlled remotely from the IAS graphic screen. The graphic display indicates the opening of the fuel oil tank filling valves, the level and quantity in the tanks, and the pressure in the bunkering line.

All outlet valves from all fuel tanks are remotely operated (pneumatic) quick-closing valves with a collapsible bridge which can be operated from the ship control centre, except those for No.1 forward HFO tank and emergency diesel generator MGO tank, which are operated by pull wires. After being tripped from the ship control centre, the valves must be reset locally. Each tank is also fitted with a self-closing test cock to test for the presence of water and to drain any water present.

Tundishes under the self-closing test cock drain any liquid to the primary bilge tank or FO drain tank, via the three-way cock OF473F. Service and settling tanks are provided with local temperature indication, plus remote level and temperature indication in the control room. The tanks also have an overfill alarm. The HFO settling tank overflows to the HFO storage tank.

All HFO tanks are fitted with heating coils, the heating steam being supplied from the heating steam system. Condensate from the heating coils flows to the engine room drain cooler and then to an observation tank before entering the cascade feed water tank. All FO transfer lines are trace heated by steam.

Heavy Fuel Oil Tanks

Compartment	**Capacities (S.G. 0.950)**	
	Volume 100% (m^3)	**Weight 95% (Tons)**
No.2 HFO tank port	1165.7	1052.0
No.2 HFO tank starboard	802.4	724.2
Forward HFO tank	5104.5	4606.8
Low sulphur HFO tank	221.1	199.6
No.1 HFO settling tank	210.9	190.4
No.2 HFO settling tank	226.2	204.2
Total in Bunker Tanks	7730.8	6977.2
HFO overflow tank	89.8	

Precautions to be Observed Prior to and During the Loading of Bunkers

During all bunkering operations the Chief Engineer will be in overall charge with assistance provided by the other engineers as required.

(**Note:** Tanks must only be filled to 98% of capacity and BPS QA bunkering procedures must be strictly adhered to.)

Before and during bunkering, the following steps should be complied with:

a) All engineers and other personnel involved in the bunkering process should know exactly what role they are to play and what their duties are to be. Personnel involved should know the location of all valves and gauges and be able to operate the valves both remotely and locally if required. A bunker plan should be drawn up prior to bunkering and all personnel involved in bunkering must receive a copy of the bunkering plan and be fully aware of the contents of the plan and understand the entire operational procedure. Company rules regarding the taking of bunkers and transfer of fuel oil within the ship must be understood by all involved in the bunkering or fuel oil transfer procedure.

b) Shore or barge tanks, whichever form is being used, should be checked for water content and volume held in each and every tank, including those defined as not part of the operation.

c) Representative samples are to be drawn using the continuous drip method for the duration of the loading operation and dispatched for analysis. Samples should be taken at the bunker supply manifold inlet to the ship system and the supplier requested to witness sampling.

d) As far as possible new bunkers should be segregated from existing bunkers on board. If bunkers being received are to be loaded into the same tanks as existing bunkers on board, great care must be taken to avoid problems of incompatibility. If there is any doubt about the compatibility between the new and existing bunkers the new bunkers should not be loaded on top of existing bunkers.

e) No internal transferring of bunkers should take place during bunker loading operations, unless permission has been obtained from the Chief Engineer.

f) The Chief Engineer should calculate the estimated finishing ullages/dips, prior to the starting of loading based on bunker quality data provided by the supplier.

g) Bunker tanks should not exceed 98% full.

h) Any bunker barges attending the vessel are to be safely moored alongside before any part of the bunker loading operation begins. Frequent checks must be made of the mooring arrangements as the bunker barge draught will change during bunkering.

i) Level alarms fitted to bunker tanks should be tested prior to any bunker loading operations.

j) The soundness of all lines should be verified by visual inspection.

k) The pre-bunkering checklist should be completed and exchanged with the supplier, who should also be provided with a copy of the bunker plan.

l) The Chief Engineer is responsible for bunker loading operations, assisted at all times by a sufficient number of officers and ratings to ensure that the operation is carried out safely.

m) A watch should be kept at the manifold during loading.

n) All personnel involved in the bunkering operation should be in radio contact.

o) The maximum pressure in the bunker line should be below 400kPa. The relief valve discharges oil to No.2 starboard HFO tank.

p) Safe means of access to barges/shore shall be used at all times.

q) Scuppers and save-alls, including those around bunker tank vents, should be effectively plugged. Oil dispersant and fuel oil absorbent materials must be readily available at the bunker manifold.

r) Drip trays are to be provided at bunker hose connections and means of containing any oil spills must be in place. Fire hoses must be rigged and charged and DP or foam extinguishers provided at the manifold.

s) The initial loading rate must be agreed with the barge or shore station and bunkering commenced at an agreed signal and communication with the supplier proved and continually tested. Only upon confirmation of there being no leakage and fuel going into only the nominated tank, should the loading rate be increased to the agreed maximum.

t) When the tank being filled reaches 95% full, the filling rate should be reduced by diverting some of the flow to another bunker tank; if the final tank is being filled the pumping rate must be reduced. Filling of the tank must be stopped when the tank reaches 98% full. When topping off the final tank the filling rate must be reduced at the barge or shore station and not by throttling the filling valve.

CAUTION

At least one bunker tank filling valve must be fully open at all times during the bunkering operation.

HFO bunker tanks are fitted with high level alarms.

All relevant information regarding the bunkering operation is to be entered in the Oil Record Book on completion of loading. The information required to be entered includes date, time, quantity transferred, tanks used and personnel involved.

Procedure for the Loading of Fuel Oil Bunkers from a Shore Station or Barge

a) At the bunker connection to be used, remove the blank and connect the bunkering hose, ensuring that all flange bolts are utilised. Check the joint and fit a new one if the joint shows any signs of damage. Containers for taking bunker samples must be prepared and set in place at the drip connection for the bunkering connection to be used. Spill control facilities must be established according to company instructions.

Bunker stations are fitted on the port and starboard sides of the ship adjacent to the cargo loading manifold. Each bunker station has a main and auxiliary connection for HFO and DO/MGO. The bunkering connections on each side of the ship are directly connected.

b) Ensure that the blanks on the other bunkering connections are secure, that the valves are closed and that drain and sampling valves are closed. The drip tray must be empty and the drain closed.

c) Open the filling valve(s) on the FO bunker/storage tanks to be filled. Tank filling valves are remotely operated from the bunker loading IAS graphic screen

Description	Valve
Forward HFO storage tank filling valve	OF501F
No.2 port HFO bunker tank filling valve	OF534F
No.2 starboard HFO bunker tank filling valve	OF533F
Low sulphur HFO storage tank filling valve	OF532F

d) Open the valve at the selected bunkering connection at the bunker manifold or bunkering station. These valves are locally actuated.

Description	Valve
Port cargo manifold main aft HFO bunkering valve	OF515F
Port cargo manifold forward HFO bunkering valve	OF513F
Starboard cargo manifold aft HFO bunkering valve	OF516F
Starboard cargo manifold forward HFO bunkering valve	OF514F
Forward line manifold valve (for filling forward tank)	OF512F

e) Establish effective communication between the control room, the engine room, the deck filling manifold and the bunkering shore station; this communication must remain established at all times.

f) Agree filling rates and signalling systems with the barge or shore station. Agree the quantity and specification of the fuel oil to be supplied.

g) Signal to the shore station to commence bunkering FO at a slow rate.

h) Check the ship to shore connection, pipeline and passageway for leaks.

i) Check that FO is flowing into the required FO storage tank(s), and not to any other tank.

j) Increase the bunkering rate to the agreed maximum.

k) Commence taking the bunker sample at the cock at the deck manifold.

Commence recording tank contents, bunker temperature and density at 30 minute intervals and calculate the quantity of bunkers shipped each time.

l) As the level in the first /bunker/storage tank approaches 95%, open another tank filling valve in order to top up the first tank slowly. When the tank reaches the 98% level close the filling valve at the bunker loading IAS graphic screen.

m) Fill the remaining tanks in the same way. For the final storage tank the filling rate must be reduced by slowing the pumping operation and this must be signalled to the barge or shore station and confirmed.

n) When the final tank is full, the barge or shore station must be signalled to stop pumping.

o) Ensure that the sample containers are properly sealed and have them despatched for analysis, ensuring that the supplier has endorsed the sample labels/seals and has been given the suppliers sample from onboard.

p) Drain the bunker lines using the pump or air blowing system as required.

q) When lines are completely drained close all bunker station and tank filling valves.

r) Disconnect the hose and replace the blank at the bunker station connection.

s) Check tank levels and agreed quantity the supplied and then, if satisfied, sign the bunker receipt after obtaining a bunker sample from the supplier and witnessed taking by ship's staff.

Complete Company paperwork and ensure signatures are obtained from the supplier where required and endorsed by the suppliers stamp where appropriate.

Procedure for the Loading of Low Sulphur Fuel Oil Bunkers from a Shore Station or Barge

a) Observe all precautions as for loading HFO bunkers and connect the bunker hose to the port or starboard HFO connection at the port or starboard bunker station. Agree loading procedures as in the procedure for HFO bunkering above, including all checks, inspections, paperwork, etc as per the normal HFO loading.

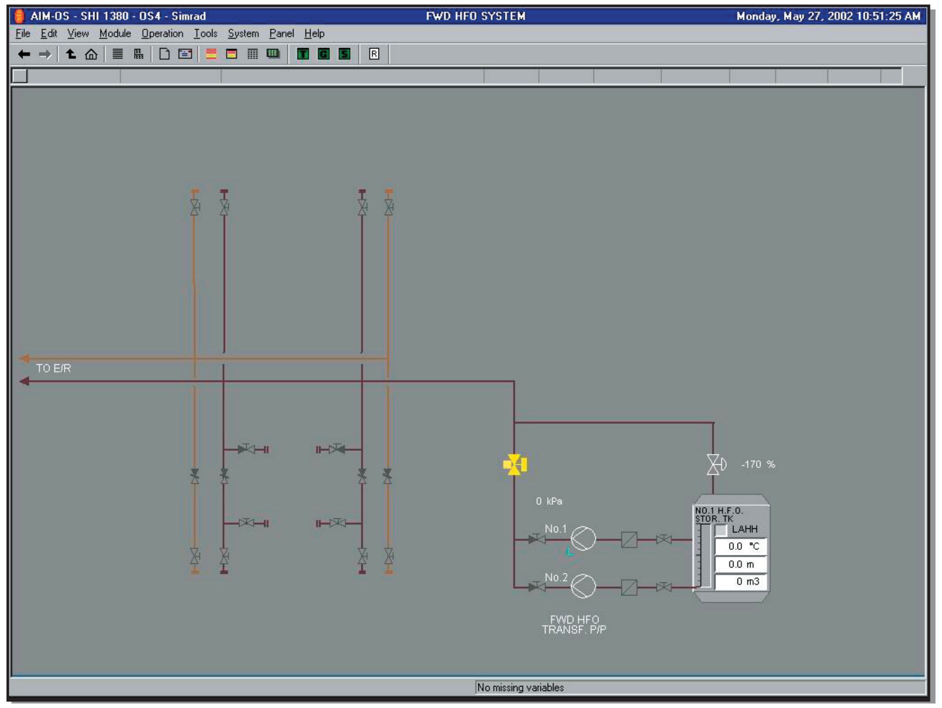
b) Ensure that all HFO tank filling valves are closed by checking at the bunker loading IAS graphic screen.

c) Open the low sulphur FO tank filling valve OF532F. A sample must be taken during bunkering.

d) When the pipeline is set and the tank valve and selected bunker manifold valves are open, signal to start loading the low sulphur FO. The levels in the low sulphur FO tank may be seen at the aft FO storage and transfer system graphic display.

e) When the low sulphur FO tank reaches 95% full the bunker barge must be signalled to reduce the pumping rate. When the tank is full pumping must be stopped.

f) When bunkering low sulphur FO is complete the line must be drained as in the procedure for loading fuel oil as above. When the lines are drained all valves must be closed, the bunkering pipe removed and the blank refitted. Proceed as per normal HFO bunkering with reference to samples, paperwork, etc at completion.



Procedure for Transferring Fuel Oil from the Forward Storage Tank to the Aft Heavy Fuel Oil Storage Tanks using the Forward Fuel Oil Transfer Pumps

The HFO stored in the forward No.1 storage tank cannot be pumped directly to the HFO settling tanks but must firstly be transferred to the aft HFO No.2 storage tanks. Two forward FO transfer pumps are provided for this purpose, the transfer line being the bunker loading line.

The transfer of HFO from the forward storage tanks to the aft HFO storage tanks may be undertaken from the bunker loading IAS graphic screen. The forward FO transfer pumps may be started and stopped from this screen. The forward HFO tank suction valves and the forward FO transfer pump discharge valves are manually operated and should be opened whenever there is a need to transfer HFO from the forward tank to the aft tanks. The transfer pump line discharge valve OF511F is remotely operated and should normally be closed unless actually transferring HFO.

a) Check the quantity of HFO in the No.2 HFO storage tank to which it is intended to transfer HFO. Check the quantity of HFO in the forward HFO storage tank from which HFO is to be transferred and note the temperature; if the temperature is too low for effective pumping then steam heating must be applied.

b) Check that the forward FO transfer pump suction filter is clean for the pump to be used.

c) Open the suction valves of the forward FO transfer pump: valve OF502F and the quick-closing valve OF521F for No.1 forward FO transfer pump and valve OF503F and the quick-closing valve OF522F for No.2 forward FO transfer pump.

d) Set the discharge valves for the forward HFO transfer pump, the forward FO storage tank suction valve and the filling valves for the aft FO storage tanks. Set the valves as in the following table:

Position	Description	Valve
Open	No.1 forward FO transfer pump discharge valve	OF525F
Open	No.2 forward FO transfer pump discharge valve	OF526F
Closed	No.2 forward FO transfer pump bypass discharge valve	OF527F
Open	Remotely operated discharge line valve	OF511F
Open	Forward bunkering line valve	OF512F
Open	No.2 HFO storage tank port filling valve	OF534F
Open	No.2 HFO bunker tank starboard filling valve	OF533F

e) Select one of the forward FO transfer pumps as the duty pump. In order to allow for operation via the IAS screen the pump main switchboard panel starter switch must be set to IAS. The switch can also be set to LOCAL which allows the pump to be started and stopped from local pushbuttons.

f) Start the selected forward HFO transfer pump and transfer HFO from the forward FO storage tank to the selected aft HFO storage tank.

g) When the desired quantity of HFO has been transferred, stop the pump.

h) If HFO is being transferred to both aft FO bunker tanks the second tank filling valve must be opened when the first tank reaches the 95% full level. The first tank filling valve must be closed when the 98% level is reached. If the tank is not to be filled to the 98% level pumping must be stopped when the desired level is reached. Alternatively the filling valve for the second tank must be opened and the filling valve for the first tank closed when the desired level is reached.

(**Note:** There must always be at least one tank filling valve open when a FO transfer pump is operating.)

i) When the desired quantity of oil has been transferred stop the forward FO transfer pump, close all valves and record the transfer in the Oil Record Book.

Procedure for Transferring Fuel Oil from the Aft Heavy Fuel Oil Storage Tanks to the Fuel Oil Settling Tanks using the Fuel Oil Transfer Pump

(**Note:** The FO settling tanks are fitted with level switches and the FO transfer pump is equipped for automatic stop under the control of these switches. Under normal circumstances the suction valves remain set so that the FO transfer pump can pump HFO into the selected FO settling tanks; one of the tanks would be in use and the other being filled or settling after filling and before use.)

When transferring HFO trace heating should be applied to the fuel lines and should be left on the transfer lines. Ensure that sufficient valves remain open on the HFO line to prevent overpressurising due to an increase in temperature.

The settling tanks are fitted with low level alarms which will indicate that a tank has reached the level where it must be replenished should that action not have been taken. The settling tank in operation must be checked periodically and an estimate made of when a changeover will be needed. If the settling tank in operation is likely to reach its low level during a period of UMS operation the settling tanks should be changed over before that period of UMS operation commences. A low level settling tank should be refilled as soon as possible.

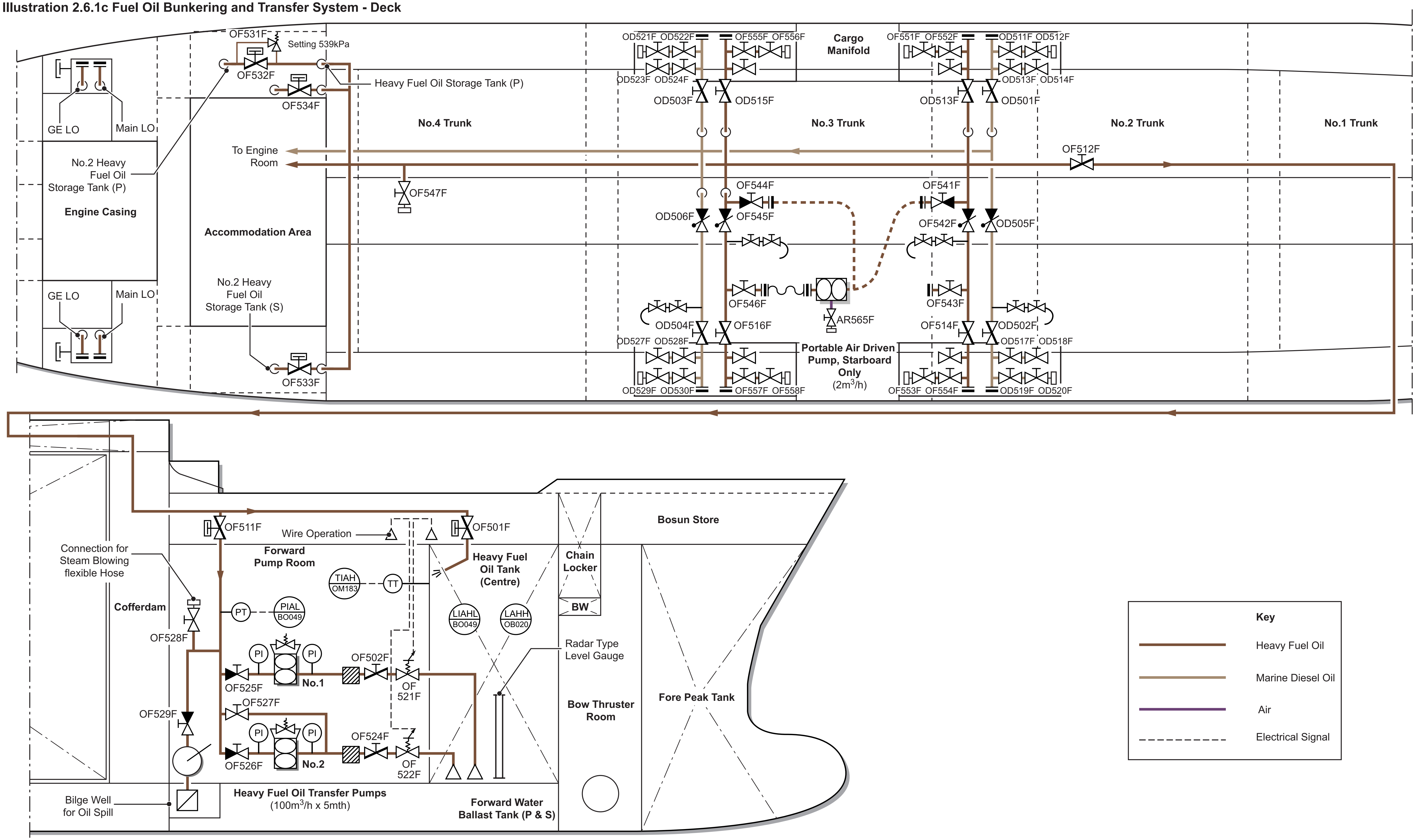
a) Check the quantity of HFO in the FO settling tank to be filled and determine how much oil is to be transferred. Check the quantity of HFO in the tank from which FO is to be transferred and note the temperature; if the temperature is too low for effective pumping then steam heating must be applied. If the quantity of HFO in the storage tank is less than the quantity to be pumped be prepared to change over tanks.

b) Check that the FO transfer pump suction filter is clean.

c) Open the quick-closing suction valve from the HFO storage tank from which FO is to be transferred and the FO transfer pump valves. Valves are as in the following table and they are normally left open.

Description	Valve
No.2 HFO bunker tank port quick-closing valve	OF003F
No.2 HFO bunker tank port line valve	OF023F
No.2 HFO bunker tank starboard quick-closing valve	OF001F
No.2 HFO bunker tank starboard line valve	OF021F
HFO transfer pump suction valve from FO storage tanks	OF005F

Illustration 2.6.1c Fuel Oil Bunkering and Transfer System - Deck



Description	Valve
HFO transfer pump suction valve	OF008F
HFO transfer pump discharge valve	OF010F

d) Ensure that the suction valves from the FO overflow tank OF004F and OF024F, the FO drain tank OF006F and the low sulphur FO tank OF002F and OF022F are closed.

e) Ensure that the FO transfer pump discharge valve to the bunker line OF012F is closed.

f) Open the filling valve OF014F for the port or OF016F for the starboard HFO settling tank, whichever is to be filled.

g) Open the tank and line suction valves from the port or starboard aft HFO storage tank, from which HFO is to be taken.

h) Check that the HFO transfer pump and DO transfer pump suction and discharge crossover line valves OF007F and OF011F are closed. (Spectacle blanks are fitted to these connections.)

i) Start the HFO transfer pump. The pump must be selected for automatic cut out when the settling tank level reaches the level switch.

j) Check that FO is being correctly transferred from the required HFO bunker tank to the designated FO settling tank.

k) When the required amount of oil has been transferred, stop the pump. Alternatively the pump can be allowed to stop automatically when the tank high level switch is activated..

(**Note:** The manually operated valves may remain open unless oil is to be transferred from tanks other than the HFO bunker tanks.)

1) Record the oil transfer in the Oil Record Book.

Procedure for the Transfer of Heavy Fuel Oil using the Diesel Oil Transfer Pump

a) Open the crossover suction valve OF007F and the crossover discharge valve OF011F and change over the spectacle blanks at each location so that they are open.

b) Close the DO transfer pump line suction valve from the DO storage tank OD002F and line discharge valves to the DO service tank OD006F.

c) Ensure that the diesel oil transfer pump discharge valve OD005F is open and that the suction valve OD003F is open. The pump is now set to take suction from the HFO system and discharge to the HFO system

d) Set the HFO tank system valves as in the previous procedure for transferring HFO using the HFO transfer pump.

e) Start the DO transfer pump from the IAS graphic screen or locally if required. Check that HFO is being transferred from the required tank to the desired tank.

f) Stop the pump when the required quantity of HFO has been transferred.

(**Note:** This operation requires manual control as the automatic pump stop only works with the FO transfer pump.)

g) Close all system valves, refit line blanks and lock the crossover valves closed.

h) Record the oil transfer in the Oil Record Book.

CAUTION

Ensure that all FO is flushed out of the diesel oil transfer pump prior to restoring it to gas oil service. This can be achieved by opening the diesel oil suction and pumping for a few moments with a discharge to the FO tanks open. Before starting the pump to transfer diesel oil, make absolutely sure that all discharges to the FO system are securely closed.

Procedure for Transferring Heavy Fuel Oil from Port to Starboard Storage Tanks, or Vice Versa

a) Open the HFO transfer pump suction valve OF008F and the discharge valve OF010F.

b) Close the HFO settling tank filling valves OF014F and OF016F.

c) Open the HFO bunker tank quick-closing valve and line valve for the tank from which HFO is to be taken; OF001F and OF021F for the starboard bunker tank and OF003F and OF023F for the port bunker tank. Fuel oil flow from the storage tanks is usually by means of the line valves with the quick-closing valves left open.

d) Open the HFO transfer pump line suction valve from the HFO storage tanks OF005F.

e) Open the bunker line valve from the HFO transfer pump OF012F.

f) At the IAS bunker system graphic screen open the filling valve for the HFO storage tank to which HFO is to be pumped. If HFO is being taken from the port tank it will be pumped to the starboard tank in which case valve OF533F must be opened; if HFO is being taken from the starboard tank then it will be pumped to the port tank and valve OF534F must be opened.

g) Confirm that the low sulphur filling valve OF532F and forward bunker line valve OF512F are closed.

h) Check the quantity of HFO to be transferred and check that the receiving tank has sufficient capacity.

i) Start the HFO transfer pump at the pump.

j) When the required quantity of HFO has been transferred stop the pump and close all valves which have been opened, ensuring no thermal pressurisation..

k) Record the oil transfer in the Oil Record Book.

Procedure for Transferring Heavy Fuel Oil from the Aft Bunker Tanks to the Forward Fuel Oil Storage Tank

HFO may be transferred from the aft No.2 storage tanks to the forward No.1 FO storage tanks if required. The procedure is similar to that for transferring HFO between the aft storage tanks as described in the previous procedure steps a) to j) inclusive except for step f). Instead of opening the filling valves for the aft storage tanks filling and line valves for the forward bunker tanks would be opened. The deck line valve OF512F would be opened manually and at the IAS screen for the forward storage tank valve OF501F would be opened and valve OF511F confirmed as closed.

Procedure for Transferring Oil from the Fuel Oil Overflow Tank to the Heavy Fuel Oil Settling Tank

a) Check the amount of fuel to be transferred and ensure that the settling tank has sufficient capacity.

b) Set the HFO transfer pump to operate remotely and manually from the IAS graphic screen.

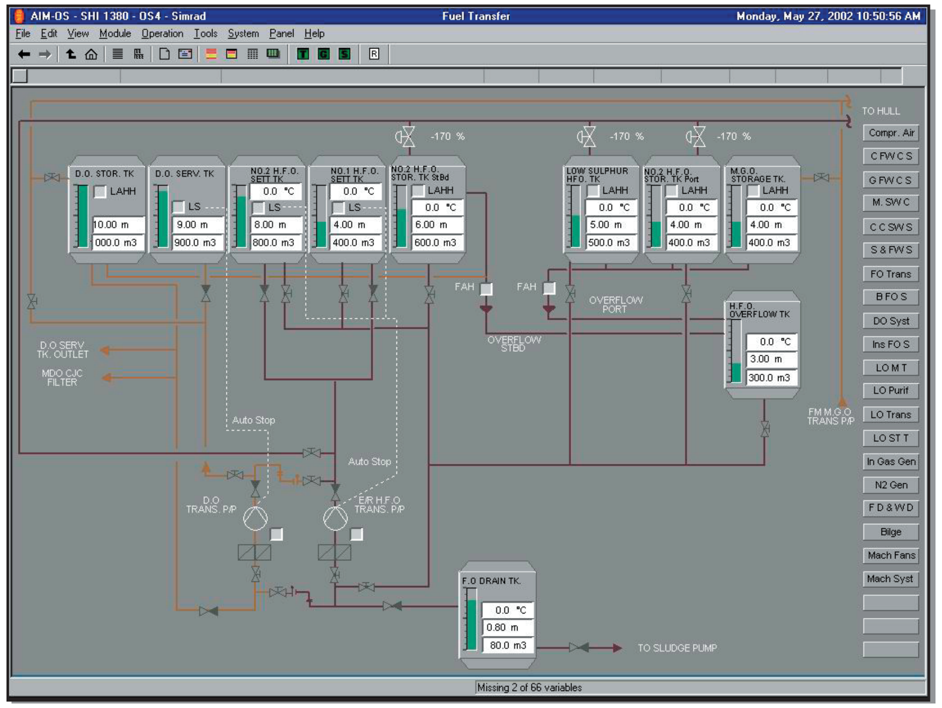
c) Open the HFO transfer pump suction valve OF008F, the line suction valve OF005F and the HFO transfer pump discharge valve OF010F.

d) Open the HFO overflow tank quick-closing valve OF004F and line valve OF024F. Open the filling valve to the desired HFO settling tank OF014F for No.1 HFO settling tank or OF016F for No.2 HFO settling tank.

e) Start the HFO transfer pump and transfer the desired quantity of FO from the FO overflow tank. When the overflow tank is empty stop the FO transfer pump and close their system valves.

(**Note:** Fuel from the FO overflow tank may be transferred to one of the No.2 aft HFO bunker tanks or the forward No.1 FO storage tank using the procedures described above except that the filling valves for the settling tanks would be closed and the line valve OF012F open together with the tank filling valve for the selected bunker or storage tank.)

(**Note:** Fuel from the FO drain tank may be transferred to the HFO settling tanks or the HFO aft bunker tanks or forward FO storage tank using the procedure as above except that the HFO overflow tank suction and line valves OF004f, OF024F and OF005F would be closed and the FO drain tank suction valve OF006F would be open.)



Procedure for Transferring Oil from the Low Sulphur Fuel Oil Storage Tank to the Heavy Fuel Oil Settling Tanks

The procedure is the same as for transferring HFO from the HFO No.2 storage tanks to the HFO settling tanks except for the line suction valves.

HFO storage tank quick closing and line suction valves must be closed (OF001F and OF021F for No.2 starboard HFO storage tank and OF003F and OF023F for No.2 port HFO storage tank) and the quick-closing suction valve OF002F and line suction valve OF022F from the low sulphur

HFO tank must be open. The HFO transfer pump is started and the desired quantity of low sulphur HFO transferred.

Diesel Oil System

Diesel oil (DO) for all purposes on board the ship is stored in the DO storage tanks located in the engine room. From the storage tank DO is transferred to the DO service tank The diesel generator and the boiler ignition burner are normally supplied with DO from the DO service tank although the burner may be supplied directly from the DO storage tank. The emergency generator engine and the inert gas generator (IGG) use gas oil (GO) which is supplied from the gas oil storage tank.

The DO transfer pump is located on the starboard side of the engine room floor and is used to transfer DO from the storage tank to the service tank. The DO transfer pump may be started and stopped remotely or locally. For local operation the control selector switch at the main switchboard starter panel must be turned to the LOCAL position and the pump may then be started and stopped by means of the local pushbuttons. There is also a LOCK position at the local pushbuttons and a RUN position. When the control selector is set to RUN and the starter panel switch set at IAS the DO transfer pump may be started and stopped manually at the IAS graphic screen. The display graphic indicates the operating status of the DO transfer pump. The DO service tank is fitted with a level switch which switches off the DO transfer pump when the maximum working level in the tank is reached. There is also a long run alarm which is activated if the pump runs for longer than 100 minutes.

DO is pumped from the DO storage tank to the DO service tank and the DO CJC filter using the DO transfer pump.

The DO storage tank is filled from a DO bunkering line with connections adjacent to the cargo loading manifold on the port and starboard side of the ship at upper deck level. There are two DO bunkering connections on each side of the ship. The DO bunkering line is fitted with a relief valve set at a pressure of 490kPa and this valve releases oil to the DO storage tank. The DO transfer pump is located in the engine room and is used to transfer DO from the DO storage tank to the DO service tank for the generator engine and boiler. It may also be used to pump HFO in an emergency and the HFO transfer pump may also be used to pump DO in an emergency.

The DO service tank overflows to the DO storage tank. The DO service tank is fitted with high level switch for stopping the DO transfer pump.

Gas oil is loaded via the diesel oil bunker line. The gas oil storage tank and diesel oil storage tank overflow to the HFO overflow tank

Gas oil is stored in the gas oil storage tank and the gas oil transfer pump is used to pump to the emergency generator gas oil service tank. The tank provides an automatic stop for the gas oil transfer pump by means of a high level switch, The IGG is supplied with gas oil directly from the gas oil storage tank by means of the IGG gas oil supply pump.

Diesel Oil and Gas Oil System Tanks

Compartment	Capacities (S.G. 0.90)	
	Volume 100% (m^3)	Weight 95% (Tons)
DO storage tank	286.6	245.1
DO service tank	55.3	47.3
Incinerator DO service tank	0.5	
Gas oil storage tank	105.2	89.9
Total	**447.1**	**382.3**
Emergency generator GO service tank	6.5	

The outlet valves from the DO and MGO storage tanks and service tanks are remote operated quick-closing valves with a collapsible bridge. Each tank is also fitted with a self-closing test cock to test for the presence of water and to drain any water present. Tundishes under the self-closing test cocks drain any liquid to the primary bilge tank or fuel oil drain tank. All tanks, excluding the emergency DG MGO storage tank, incinerator DO tank and waste oil tank are provided with level indication, plus remote level indication in the control room. No.1 HFO storage tank, No.2 port and starboard HFO tanks, the low sulphur HFO tank and the DO storage tank have an overfill alarm set at 98% capacity. The service tanks also have overfill alarms.

Procedure for Loading Diesel Oil and Gas Oil From a Shore Station or a Barge

The precautions and organisation for loading DO and Gas oil should followed, as described for HFO and the BPS QA bunkering procedures must be strictly adhered to. The DO and gas oil storage tanks checked to ensure that there is sufficient capacity for the DO and Gas oil to be loaded.

a) At the DO bunker connection to be used the bunker line blank is removed and the bunkering hose connected. The joint should be inspected and replaced as soon as it shows signs of damage.

b) A drip tray is arranged beneath the bunker pipe connection and equipment organised to deal with any oil spill.

c) Ensure that the blanks on the other bunkering connections are secure and that the valves are closed. Ensure that the drain and sampling valves are closed. Open the DO bunker station valve for the line to be used. Valves OD501F (port/forward), OD503F9 (port/aft), OD502F (starboard/forward) and OD504F (starboard/aft) must be closed.

d) Open the selected DO storage tank inlet valve OD009F or the gas oil storage tank inlet valve OD011F depending upon which fuel is being loaded.

e) When all pipes and connections are checked, signal the shore station or bunker barge to commence pumping at the agreed low rate.

f) When it is confirmed that there are no leaks, signal to increase the delivery rate to the agreed maximum.

g) Open the sampling cock and begin taking a sample of the delivered DO or gas oil.

h) When the storage tank is 95% full signal the shore station or barge to reduce the delivery rate and when the tank is 95% full signal to stop pumping. Levels and contents of the DO and gas oil storage tanks may be seen from the aft FO storage and transfer system IAS graphic screen.

i) Once the DO line has been cleared from the supplier, 'air blow' and close the manifold valve.

j) Open the vent and allow the bunker hose and pipelines to drain.

k) Disconnect the hose and refit the blank.

l) Collect the DO or gas oil sample and have it sent for analysis.

m) Check the quantity of fuel delivered to the storage tank, agree the delivery quantity with the supplier and sign the receipt. Complete the Oil Record Book with details of the bunkering.

Procedure for the Transfer of Diesel Oil using the Diesel Oil Transfer Pump

Diesel oil may be transferred to the DO service tank using the DO transfer pump. The pump may also be used for transferring HFO in an emergency and the HFO pump may be used for transferring DO when the DO transfer pump is inoperative.

a) Check that there is sufficient DO in the DO storage tank and that the tank to which the DO is to be pumped has sufficient capacity.

b) Ensure that the crossover valves to the HFO transfer pump OF007F and OF011F are closed and the spectacle blank in place.

c) Ensure that the DO transfer pump suction strainer is clean.

d) Open the DO storage tank suction valve OD001F, the DO transfer pump line suction valve OD002F and the DO transfer pump suction valve OD003F.

e) Open the DO transfer pump discharge valve OD005F and the line valve OD006F together with the DO service tank filling valve OD008F.

(**Note:** The system is normally set for pumping to the DO service tank; the pump is set to IAS and Auto operation, automatic operation being selected at the IAS graphic screen. In automatic mode the pump will cut out when the level of the DO service tank reaches the upper limit.)

f) Start the DO transfer pump and check that DO is being pumped to the DO service tank. When the desired quantity of DO has been transferred stop the pump or allow the automatic stop system to operate.

(**Note:** The DO transfer pump may be used to pump DO into the DO bunker line if required by opening valve OD007F and closing the DO service tank filling valve.)

Procedure for the Transfer of Diesel Oil using the Heavy Fuel Oil Transfer Pump

Diesel oil may be transferred to the DO service tank using the HFO transfer pump. The procedure is similar to that for transferring DO using the DO transfer pump except that the crossover valves between the two pumps, OF007F and OF011F must be open together with the line spectacle blanks.

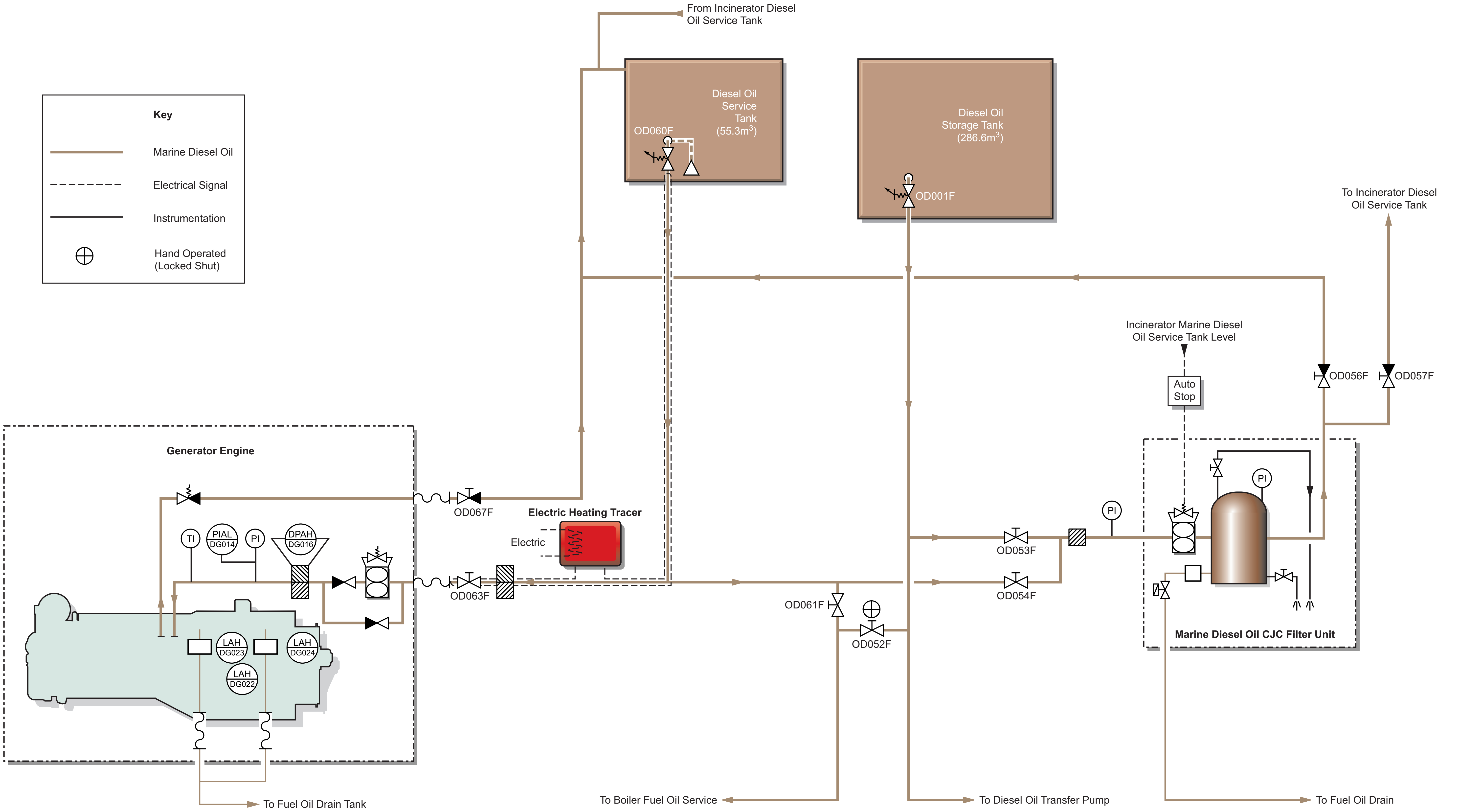
The HFO transfer pump suction valves from the HFO storage tanks, the HFO overflow tank, the FO drain tank and the low sulphur FO tank must be closed.

Transfer procedure is the same as for transfer using the DO transfer pump except that the automatic stop facility will not work and so the pump must be started and stopped manually.

Alarms

Tag	Description	Low	High
MM0182/3	No.1 and 2 HFO settling tanks temperature		80°C
MM0187/8	No.2 HFO storage tanks (P and S) emperature		80°C
MM0184	FO drain tank temperature		60°C
MM0188	HFO overflow tank temperature		60°C
MM0189	Low sulphur HFO tank temperature		60°C
BD036	FO drain tank level		0.9m
BD039	HFO overflow tank level		3.9m
BD40	MGO storage tank level	0.6m	4.7m
BD42	No.2 port HFO storage tank level	0.6m	15.7m
BD43	Low sulphur HFO tank level	0.6m	11m
BD44	Diesel oil storage tank level	0.6m	11m
BD46	No.2 starboard HFO storage tank level	0.6m	15.7m
BD47	No.1 HFO settling tank level	0.6m	6.2m
BD48	No.2 HFO settling tank level	0.6m	6.2m
BD49	No.1 HFO storage tank level	0.6m	18m
BD50	Diesel oil storage tank level for ER		0.3m
CM179	No.1 forward HFO tank temperature		60°C
CM183	Forward HFO transfer pump discharge pressure 200kPa		

Illustration 2.6.2a Diesel Oil Filtering and Generator Engine Diesel Oil Service System



2.6.2 DIESEL OIL FILTERING AND GENERATOR ENGINE DIESEL OIL SERVICE SYSTEM

The main diesel generator engine runs on DO which is supplied from the DO service tank. DO flows from the service tank to the generator engine by gravity, passing though a duplex filter on the way to the generator engine feed fuel pump. The supply line from the DO service tank to the generator engine is electrically trace heated.

The generator engine has its own engine driven fuel feed pump which maintains the engine's fuel rail supplied with DO. The fuel feed pump supplies excess fuel in order to ensure that the fuel rail, which supplies the fuel injection pumps, is maintained under a slight pressure at all times. The excess fuel flows back to the DO service tank, together with the DO spill from the DO injectors.

Leakage from the generator engine fuel systems flows to the FO drain tank via the fuel leakage detectors.

The DO service tank can also supply the boiler FO pumps should it be necessary to operate the boilers on DO.

The generator engine fuel supply system is manually set.

Procedure for the Transfer of Diesel Oil from the Diesel Oil Storage Tank to the Incinerator Diesel Oil Service Tank

Diesel oil is transferred to the incinerator DO service tank from the DO storage or service tanks via the DO CJC filter unit.

This unit has its own pump which has an automatic cut-out facility from a level switch in the incinerator DO service tank.

a) Open the DO CJC filter outlet valve to the incinerator DO service tank OD057F and the inlet valve from the DO storage tank OD053F, or the inlet valve from the DO service tank OD054F. Open the inlet valve to the incinerator DO service tank OD361F.

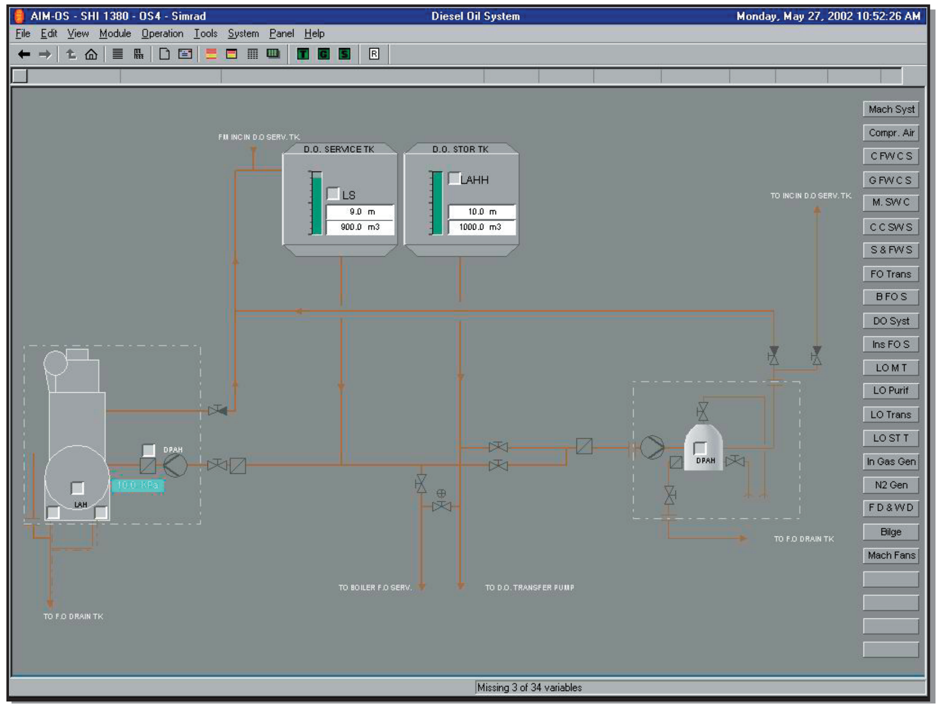
b) Open the DO storage tank quick closing outlet valve OD001F, or the DO service tank outlet valve OD060F.

c) Check that the filter valves are correctly set and that the CJC filter is operational.

d) Start the CJC filter pump and transfer the desired quantity of oil to the incinerator DO service tank. The pump will stop when the tank is full.

e) Check the quantity of fuel transferred and record the transfer in the Oil Record Book.

f) Valves may be left set unless the CJC filter is to be used for transferring DO from the DO storage tank to the DO service tank.



Procedure for the Transfer of Diesel Oil from the Diesel Oil Storage Tank to the Diesel Oil Service Tank

Diesel oil is transferred to the DO service tank from the DO storage tank via the DO CJC filter unit. This unit has its own pump which has an automatic cut-out facility from a level switch in the incinerator MDO service tank and so when pumping DO to the DO service tank the pump must be operated manually.

a) Open the MDO CJC filter outlet valve to the DO service tank OD056F and the inlet valve from the DO storage tank OD053F. Ensuring valves OD057F and OD054F are closed.

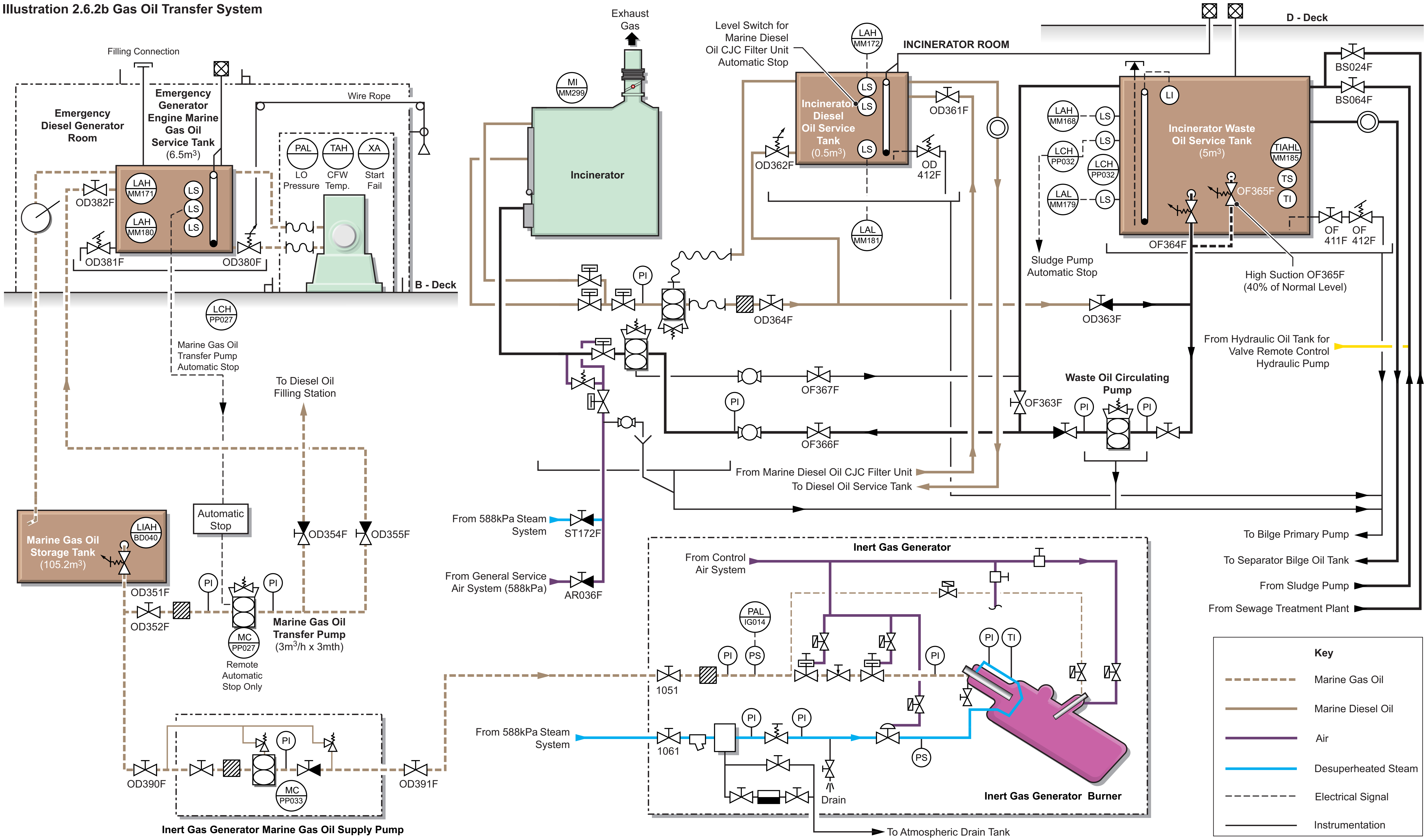
b) Open the DO storage tank quick closing outlet valve OD001F.

c) Check that the filter valves are correctly set and that the CJC filter is operational.

d) Start the CJC filter pump and transfer the desired quantity of oil to the DO service tank. Stop the pump when the tank is full and close the valves.

e) Check the quantity of fuel transferred and record the transfer in the Oil Record Book.

Illustration 2.6.2b Gas Oil Transfer System



Procedure for the Transfer of Gas Oil from the Gas Oil Storage Tank to the Emergency Generator Engine Gas Oil Service Tank

Gas oil is transferred to the emergency generator engine gas oil service tank from the gas oil storage tank via the gas oil transfer pump.

a) Open the quick closing outlet valve from the gas oil storage tank OD351F and the gas oil transfer pump suction valve OD352F.

b) Open the gas oil transfer pump outlet line valve to the emergency generator engine gas oil storage tank OD355F and close the line valve to the DO filling station OD354F.

c) Open the emergency generator engine gas oil service tank filling valve OD382F.

d) Set the gas oil transfer pump to automatic operation and start the pump. The pump will operate to transfer gas oil from the gas oil storage tank to the emergency generator engine gas oil service tank. The pump will stop automatically when the upper level switch is activated. The emergency generator engine gas oil tank overflows to the gas oil storage tank.

Procedure for Operating the Generator Engine Diesel Oil System

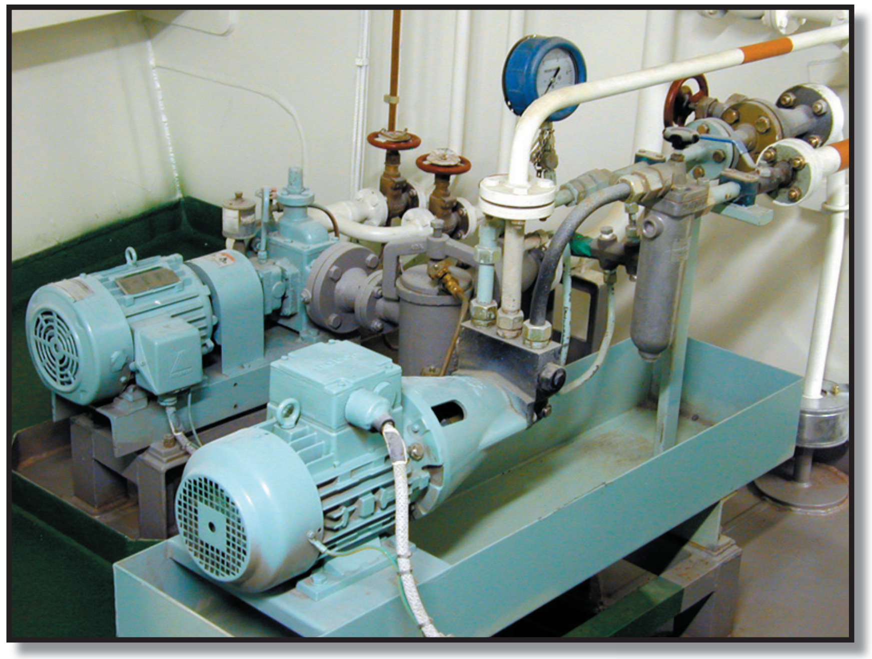
a) Check that there is sufficient fuel in the DO service tank and replenish if necessary using the procedure described in section 2.6.1.

b) Set the system valves as in the following table.

Position	Description	Valves
Open	DO service tank quick-closing outlet valve	OD060F
Open	Engine fuel inlet valve	OD063F
Open	Engine fuel return valve	OD067F

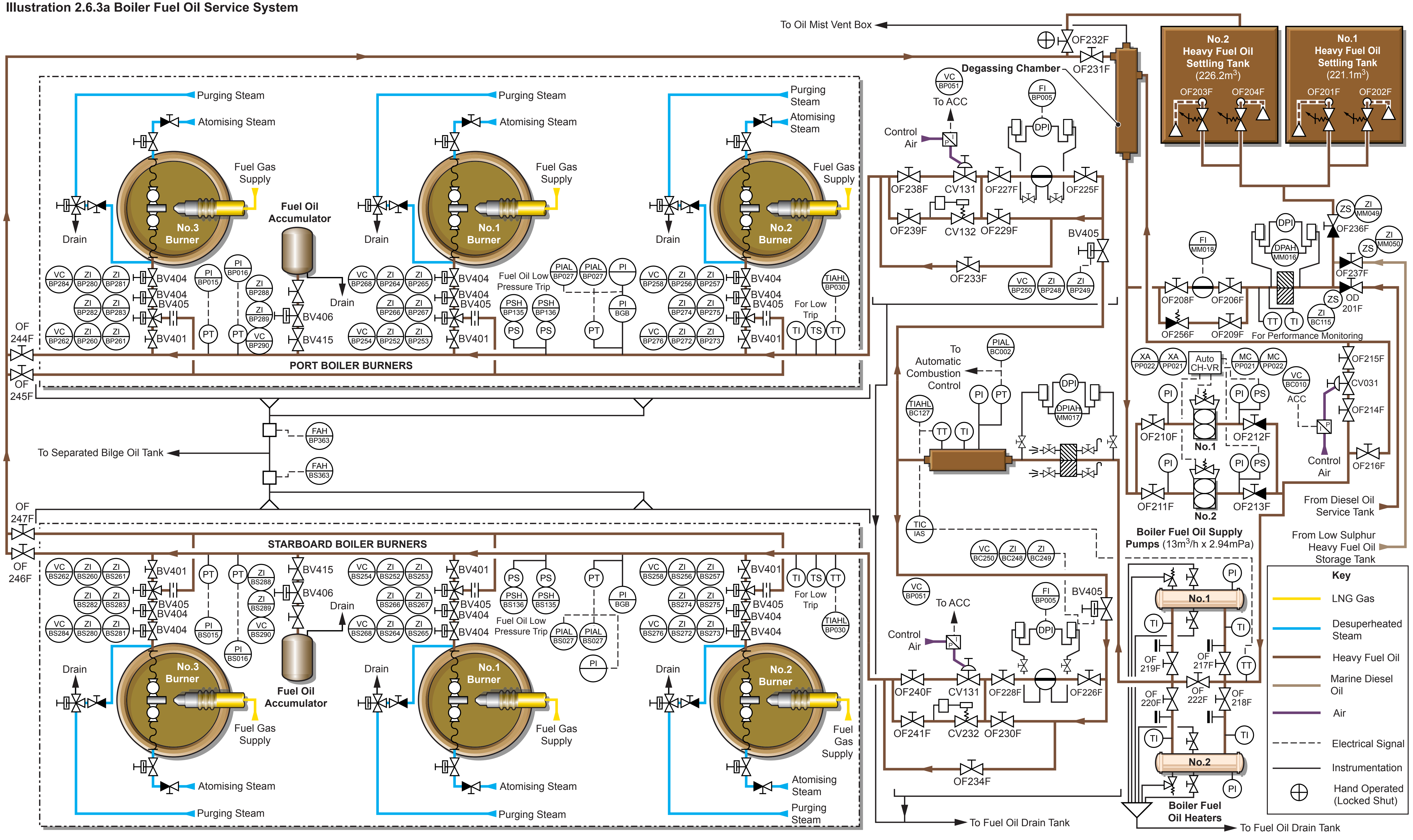
c) Operate the generator engine as required and replenish the DO service tank when necessary.

Gas Oil Transfer Pump



IG Generator Gas Oil Supply Pump

Illustration 2.6.3a Boiler Fuel Oil Service System



2.6.3 BOILER FUEL OIL AND FUEL GAS SERVICE SYSTEMS

Boiler Fuel Oil Supply Pump

Maker:	Taiko Kikai Ind. Ltd
No. of sets:	2
Type:	Horizontal screw
Model:	MSES-15XA
Capacity:	13m^3/h at 2.94MPa and 25.8cSt

Introduction

The boilers can operate on liquid fuel oil and gaseous fuel from cargo tank boil-off. The quantity of gaseous fuel used depends upon the cargo tank boil-off rate and so HFO will always be available to supplement the gas. Depending upon circumstances it may be necessary to operate with 100% HFO at times. The burner management system is described in section 3.3.3.

There are two boilers and each is fitted with three burners. These burners can operate on HFO or gas. Each boiler can be treated as a separate item in terms of fuel supply, one on gaseous fuel and the other on HFO.

The Fuel Oil System

HFO is taken from the HFO settling tanks or the low sulphur HFO tank. There are two boiler FO supply pumps which are on a Duty/Standby selection. The pumps may be operated locally or from the IAS system operator station. The pumps may be selected for local or remote operation by turning the switch at the pump local control to the NOR position. In the LOCK position the pump may not be started. For local operation a pump is started and stopped by means of the local START and STOP pushbuttons. A pump can be selected for remote control operation via the IAS screen by turning the main switchboard panel switch to IAS. The pump may now be operated in manual or auto mode. When selected for automatic operation the pump will act as the standby pump cutting in automatically if the duty pump cannot maintain the desired pressure.

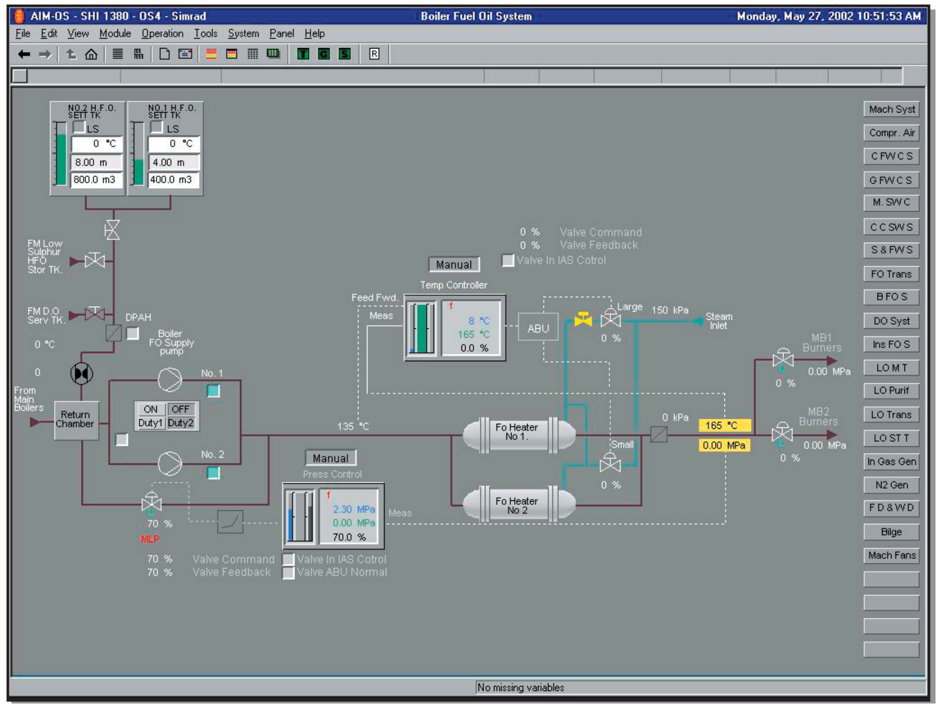
A pump may only be selected as the standby pump if

- The other pump is already running
- Both pumps are selected in NOR mode
- The pump is in IAS mode
- The pump is not tripped

The operation of the IAS control is given in more detail in part 1 and section 3.1.

HFO is taken from the operating HFO settling tank and flows to the boiler FO supply pump suction via a duplex filter and flow meter. The boiler FO supply pumps also taken suction from the FO degassing chamber as the pumps operate at a constant pressure discharge using a recirculating PCV to maintain this, the excess FO being returned to the FO degassing chamber and hence back into the pump suction.

The boiler FO supply pumps force the HFO through one of the two steam heated FO heaters and a hot duplex discharge filter. There are two steam valves of different size working in a split range configuration. A temperature transmitter located after the hot discharge filter regulates the steam supply to the FO heaters in order to maintain the desired HFO temperature of 112 C thus viscosity. A 4-20mA signal to the ABU hardware unit is split into two outputs, where on signal of 4-20mA works on the smaller valve CV033 and the second signal of 12-20mA works on the larger valve CV032. The piston valve BV432 will open when the ABU unit output is greater than 60% and close when the output is smaller than 40%.



From the FO chamber which accommodates the temperature transmitter the heated HFO is delivered to the boiler FO manifolds. The two boilers have separate supply manifolds and each has its own pressure regulating valves and flow meter. There is a main pressure control valve and a minimum pressure keep valve per boiler. The main pressure regulating valve is controlled from the IAS.

A fuel oil recirculating line is also provided at the end of each boiler fuel manifold to allow for warming through of the fuel system. Each burner has a three-way valve which diverts HFO into the return manifold when the boiler fuel system is on standby when gas only burning.

Procedure for Preparing the Boiler Fuel Oil System for Operation from Cold

The description assumes that the boiler is being flashed up from cold and that fuel is being taken from the diesel oil service tank. It is assumed that the boiler has been shut down with DO in the fuel lines.

Normally this is not necessary if steam is available to heat the system but if the boiler plant is to be totally shut down and no steam is available a boiler must be flashed up from cold using DO. In order to ensure that DO can flow readily through the fuel oil lines the boiler fuel lines must be purged of HFO by circulating DO before the boiler is shut down.

a) Check the quantity of DO in the DO service tank and replenish if necessary.

b) Ensure that all instrument and control valves are open and that instruments are reading correctly.

c) Ensure that there is control air available at pressure regulating valves.

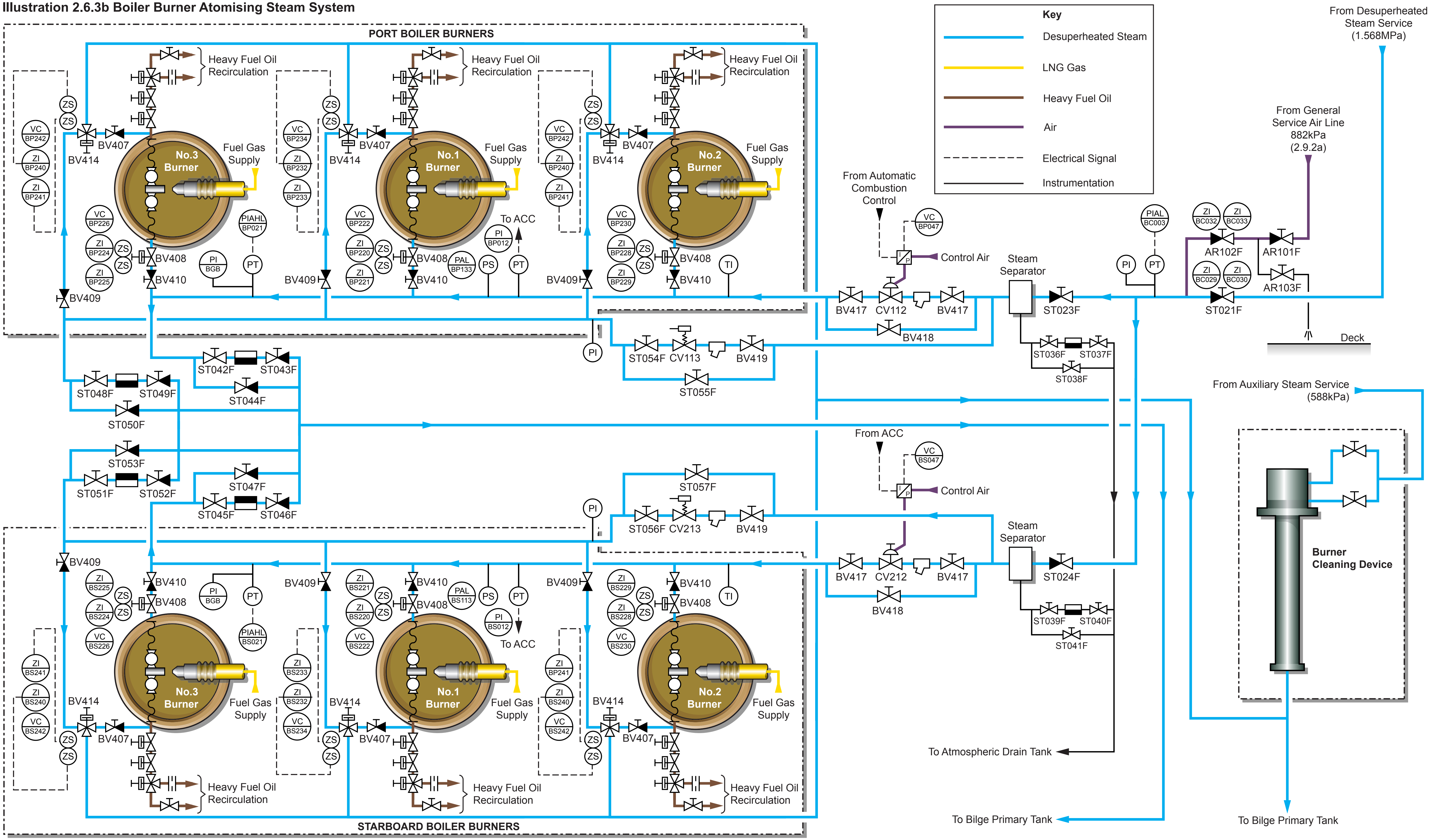
d) Set the manually operated valves as in the following table.

Position	Description	Valve
Closed	No.1 HFO settling tank high/low quick-closing valve	OF201F/OF202F
Closed	No.2 HFO settling tank high/low quick-closing valve	OF203F/Of204F
Closed	Line valve from HFO settling tanks	OF236F
Closed	Low sulphur HFO tank quick-closing valv	OF002F
Closed	Line valve from low sulphur HFO tank	OF237F
Open	DO service tank quick-closing outlet valve	OD060F
Open	Line valves from the DO service tank	OD061F/OD201F
Open	GS air to the fuel atomising system	AR102F

(**Note:** The valves OD201F, OD236F and OD237F are fitted with limit switches to determine when the IAS should bypass the low fuel oil temperature trips.)

Position	Description	Valve
Open	Flow meter inlet valve	OF206F
Open	Flow meter outlet valve	OF208F
Closed	Flow meter bypass valve	OF209F

Illustration 2.6.3b Boiler Burner Atomising Steam System



Position	Description	Valve
Open	Constant pressure control valve outlet valve	OF215F
Open	Constant pressure control valve inlet valve	OF214F
Closed	Constant pressure control valve bypass valve	OF216F
Open	Port boiler FO pump suction valve	OF210F
Open	Port boiler FO pump discharge valve	OF212F
Open	Starboard boiler FO pump suction valve	OF211F
Open	Starboard boiler FO pump discharge valve	OF213F
Open	Upper boiler FO heater inlet valve	OF217F
Open	Upper boiler FO heater outlet valve	OF219F
Open	Lower boiler FO heater inlet valve	OF218F
Open	Lower boiler FO heater outlet valve	OF220F
Open	Boiler FO heater bypass valve	OF222F
Open	Inlet valve to de-gassing chamber	OF231F
Closed(locked)	Return valve to No.2 HFO settling tank	OF232F

Port Boiler

Position	Description	Valve
Open	Port boiler cold start valve	OF233F
Open	Port boiler FO flow meter inlet valve	OF225F
Open	Port boiler FO flow meter outlet valve	OF227F
Open	Port boiler FO flow meter bypass valve	OF229F
Operational	Pressure control valve	CV131
Open	Pressure control valve outlet valve	OF238F
Open	Minimum pressure keep valve outlet valve	OF239F
Open	Inlet valve to No.1 burner	BV401
Open	Inlet valve to No.2 burner	BV401
Open	Inlet valve to No.3 burner	BV401
Open	Return line valve	OF244F
Open	Burner bypass return valve	OF245F

Starboard Boiler

Position	Description	Valve
Open	Starboard boiler cold start valve	OF234F
Open	Starboard boiler FO flow meter inlet valve	OF226F
Open	Starboard boiler FO flow meter outlet valve	OF228F
Open	Starboard boiler FO flow meter bypass valve	OF230F
Operational	Pressure control valve	CV231
Open	Pressure control valve outlet valve	OF240F
Open	Minimum pressure keep valve outlet valve	OF241V
Open	Inlet valve to No.1 burner	BV401
Open	Inlet valve to No.2 burner	BV401
Open	Inlet valve to No.3 burner	BV401
Open	Return line valve	OF246F
Open	Burner bypass return valve	OF247F

e) Select both boiler FO pumps for REMOTE mode at their local selector switches.

f) At the IAS boiler fuel system graphic screen start one of the boiler FO pumps in manual, DO from the DO service tank will be circulated around the system and recirculated back to the pump suction via the return chamber. Select the other pump in AUTO mode at the IAS screen; this pump will now act as the standby pump and will cut in automatically should the duty pump fail to maintain the desired fuel system pressure.

Once circulation of DO is confirmed, the following valves should be closed for actually flashing the boiler: OF233F, OF220F, OF244F, OF234F, OF230F and OF246F.

When the boiler control system is actuated in order to commence firing on DO the controlled valves in the FO supply pipes will open and DO will flow to the burner supply line allowing the boiler to be flashed. The recirculation valves will be opened in order to allow the release of excess fuel and this will flow back to the return chamber.

Operation of the burner control system is described in section 3.3.3. Manufacturer's instructions regarding the procedure for raising steam from cold must be followed precisely. When the boiler has raised steam to sufficient pressure using DO, heating steam will be available for tank heating, trace heating and for the boiler FO heaters. Heavy fuel oil in the settling and bunker tanks must be heated to the correct temperature to allow for pumping.

WARNING
When using diesel oil as the fuel, only atomising air must be used.

Alarms

Tag	Description	High Alarm
MM017	Fuel oil heater outlet strainer differential pressure	80kPa
PP021	No.1 boiler FO supply pump pressure control	2600kPa
PP022	No.2 boiler FO supply pump pressure control	2600kPa

Procedure for Changing the Boiler Fuel Oil Supply System from Diesel Oil to Heavy Fuel Oil

The description assumes that HFO will be taken from No.1 HFO settling tank.

a) When the desired pressure is achieved burning diesel oil, change over to HFO once DO has been recirculated and the fuel oil temperature has reached a minimum of about 70°C at the burner rail.

b) Change the system valves as in the following table. Most valves will remain in the same position as given in the procedure for raising steam from cold and so only the valve changes are listed.

Position	Description	Valve
Open	No.1 HFO settling tank quick-closing low outlet valve	OF201F

(**Note:** The high outlet valve OF204F would normally only be used during rough weather.)

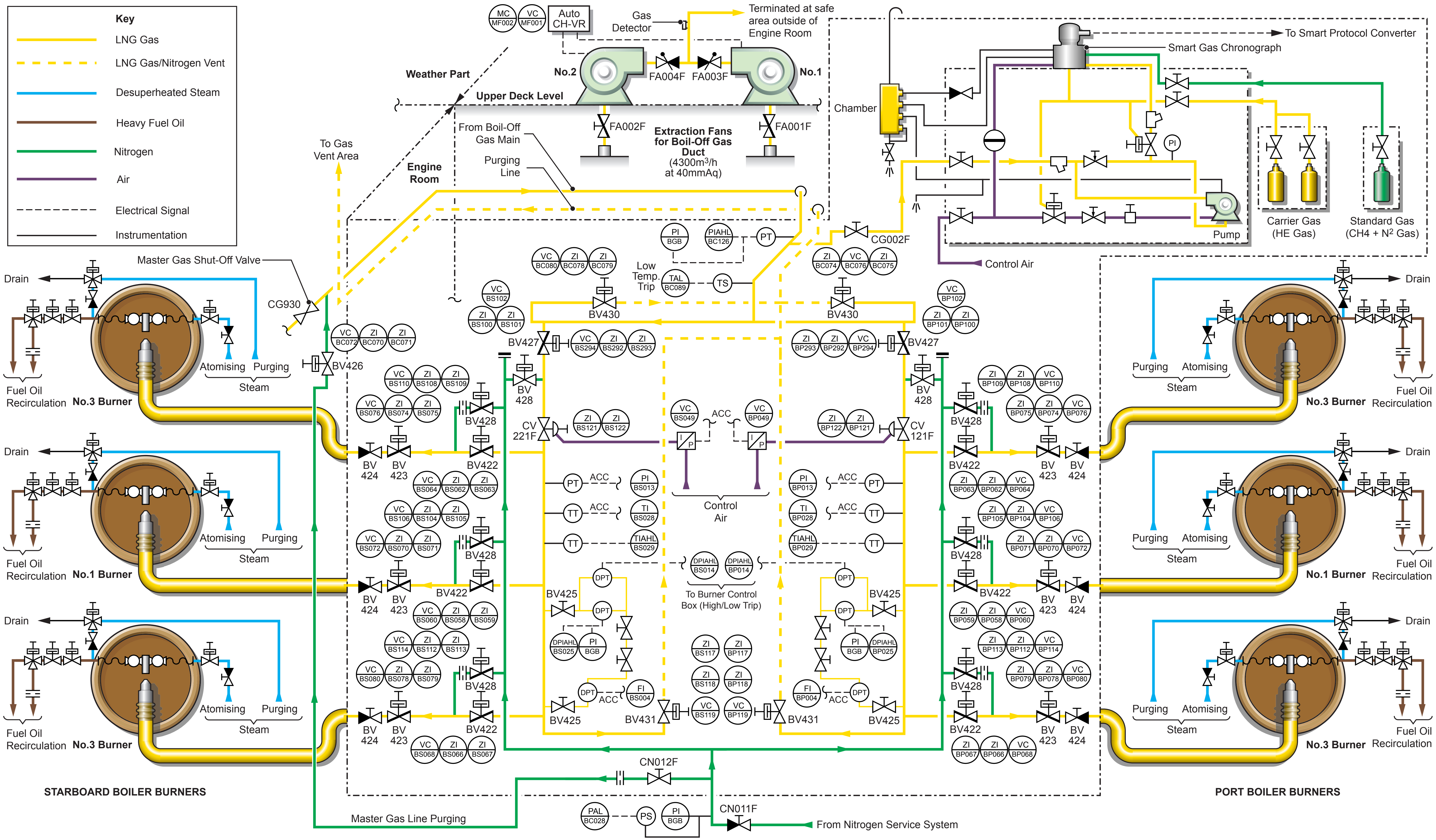
Position	Description	Valve
Open	Line suction valve from HFO tanks	OF236F

c) Supply steam to the boiler FO pump trace heating system and to the boiler FO heaters.

d) The boiler may be flashed up on HFO. Atomising air must be used initially in order to ensure that all diesel oil has been burned. The change to atomising steam can be made when only HFO is reaching the burners.

(**Note:** When gas burning commences the burning of fuel oil is reduced and may be shut off completely if sufficient gas is available. In the event of loss of gas during dual firing or 100% gas firing there is automatic changeover to oil firing. For this reason the HFO system must be kept warmed through.)

Illustration 2.6.3c Boiler Fuel Gas Service System



Changeover from Heavy Fuel Oil Operation to Diesel Oil Operation

In the event of the vessel being in port for a prolonged period with the steam system shut down it is necessary to change the boiler fuel system over from HFO operation to DO operation in order to ensure that all fuel pipes contain DO which can be readily pumped. The procedure for changing essentially means removing all HFO from the pipework and replacing it with DO. This is better done whilst the boilers are still being fired as then it is simply a case of burning off the HFO in the lines and replacing it with DO.

Procedure for Changing from Heavy Fuel Oil Firing to Diesel Oil Firing Whilst the Boilers are still Operating

a) Ensure that there is sufficient diesel oil in the DO service tank for the operation of the generator engine and the boiler. If necessary replenish the DO service tank.

b) Change the atomising system from steam atomising to air atomising by closing valve ST021F and opening valve AR102F.

c) Open the DO tank quick-closing suction valve OD060F if not already open and then open the DO supply line valve OD061F.

d) Slowly open the boiler system DO supply valve OD201F whilst at the same time closing the HFO supply valve OF236F.

e) Gradually shut off steam to the fuel oil heaters and the trace heating lines.

f) Heavy fuel in the boiler burner supply system will gradually be used whilst firing the boilers and this will be replaced by diesel oil. Keep a check on the system temperature to ensure that the temperature does not fall too quickly whilst there is still HFO in the pipelines. Both boiler FO service pumps will have to be operated during this procedure in order to ensure that the HFO is replaced in all parts of the system. All burners should also be operated in order to ensure that there is DO in all burner lines.

g) When the HFO has been completely replaced by DO the burners may be shut down when the boilers are not required.

Procedure for Changing from Heavy Fuel Oil Firing to Diesel Oil Firing after the Boilers have been Shut Down

If a boiler has been shut down the fuel system may be purged of HFO by pumping DO in and forcing the HFO out. Steam should still be available for trace heating and the FO heaters so that the HFO viscosity is low enough to allow for pumping. Ideally the change to DO should be made when a boiler is still operating but for emergency reasons a change whilst out of service might be required.

a) Ensure that there is sufficient DO in the generator engine gas oil service tank for the operation of the generator engines and the boiler. If necessary replenish the generator engine diesel oil service tank.

b) Open the DO supply valve OD061F: it is assumed that the DO service tank quick-closing valve OD060F is already open.

c) Open the supply inlet valve from the DO service tank OD201F and close the HFO supply valve OF236F. Ensure that the boiler manual recirculating valves OF244F, OF245F, OF246F and OF247F are open.

d) Unlock and open No.2 HFO settling tank return inlet valve OF232F and close the return chamber inlet valve OF231F. Before the procedure is commenced a check must be made to ensure that No.2 HFO settling tank has sufficient capacity to receive the HFO displaced from the pipe system.

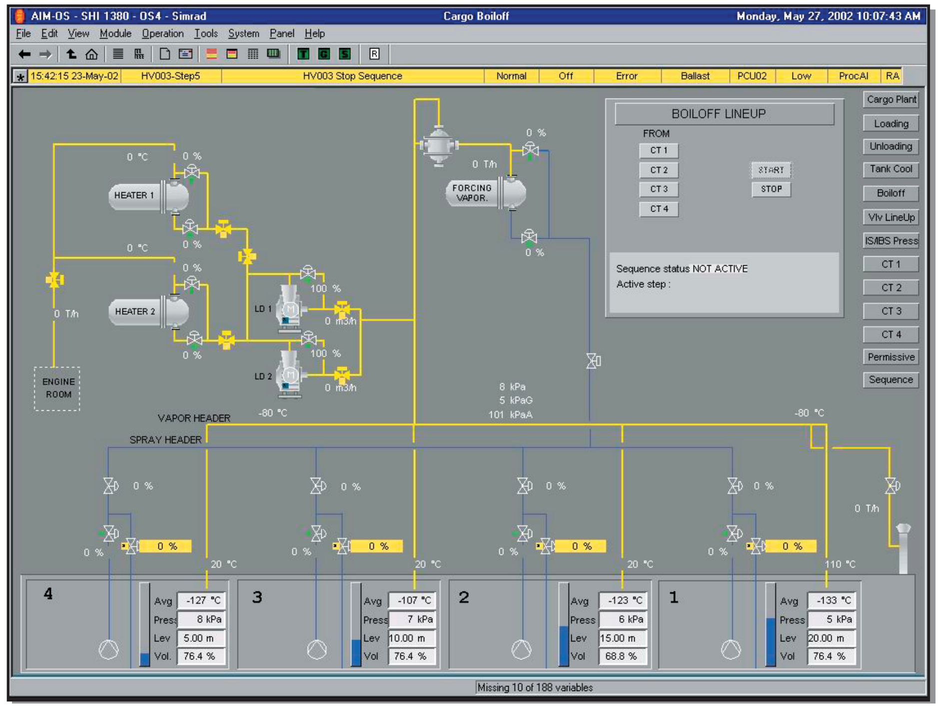
e) Manually start one of the boiler FO service pumps either from the local position or the IAS screen. Allow the pump to operate and draw DO from the DO oil service tank.

f) When the pump and its inlet and outlet lines are completely filled with DO, stop the pump and start the other pump.

g) Shut off the trace heating and steam supply to the FO heaters; turn off the viscorator.

h) Allow the second pump to operate and pump DO into the system. The DO will displace the HFO which will flow to No.2 HFO settling tank.

i) Only leave the boiler FO service pump operating long enough to displace all HFO from the system to the HFO settling tank. If the pump is left running for a prolonged period large quantities of diesel oil will be pumped to No.2 HFO settling tank.



j) Stop the pump when all of the HFO has been displaced to No.2 HFO settling tank; a reasonable guide to this is when the return pipe to the HFO settling tank falls in temperature indicating that cold diesel oil is flowing.

k) Close all system valves and shut off all power to pumps etc.

Some HFO will be left in the branch pipes to the burners but this cannot be removed by a circulation system. Only a change to gas oil whilst the burners are in service will ensure that the entire fuel system, is filled with gas oil.

The Boil-off Gas System

The boil-off gas supply system to the engine room is shown on the IAS cargo boil off graphic screen. Gas from the tanks has to be compressed before being supplied to the boiler burner system and two low duty compressors are fitted for this purpose. If the gas header pressure is sufficiently high the gas will flow freely, bypassing the compressor.

Before burning gas the extraction fan above the boiler hood must be operating.

Observe all company regulations regarding operation of the boilers using gas. Ensure that gas is available and check that the gas supply system is operational.

Check that all control and safety devices are operational and that all instruments are functioning correctly

The burners can either be on dual burning, with both the fuel oil and fuel gas burners in use, or only the fuel gas burners in use. For the burners to be on fuel gas only the following conditions must apply:

- Main turbine must be in Full Away condition (above 68 rpm)
- The steam dump system must be on automatic and closed
- Request from the gas engineer to go on boil-off gas
- Dual fuel mode available

The gas compressors may be selected for operation from the IAS screen and one will normally be operating with the other isolated.

The low duty gas compressors are set up by the gas engineer, see Cargo Manual section 4.4.2 LD Compressor. Once set up, the compressor can be started from the ECR IAS screen above if the command is transferred to the engine room.

Boil-off Gas and Low Duty Compressor Control System

PID 1 is the normal controller for the LD compressor guide vane and speed control. This has a set point of 80% which will control the compressor speed to attempt to keep the gas control valves 80% open.

The output from the controller is a split range:

- 0-35% Guide Vane Opening
- 35-100% Speed Control

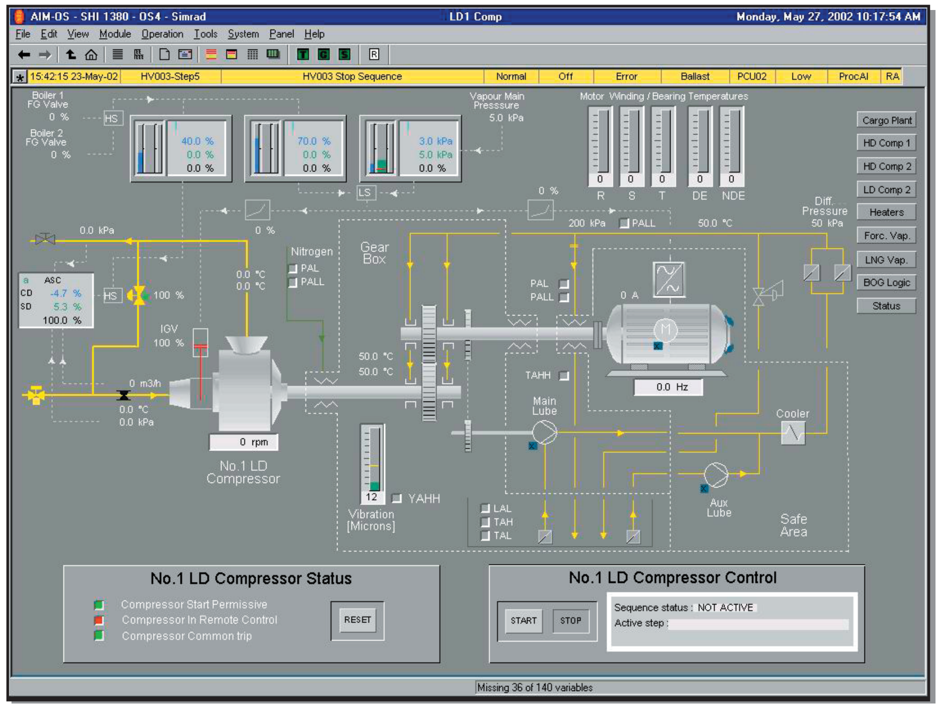
PID 2 is for tank pressure protection and is set between 3 and 5kPa. If the tank pressure falls to 3kPa PID 2 takes over control of the LD compressor in a bumpless transfer, matching PID 1. It will then reduce the speed of the LD compressor back to a minimum and close the vanes. It will maintain control of the LD compressor until the tank pressure returns to 5kpa at which point operation of the LD compressor will be transferred back to PID 1.

At 3kPa it will also provide a fuel oil back-up signal bringing in the fuel oil burners if the boiler was running on gas only. The burning mode will not change back to gas only firing at this point, that would have to be instigated manually.

If dump mode is engaged for tank pressure control the excess gas dump control will open the dump valve when tank pressure rises above the set pressure to increase boiler load and control the position of the dump valve to maintain the tank pressure.

The dump valve will not open under the following circumstances.

- Main turbine not in manoeuvring range
- Main condenser pressure high - 21.4 kPa absolute.
- Main condenser SW outlet temperature high - 70°C



Tank Pressure Control Parameters

Gauge:	7kPa Laden 10kPa Ballast
Absolute:	108kPaA

If burners are in dual mode the tank pressure control system will operate to maintain the tank pressure at the desired setting and restrict operation of PID1 and output to the LD compressor. If the tank pressure is higher than the set pressure PID1 will control the LD output for speed and vane control as per boiler demand to maintain the gas valves at 80% open.

However, if the pressure drops below the set pressure the tank pressure control system will be the output to the LD and reduce the speed/vane position until pressure increases above the set value. Under these conditions the fuel oil signal will increase to maintain boiler pressure.

This is not the case if burners are in the gas only mode where PID1 will retain control of the LD compressor until the 3kPa level is reached when PID2 will be the output to the LD compressor and operate the fuel back-up signal.

Alarm

Tag	Description	Low
MM240	Nitrogen BOG purge pressure	100kPa

Procedure for Preparing the Boiler Gas Service System for Operation

Using No.2 low duty compressor and No.2 heater.

The following valves are manually opened by the gas engineer, who is responsible for the tank pressures and temperatures.

Position	Description	Valve
Open	No.2 LD compressor outlet valve	CG914
Open	No.2 heater outlet valve	CG924
Open	Vapour header outlet valve	CG704

These manually operated valves would normally be open unless a compressor or heater was isolated for repair.

The following valves are opened using the Cargo Boil Off IAS screen.

Position	Description	Valve
Open	No.2 heater inlet valves	CG918, CG920
Open	No.2 LD compressor inlet valve	CG902
Open	Gas master valve to the engine room	CG930

The IAS screen displays the system information which includes temperatures and pressures and the status of the heater isolating valves and the master gas valve.

a) Adjust the vapour header pressure controller set point to above the process value to fully open the surge valve and allow the LD compressor to start on a light load.

b) Before starting the gas compressor, click on and place the following in AUTO mode:

- The auxiliary LO pump control
- The compressor motor control
- The compressor vane control
- The anti-surge (bypass) valve control

c) Start the LD compressor by pressing the start sequence icon

The following sequence will occur

- The auxiliary LO pump starts
- After a period of 30 seconds, the motor starts
- The anti-surge valve will fully open, over a period of 2 minutes

d) Adjust the vapour header pressure controller set point to just below the process value.

The resulting vapour header pressure controller signal will cause the fuel gas valve controller to open the fuel gas valve.

The system will now by controlled by the boiler load and the fuel gas valve controller will go to MANUAL mode.

e) Click on the fuel gas controller and change it to AUTO mode to allow the engine room system to control the boil-off gas pressure.

The boil-off gas is consumed using in the following methods

- The boiler will increase the fuel gas flow and decrease the fuel oil flow
- If the normal boiler output is not enough to control the boil-off gas pressure, the system opens the steam dump valve to the main condenser.

When gas burning commences, the burning of fuel oil is reduced and may be shut off completely if sufficient gas is available. In the event of loss of gas during dual firing or 100% gas firing there is automatic changeover to oil firing. For this reason the HFO system must be kept warmed through.

After the use of gas in the gas burner system the entire pipework must be purged by blowing nitrogen through the pipes. This is part of the burner management system as described in section 3.3.3.

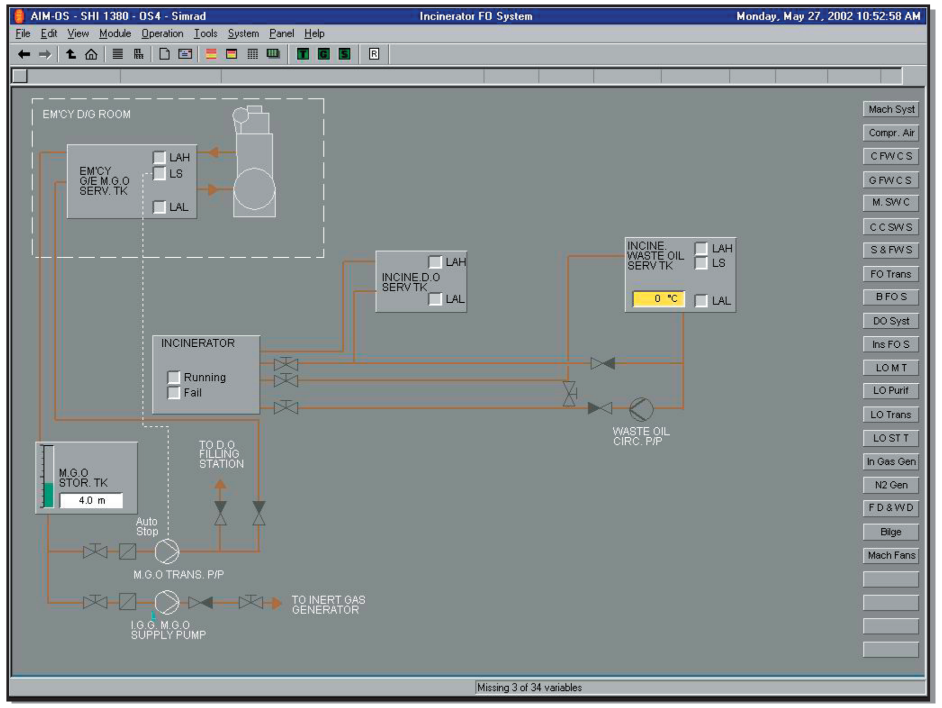
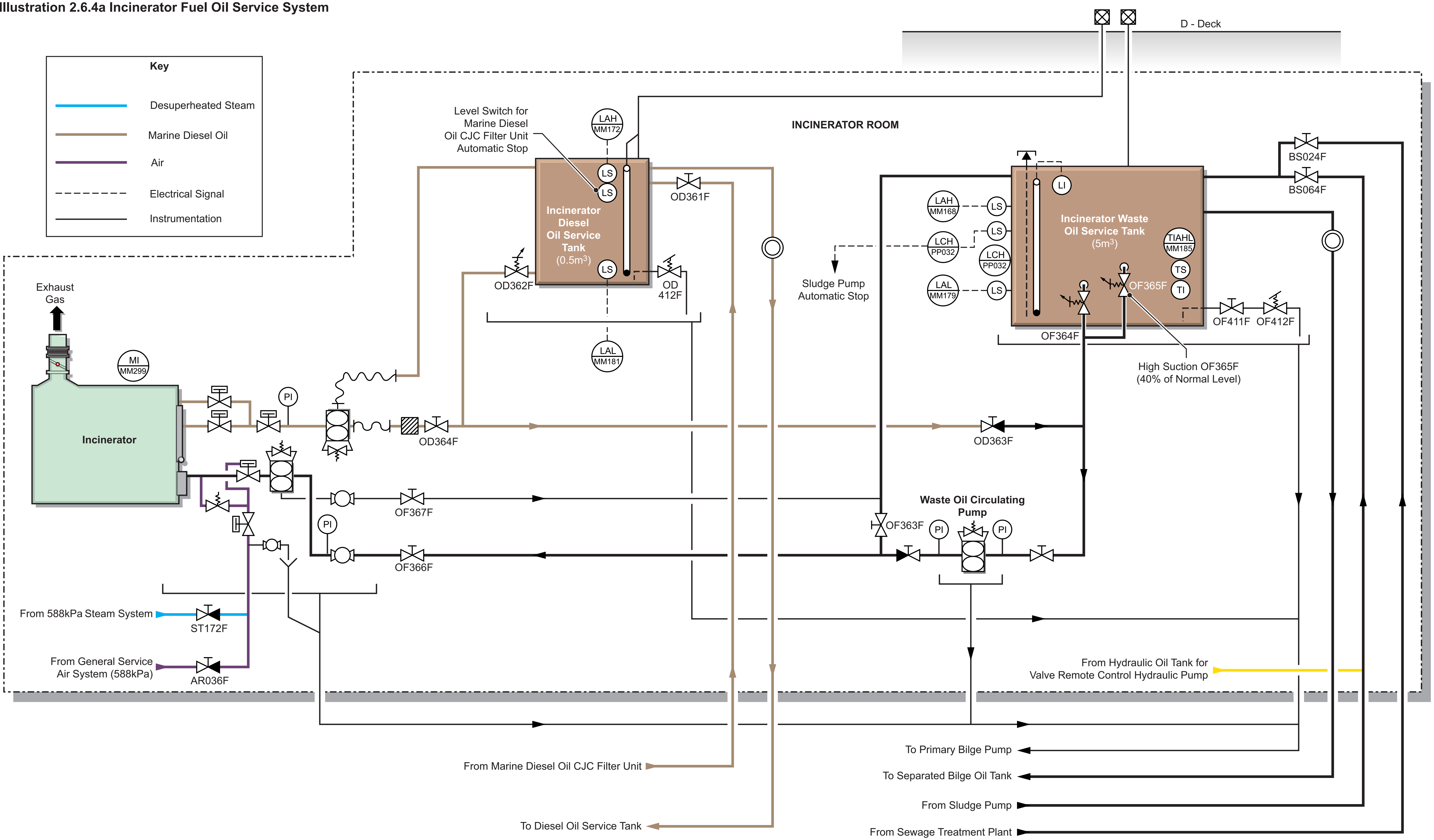


Illustration 2.6.4a Incinerator Fuel Oil Service System



2.6.4 INCINERATOR FUEL OIL SERVICE SYSTEM

Sludge Pump

Maker:	Taiko Kikai Ind. Ltd
No. of sets:	1
Type:	Mono screw
Model:	HNP-401
Capacity:	5.0m^3/h at 392kPa

Flue Gas Fan

Capacity:	9,500m^3/h
Motor:	8.6kW at 1,760rpm - belt drive to fan

Waste Oil Pump

Maker:	PCM Pumps
Type:	M110 F4
Motor maker:	Leroy Somer
Capacity:	0.3kW

Waste Oil Circulating Pump

Maker:	Uniblock
Type:	40-131/0222 NE-W5-GF
Capacity:	6m^3/h at 210kPa

Introduction

The incinerator burns DO in order to raise the temperature of the incinerator furnace to assist in the combustion of solid garbage and waste oil. The incinerator DO service tank is replenished from the DO storage tank by the DO CJC filter unit which includes its own pump.

The DO CJC filter unit is operated in automatic mode and has an automatic stop switch connected to the incinerator DO tank high level switch. The incinerator DO service tank overflows to the DO service tank.

The incinerator waste oil service tank is replenished by the sludge pump which takes suction from the separated bilge oil tank, the lubricating oil sludge tank, the FO drain tank and the LO drain tank. The pump is manually actuated from the local position but there is an automatic stop facility from a high level switch in the waste oil service tank. The waste oil service tank may also receive sewage sludge from the sewage treatment plant.

After a period of settling in the waste oil service tank, with steam heating applied if necessary, the tank is sludged using the sludge cock and the waste oil may then be burned in the incinerator. A waste oil circulation pump is operated taking suction from the waste oil service tank and returning the oil to the tank. This ensures an even temperature distribution and prevents stratification of the oil in the tank. Any water or solids in the waste oil charge are evenly dispersed so that the waste oil will burn effectively. This pump is also the supply pump for the incinerator sludge burner.

Procedure for Filling the Incinerator Diesel Oil Service Tank

a) Check the quantity of DO in the incinerator DO service tank and determine how much DO needs to be transferred.

b) Ensure that there is sufficient DO in the DO storage tank; replenish the tank if necessary.

c) Open the DO storage tank quick closing outlet valve OD001F and the supply valve to the DO CJC filter unit OD053F.

d) Open the DO CJC filter outlet valve to the incinerator DO service tank OD057F.

e) Open the incinerator DO service tank inlet valve OD361F.

f) Start the DO CJC filter unit and transfer the desired quantity of DO to the incinerator DO service tank. When the desired quantity has been transferred stop the pump, close the valves and record details of the transfer in the Oil Record Book. Frequently test the CJC filter unit automatic stop on the incinerator DO service tank high level switch.

Procedure for Transferring Waste Oil to the Incinerator Waste Oil Settling Tank

The description assumes that waste oil is being taken from the separated bilge oil tank and the sludge pump is being used.

a) Check the quantity of waste oil in the incinerator waste oil service tank and determine the quantity of waste oil to be transferred.

b) Set the valves as in the following table.

Position	Description	Valve
Open	Sludge pump suction valve from separated bilge oil tank	BG058F
Closed	Sludge pump suction valve from LO sludge tank	BG067F
Closed	Sludge pump suction valve from FO and LO drain tanks	BG059F
Open	Sludge pump discharge valve	BG062F
Open	Incinerator waste oil service tank inlet valve	BG064F
Close	Sludge pump discharge to separated bilge oil tank	BG061F

c) Select the sludge pump for AUTO operation and start the pump from the local position by pressing the START pushbutton.

d) When the waste oil service tank level rises to the pump cut-out switch position, the switch will be activated and the sludge pump will stop. The pump may also be stopped manually if required. The incinerator waste oil settling tank overflows to the separated bilge oil tank.

(**Note:** If the contents of the LO sludge tank, FO drain tank or LO drain tank are to be transferred to the incinerator waste oil service tank the procedure is the same except that the suction valve from the separated bilge oil tank must be closed and the suction valves from the other tank opened. When pumping oil from the LO drain tank, the LO drain tank suction valve OL045F must also be opened.)

Procedure for Preparing the Incinerator Waste Oil and Diesel Oil Systems

Assume that the incinerator waste oil service tank heating coils are already in use.

a) Drain water from the incinerator DO service tank by opening the self-closing valve OD412F until no water is observed.

b) Open the incinerator DO service tank quick-closing outlet valve OD362F.

c) Open the DO supply valve OD364F to the incinerator DO burner.

The incinerator gas oil system is now ready for operation.

d) Drain water from the incinerator waste oil service tank via valves OF411F and OF412F.

e) Open the incinerator waste oil service tank low suction valve OF364F.

f) Open the incinerator waste oil circulating pump inlet and outlet valves and the waste oil recirculating valve OF363F.

g) Start the incinerator waste oil circulating pump and circulate the contents of the waste oil service tank to ensure thorough mixing and even temperature.

h) Open the waste oil inlet valve to the incinerator OF366F and waste oil return valve OF367F.

i) Ensure that the crossover valve between the waste oil and gas oil systems OD363F is closed.

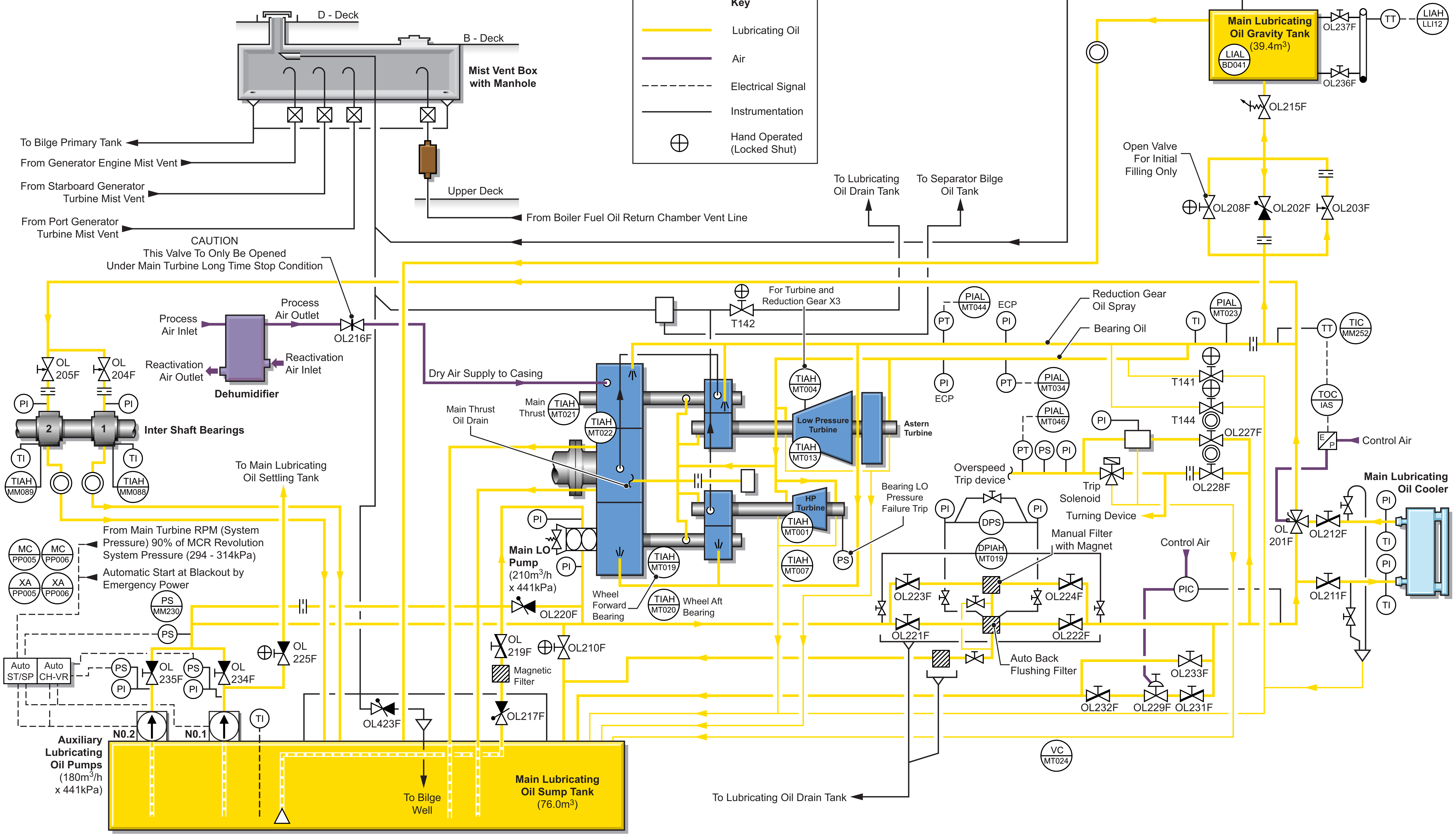
j) When the incinerator waste oil service tank is at the correct temperature and the incinerator is ready to burn waste oil close the incinerator waste oil bypass valve OF363F.

The incinerator is now able to burn waste oil.

2.7 Lubricating Oil Systems

Illustrations

Illustration 2.7.1a Main Turbines Lubricating Oil System



2.7 LUBRICATING OIL SYSTEMS

2.7.1 MAIN TURBINE LUBRICATING OIL SYSTEM

Auxiliary (Electric Motor Driven) Lubricating Oil Pump

Maker:	Shinko Ind. Ltd
No. of sets:	2
Model:	SAG150-2
Capacity:	180m^3/h at 45mth and discharge pressure 401.8kPa

Main (Direct Driven) Lubricating Oil Pump

Maker:	Taiko Kikai Ind. Ltd
No. of sets:	1
Type:	LBS-190KH
Capacity:	210m^3/h at 390kPa

Introduction

The main turbine is supplied with lubricating oil from the main LO sump tank by one of two auxiliary LO pumps. One of these pumps will be selected as the duty pump and the other pump as the standby to cut in automatically should the duty pump fail to maintain the lubricating oil supply pressure. The pumps may be arranged for automatic start and stop and automatic changeover. An emergency start facility is provided in the event of blackout, the power being taken from the emergency switchboard.

A main LO pump is driven by the HP gearbox pinion and when the propeller is operating at above 75 rpm (LO pressure above 380kPa) the pressure switch MM230 is activated and the IAS closes valve OL229F. After a time delay of 3-4 seconds the IAS will stop the duty LO pump and the main lubricating oil pump will supply the requirements of the system. When the propeller slows and causes the LO pressure to fall below 350kPa the duty LO pump will automatically start.

The duty LO pump circulates lubricating oil around the gearbox system and turbine bearings. The main LO circulation system also includes the intermediate shaft bearing. The main LO circulation system supplies LO to the system via the LO coolers, a three-way temperature valve regulating the flow of oil through the LO cooler in order to maintain the desired inlet temperature to the bearings. A constant pressure control valve regulates the LO and governor oil pressure by recirculating excess oil (pressure) back to the main turbine drain tank (sump).

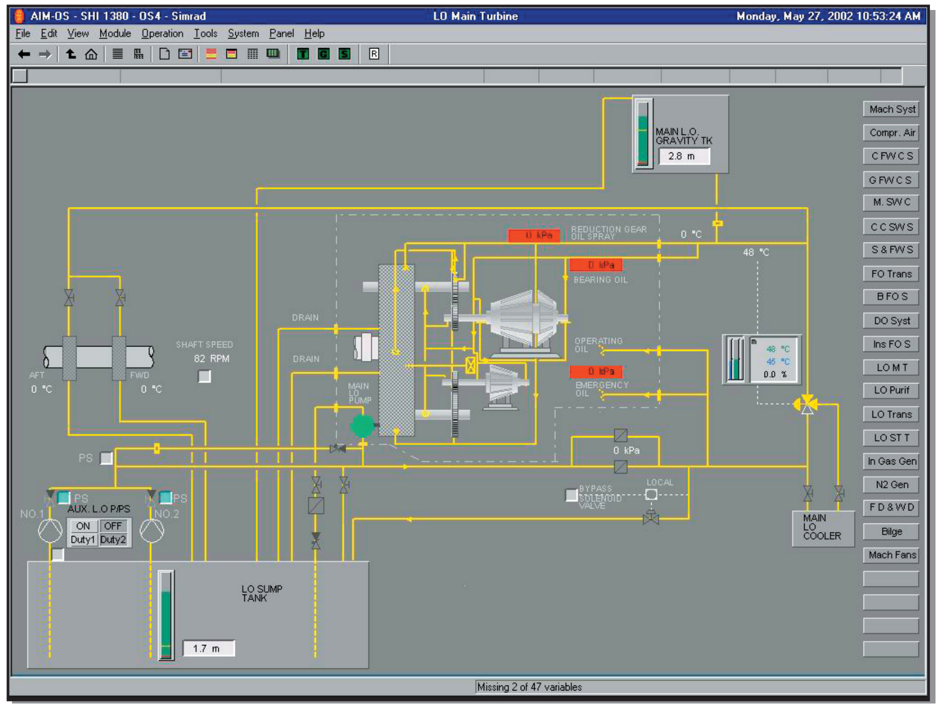
A LO gravity tank forms part of the lubricating oil system and this receives a supply of lubricating oil whenever a pump is running. The tank overflows to the main LO sump tank.

The supply to the gravity tank is via a throttling valve to ensure a continuous 'top up' supply to the tank. The emergency outlet is via a larger bore non-return valve OL202F and orifice to provide an adequate LO supply for a maximum time and allows the gravity tank to provide an emergency lubricating oil supply to the system, in the event of complete failure of the pumping system. The emergency supply allows the turbine to be stopped and so prevents damage due to lack of lubricant.

There is one LO cooler which is cooled by fresh water from the central FW cooling system, see section 2.4.1.

A control oil system is provided at the turbine. This is dependent on the main LO system and is discussed in section 3.4.2. It is supplied by the same pumps as the LO supply, but at a primary (higher) pressure than the LO supply as a result of the orifice fitted in the LO supply to the bearings and gearing.

The main LO gravity tank is fitted with a low level alarm.



A dehumidifier is connected to the gearbox and removes moisture from the gearbox atmosphere and hence from the lubricating oil system. The dehumidifier is air reactivated by heating dry air passing over the desiccant dryer.

Control

The pumps are arranged in a Duty/Standby configuration with one pump started as the duty pump via the IAS screen and the other selected as the standby pump. The standby pump will start if the duty pump stops or the LO pressure is low.

The second pump may be selected for standby (auto) mode when the duty pump is running. Selection for standby (auto) mode may be made provided that the pump is stopped, is set to remote mode, is not tripped and provided that the other pump is running. In the event of the running pump tripping or producing a low pressure, the IAS initiates an alarm and when the low-low pressure is reached the standby pump is started. The original running pump is not stopped by the IAS and must be stopped manually for investigation if it has not already tripped.

A manual start is not available for a pump set to standby and if for any reason the operator wishes to start the standby pump then the status of the pump must be changed from standby (auto) to manual at the IAS graphic screen.

The auxiliary LO pumps may be started manually from the IAS provided that they are set to remote mode at the pump control selector switch. If both pumps are in manual the IAS cannot start the second pump in the event of a low-low pressure as auto mode is not selected for the second pump.

In the event of a blackout the IAS remembers which pump was running at the time of the blackout, and whether or not the second pump was selected as the standby pump.

Provided that the running pump prior to the blackout was selected in remote the IAS will start the previously running pump as part of the sequential restart system. Should the pump fail to start within a preset time the standby pump will be started, provided that the second pump was selected in auto mode.

When the main LO pump is operating the standby facility still applies and one of the auxiliary pumps may be selected as the standby pump. This would be done at start-up of the system as one of the auxiliary LO pumps would be started and the other selected as the standby pump. When the turbine is in the at sea condition and the main LO pump takes over, the running auxiliary LO pump will cut out. The auxiliary LO pump selected as the standby pump will remain in that condition and will cut in should the main LO pump fail to maintain the required LO pressure.

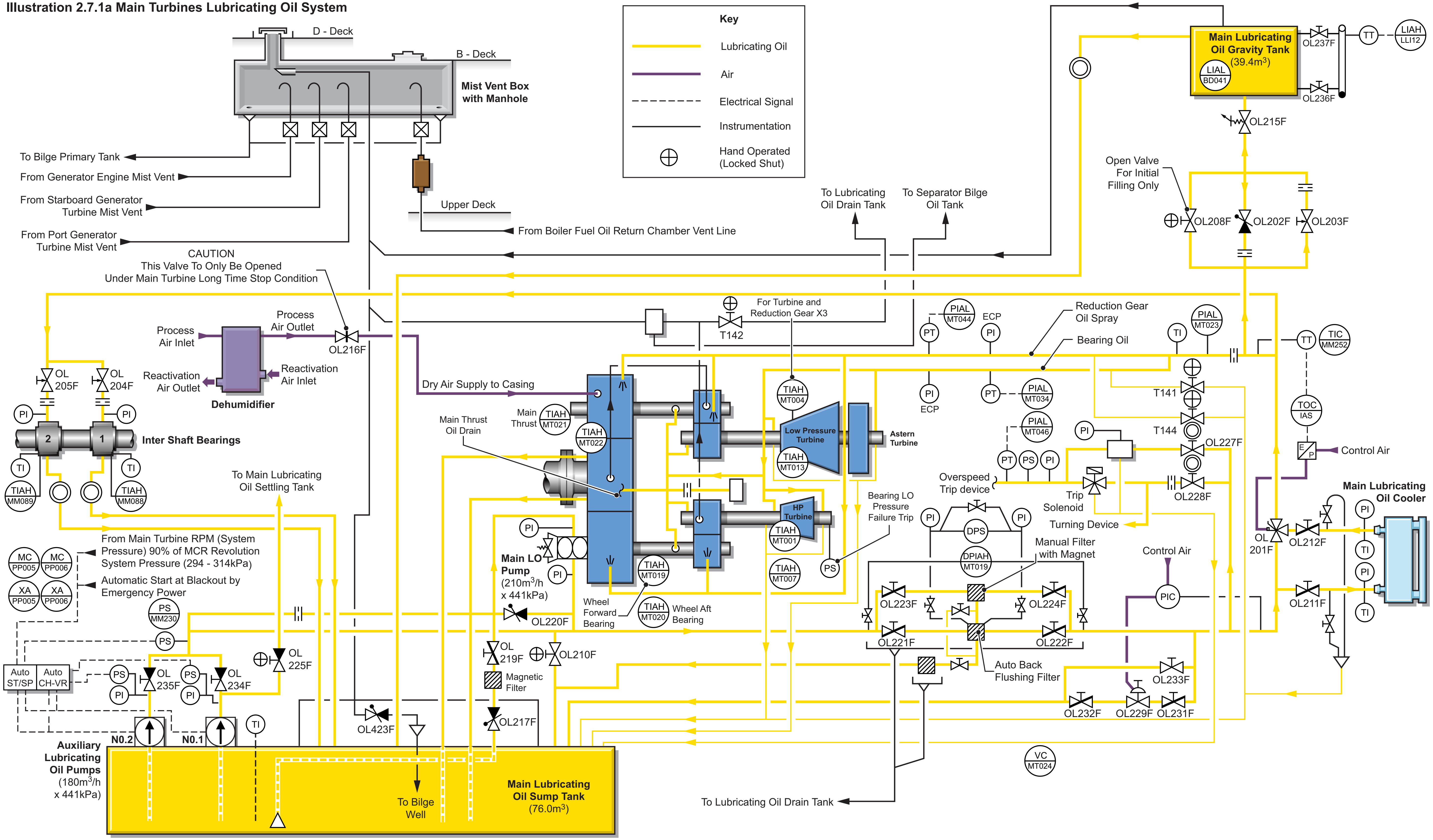
The auxiliary LO pumps may be started from the local position by selecting LOCAL at the pump control selector and then pressing the START pushbutton to start and the STOP pushbutton to stop. There is no standby facility in local control. The pumps may be switched off at the control selector by turning the switch to OFF. Even when in remote mode the pumps may be stopped from the local panel by pressing the STOP pushbutton.

Procedure for Operating the Main Engine Lubricating Oil System

It is assumed that the turbine is stopped but is being prepared for starting.

a) Check the level of oil in the main LO sump and replenish if necessary.

Illustration 2.7.1a Main Turbines Lubricating Oil System



b) Ensure that fresh water is circulating through the LO cooler (see section 2.4.1).

c) Ensure all pressure gauge and instrumentation valves are open and that instruments are reading correctly.

d) Set up valves as in the following table:

Position	Description	Valve
Open	No.1 auxiliary LO pump discharge valve	OL234F
Open	No.2 auxiliary LO pump discharge valve	OL235F
Open	Inlet valve to auto backflush filter	OL221F
Open	Outlet valve from auto backflush filter	OL222F
Open	Inlet valve to manual magnetic filter (normally closed when auto backflushing filter is in use)	OL223F
Open	Outlet valve from manual magnetic filter (normally closed when auto backflushing filter is in use)	OL224F
Open	Inlet valve to pressure control valve	OL231F
Open	Inlet valve to pressure control valve	OL232F
Closed	Pressure control valve bypass valve	OL233F
Operational	Pressure control valve	OL229F
Lock open	Control oil to main turbine manoeuvring valves	OL227F
Lock open	Control oil to main turbine trip solenoid and turning gear interlock	OL227F
Open	LO inlet valve to LO cooler	OL211F
Open	LO outlet valve from LO cooler	OL212F
Operational	LO cooler three-way valve	OL201F
Open	Main LO pump inlet valve from LO sump tank	OL219F
Open	Gravity tank inlet valve and LOCK SHUT once gravity tank is overflowing	OL208F
Open	Gravity tank quick closing inlet/outlet valve	OL215F
Throttled	Gravity tank overflow control valve	OL203F
Open	No.1 intermediate bearing inlet valve	OL204F
Open	No.2 intermediate bearing inlet valve	OL205F
Open	Dehumidifier inlet valve from gearbox and run unit (should already be open whilst LO system is shut down and maintain open until main turbine is full away on passage)	OL216F

(**Note:** It is assumed that all turbine and gearbox system lubricating valves remain open.)

e) Select both auxiliary LO pumps for remote operation at the local control selector. At the IAS graphic screen for the turbine LO system start one of the pumps as the duty pump by selecting MANUAL mode for that pump and then start the pump. At the IAS graphic screen select the second pump as the standby pump by selecting AUTO mode for that pump.

(**Note:** If the oil temperature of the oil is low steam heating must be applied whilst the oil is circulating in order to raise the temperature to an acceptable level. Also put the LO purifier in use as soon as possible, which will raise the LO temperature.)

f) Check the flow of lubricating oil throughout the system, ensuring that the flow is adequate to all parts, including the intermediate shaft bearings, and that there are no leaks. Utilise LO flow sight glasses on all bearings and gravity tank.

g) Keep the LO system circulating and allow the temperature of the system to gradually increase to normal operating temperature.

h) When the system LO temperatures and pressures are stable the LO system is ready and the turbine may be started provided that other systems are operating correctly.

(**Note:** When the turbine is operating at full sea conditions the main LO pump will be supplying LO to the system and the running auxiliary LO pump may be stopped. The standby LO pump remains in standby mode.)

During operation of the main LO system overflow from the gravity tank may be observed at the overflow sight glass situated near the gravity tank. System pressures and temperatures may be observed at the main engine lubricating oil system graphic screen. System pressure and temperature alarms and tank level alarms operate through the IAS.

Alarms

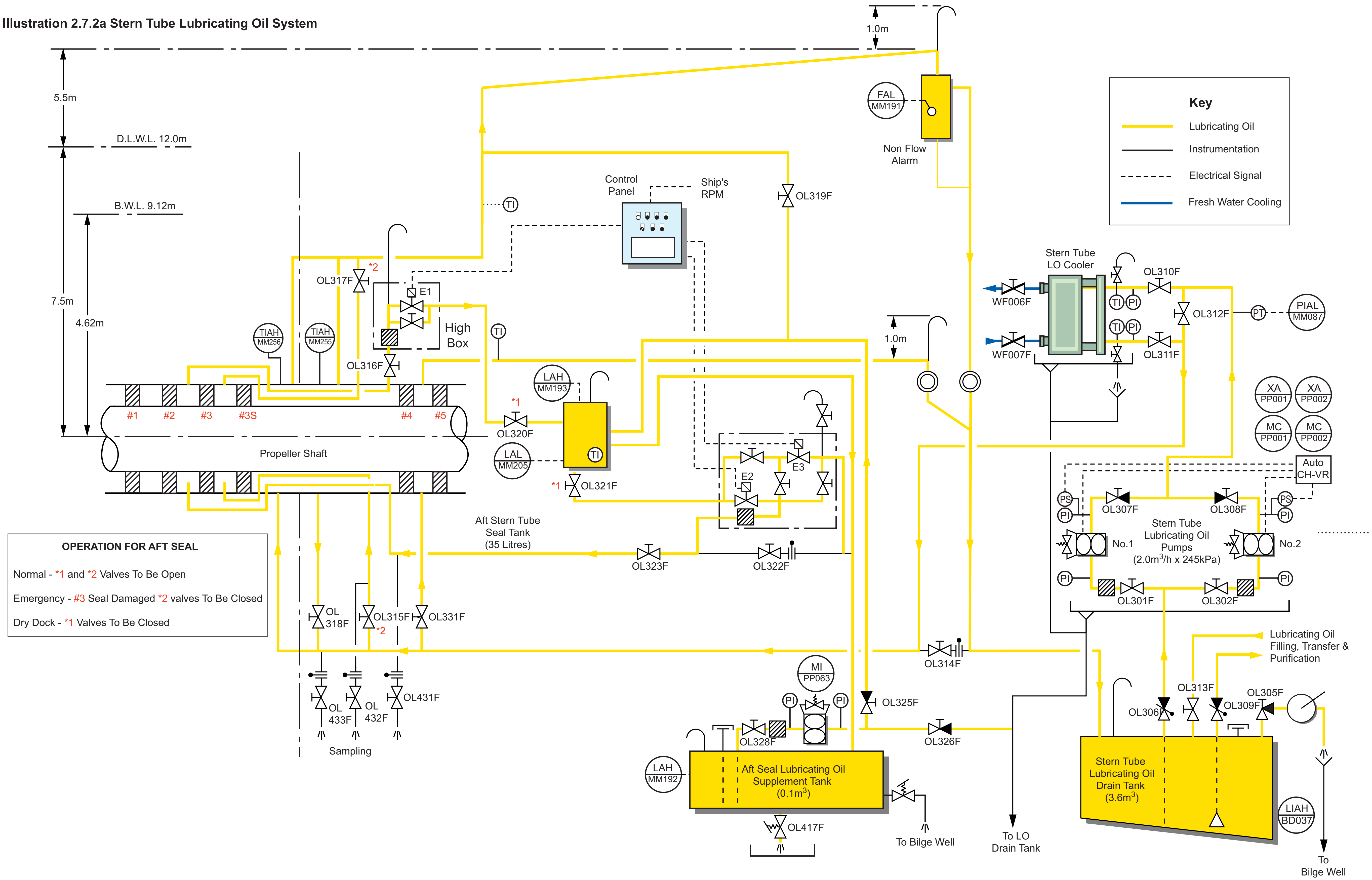
Tag	Description	High
MM088	Intermediate shaft forward bearing LO temperature	60°C
MM089	Intermediate shaft aft bearing LO temperature	60°C
MT002/018	Main gearing bearing LO temperatures	75°C
MT019/20	MT wheel forward and aft bearing LO temperature	55°C
MT021	MT thrust bearing LO temperature	55°C
MT022	MT thrust pad bearing LO temperature	110°C
MT023	MT bearing LO temperature	55°C

Tag	Description	Low
MT034	Main turbine bearing LO pressure	70kPa
MT044	Main gearing LO pressure	70kPa
MT046	Main turbine manoeuvring control oil pressure	250kPa
PP005	No.1 auxiliary LO pump outlet pressure control	350kPa
PP006	No.2 auxiliary LO pump outlet pressure control	350kPa
BD035	Main LO sump level	0.3m
BD041	Main LO gravity tank level	0.6m

Tag	Description	High high
MT064	Main thrust pad temperature	110°C

Tag	Description	Low low
MT074	Main turbine LO pressure trip	50kPa
MT075	Main turbine control oil pressure trip	200kPa

Illustration 2.7.2a Stern Tube Lubricating Oil System



Key

- Lubricating Oil
- Instrumentation
- Electrical Signal
- Fresh Water Cooling

OPERATION FOR AFT SEAL

Normal - *1 and *2 Valves To Be Open

Emergency - #3 Seal Damaged *2 valves To Be Closed

Dry Dock - *1 Valves To Be Closed

2.7.2 STERN TUBE LUBRICATING OIL SYSTEM

Stern Tube Seal

Manufacturer:	Kobelco Marine Eng. Co. Ltd
Type:	DX-850

Stern Tube Lubricating Oil Pump

Maker:	Taiko Kikai Ind. Ltd
No. of sets:	2
Type:	Horizontal gear
Model:	NHG-2MT
Capacity:	2.0m^3/h at 196kPa

After Seal Supplement Lubricating Oil Pump

Maker:	Taiko Kikai Ind. Ltd
No. of sets:	1
Type:	Horizontal gear
Model:	NHG-0.3M
Capacity:	0.2m^3/h at 149kPa

The stern tube provides a bearing support for the propeller shaft which is oil lubricated and is sealed at both ends using lip type seals. The stern tube bearing lubricating system is independent of other systems. There are three lubricating systems for the stern tube, one for the bearing unit, one for the aft seal assembly and one for the forward seal assembly. The bearing and seal systems are interconnected and they all use the same lubricating oil.

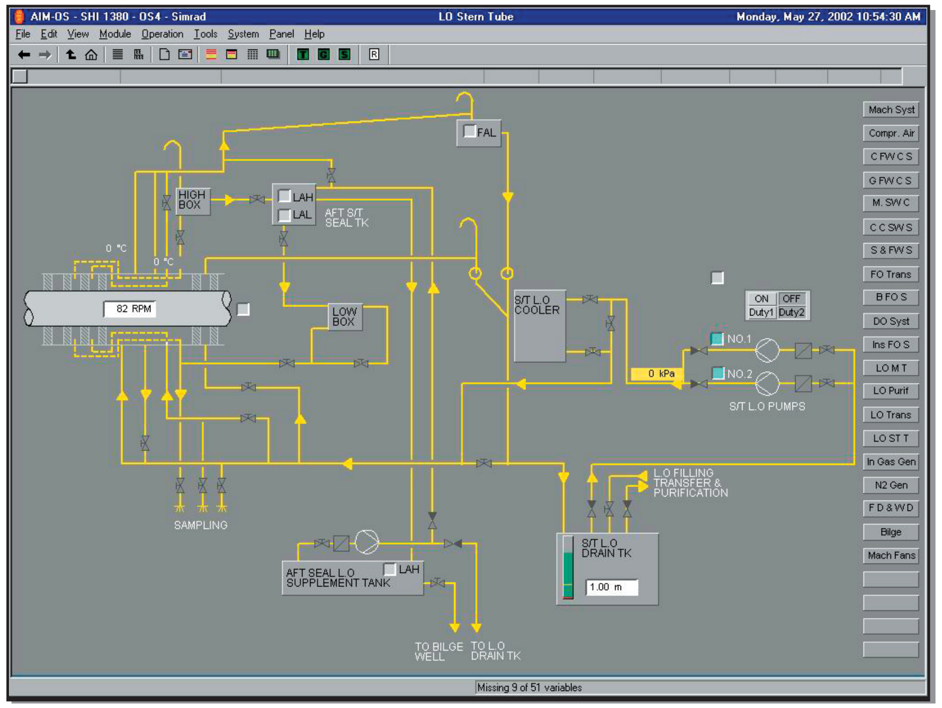
The stern tube assembly passes through a tank which is filled from the distilled water system and provides cooling to the stern tube.

The bearing area is lubricated by means of a constant head (constant pressure) system with oil supplied to the stern tube by one of two stern tube LO pumps. A header pipe with return flow alarm tank maintains the constant pressure in the system. Oil returning from the bearing flows back to the stern tube LO drain tank from where the duty stern tube LO pump takes suction. There are two stern tube LO pumps, one being selected as the duty pump and the other as the standby pump to cut in automatically should the duty pump fail. The pumps may be selected for local operation but are normally set to remote operation from the IAS stern tube system screen graphic display. The duty and standby pumps are selected at the graphic display. These pumps discharge oil through the cooler.

The stern tube LO cooler is cooled by water circulating from the central cooling fresh water system (see section 2.4.1).

From the cooler the LO is directed to the stern tube bearing where it provides lubrication and cooling. This oil returns to the stern tube LO drain tank via the header pipe and alarm box.

The LO supply from the cooler also flows to the forward seal with the return flowing back to the drain tank. The supply valve to the forward seal is throttled in order to regulate the amount of oil flowing. The vented return pipe from the forward seal is located at a height of 1.5m above the shaft centre line and this controls the pressure of the oil at the forward seal.



Oil supply to the after seal is from the after seal tank, the overflow level being 1.5m above the shaft centre line in order to regulate the pressure. The after seal tank overflows to the after seal supplement tank which is fitted with a pump used to replenish the after seal tank as required. The after seal tank may be filled from the stern tube LO circulating system if required. High and low boxes are included in the after seal LO system and these contain a number of valves, one of which is a solenoid valve operated from the control panel. These valves operate automatically to regulate the oil flow through the after seal system depending upon the speed of the shaft.

Seals are provided at the outer and inner ends of the stern tube, these being designed to prevent the entry of water into the stern tube area and prevent oil leaking out to sea or into the machinery space at the forward end of the stern tube.

The aft seal consists of three parts, the four rubber lip sealing rings, the metal housing holding the sealing rings and a liner which rotates with the propeller shaft.

The aftermost sealing ring is No.1 seal ring and this faces outwards, as does No.2 seal. Seal rings No.3 and No.3S both face forward. A natural oil circulation is set up in the after seal system when the shaft turns thus oil flows through the seal space.

The sealing system incorporates a standby seal No.3S, which under normal operating conditions is under no load. In the event of a failure of the seal ring No.3, seal ring No.3S is used to protect the system. Oil is normally supplied to the space between rings No.3 and No.3S from the stern tube LO circulation pump via inlet valve OL315F and outlet valve OL317F. In the event of failure of No.3 seal, both of these valves must be closed.

The space between seal rings No.1 and 2 is filled with lubricating oil during the commissioning stage and has no direct link to the piped lubricating/sealing system.

The forward seal has two sealing rings, both facing aft, the seal is provided with an oil supply from the main LO circulating system with the supply pressure regulated via valve OL331F and observation of the overflow sight glass.

Abnormal leakage of oil from the stern tube bearing outboard enters the aft seal system and that results in a rise in the aft seal supplement tank level. This will activate the high level alarm on this tank. Slight leakage during service is normal.

Oil pressure in the stern tube bearing is higher than the static pressure from the sea water head on the outer seals. The following apply to this system:

1. Isolated failure of #1 and #2 seals will manifest itself with an ingress of sea water into the aft seal LO supplement tank.

2. Isolated failure of #3 seal will manifest itself with an increase of level in the aft seal LO supplement tank without water contamination.

3. Isolated failure of #3 seal is undetectable.

4. Isolated failure of #4 seal will manifest itself in an increased flow at the forward seal outlet sight glass.

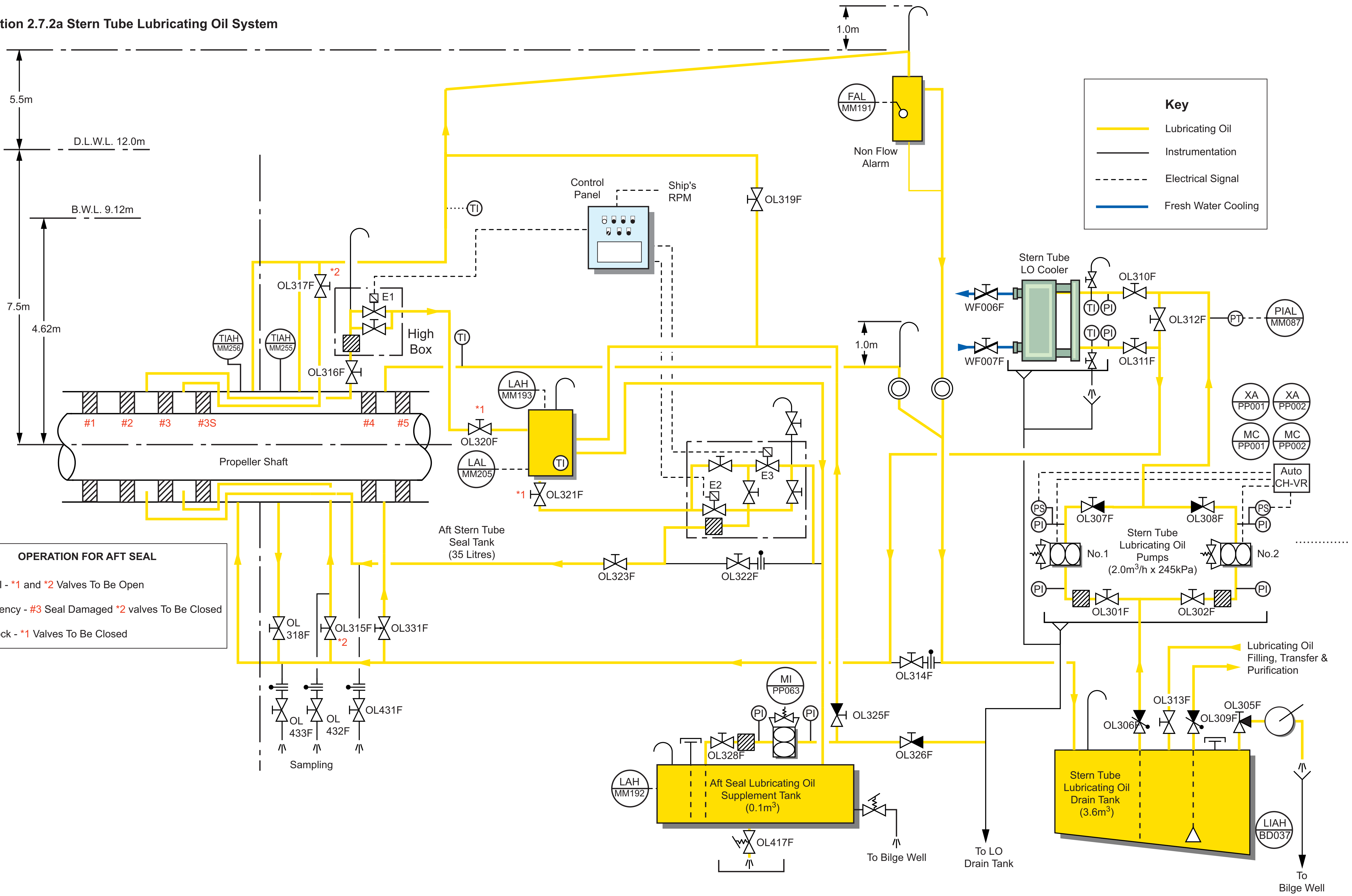
Procedure for the Preparation of the Stern Tube and Seal Lubricating Oil System

a) Ensure that all instrumentation valves are open.

b) Check the oil level in the aft stern tube seal tanks, stern tube LO drain tank and supplement top-up as necessary.

c) Set valves as shown in the table below.

Illustration 2.7.2a Stern Tube Lubricating Oil System



OPERATION FOR AFT SEAL

Normal - *1 and *2 Valves To Be Open

Emergency - #3 Seal Damaged *2 valves To Be Closed

Dry Dock - *1 Valves To Be Closed

Position	Description	Valve
Open	No.1 stern tube LO pump suction valve	OL301F
Open	No.1 stern tube LO pump discharge valve	OL307F
Open	No.2 stern tube LO pump suction valve	OL302F
Open	No.2 stern tube LO pump discharge valve	OL308F
Open	LO cooler inlet valve	OL310F
Open	LO cooler outlet valve	OL311F
Closed	LO cooler bypass valve	OL312F
Closed	Line drain valve	OL314F
Open	Supply valve to after seal (No.3 and No.3S)	OL315F
Open	Return valve from after seal (No.3 and No.3S)	OL317F
Open	After seal LO valve	OL323F
Closed	After seal low box bypass valve	OL322F
Open	After seal return valve	OL316F
Open	After seal LO tank inlet valve	OL320F
Open	After seal LO tank outlet valve	OL321F
Closed	After seal LO tank filling valve	OL319F
Closed	Stern tube bearing LO drain valve	OL318F
Closed	Sampling valves	OL431F/OL432F/OL433F
Open	After seal LO supplement pump suction valve	OL328F
Open	After seal LO supplement pump discharge valve	OL325F
Closed	After seal LO supplement pump discharge valve to LO drain tank	OL326F

d) Ensure that there is power at the stern tube system control box and activate the system.

e) Open the cooling water inlet and outlet valves to the stern tube LO cooler (see section 2.4.1) and ensure that fresh cooling water is circulating through the cooler.

f) Start the duty stern tube LO pump and check that oil is flowing through the bearing system and forward seal and returning to the drain tank by means of the sight glasses. Adjust the flow of oil to the forward seal as required on throttle valve OL331F.

g) Switch the other stern tube LO pump to standby.

h) Check the aft seal tank line for water.

i) Take an oil sample for analysis from the sampling valves at weekly intervals.

Operation of the Emergency Aft Seal 3S

See information on illustration 2.7.2a.

Alarms

Tag	Description	Low	High
MM087	Stern tube LO pump outlet pressure	170kPa	
MM087	Stern tube bearing temperature		60°C
PP001	No.1 LO pump outlet pressure control	150kPa	
PP002	No.2 LO pump outlet pressure control	150kPa	
BD037	Stern tube LO drain tank level	0.3m	1.2m

Tag	Description	High
MM255	Stern tube forward bearing temperature	60°C
MM256	Stern tube aft bearing temperature	60°C

Operation of the Port Anti-Pollution (PAP) System

The system is installed to prevent leakage of stern tube oil into sea when the vessel is in port. The oil in No.2/3 chamber in the stern seal is automatically filled or drained to the aft seal supplementary tank when the propellor shaft rises above or below 55rpm as follows.

1. Propellor shaft revolutions rises above 55 rpm.
- Solenoid valve E2 opens
- After 10 seconds solenoid valve E3 closes
- After 30 minutes solenoid valve E1 opens

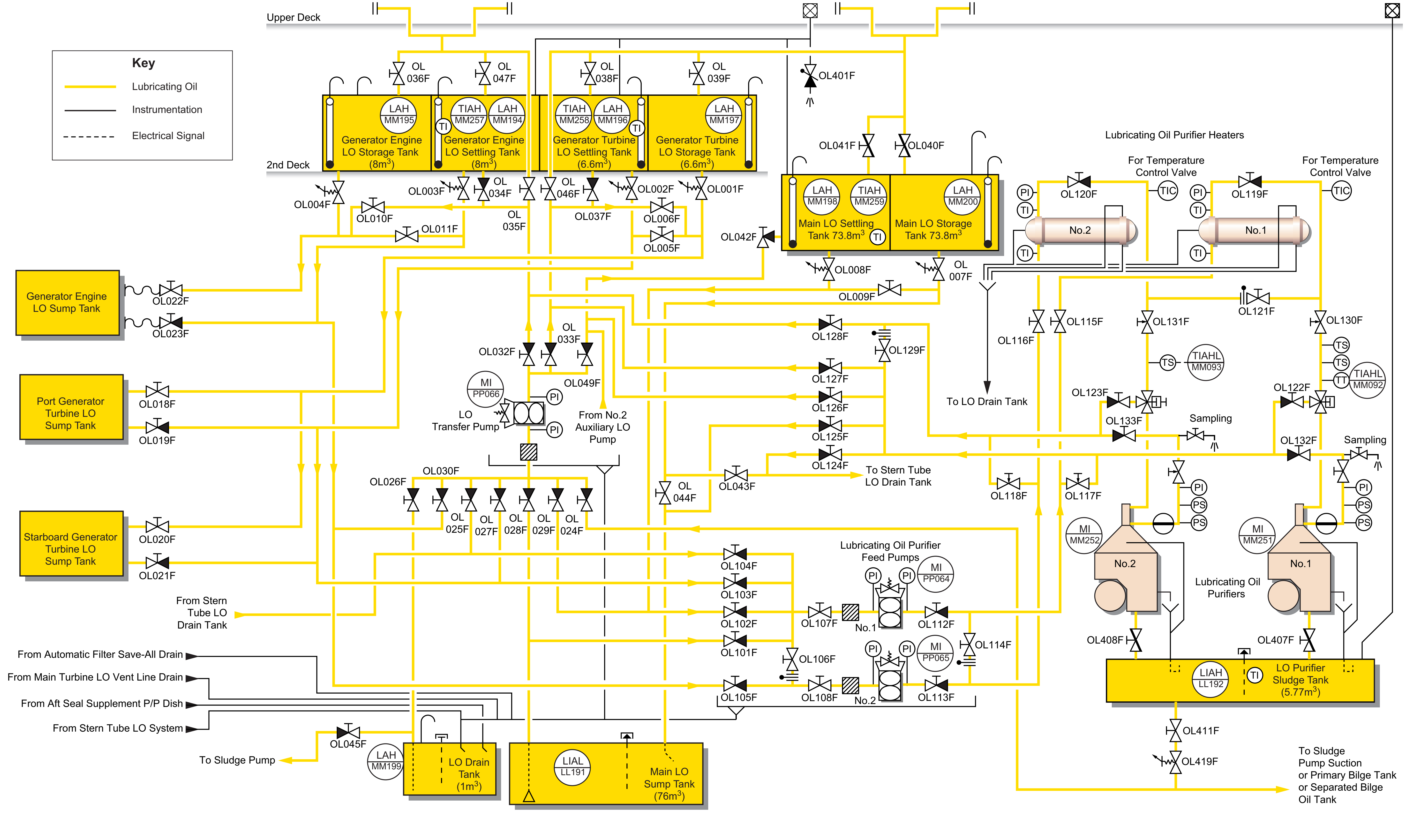
Oil flows from the aft seal tank to the aft seal chamber and the control panel shows E1 and E2 lights on.

2. Propellor shaft revolutions falls below 55 rpm.
- Solenoid valve E2 closes
- Solenoid valve E3 opens
- Solenoid valve E1 closes

Oil flows from the aft seal chamber to the supplementary tank and the control panel shows E3 light on.

PAP Panel Situated Port Side of Shaft Tunnel

Illustration 2.7.3a Lubricating Oil Purifying System



2.7.3 LUBRICATING OIL PURIFYING SYSTEM

Lubricating Oil Purifier

Maker:	Alfa Laval
No. of sets:	1
Model:	MOPX205
Capacity:	3,600 litres/hour

Purifier Lubricating Oil Feed Pump

Maker:	Taiko Kikai Ind. Ltd
No. of sets:	2
Type:	Horizontal gear
Model:	NHG-4MT
Capacity:	3.6m^3/h at 245kPa

Introduction

There two centrifugal self-cleaning LO purifiers. One is dedicated to the main engine and generator turbines, and the other is dedicated to the diesel generator engine systems. If necessary it is possible to use either purifier for all LO systems.

The purifiers can be used for batch purification or for continuous purification.

The lubricating oil purifiers are supplied with oil by dedicated LO supply pumps, one pump for each purifier, which pass the LO through a steam heater before it enters the purifier.

Instrument air is supplied to the purifiers to control the supply of oil to the bowl. Operating fresh water from the FW hydrophore tank is supplied for sealing and flushing purposes. Distilled water is not acceptable for the purifiers.

The MOPX System

The MOPX separator operates as a purifier, cleaned oil leaving the separator through the oil outlet whilst water and sludge accumulate at the outside of the separator bowl. The control unit supervises the operation of the entire separation system, monitoring the separator output, controlling the unit and activating alarms as necessary.

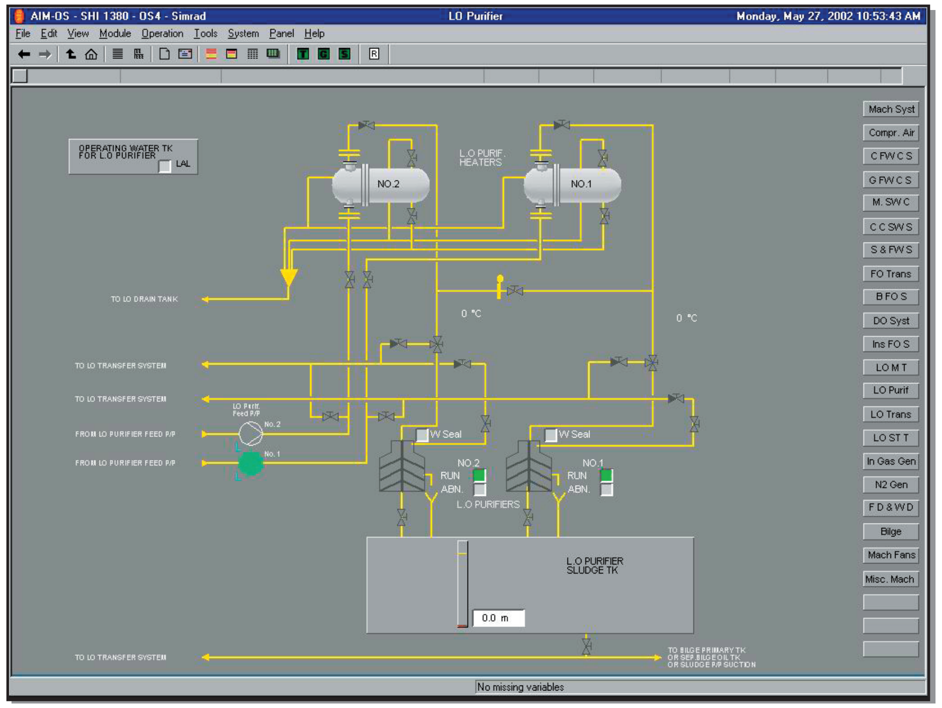
During the process cycle a specific amount of water is added to the bowl to form a water seal. Unprocessed oil is then fed to the centre of the bowl.

During the separation process the sludge and water accumulates at the periphery of the bowl and clean oil is discharged from the separator by the intergrated paring disc.

When water accumulation in the bowl approaches the disc stack, traces of water escape through the water outlet to the sludge tank.

The control system discharges sludge and water from the bowl at preset intervals or when needed. After a preset time between discharge sequences, the oil feed stops and displacement water is added to the bowl. The water reduces the oil loss and the sludge discharge is initiated.

The next process starts with water being added for a new seal.
Flow is controlled to the purifiers by operating the inlet throttle valves OL130F and OL131F.



CAUTION

Care must be taken when operating the purifier system. Hot oil and steam are present and can result in serious injury if leakage occurs. There is a fire risk from the presence of hot oil and all precautions must be taken to prevent a fire and to deal with one should an outbreak occur. The extinguishing system must be checked frequently. Centrifuges operate on an automatic sludging system but failure of the system to effectively discharge sludge can cause overload and subsequent breakdown of the bowl arrangement which rotates at high speed. After manual cleaning, care is needed to ensure that the bowl is assembled correctly, as incorrect assembly can result in disintegration at high rotational speed.

All operating and maintenance precautions stipulated by the manufacturer in the maintenance manual must be observed.

Procedure for Operating the Main Turbine Lubricating Oil Purifying System

Purifying LO from the main turbine LO sump tank back to the main turbine LO sump tank using No.1 LO purifier and the steam heater.

a) Check and record the level of oil in all LO tanks.

b) All valves in the purifier system should be initially closed.

c) Open the control air valves and the operating fresh water supply valve to the purifier.

d) Ensure that there is electrical power at the purifier control box.

e) Set the valves, as shown in the following table.

Position	Description	Valve
Open	No.1 purifier LO supply pump suction valve from the LO sump tank	OL101F
Open	No.1 purifier supply pump suction valve	OL107F
Open	No.1 purifier supply pump discharge valve	OL112F
Throttled	Purifier pump delivery regulating valve	OL117F
Closed	Purifier feed pumps crossover suction valve	OL106F
Closed	Purifier feed pumps crossover discharge valve	OL114F
Open	No.1 main LO purifier steam heater inlet valve	OL115F
Open	No.1 main LO purifier steam heater outlet valve	OL119F
Closed	Purifier heater crossover valve	OL121F
Open	No.1 purifier supply valve	OL130F
Operational	No.1 purifier three-way valve	
Open	No.1 purifier bypass valve	OL122F
Open	No.1 purifier outlet valve	OL132F
Throttled	No.1 purifier outlet flow regulating valve	
Open	No.1 purifier line valve to turbine sump tank	OL125F

(**Note:** All other valves must be closed.)

f) Ensure the purifier brake is off and the purifier is free to rotate.

g) Ensure that the purifier bowl is assembled correctly and that the hood is fitted and secured.

h) Check the purifier gearbox oil level.

i) Check that the No.1 LO purifier feed pump suction strainer is clean.

j) Start the No.1 LO purifier feed pump locally. Oil will bypass the purifier by means of the three-way valve. It will be drawn from the main LO sump tank and flow back to the main LO sump tank.

k) Start the purifier and ensure that the bowl runs up to speed; check the starting current.

l) Check that the bowl closes under the action of the operating water.

m) Switch on the control unit

n) Slowly open the steam supply to the No.1 LO purifier heater.

o) Set the steam temperature control to the required temperature; check the temperature setting if it has previously been set. Take care to avoid overheating the oil.

p) Lubricating oil will now be circulating through the heater back to the main LO sump tank.

q) When the purifier has run up to speed start the programme by pressing the START key. The purifier will then operate automatically to purify the LO. The purifier operates automatically with the bowl being sludged as required by a timed sludge cycle.

The purifier will run through the start up sequence, including a sludge discharge, before going on line.

r) Check that the purifier is operating correctly and that there is adequate throughput.

s) Ensure that there is no abnormal discharge from the sludge discharge.

t) Check that LO is being drawn from the LO circulation tank and being returned to the LO circulation tank.

To Stop the Purifier

a) Shut off the steam to the heater and allow the LO to flow for a few minutes.

b) Press the STOP soft key to initiate an ejection programme and the stop procedure.

The purifier will commence the shut down sequence and then stop.

c) Switch off power to the purifier motor.

d) Close the clean oil outlet valve.

e) Stop the feed pump.

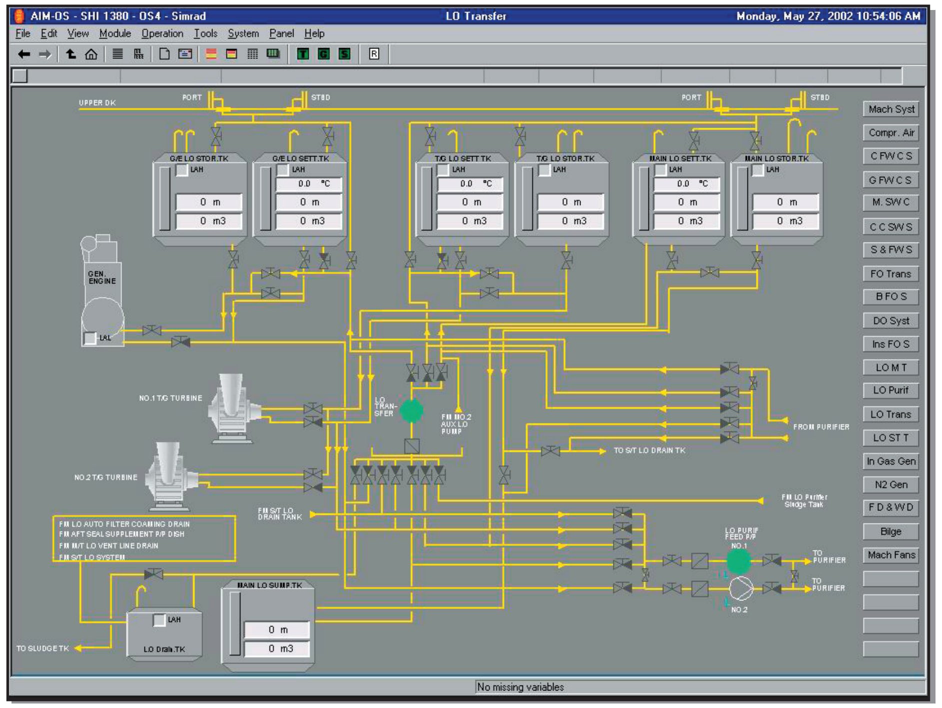
f) Shut off the water supplies.

g) Shut all valves.

h) When the purifier has stopped apply the brake and dismantle for cleaning if required.

Alarms

Tag	Description	Low Alarm	High Alarm
MM092/3	Purifier heater outlet temperature	60°C	100°C
BD038	LO purifier sludge tank level	0.3m	1.2m



Procedure for Purifying Lubricating Oil from the Main Lubricating Oil Sump Tank to the Main Lubricating Oil Settling Tank

Lubricating oil may be pumped from the main LO sump tank to the main LO settling tank via the No.1 LO purifier.

The procedure is the same as purifying LO from the main LO sump back to the main LO sump as above except for the setting of the valves.

Valve settings remain the same as in the procedure for purifying oil from the main LO sump tank back to the main LO sump tank except for the following:

Position	Description	Valve
Closed	No.1 purifier line valve to turbine sump tank	OL125F
Open	No.1 purifier line valve to main LO settling tank	OL126F
Open	Main LO settling tank filling valve	OL042F

The purifier is operated in the same way as the procedure for purifying LO from the main sump back to the main sump.

Procedure for Purifying Lubricating Oil from the Main Lubricating Oil Settling Tank to the Main Lubricating Oil Sump Tank

Lubricating oil may be purified from the main LO settling tank to the main LO sump tank and the arrangement is the same as for purifying the main LO sump back to the main LO sump except for the valve settings as follows.

Position	Description	Valve
Closed	No.1 purifier LO supply pump suction valve from the LO sump tank	OL101F
Open	No.1 purifier LO supply pump suction valve from the LO settling and storage tanks	OL102F
Open	Outlet valve from main LO settling tank	OL008F

The purifier is operated in the same way as for purifying LO from the main LO sump tank back to the main LO sump tank

Procedure for Purifying the Turbine Generator Lubricating Oil

Oil may be taken from the turbine generator sumps and purified to the turbine generator LO settling tank using No.1 LO purifier.

The procedure is the same as that for purifying LO from the main sump back to the main sump as in the first procedure described. Valve settings remain the same except for the following:

Position	Description	Valve
Closed	No.1 purifier LO supply pump suction valve from the LO sump tank	OL101F
Open	No.1 purifier LO supply pump suction valve from the turbine generator LO sump and tank system	OL103F
Open/Closed	No.1 turbine generator LO sump suction valve	OL019F
Open/Closed	No.2 turbine generator LO sump suction valve	OL021F
Open	Return line valve to turbine generator system	OL127F
Closed	No.1 purifier line valve to main turbine sump tank	OL125F
Open	Line valve to turbine generator storage and settling tanks	OL046F
Open	Inlet valve to turbine generator LO settling tank	OL038F
Closed	Inlet valve to turbine generator LO storage tank	OL039F
Closed	Inlet valve to main turbine LO settling tank	OL041F
Closed	Inlet valve to main turbine LO storage tank	OL040F

(**Note:** The turbine generator LO sump from which the LO is to be taken is selected as required. If the LO is to be purified to the turbine generator LO storage tank or the main LO settling tanks the appropriate valves above are changed.)

Lubricating oil from the turbine generator LO settling tank may be returned to a turbine generator sump via No.1 purifier. The procedure is the same as for purifying LO from a turbine generator sump to the turbine generator LO settling tank except for the following valve settings.

Position	Description	Valve
Closed	No.1 turbine generator LO sump suction valve	OL019F
Closed	No.2 turbine generator LO sump suction valve	OL021F
Open	Turbine generator LO settling tank quick-closing outlet valve	OL002F
Open	Turbine generator tank system crossover line valve	OL006F
Closed	Turbine generator tank system crossover line valve	OL005F
Closed	Turbine generator LO storage tank quick-closing outlet valve	OL001F
Closed	Line valve to turbine generator storage and settling tanks	OL046F
Open/Closed	Inlet valve to No.1 turbine generator LO sump tank	OL018F
Open/Closed	Inlet valve to No.2 turbine generator LO sump tank	OL208F

Procedure for Purifying the Stern Tube System Lubricating Oil

No.1 LO purifier may be used for purifying LO from and to the stern tube LO sump tank. The procedure is the same as for purifying LO from the main turbine sump tank back to the main turbine sump tank except for the setting of valves. The valve settings remain the same as for that procedure except for the following:

Position	Description	Valve
Closed	No.1 purifier LO supply pump suction valve from the LO sump tank	OL101F
Open	No.1 purifier LO supply pump suction valve from the stern tube LO sump tank	OL104F
Closed	No.1 purifier line valve to turbine sump tank	OL125F
Open	No.1 purifier line valve to stern tube LO sump tank	OL124F
Closed	Line valve from main LO storage tank	OL043F
Open	Stern tube LO sump tank filling valve	OL313F

Operation of No.2 Lubricating Oil Purifier

The previous descriptions have related to No.1 LO purifier which can be classed as the general purpose LO purifier as it can be operated on the main, generator and stern tube LO systems without too much trouble.

No.2 LO purifier is used for the generator engine LO systems. The purifier is identical to No.1 LO purifier and its operation and control are the same. The description of the operation of No.2 purifier is the same as for No.1 purifier except for the setting of valves. The example below gives the valve settings for purifying LO from the generator engine sump tank back to the LO sump tank.

Position	Description	Valve
Open	Generator engine LO sump tank outlet valve	OL023F
Open	No.2 purifier LO supply pump suction valve from the generator engine system	OL105F
Open	No.2 purifier LO supply pump suction valve	Ol108F
Open	No.2 purifier supply pump discharge valve	OL113F
Closed	Purifier feed pumps crossover suction valve	OL106F
Closed	Purifier feed pumps crossover discharge valve	OL114F
Open	No.2 main LO purifier steam heater inlet valve	OL116F
Open	No.2 main LO purifier steam heater outlet valve	OL120F
Throttled	Purifier pump delivery regulating valve	OL118F
Closed	Purifier heater crossover valve	OL121F
Open	No.2 purifier supply valve	OL131F
Operational	No.2 purifier three-way valve	
Open	No.2 purifier bypass valve	OL123F
Open	No.2 purifier outlet valve	OL133F
Throttled	No.2 purifier outlet flow regulating valve	
Open	No.2 purifier line valve to generator engine system	OL128F
Open	Line valve from tanks to engine sump	OL010F
Open	Generator engine sump inlet valve	OL022F

(**Note:** All other valves must be closed.)

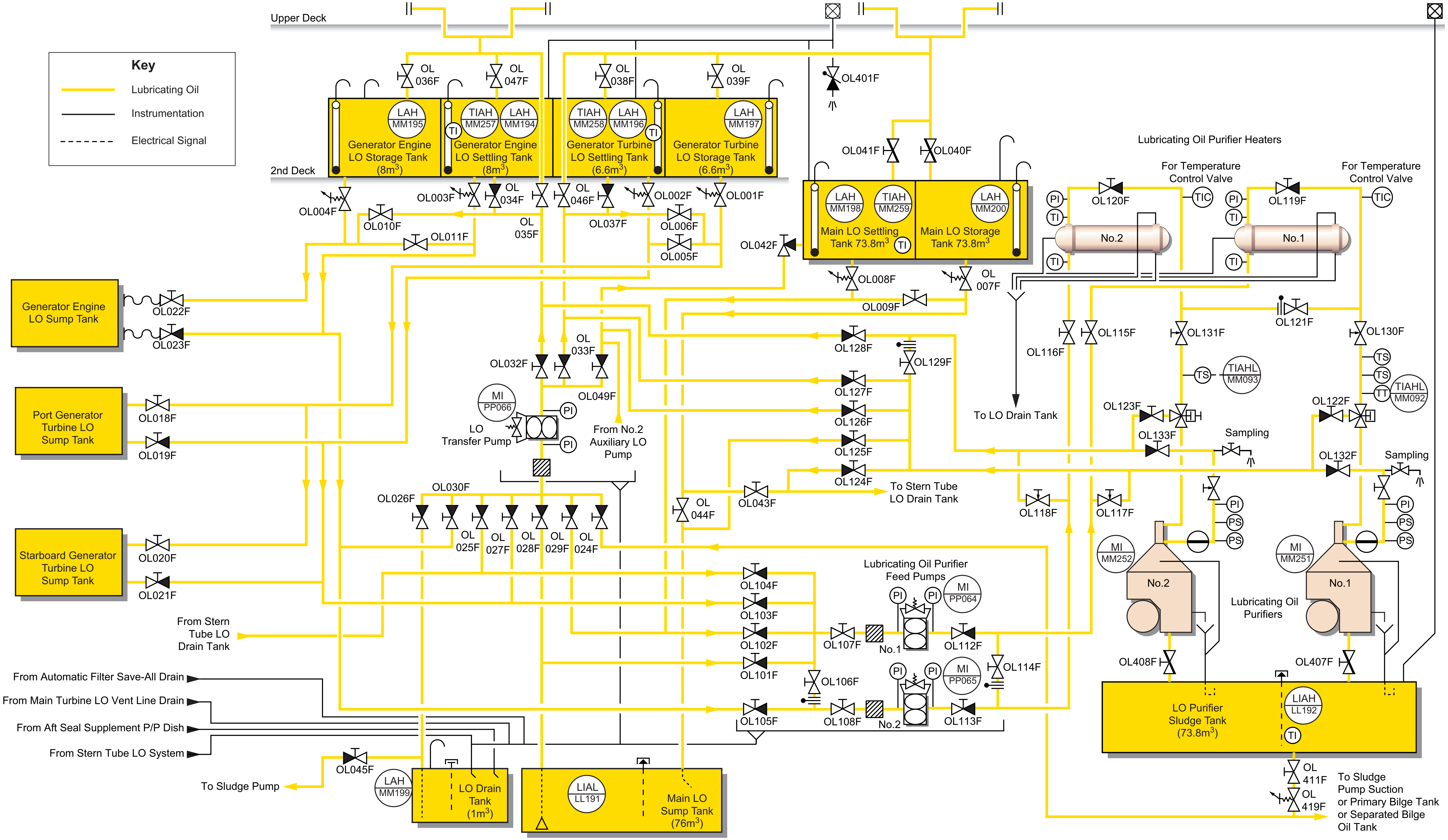
The purifier is operated as for No.1 purifier with LO drawn from the turbine generator LO sump and returned to the sump.

In order to purify LO from the generator engine sump to the generator engine LO settling tank the line valve OL010F and sump inlet valve OL022F must be closed.

The settling and storage tank supply valve OL035F must be opened together with the generator engine LO settling tank filling valve OL047F; the generator engine LO storage tank filling valve OL036F must be closed and blanks secured on the port and starboard bulk LO connections.

Lubricating oil may be run down from the generator engine LO settling tank back to the engine sump or it may be purified back to the sump if required.

Illustration 2.7.4a Lubricating Oil Filling and Transfer System



2.7.4 LUBRICATING OIL FILLING AND TRANSFER SYSTEM

Lubricating Oil Transfer Pump

Maker:	Taiko Kikai Ind. Ltd
No. of sets:	1
Type:	Horizontal gear
Model:	NHG-5MT
Capacity:	5.0m^3/h at 392kPa

Introduction

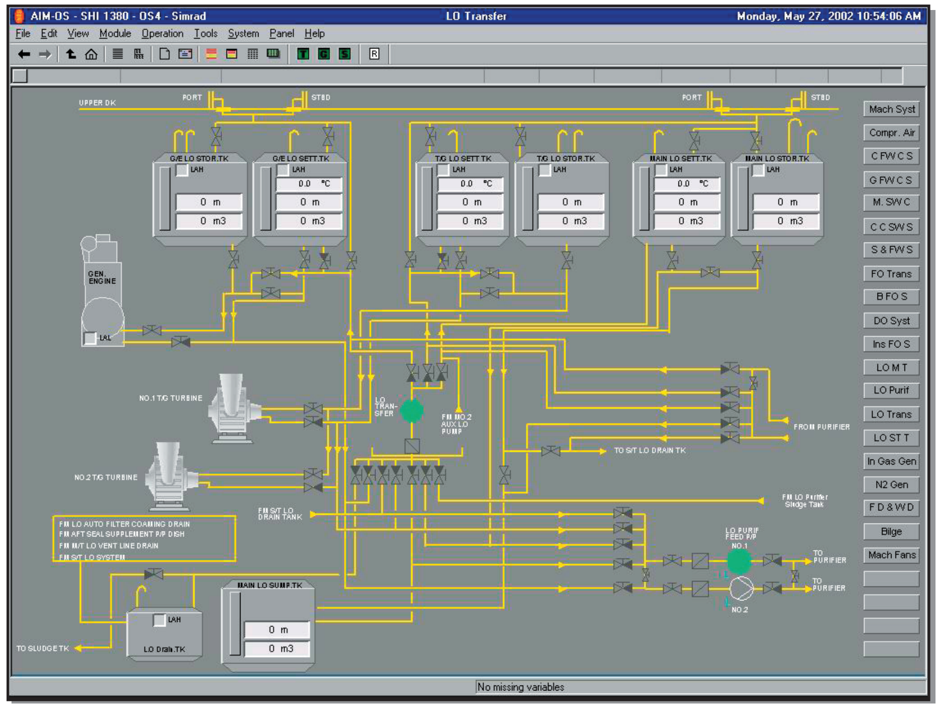
Lubricating oil is stored in the following tanks, located in the engine room.

Tank	Volume 100% (m^3)	Quick-Closing Valves
Main LO storage tank (S)	73.8	OL007F
Main LO settling tank (S)	73.8	OL008F
LO drain tank	1.0	
Generator engine LO storage tank(S)	8.0	OL004F
Generator engine LO settling tank(S)	8.0	OL003F
Generator turbine LO storage tank(S)	6.6	OL001F
Generator turbine LO settling tank(S)	6.6	OL002F
Main LO sump tank (C)	76.0	
Stern tube LO drain tank(C)	3.6	
After seal LO supplement tank	0.1	
After stern tube seal tank	0.035	
No.1 LO daily use tank	0.2	
No.2 LO daily use tank	0.2	

All outlet valves from large LO storage and settling tanks in the engine room are remote quick-closing valves with a collapsible bridge, which can be operated from the ship's fire control station. After being tripped the valves must be reset locally. Each tank is also fitted with a self-closing test cock to test for the presence of water and to drain any water present. Tundishes under the self-closing test cock drain any test liquid to the primary bilge tank or to the fuel oil drain tank.

Lubricating oil is run down from the storage tanks to the main LO sump tank, the diesel generator engine sump, the turbine generator engine sumps and the stern tube LO sump tank.

Main LO sump tank can be pumped or purified to the main LO settling tank before being purified or run back to the sump. The diesel generator engine sump oil can be pumped to the generator engine LO settling tank, or the main LO settling tank. The turbine generator sump oil can be pumped to the turbine generator LO settling tank, or the main LO settling tank. Heating coils are fitted to the main, the generator engine and the turbine generator lubricating oil settling tanks. All storage tanks are filled from connections on both sides of the ship at the loading stations located at the port and starboard sides of the accommodation at the upper deck level. The main LO and diesel generator engine LO storage tanks have separate filling lines. Generator turbine LO and main LO use the same filling line.



The LO transfer pump is used to transfer LO from one part of the ship to another. Its duties include batch transfer of LO from the main LO sump to the main LO settling tank prior to batch purification. It can also be used for pumping the contents of generator engine sumps to the generator engine LO settling tank and the turbine generator sumps to the turbine generator LO settling tank prior to purification. The contents of the stern tube LO sump and the LO drain tank may also be pumped to the main LO settling tank.

The LO transfer pump may be controlled locally or remotely from the IAS Lubricating Oil Transfer system graphic screen. A selector switch at the pump may to switched to LOCAL for local control, to REMOTE for control from the IAS or OFF which prevents the pump from being started. In local control the pump is started and stopped by pressing the local START and STOP pushbuttons. With the pump set to remote it may be controlled manually from the graphic screen. The graphic screen also displays alarm conditions for the tanks and the level of oil in the main LO sump tank.

The LO transfer pump can take suction from the following:

Location	Valve
LO drain tank	OL026F
Generator engine LO system	OL030F
Generator turbine LO system	OL027F
LO purifier sludge tank or separated bilge oil tank	OL024F
Main LO settling and storage tanks	OL029F
Main LO sump tank	OL028F
Stern tube LO drain tank	OL025F

The system valves in each case allows for suction from the relevant sump tanks, the storage tank and the settling tank with those tank valves also being open.

The LO transfer pump may discharge to the following:

Location	Valve
Main LO settling tank	OL049F
Generator turbine LO settling and storage tanks	OL033F
Generator engine LO settling and storage tanks	OL032F

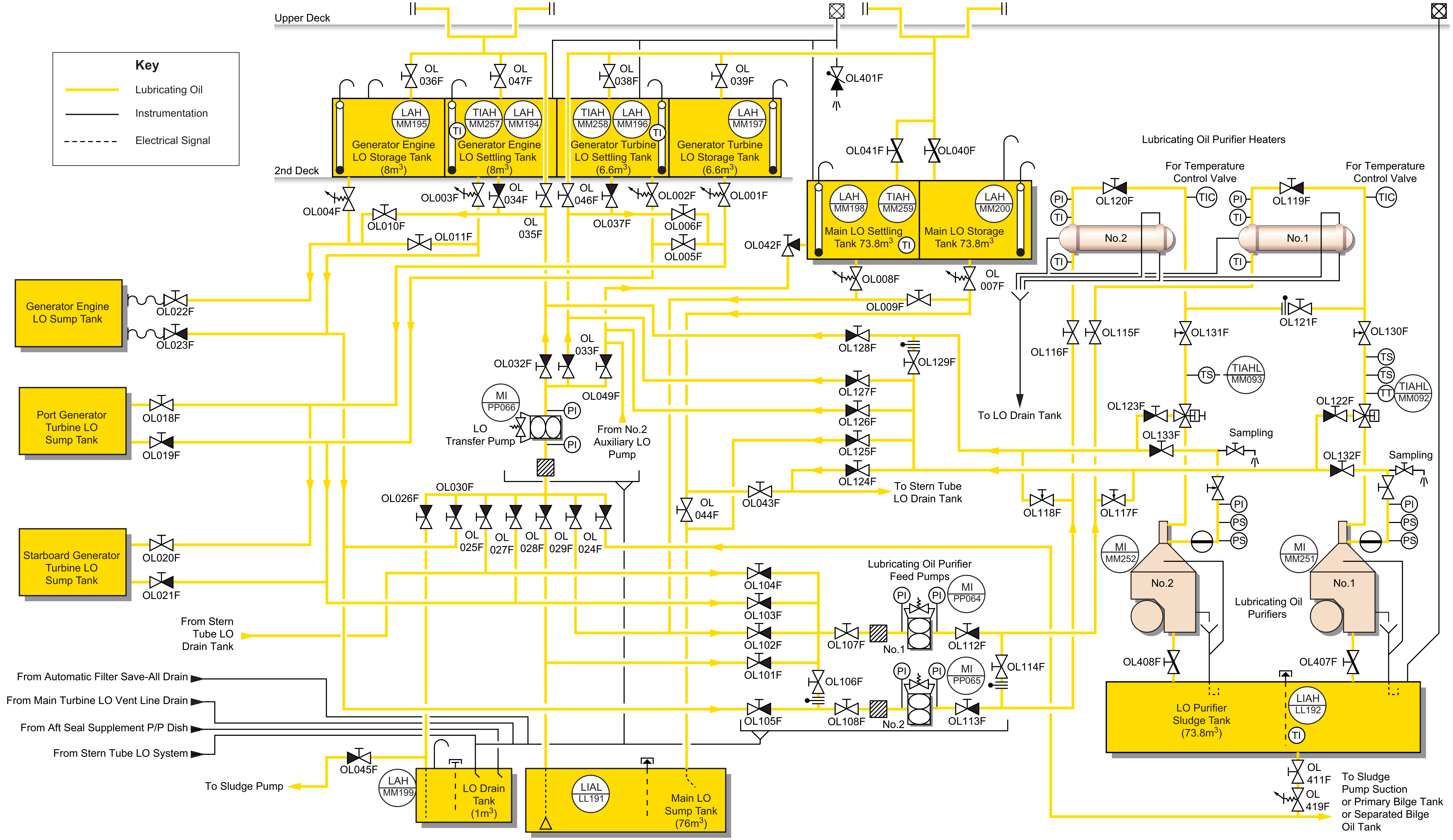
CAUTION

Extreme care must be taken when transferring LO so that oils do not become mixed. The setting of all valves must be checked prior to starting operations so that oil will only be pumped from the intended source and to the intended destination.

Alarms

Tag	Description	High
MM257	Generator engine LO settling tank temperature	80°C
MM258	Generator turbine LO settling tank temperature	80°C
MM259	Main LO settling tank temperature	60°C

Illustration 2.7.4a Lubricating Oil Filling and Transfer System



Procedure for the Transfer of Lubricating Oil by means of the Lubricating Oil Transfer Pump

a) Check and record the level of oil in all LO tanks.

b) Check that all the tank suction and filling valves are closed.

c) Check that the LO transfer pump suction filter is clean.

d) Open the suction valve(s) from the relevant source as in the following table:

Description	Valve
Main Engine Sump	
LO transfer pump suction valves from main LO sump tank	OL028F
From Stern Tube Lubricating Oil Sump Tank	
LO transfer pump suction valves from stern tube drain tank	OL025F
From Main Lubricating Oil Settling and Storage Tanks	
LO transfer pump suction valves from main LO settling tank	OL029F/ OL008F
LO transfer pump suction valves from main LO storage tank	OL029F/ OL009F/OL007F

Description	Valve
Generator Engine Lubricating Oil System	
LO transfer pump suction valves from generator engine sump	OL030F/ OL023F
LO transfer pump suction from generator engine settling tank	OL030F/ OL003F
LO transfer pump suction from generator engine storage tank	OL030F/ OL011F/OL04F

Description	Valve
Generator Turbine Lubricating Oil System	
LO transfer pump suction from No.1 turbine generator sump	OL027F/ OL019F
LO transfer pump suction from No.2 turbine generator sump	OL027F/ OL021F
LO transfer pump suction from turbine generator settling tank	OL027F/ OL002F
LO transfer pump suction from turbine generator storage tank	OL027F/ OL005F/OL001F
From Lubricating Oil Drain Tank	
LO transfer pump line suction valve from LO drain tank	OL026F

e) Open the discharge valve(s) to the relevant tank:

Description	Valve
Shore connection valve (turbine LO)	OL033F/OL046F
Shore connection valve (generator engine LO)	OL032F/OL035F
Main LO settling tank	OL042F/OL049F
Generator turbine LO settling tank	OL033F/OL046F/OL038F
Generator turbine LO storage tank	OL033F/OL046F/OL039F
Generator turbine LO settling tank	OL032F/OL035F/OL047F
Generator turbine LO storage tank	OL032F/OL035F/OL036F

f) Check that the valve system is correctly set and then start the LO transfer pump from the IAS graphic screen or locally if required.

g) Ensure that the oil is being correctly transferred.

h) When the required quantity of oil has been transferred, stop the pump and close all valves.

i) Check and record the levels in all LO tanks and record the amount of oil transferred in the Oil Record Book with details of date, time and personnel involved.

Procedure for the Transfer of Lubricating Oil by Gravity

All valves should be in the CLOSED position.

a) Drain any water from the tank by operating the self-closing drain cock and then open the following valves depending on the service selected.

Main Lubricating Oil System

From lubricating oil storage and settling tanks to the main LO sump, the stern tube LO drain tank:

Description	Valve
Main LO storage tank quick-closing outlet valve to main sump	OL007F/ Ol044F
Main engine LO settling tank quick-closing valve to main sump	OL008F/ OL009F/OL044F
To stern tube LO drain tank	OL007F/OL043F/OL313F
To stern tube LO drain tank	OL008F/OL009F/OL043F/OL313F

Generator Engine System

From the generator engine LO storage and settling tanks to the generator engine sumps.

Generator Turbine System

From the generator turbine LO storage and settling tanks to the turbine generator sumps.

Description	Valve
Generator turbine LO storage tank quick closing outlet valve	OL001F/ Ol018F or OL020F
Generator turbine LO settling tank quick closing outlet valve	OL002F/ OL005F/OL018F/OL020F

b) Ensure that oil is being correctly transferred.

c) When the required quantity of oil has been transferred, close all valves.

d) Check and record the levels in all LO tanks and record the amount of oil transferred in the Oil Record Book together with the date, time and personnel involved.

Procedure for Loading Lubricating Oil

The preparation and operation procedures for loading should be followed as described in section 2.6.1 Fuel Oil Bunkering and Transfer System. The precautions to be observed when loading LO are the same as for loading fuel oil. Main LO and turbine generator LO use the same filling line and the generator engine LO has its own filling line. There are filling connections on the port and starboard sides of the accommodation block at upper deck level.

a) Check that there is sufficient capacity in the tank to accommodate the LO ordered.

b) Agree with the supplier the amount of LO to be supplied for each category of oil; check that the grades of LO ordered are to be delivered.

c) Remove the line blank to the required filling line.

d) Connect the loading hose and open the appropriate tank valve.

Description	Valve
Main LO storage tank filling valve	OL040F
Main LO settling tank filling valve	OL041F
Generator turbine LO storage tank filling valve	OL039F
Generator turbine LO settling tank filling valve	OL038F
Generator engine LO storage tank filling valve	OL036F
Generator engine LO settling tank filling valve	OL047F

e) Proceed with the loading operation.

f) Ensure that oil is being loaded into the correct tank.

g) When the required quantity of oil has been loaded, signal for the pumping to stop. Allow the pipe to drain and then close all valves.

h) Remove the supply pipe and refit the blank.

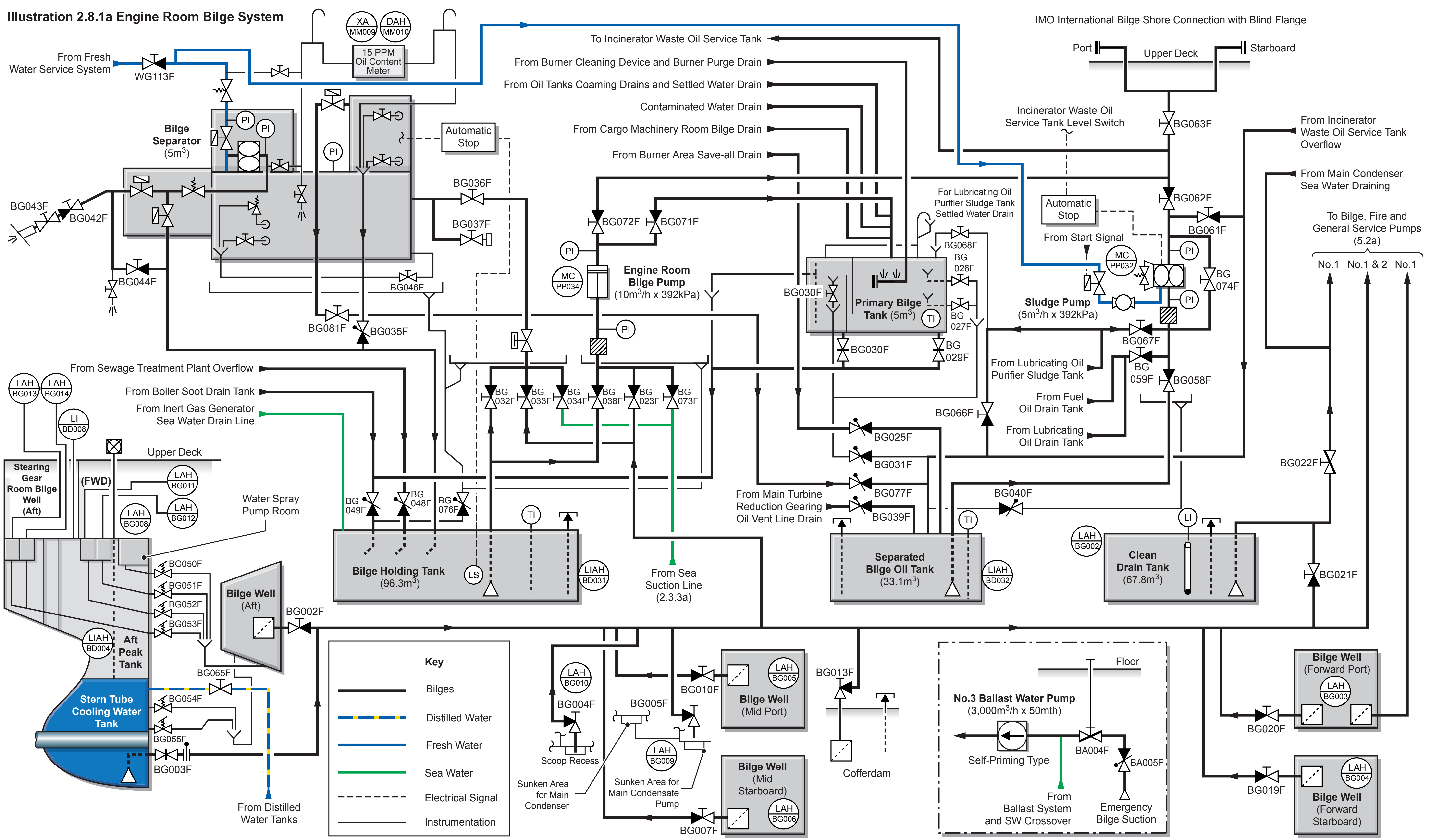
i) Check and record the levels in all LO tanks and record the amount of oil loaded.

BPS QA procedures are to be strictly adhered to.

2.8 Bilge System

Illustrations

Illustration 2.8.1a Engine Room Bilge System



2.8 BILGE SYSTEM

2.8.1 ENGINE ROOM BILGE SYSTEM

Engine Room Bilge Pump

Maker:	Taiko Kikai Ind. Ltd
No. of sets:	1
Type:	Displacement
Model:	VPS-10
Capacity:	$10m^3/h$ at 40mth

Sludge Pump

Maker:	Taiko Kikai Ind. Ltd
No. of sets:	1
Type:	Mono screw
Model:	HNP-401
Capacity:	$5.0m^3/h$ at 343kPa

Bilge, Fire and General Service Pump

Maker:	Shinko Ind. Ltd
No. of sets:	2
Type:	Centrifugal self-priming
Model:	RVP200-2MS
Capacity:	$245/150m^3/h$ at 35mth/120mth

Bilge Separator

Maker:	Hamworthy
No. of sets:	1
Model:	HS5 Mk11
Capacity:	$5m^3/h$

Introduction

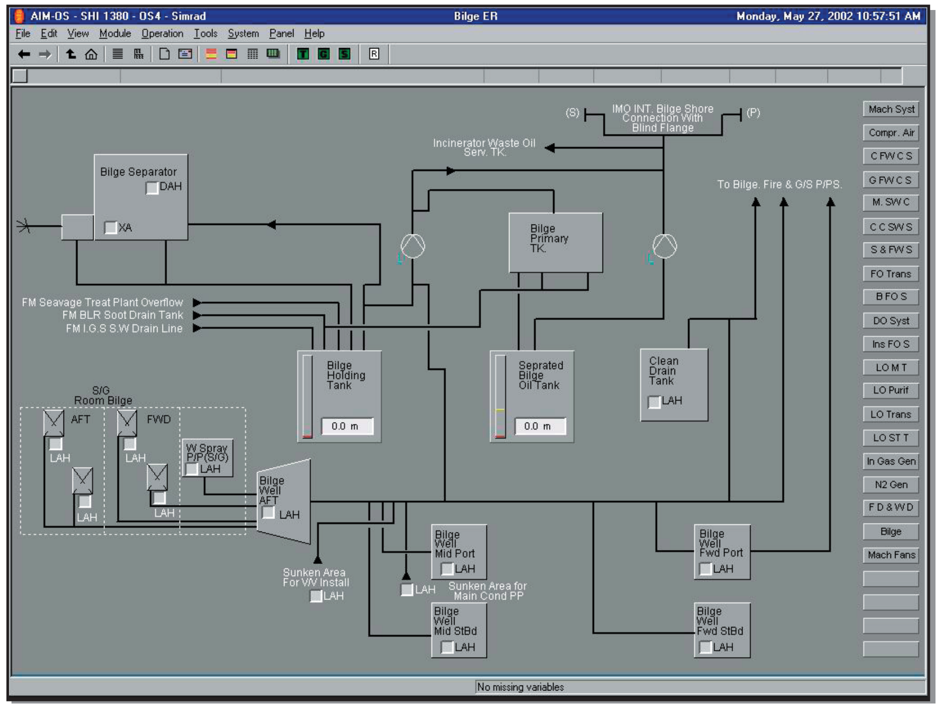
The engine room bilge pump can take suction from:

- Engine room bilge wells
- Stern tube cooling water tank
- Bilge holding tank
- Scoop recess
- Cofferdam
- Clean drain tank
- Main condenser and condenser pump sunken areas
- The sea water suction main

Apart from the sea water suction and the bilge holding tank, all of the bilge pump suctions are connected to the bilge main.

The engine room bilge pump discharges to:

- The primary bilge tank
- Incinerator waste oil service tank
- Shore connections on the port and starboard side



All bilge wells are fitted with high level alarms as is the sunken area for the sea water scoop. The bilge holding tank, the clean drain tank and the separated bilge oil tank are fitted with high level alarms. The alarms have a 20 seconds time delay.

The bilge system can only be operated manually, except for the level alarms which are monitored by the IAS and displayed on the bilge graphic screen.

The sludge pump can be operated from the IAS and can take suction from:

- Separated bilge oil tank
- The LO drain tank
- The FO drain tank
- The LO purifier sludge tank

The sludge pump can discharge to:

- The incinerator waste oil service tank
- Shore connections on the port and starboard side
- Separated bilge oil tank

The self-priming bilge, fire and GS pumps can take suction from:

- Bilge suction main
- Sea water suction main
- No.1 pump has a direct suction from the port forward bilge well and can take suction from the clean drain tank, the fresh water tanks and the main condenser
- No.2 pump also has a direct suction from the port forward bilge well via cross connecting valve FD006F

The self-priming bilge, fire and GS pumps can discharge to:

- Overboard via the ballast eductor overboard line
- Fire and wash deck line
- Hull water spray system
- The ballast stripping eductor

CAUTION

The overboard discharge is not to be used for discharging bilges unless under emergency conditions.

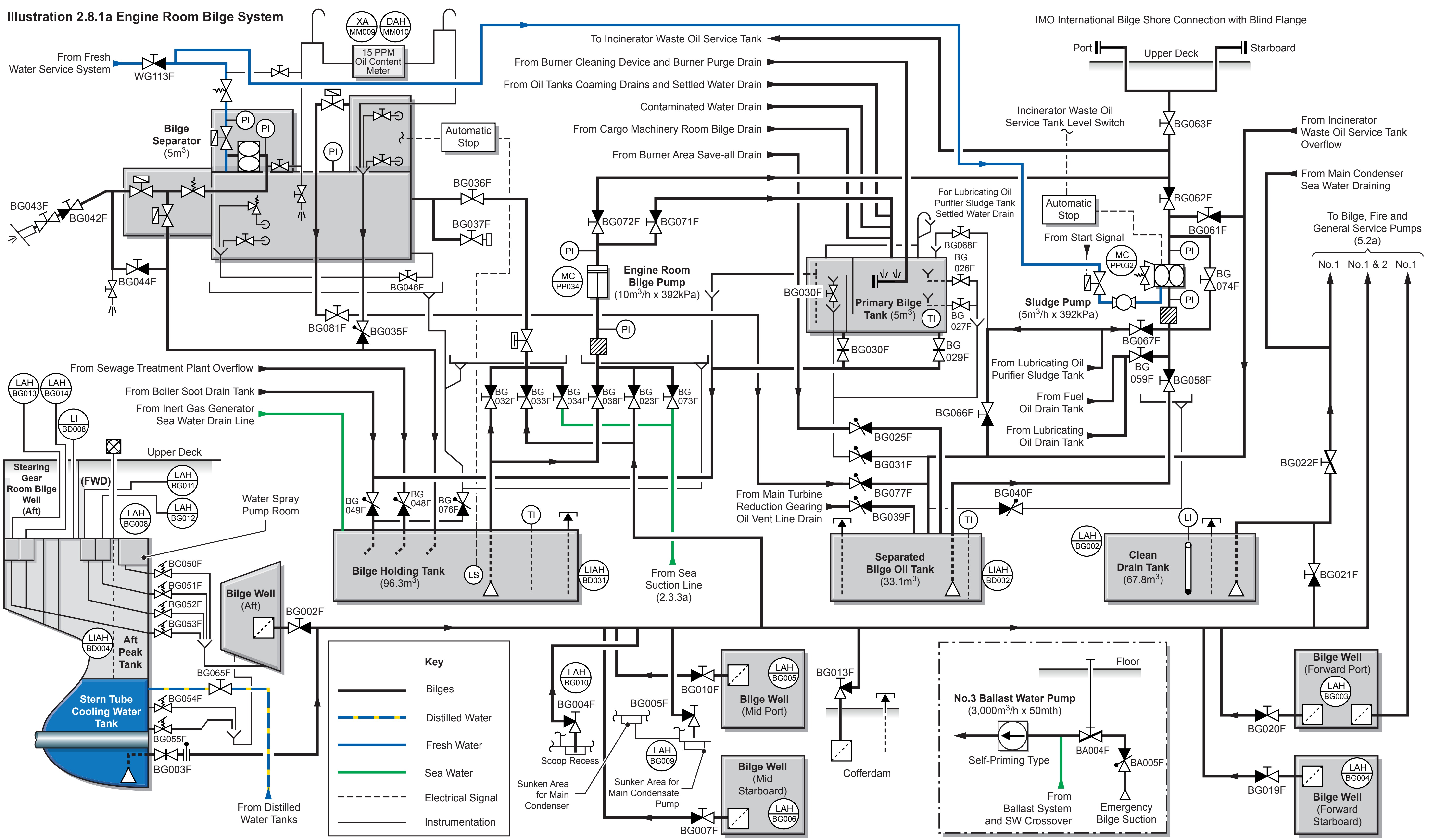
No.3 ballast pump is self-priming and has an emergency bilge suction via valve BA004F.

The Oily Bilge Water Separator

The bilge separator operates automatically and discharges water overboard and separated oil to the separated bilge tank. The oily bilge water is initially pumped into the bilge holding tank, using the engine room bilge pump, via the bilge primary tank and the separator extracts bilge water from the bilge holding tank. The separator has a pump located at the outlet and this draws bilge water through the separator rather than pumping it through. This arrangement prevents the mixing of oil and water by the action of the pump which would occur if the bilge water was pumped into the separator.

The oily bilge water enters the separator and passes through a number of chambers where oil is separated from the water. Separated oil particles flow to the collecting chamber at the top of the separator unit. Oil probes in this chamber monitor the level of the oil and when the lower probe is activated, indicating that the chamber is nearly full of oil, the discharge cycle commences.

Illustration 2.8.1a Engine Room Bilge System



The induction pump is stopped, the oil discharge valve is opened and flushing water enters the separator. This flushing water displaces the oil which flows to the separated bilge oil tank.

When the upper oil probe in the oil collecting chamber senses the presence of water, indicating that the oil has been displaced, the flushing water is shut off, the oil discharge valve is closed and the induction pump commences operation again drawing bilge water from the bilge holding tank. The oily water separator induction pump can also take suction from the bilge main and the sea suction line.

The separator induction pump is provided with an automatic stop facility which stops the separator operating when the bilge holding tank is empty.

The oil content discharge (OCD) monitor located after the separator discharge, samples the bilge water as it passes out of the separator. Should the oil content exceed 15ppm, the solenoid valves operate to change the output flow from the overboard discharge back to the bilge holding tank. An audible alarm sounds to warn the operator of the situation.

The separator works automatically at all times and will operate as long as there is water being pumped into it. Heating may be applied in order to improve separation but the heater will only operate when the separator is full. The separator is fitted with sampling valves which allow an oil sample to be drawn and enable the oil/water interface level to be determined.

CAUTION

The oily water separator is designed to separate oil from water, not water from oil. Therefore if the bilge supply to the separator contains excessive amounts of oil it will render the equipment useless and result in unnecessary maintenance.

The maximum flow capacity should not be exceeded as excess flow will prevent effective separation. The separator supply suction strainer should be kept clean in order to avoid large solid particles entering the separator as these will have a detrimental effect on separation.

Procedure for Pumping the Bilge Holding Tank through the Oily Bilge Separator

The description assumes that the separator has already been commissioned and that it is filled with water. Valve BG037F is used for priming the separator for commissioning and after it has been drained for overhaul.

a) Check that the strainers are clean.

b) Open the suction valve BG032F from the bilge holding tank.

c) Check that the FW system is operating and able to supply the oily bilge separator and that valve WG113F is open.

d) Set the valves as in the following table:

The reclaimed oil will be discharged to the separated bilge oil tank.

Position	Description	Valve
Closed	Separator drain valves	
Operational	Solenoid controlled discharge valves	
Open	Separator overboard discharge valves	BG043F/BG042F
Closed	Return valve to bilge holding tank	BG044F
Open	Separated oil discharge valve to bilge oil tank	BG081F
Open	Inlet valve to separator	BG036F

e) Check that there is power to the separator control panel and that the separator unit is switched on.

f) Ensure that all valves which are not required to be set for operation are closed.

g) Start the separator operating automatically by selecting AUTO operation and pressing the START pushbutton.

h) Switch on the oil monitoring unit and check its operation.

i) The separator will run automatically, discharging oil to the separated bilge oil tank when the oil sensing probe detects an oil level. The oil content of the discharge water will be constantly monitored.

j) Stop the separator when the desired level is reached in the bilge holding tank. Switch off the oil content monitoring unit, shut off the separator and close all pump valves. When in automatic mode the separator induction pump will stop when the low level switch in the bilge holding tank is activated.

The clean exit water will be discharged overboard. Oil contamination of 15ppm or over will automatically be discharged back to the bilge holding tank until the water is clean enough to discharge overboard. Any oil collected at the top of the bilge separator will be discharged to the separated bilge oil tank.

The separator induction pump may also be used for pumping bilge wells directly. In this case the suction valve from the bilge main BG033F must be open and the suction valve from the bilge holding tank BG032F closed. Individual bilge well suction valves must be opened as required.

Pumping Bilges to the Primary Bilge Tank

Engine room bilge wells, void spaces, the cofferdam and other spaces may be pumped to the primary bilge tank using the engine room bilge pump. The bilge pump may also pump these spaces to the shore connections.

Procedure for Pumping Bilges to the Bilge Primary Tank Using the Engine Room Bilge Pump

a) Clean all suction strainers.

b) Check that all instrumentation is working correctly.

c) Set the pump valves as in the following table:

The valve settings assume suction from the starboard forward bilge well. If other bilge spaces are to be pumped the appropriate valves must be opened.

Position	Description	Valve
Open	Engine room bilge pump suction from bilge main	BG023F
Open	Engine room bilge pump discharge valve to primary bilge tank	BG071F
Open	Starboard forward bilge well suction valve	BG019F
Closed	Port forward bilge well suction valve	BG020F
Closed	Cofferdam suction valve	BG013F
Closed	Starboard middle bilge well suction valve	BG007F
Closed	Port middle bilge well suction valve	BG010F
Closed	Bilge well near scoop recess	BG004F
Closed	Condenser sunken area suction valve	BG005F
Closed	Clean drain tank suction valve	BG021F
Closed	Aft bilge well suction valve	BG002F
Closed	Stern tube cooling FW tank suction valve	BG003F

d) Start the engine room bilge pump locally and check that the correct compartment is being pumped. Operate the pump until the bilge well is empty. Change suction valves to pump other bilge wells or compartments as required.

e) Following manual pumping of bilge wells or compartments to the primary bilge tank, close all bilge well and compartment suction valves.

Bilge wells and compartments connected to the bilge suction main may be pumped to the bilge separator using the separator induction pump.

In this case the engine room bilge pump suction valve from the bilge main BG023F must be closed and the suction valve to the bilge separator induction pump BG033F must be open. Bilge well and compartment suction valves connected to the bilge main are opened as required to pump out that particular bilge well or compartment. But the normal operation for pumping out bilge wells would be by using the engine room bilge pump discharging to the primary bilge tank.

Water in the primary bilge tank is allowed to settle, with steam heating applied as necessary. There are two main compartments in the primary bilge tank and these are separated by means of a baffle. The inlet side of the tank is provided with two oil test valves and the oil will mainly separate from the bilge water in the inlet compartment. The oil will float to the top of the tank and may be detected by means of the test valves BG026F and BG027F. Oil is drained from the primary bilge tank to the separated bilge oil tank by means of the test valves on the inlet side. The water side of the primary bilge tank is provided with an oil test valve BG028F and this is used to detect and drain oil from the water side of the tank. The primary bilge tank overflows to the bilge holding tank.

Water from the primary bilge tank compartments is drained to the bilge holding tank by means of valves BG030F and BG029F. The water discharge side is drained by means of valve BG030F and the inlet side is drained by means of valve BG029F. Normally the bilge tank is operated by overflowing to the bilge holding tank. Valves BG029F and BG030F are generally used at tank miantenance and cleaning.

The primary bilge tank also receives water from the cargo machinery bilge drain, the contaminated water drain, oil tank coamings and from the burner cleaning device and purge drain.

Procedure for Pumping the Bilge Compartments or the Bilge Holding Tank to the Shore Connection using the Engine Room Bilge Pump

The procedure is the same as for pumping any bilge well or compartment connected to the bilge suction main to the bilge primary tank except that the discharge valves on the engine room bilge pump are arranged differently.

a) The bilge pump valves should be arranged as follows:

Position	Description	Valve
Closed	Engine room bilge pump suction valve from sea	BG073F
Open	Engine room bilge pump suction from bilge main	BG023F
	OR	
Open	Engine room bilge pump suction from the bilge holding tank	BG038F
Closed	Engine room bilge pump discharge valve to bilge primary tank	BG071F
Open	Engine room bilge pump discharge valve to shore line	BG072F
Open	Shore connection line valve	BG063F
Open	Port shore connection discharge flange	
Closed	Starboard shore connection discharge flange	

In the arrangement above it is assumed that the bilges will be discharged ashore via the port shore connection.

b) Remove the blank from the port shore connection pipe and attach the shore discharge pipe.

c) Agree a pumping arrangement with the shore authorities.

d) Start the engine room bilge pump and pump out the selected bilge compartments using the valves as indicated in part c) of the previous procedure for pumping bilges to the bilge primary tank.

e) Stop the bilge pump when the compartments to be pumped are dry, close all valves and return the spectacle blank to the closed position.

Procedure for Pumping Bilges using the Bilge, Fire and GS Pumps

These pumps may be used for pumping the bilges connected to the bilge main. These pumps also supply SW to the fire and wash deck system thus they can operate the ballast stripping eductor which is used to pump out the port and starboard engine room ballast tanks and the after peak tank. The bilge, fire and GS pumps are used to pump the bilges directly overboard and so they are not the main means by which the bilges will be pumped out. Unlike the overboard discharge from the bilge separator there is no 15ppm monitor located in the discharge line.

a) Check that the bilge strainers are clear.

b) Determine which pump is to be used for pumping the bilges.

c) Set the bilge, fire and GS pump valves as in the following table:

(**Note:** There are valve interlocks which prevent the suction valve being opened from the bilge main, and the direct bilge in the case of No.1 pump, when the discharge valve to the fire main is open.)

Position	Description	Valve
Open	No.1 bilge, fire and GS pump discharge valve to the overboard discharge line	FD010F
Open	No.2 bilge, fire and GS pump discharge valve to the overboard discharge line	FD011F
Open	Overboard discharge valve (remotely operated)	BA030F
Open	No.1 bilge, fire and GS pump suction valve from bilge main	FD006F
Open	No.1 bilge, fire and GS pump interlocked suction valve from bilge system	FD003F

(**Note:** Valves FD008F and FD012F (discharge to fire main) must be closed before valve FD003F is opened.)

Position	Description	Valve
Closed	No.1 bilge, fire and GS pump direct bilge suction valve	FD007F
Open	No.2 bilge, fire and GS pump interlocked suction valve from bilge system	FD004F

(**Note:** Valves FD009F and FD013F (discharge to fire main) must be closed before valve FD004F is opened.)

d) Open the bilge suction valves, as required, in the following table:

Bile Main Suction Valves

Description	Valve
Starboard forward bilge well suction valve	BG019F
Port forward bilge well suction valve	BG020F
Cofferdam suction valve	BG013F
Starboard middle bilge well suction valve	BG007F
Port middle bilge well suction valve	BG010F
Bilge well near scoop recess	BG004F
Condenser sunken area suction valve	BG005F
Clean drain tank suction valve	BG021F
Aft bilge well suction valve	BG002F
Stern tube cooling FW tank suction valve	BG003F

e) Start the selected bilge, fire and GS pump and pump the contents of the selected bilge overboard.

(**Note:** The No.1 fire, bilge and GS pump has a direct suction from the forward port bilge well. The suction valve for this is FD007F.)

CAUTION

Before any bilges are pumped directly overboard, it must be ensured that no local or international anti-pollution regulations will be contravened except where safety of the ship or personnel is involved. Pumping machinery spaces bilges overboard must be conducted using an oil content monitor EXCEPT in an emergency ONLY.

Steering Gear Room Bilges

Bilges in the steering gear room are drained to the aft bilge well. The steering gear room after bilge wells are drained by means of valve BG053F located in the engine room. The forward steering gear room bilge wells are drained by means of valves BG052F and BG051F located in the engine room.

The water spray pump bilge well is drained into the after engine room bilge well by means of valve BG050F located in the engine room and water spray pump room save-all in the steering compartment.

In Port or Coastal Waters

Any bilges which require pumping, when in port, should only be pumped to the bilge holding tank using the engine room bilge pump. The contents of the bilge holding tank can then be processed in the bilge oily water separator when the vessel is in open water.

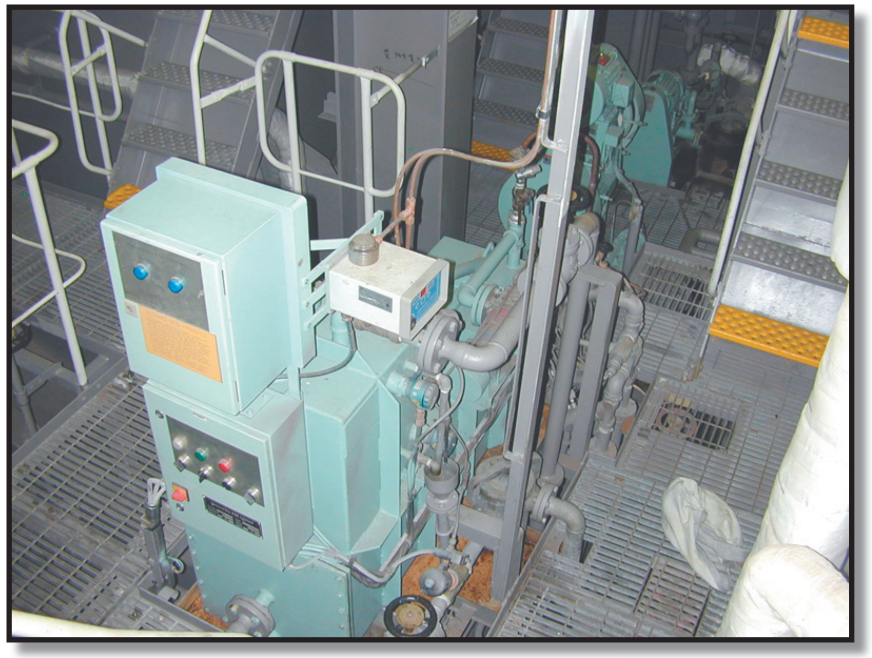
At Sea

The engine room bilges and the contents of the bilge holding tank should only be pumped overboard through the oily water separator system. Any oil will then be separated out and discharged to the waste oil tank and the clean water will be discharged overboard if the oil content is below 15ppm.

((**Note:** Always advise the duty engineer prior to starting the fire pump and confirm the availability of the GS/fire and bilge pumps for use on the fire and wash deck system.)

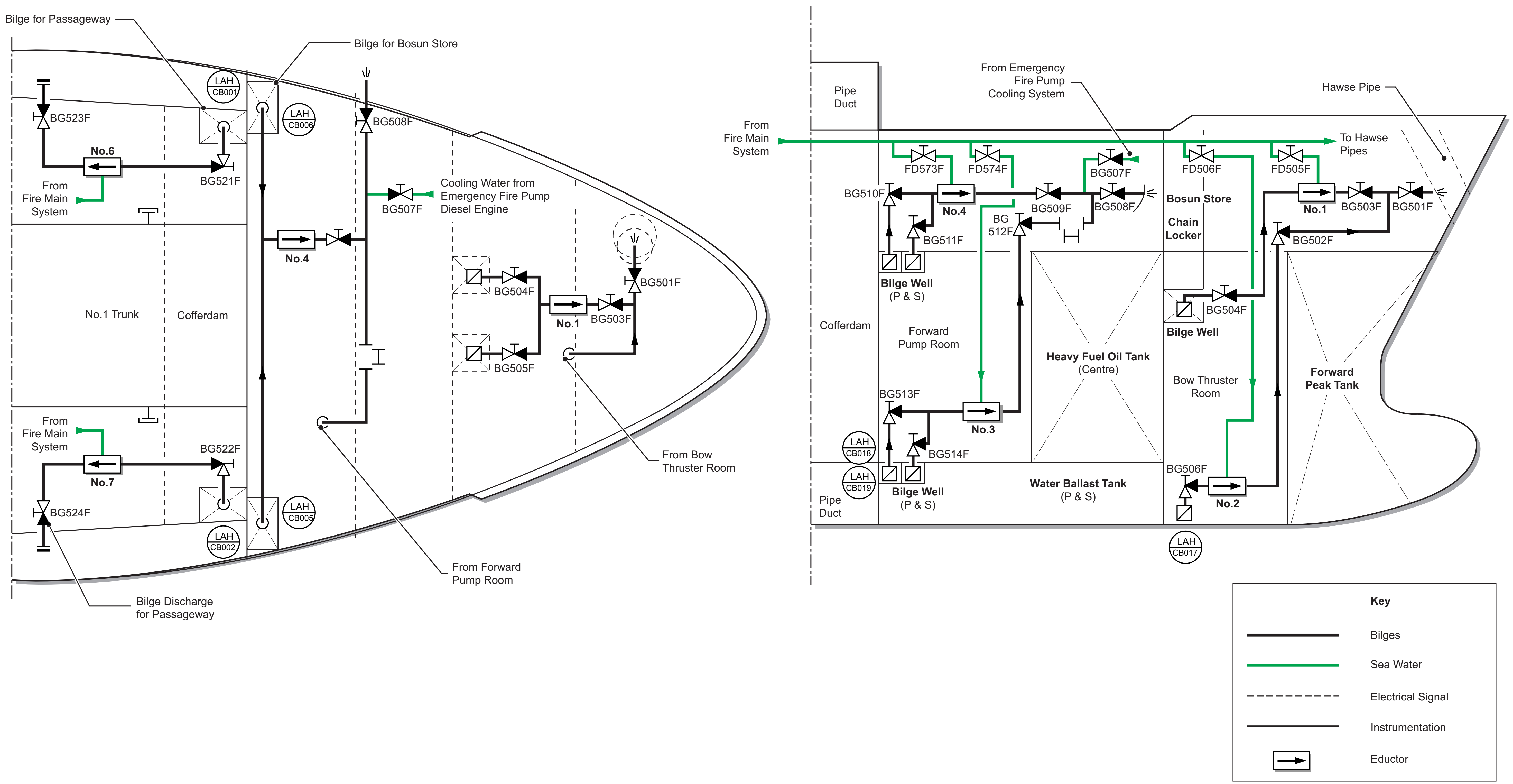
Alarms

Tag	Description	High
BD031	Bilge holding tank level	3.2m
BD032	Separated bilge oil tank level	0.85m



Bilge Separator and Pumps

Illustration 2.8.2a Forward Bilge System



2.8.2 FORWARD BILGE SYSTEM

The chain lockers, bosuns' store, bow thruster compartment and forward pump room have bilge wells with alarms with a 20 seconds time delay. The bilges are discharged using bilge eductors. The eductors have a capacity of 5.0m^3/h and are driven by sea water from the deck fire hydrants system supplied by any of the fire pumps. The bilge water is discharged overboard.

Procedure for Discharging Bilge Water from the Chain Locker, Bosun's Store, Bow Thruster Compartment and Forward Pump Room

There are four eductors, each draining different bilge wells.

a) Start any fire pump to pressurise the fire main system after setting the valve system. The engine room fire pump or the bilge, fire and GS pumps or the emergency fire pump can be by manually started or a request made to the bridge for any of the pumps to be started. Fire pumps are normally kept ready with valves open so that any of the pumps can immediately supply the fire main, which is kept pressurised by the fire jockey pump and associated hydrophore tank.

b) Open the eductor overboard discharge valve BG501F to discharge from the chain lockers and the bow thruster room.

c) Open the eductor overboard discharge valve BG508F to discharge from the forward pump room and the bosun's store.

d) Open the eductor and system valves as in the following tables.

Bow Thruster Room Bilge Well

Description	Valve
Sea water supply valve	FD506F
Eductor discharge valve	BG502F
Thruster room bilge well suction valve (non-return valve set open)	BG506F

Chain Lockers

Description	Valve
Sea water supply valve	FD505F
Eductor discharge valve	BG503F
Port chain locker suction valve	BG504F
Starboard chain locker suction valve	BG505F

Bosun's Store Bilge Wells

Description	Valve
Sea water supply valve	FD573F
Eductor discharge valve	BG509F
Port eductor suction valve	BG510F
Starboard eductor suction valve	BG511F

e) Close the eductor overboard discharge valve BG501F when the operation of pumping out the bow thruster room and chain lockers are completed.

Forward Pump Room Bilge Wells

Description	Valve
Sea water supply valve	FD574F
Eductor discharge valve	BG512F
Forward pump room port bilge well	BG513F
Forward pump room starboard bilge well	BG514F

f) When the sea water supply valve to the eductor is opened the eductor will create a partial vacuum in the eductor suction pipe and that will remove water from the bilge well.

g) Close the bilge well suction valve when the well is empty.

h) Shut the water supply valve to the eductor when all bilges connected to that eductor are empty and then close the system valves.

i) Close the eductor overboard discharge valve BG508F.

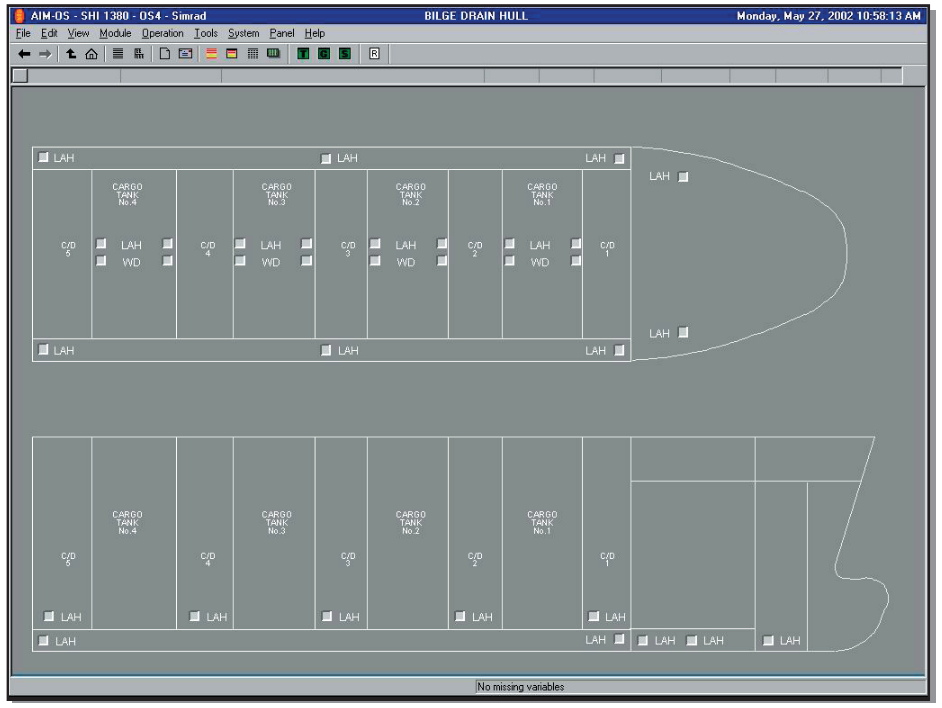
(**Note:** Only clean water may be pumped from the forward pump room. The spool piece downstream of the eductor discharge valve BG512F is to be temporarily fitted. Any contaminated water/oil accummulation is discharged into the fuel oil discharge line from the forward HFO transfer pump, utilising the hand operated pump provided for this purpose. This operation requires opening the hand pump discharge valve OF529F, the remotely operated HFO transfer pump common discharge valve OF511F and No.1 forward HFO tank filling valve OF501F. The contents of the pump room are thus discharged into No.1 HFO tank.)

Procedure for Pumping Out the Passageway Bilges Using the Passageway Stripping Eductors

The eductors operate using sea water from the fire and wash deck main. The fire and wash deck main is provided with sea water by the bilge, fire and GS pumps or the fire pump.

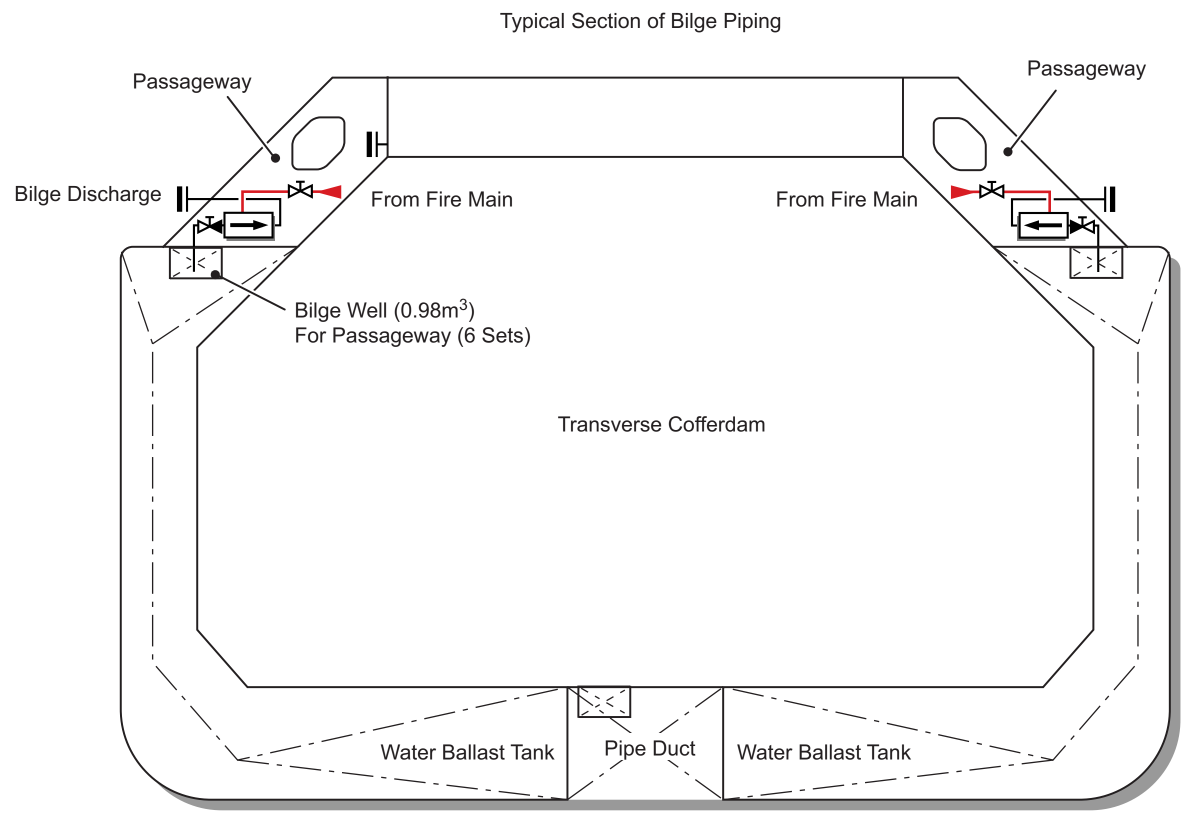
The passageway bilge eductors have a capacity of 5.0m^3/h and they are located in the port and starboard passageways at the aft, centre and forward positions.

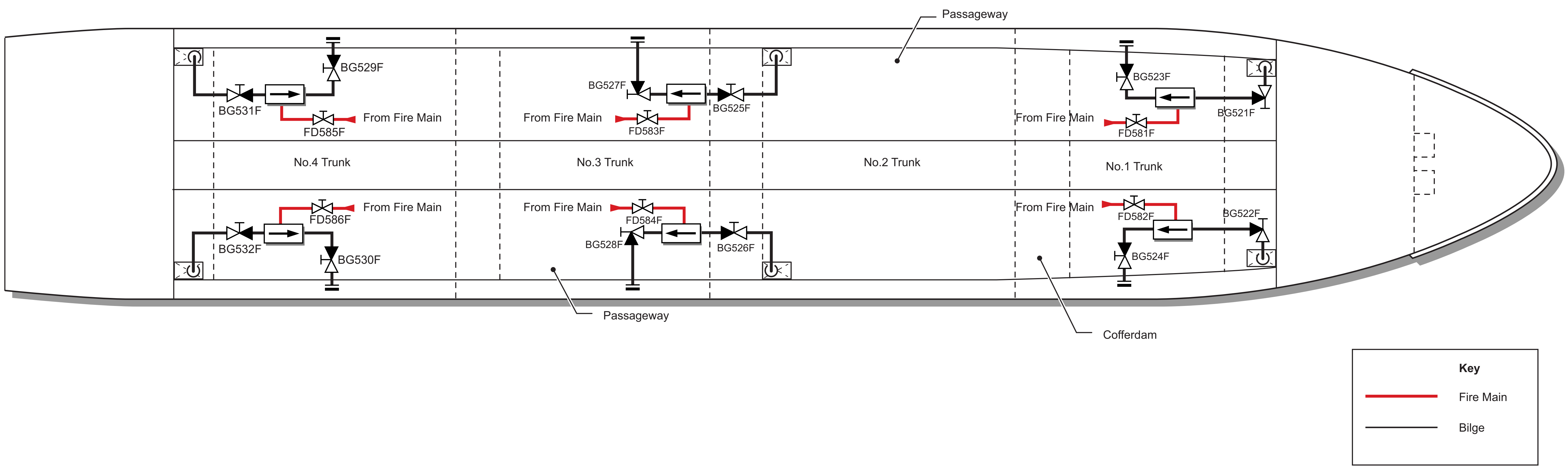
a) Set the fire pump or, if unavailable, the bilge, fire and GS pump to provide sea water to the ejector; the arrangement presumes that the sea water main is connected to the sea via one of the sea chests as described in section 2.3.2. For the fire pump valve, confirm that the suction valve FD041F and discharge valve FD043F are open. For No.1 GS pump valve FD001F should be open and for No.2 GS pump valve FD002F should be open. As the pumps are required to supply sea water to the fire main these sea suction valves are normally open.



b) Set the bilge, fire and GS pump discharge valves so that water is directed to the fire and wash deck main. No.1 pump fire main discharge valve FD012F must be open and for No.2 pump fire main discharge valve FD013F must be open.

Illustration 2.8.2b Passageway Bilge System





c) Start the fire pump or the selected bilge, fire and GS pump and supply sea water to the fire main. Under normal circumstances the fire main valves from the engine room fire pump and the bilge, fire and GS pumps and the emergency fire pump are open so that the fire main may be pressurised above the jockey pump pressure immediately when required.

d) Open the water supply valve and stripping eductor overboard discharge valve as in the following table and when the eductor is producing the correct vacuum, open the inlet valve from the passageway bilge well.

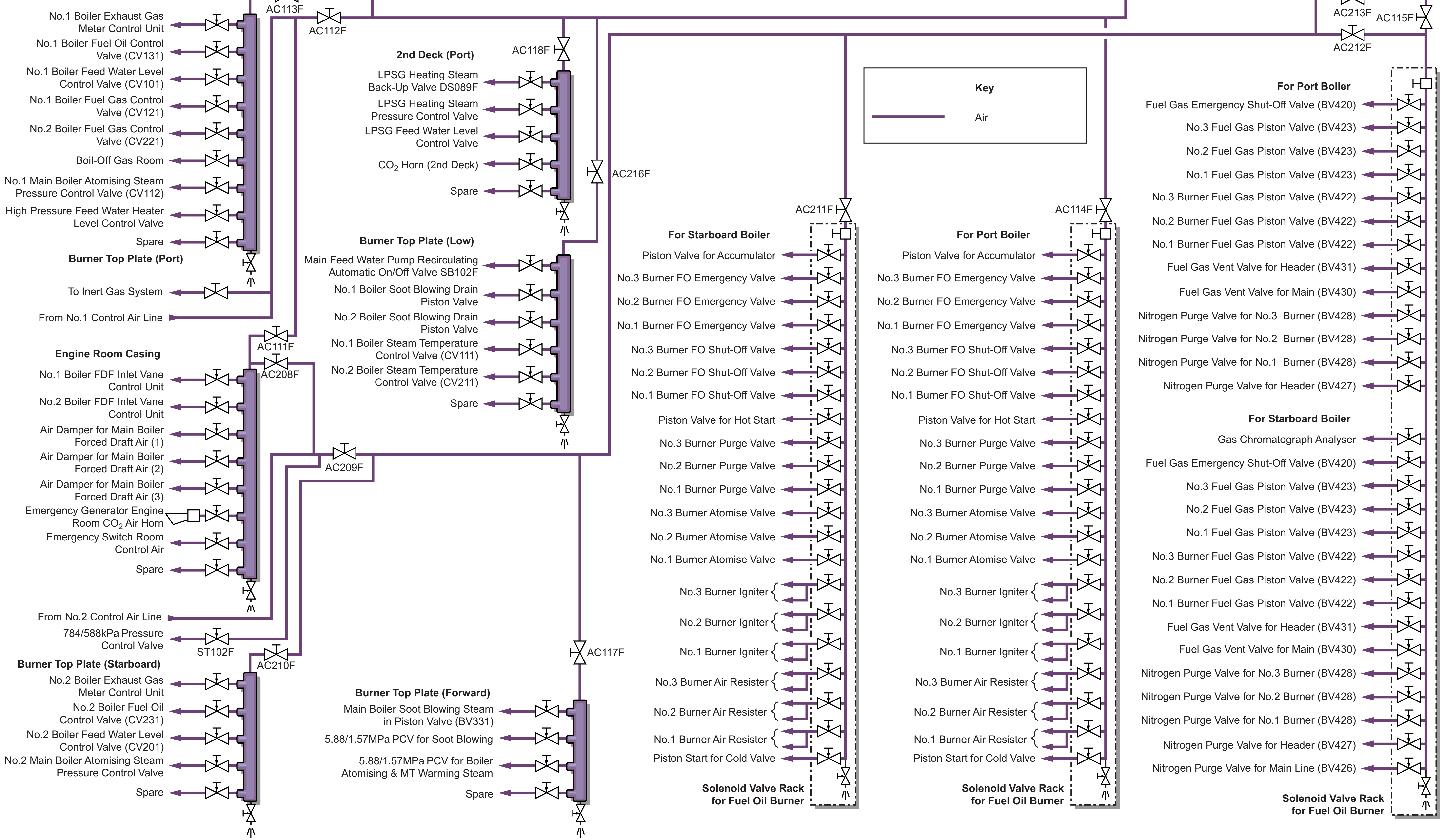
Position	Description	Valve
Port Aft Passageway		
Open	Sea water supply valve	FD585F
Open	Eductor overboard discharge valve	BG529F
Open	Eductor suction valve from passageway bilge well	BG531F
Starboard Aft Passageway		
Open	Sea water supply valve	FD586F
Open	Eductor overboard discharge valve	BG530F
Open	Eductor suction valve from passageway bilge well	BG532F
Port Centre Passageway		
Open	Sea water supply valve	FD583F
Open	Eductor overboard discharge valve	BG527F
Open	Eductor suction valve from passageway bilge well	BG525F
Starboard Centre Passageway		
Open	Sea water supply valve	FD584F
Open	Eductor overboard discharge valve	BG528F
Open	Eductor suction valve from passageway bilge well	BG526F
Port Forward Passageway		
Open	Sea water supply valve	FD581F
Open	Eductor overboard discharge valve	BG523F
Open	Eductor suction valve from passageway bilge well	BG521F
Starboard Forward Passageway		
Open	Sea water supply valve	FD582F
Open	Eductor overboard discharge valve	BG524F
Open	Eductor suction valve from passageway bilge well	BG522F

e) When the passageway bilge well is empty close the passageway bilge well suction valve and the sea water supply and eductor discharge valves. If required, empty another passageway bilge well in the same way. When all passageway bilge wells are empty stop the bilge, fire and GS pump and close all valves not required to be open.

2.9 Compressed Air Systems

Illustrations

Illustration 2.9.1a Control Air System



2.9 COMPRESSED AIR SYSTEMS

2.9.1 CONTROL AIR SYSTEM

Control and General Service Air Compressors

Maker:	J.P. Sauer
No. of sets:	3
Type:	Screw SCK 101-13M60wk - water cooled
Capacity:	$8.3m^3$/min at a pressure of 1176kPa

Control Air Dryer

Maker:	Tamrotor Marine Compressors
No. of sets:	2 comprising running and standby chambers
Model:	DK420
Type:	Hankinson activated alumina
capacity:	$300m^3$/h at dew point -40°C and 882kPa

Introduction

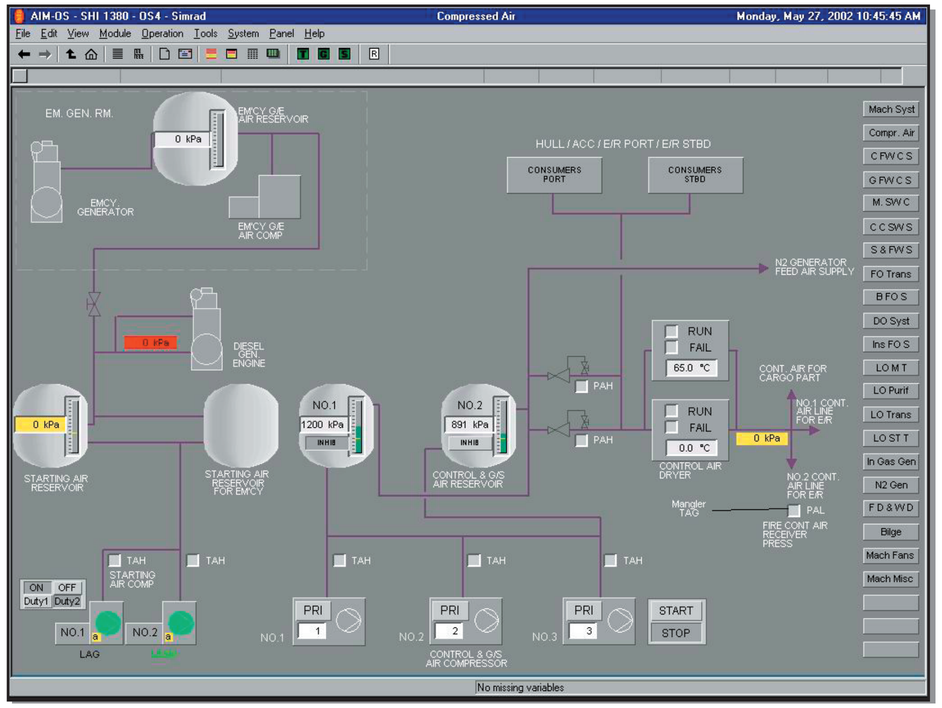
The control air systems are supplied from the control air reservoir which is supplied by a combination of three control and general service air compressors. One air compressor will normally be selected as the lead (priority 1) compressor for the air system, with the others acting as the lag (priority 2 and 3). The control air system operates at a pressure of 882kPa, the air being supplied from the air compressors via reducing valves. The air compressors are cooled by the central fresh water cooling system.

The control air is processed through a control air dryer and associated filters before supplying the control air services. The dryer is of the activated alumina type where the chemical acts as a desiccant to absorb moisture in the air. There are two control air dryers and these supply the engine room control systems and the cargo control systems. Normally one control air dryer will be in use with the other ready for use or undergoing maintenance.

The drying process is automatic and the desiccant is regenerated whilst the unit is in operation. Each dryer has two towers containing desiccant, one tower will be operational and the other will be regenerating. This regeneration is achieved by back flowing dry air from the in use tower, through the regenerating tower, thereby purging moisture from the desiccant and blowing to atmosphere, via a vent solenoid valve. The operation to change between towers is automatic. The desiccant material has an operating life in excess of 5 years.

Engine room control air is supplied to two separate branch lines and these then supply the control air manifolds. The control air manifolds are supplied by both branch lines, thus allowing for back-up in the event of problems with one of the branch lines which form a sectionable ring main. Direct control air supplies are taken to a number of locations. The control air manifolds supply control air to control systems. The manifolds are fitted with inlet isolating valves and drain valves.

(**Note:** It is essential that the control air is dried before entering the control system as any moisture in the control air can cause problems at actuators or other parts of the control system which could lead to failure.)



Automatic start and stop is provided for the operating compressor(s) by means of a pressure switch. The lead compressor will start when the reservoir pressure falls to 882kPa and the lag compressor will start if the pressure falls to 686kPa. The compressors can be started and stopped locally and manual start and stop is provided from the IAS provided that the compressor is in remote control mode.

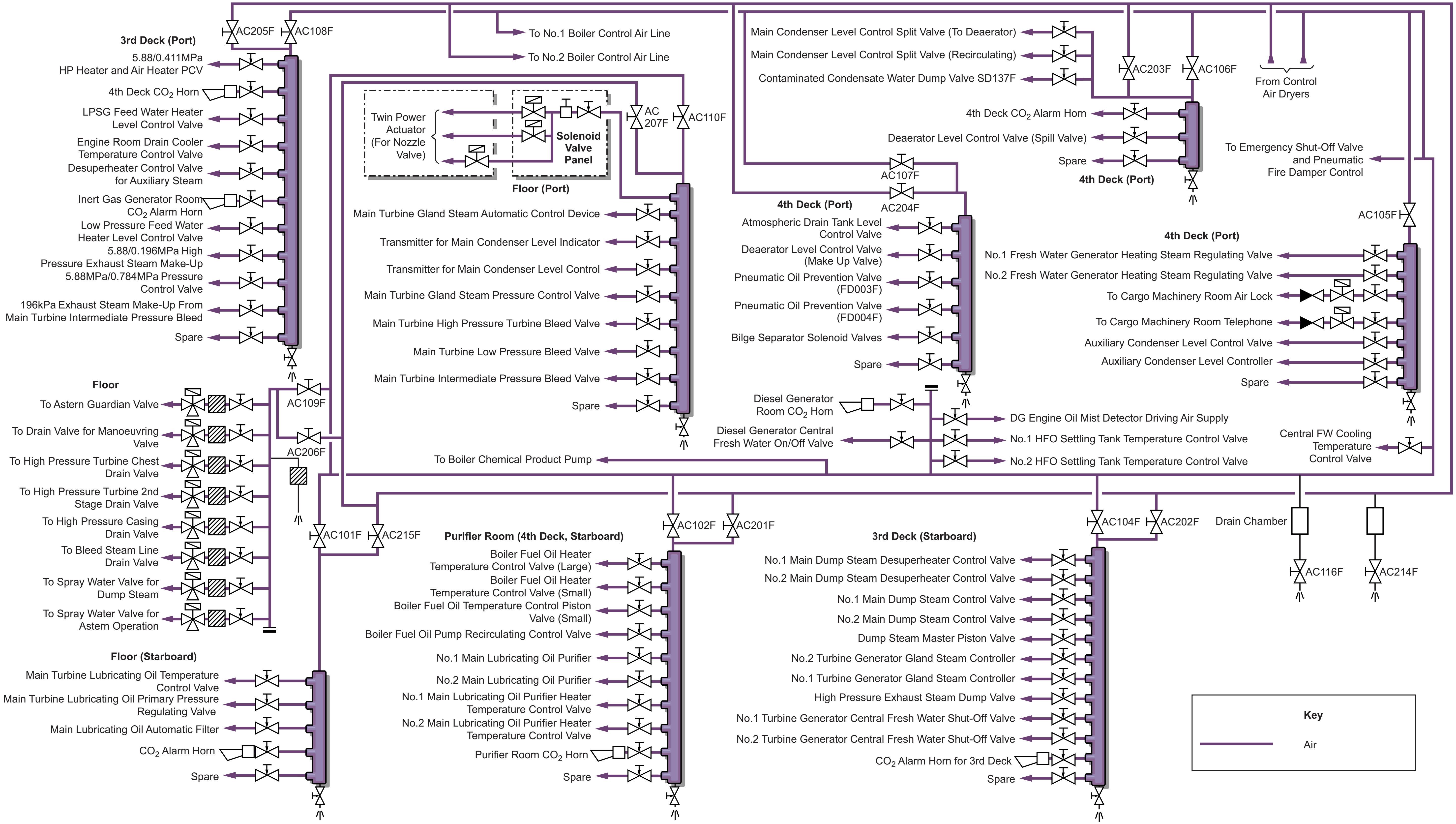
In order for the air compressors to act as a duty/standby trio they must be set to IAS on the starter panels on the main switchboard and selected at the Auto/Manual selector soft key on the graphic screen. The duty compressor will be selected as priority 1 and the standby compressors as priority 2 and 3. Selections are made from the IAS screen. Manual operation of compressors can be made locally or from the IAS.

Failure of any compressor or air dryer, or a low system pressure, will raise an alarm.

Alarms

Tag	Description	Low
MM269	Control air line pressure	600kPa

Illustration 2.9.1b Control Air System



Procedure for Operating the Control Air Dryer

The dryer must be installed and commissioned according to the manufacturer's instruction. When the desiccant has been correctly activated it should provide useful service for at least five years provided that it is purged correctly. The description below assumes that the dryer is in normal operation following correct commissioning.

a) Inlet and outlet valves must be slowly opened, AC010F and AC012F for No.1 dryer or AC011F and AC013F for No.2 dryer.

b) Compressed air must be supplied to the system with the inlet and outlet lines at the same pressure.

c) The main switch at the electrical cabinet must be turned to the ON position.

The dryer is now in operation. Operational status regarding solenoid valves are indicated on the control panel by LEDs.

Dip switches at the dryer control panel enable a number of controller functions to be set. Amongst the features which can be set are the working pressure, the operating cycle time and the test mode. It is also possible to select an economy cycle for purge air if the control air flow is lower than the maximum capacity of the dryer.

CAUTION

The dryer settings must not be changed without good reason and the manufacturer's instructions must be consulted before making any change. Defective operation of the dryers can cause moisture to enter the control system and that can damage components and result in defective control of the equipment.

Control Air Dryers

Illustration 2.9.1c Control Air Dryers

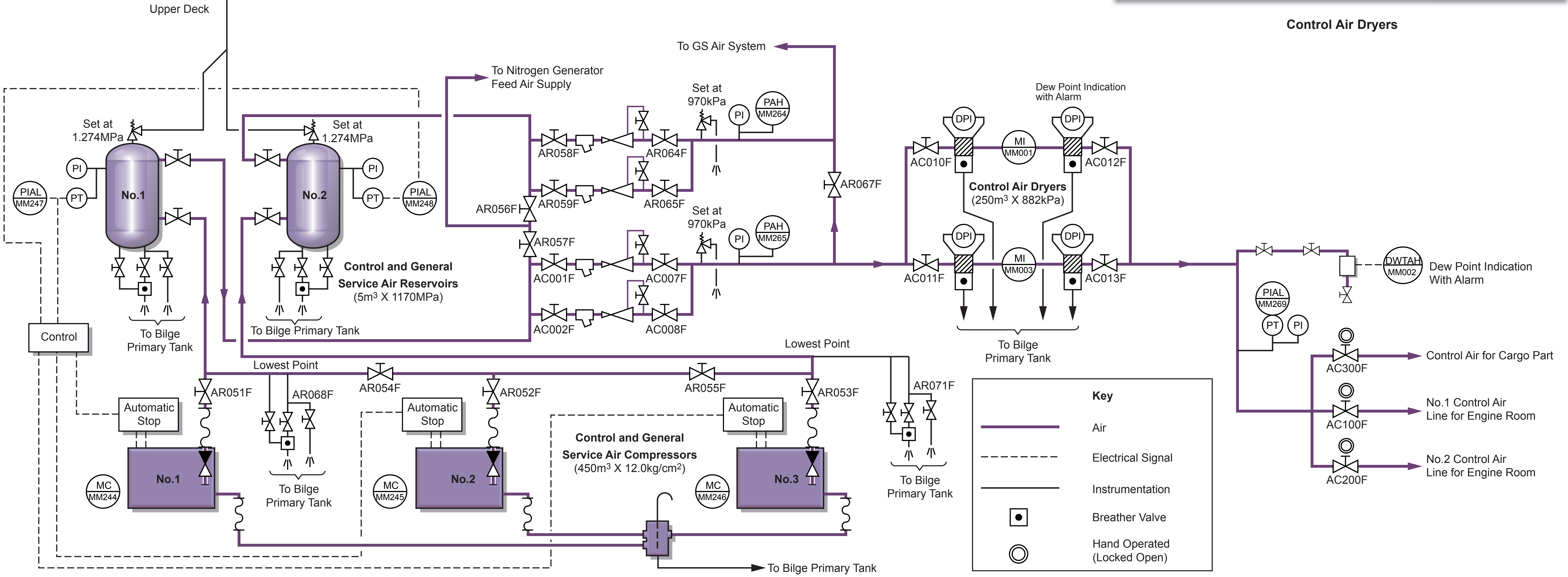
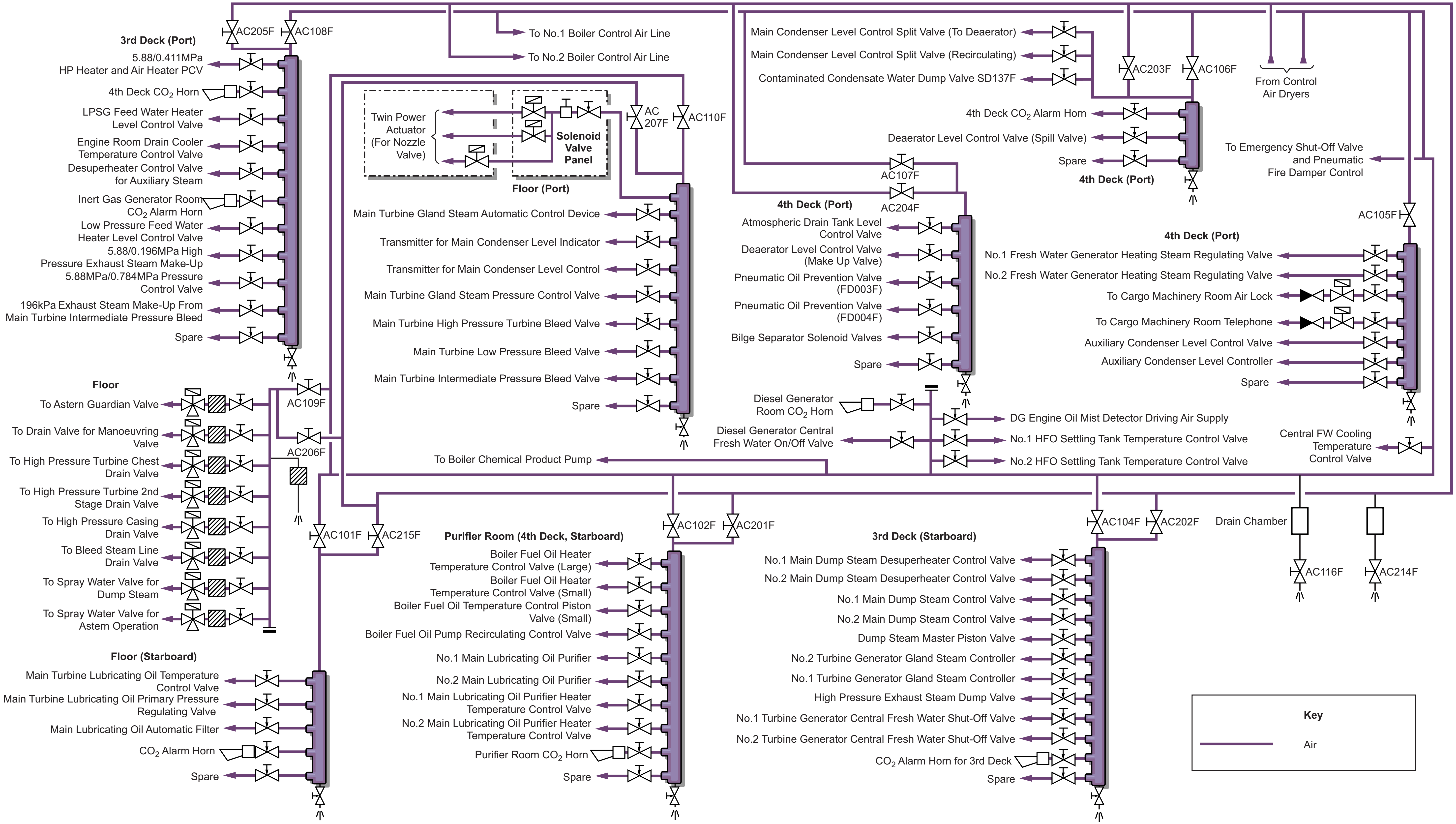


Illustration 2.9.1b Control Air System



Procedure for Operating the Control Air System

a) Ensure that all instrumentation valves are open and that the instrumentation is functioning correctly. Check that water is being supplied from the central fresh water cooling system.

b) Open the inlet valves to the control and general service air reservoirs and the outlet valves from the control and general service air compressors. No.1 compressor outlet valve AR051F supplies No.1 reservoir directly and No.2 reservoir via line valve AR054F. No.2 compressor outlet valve AR052F must be open and this compressor supplies No.1 reservoir via line valve AR054F and No.2 reservoir via line valve AR055F. No.3 compressor outlet valve AR053F supplies No.2 reservoir directly and No.1 reservoir via line valves AR054F and AR055F.

Normally valves will be set so that both reservoirs are in use, one as the GS air and the other as the control air. The compressor's discharge and line valves will all be open so that any compressor can fill both reservoirs. The compressors start and stop automatically according to the system pressure.

c) At the main switchboard panels select all compressors for IAS operation. Select AUTO operation at the IAS screen and start the lead compressor. The other compressors are selected as first and second priority compressors. Check that the lead compressor operates correctly.

d) Ensure that there is air in the control and general service air reservoir at the desired pressure and that the control and general service air compressors are operating. Open the outlet valve from the control and service air reservoirs.

e) Open the control and general service air outlet valve for the operating control and general service air reservoir and then set up valves as shown in the following table:

Position	Description	Valve
Reducing Valve System		
Open	No.1 reservoir primary reducing valve inlet valve	AC001F
Open	No.1 reservoir primary reducing valve outlet valve	AC007F
Open	No.1 reservoir secondary reducing valve inlet valve	AC002F
Open	No.1 reservoir secondary reducing valve outlet valve	AC008F
Open	No.2 reservoir primary reducing valve inlet valve	AC058F
Open	No.2 reservoir primary reducing valve outlet valve	AC064F
Open	No.2 reservoir secondary reducing valve inlet valve	AC059F
Open	No.2 reservoir secondary reducing valve outlet valve	AC065F
Close	Control air to N_2 plant	AR057F
Close	Crossover valve between No.1 and No.2 reducing valve systems	AR067F
Open	GS air to N_2 plant	Ar056F
Control Air System		
Open	No.1 control air dryer inlet valve	AC010F
Open	No.1 control air dryer outlet valve	AC012F
Close	No.2 control air dryer inlet valve	AC011F
Close	No.2 control air dryer outlet valve	AC013F
Open (locked)	Cargo system control air supply valve	AC300F
Open (locked)	No.1 engine room control air line valve	AC100F
Open (locked)	No.2 engine room control air line valve	AC200F
Open	Crossover valve between No.1 and No.2 control air systems	AC213F
No.1 Control Air Line Direct Connections		
Open	No.1 boiler control air line	
Open	Fire dampers and emergency shut-off valves	
Open	Boiler chemical product pump	
Open	Inert gas system	
Open	Central cooling fresh water temperature control valve	
Open	Diesel generator room CO_2 alarm horn	
Open	Diesel generator engine cooling water temperature control valve	
Open	No.1 HFO settling tank temperature control valve	
Open	No.2 HFO settling tank temperature control valve	
Open	Diesel generator oil mist detector driving air supply	
No.2 Control Air Line Direct Connections		
Open	No.2 boiler control air line	
Open	8.0kg/cm²/6.0kg/cm² pressure control valve	
Open	No.1 control air system line valve	AC112F
open	No.2 control air system line valve	AC209F

Control Air Manifolds

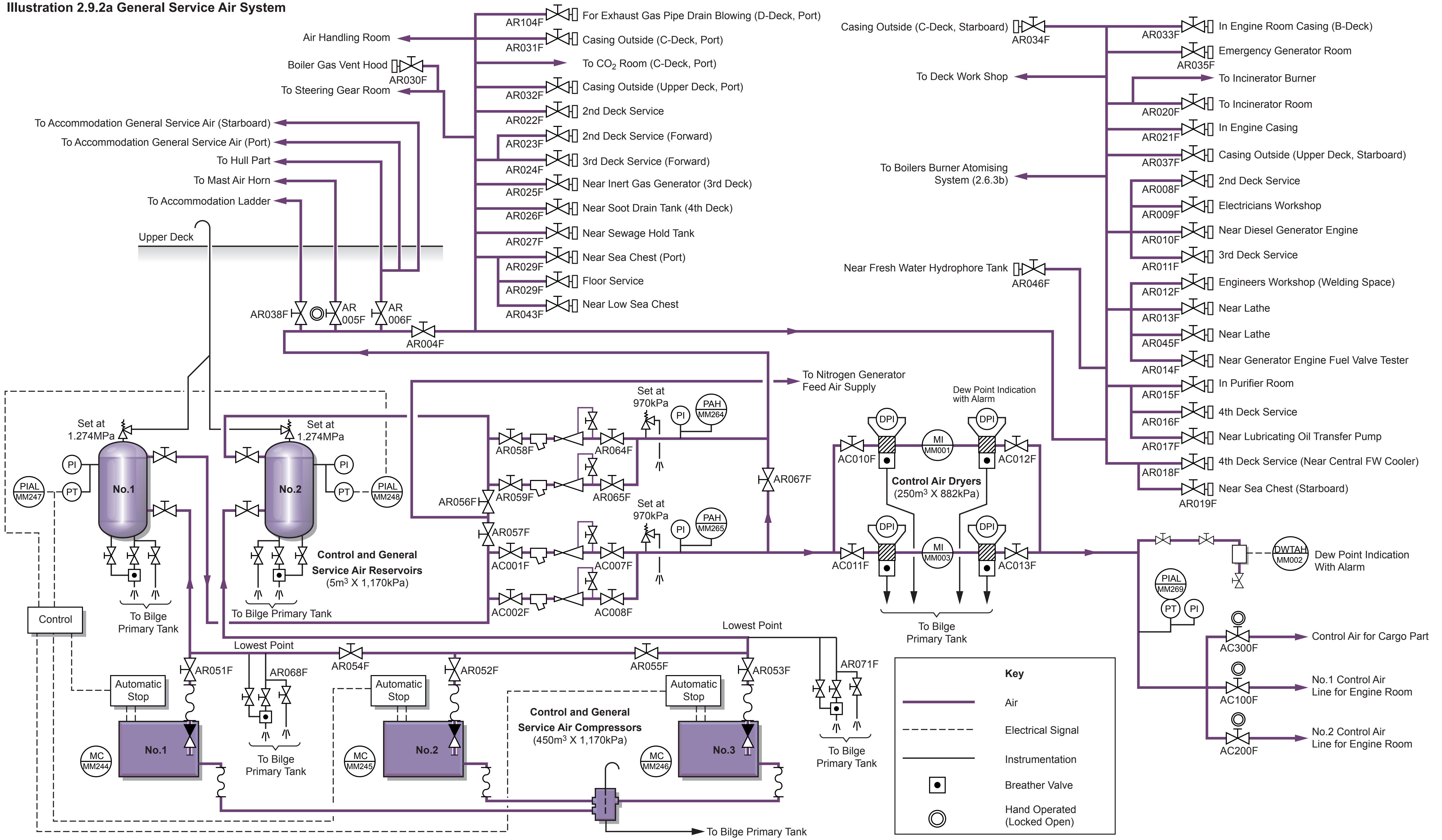
Location	No.1 Line Valve	No.2 Line Valve
Floor	AC109F	AC206F
Floor starboard	AC101F	AC215F
Floor port	AC110F	AC207F
3rd deck port	AC108F	AC205F
3rd deck starboard	AC104F	AC202F
4th deck port	AC105F	
4th deck port	AC106F	AC203F
4th deck port	AC107F	AC204F
Purifier room 4th deck	AC102F	AC201F
Engine room casing	AC111F	AC208F
Burner top plate (port)		AC113F
2nd deck port		AC118F
Burner top plate (low)		AC216F
FO burner solenoid rack (port boiler)		AC114F
FO burner solenoid rack (starboard boiler)		AC211F
FO burner solenoid rack (starboard boiler)		AC115F, AC212F
Burner top plate (forward)		AC117F
Burner top plate (starboard)		AC210F

(**Note:** Although valves are shown as open this is their normal operating condition and they will be closed if the service is not being used. Manifolds are provided with drain valves and these should be operated daily in order to drain any water which is present in the system.)

f) Check the operation of the control air system periodically and ensure that the dryers are working effectively.

(**Note:** The two control air lines are provided with drain chambers at the lowest points of the lines and the drain valves AC116F and AC214F from these chambers must be opened daily to drain any water.)

Illustration 2.9.2a General Service Air System



2.9.2 GENERAL SERVICE AIR SYSTEM

Introduction

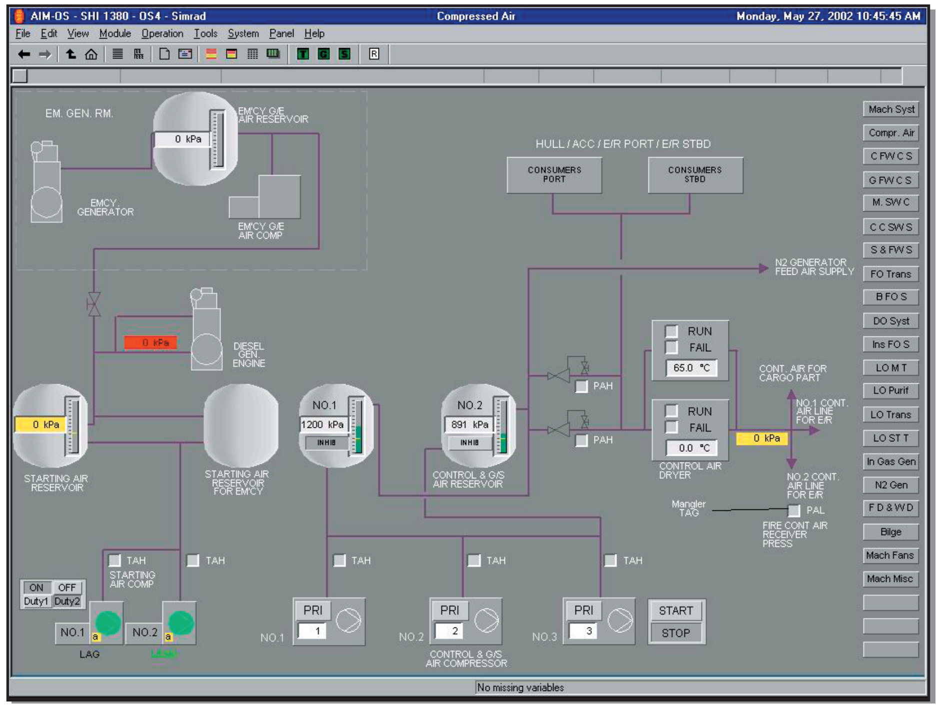
The general service air system is normally supplied from the general service air reservoir which is replenished by the air compressor as explained in section 2.9.1. The general service air system supply does not pass through the control air dryers as the air is for general use and does not require drying, but may be directed to the dryers when the control air reservoir is shut down for maintenance/survey.

The general service air system supplies the following:

- Deck services
- Accommodation ladder
- Accommodation services
- Engine room services
- CO_2 room
- FW hydrophore tank
- Purifier room
- Emergency generator room
- Incinerator room
- Incinerator burner
- Boiler
- N_2 generator
- Workshop services
- Boiler atomising
- Air horn

Procedure for Preparing the General Service Air System for Operation

a) Ensure that all instrumentation valves are open and that the instrumentation is functioning correctly. Check that water is being supplied from the central fresh water cooling system.



b) Open the inlet valves to the control and general service air reservoirs and the outlet valves from the control and general service air compressors. No.1 compressor outlet valve AR051F supplies No.1 reservoir directly and No.2 reservoir via line valve AR054F. No.2 compressor outlet valve AR052F must be open and this compressor supplies No.1 reservoir via line valve AR054F and No.2 reservoir via line valve AR055F. No.3 compressor outlet valve AR053F supplies No.2 reservoir directly and No.1 reservoir via line valves AR054F and AR055F.

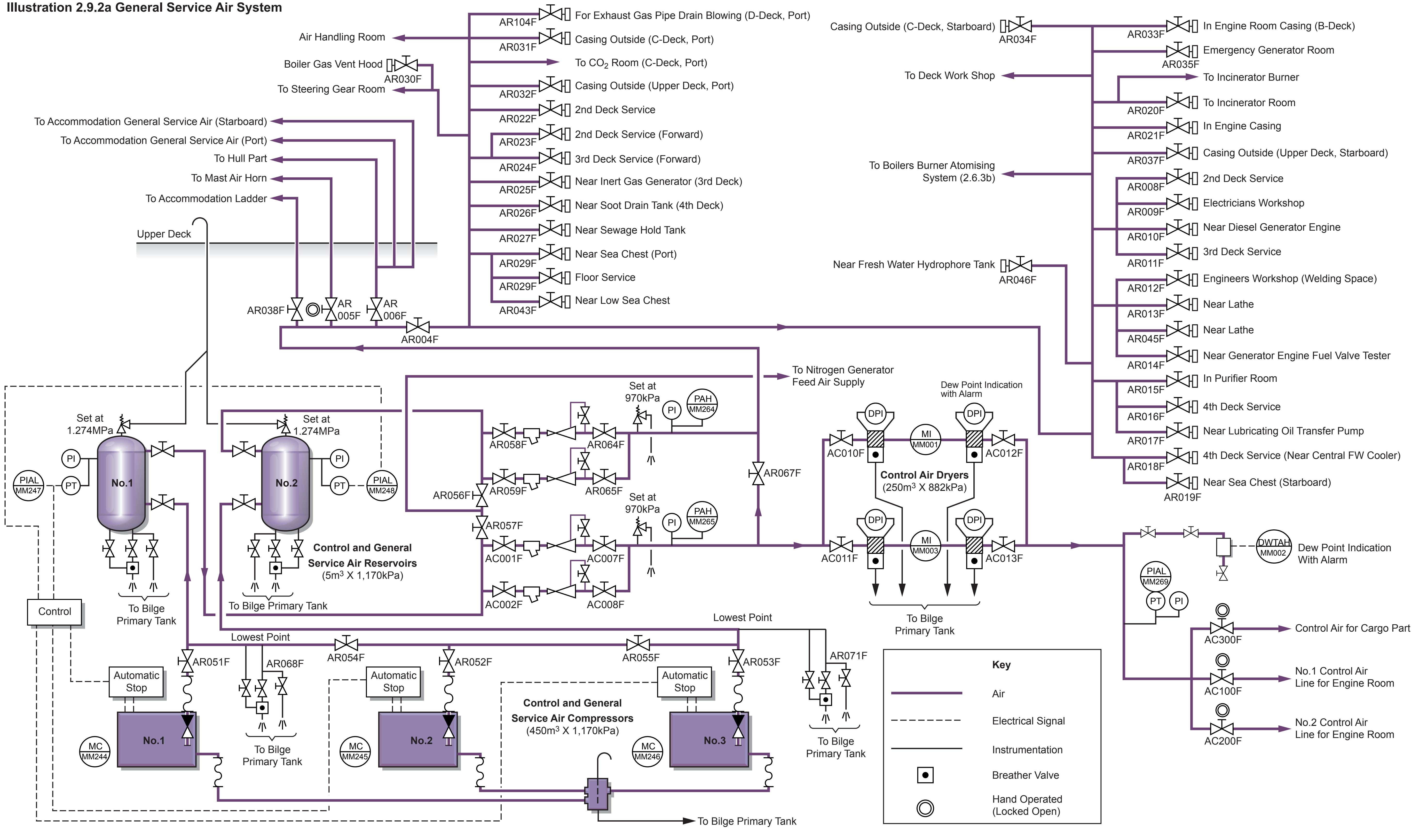
Normally valves will be set so that one of the reservoirs will be selected as the control air reservoir and the other as the GS air reservoir. The compressor's discharge and line valves will all be open so that any compressor can fill either of the reservoirs. The compressors start and stop automatically according to the system pressure.

c) At the main switchboard panels select all compressors for IAS operation. Select AUTO operation at the IAS screen and start the lead compressor. The other compressors are selected as first and second priority compressors. Check that the lead compressor operates correctly.

d) Ensure that there is air in the general service air reservoir at the desired pressure and that the general service air compressor is operating. Open the outlet valve from the general service air reservoir and set the GS air valves as shown in the follow table.

Position	Description	Valve
Reducing Valve System		
Open	No.2 reservoir primary reducing valve inlet valve	AC058F
Open	No.2 reservoir primary reducing valve outlet valve	AC064F
OR		
Open	No.2 reservoir secondary reducing valve inlet valve	AC059F
Open	No.2 reservoir secondary reducing valve outlet valve	AC065F
Close	Crossover valve between No.1 and No.2 reducing valve systems	AR067F
Service Air System Valves		
Closed	N_2 generator supply valve from No.1 reservoir	AR057F
Open	N_2 generator supply valve from No.2 reservoir	AR056F
Open	Accommodation ladder supply valve	AR038F
Open(locked)	Mast air horn supply valve	AR005F
Open	Deck and accommodation air supply valve	AR006F
Open	Service air line valve	AR004F
Service Air Outlet Connections - As Required		
Open	Near sea chest port	AR028F
Open	Near sea chest starboard	AR019F
Open	Near low sea chest	AR043F
Open	Floor services	AR029F
Open	Near sewage holding tank	AR027F
Open	Near soot drain tank (4th deck)	AR026F
Open	Near IGG (3rd deck)	AR025F
Open	3rd deck services	AR024F
Open	2nd deck services (fwd)	AR023F
Open	2nd deck services	AR022F
Open	Casing outside (upper deck port)	AR032F
Open	Casing outside (C deck port)	AR031F
Open	Exhaust gas pipe drain blowing (D deck port)	AR104F
Open	4th deck services (near central cooler)	AR018F
Open	Near LO transfer pump	AR017F

Illustration 2.9.2a General Service Air System



Position	Description	Valve
Open	4th deck services	AR016F
Open	In purifier room	AR015F
Open	Near generator engine fuel valve test rig	AR014F
Open	Near lathe	AR013F
Open	Near lathe	AR044F
Open	Workshop welding space	AR012F
Open	3rd deck services	AR011F
Open	Near diesel generator engine	AR010F
Open	Electrical workshop	AR009F
Open	2nd deck services	AR008F
Open	Casing outside (upper deck starboard)	AR037F
Open	In engine casing	AR021F
Open	Incinerator room	AR020F
Open	Emergency generator room	AR035F
Open	In engine casing (B deck)	AR033F
Open	Casing outside (C deck starboard)	AR034F
Open	Near FW hydrophore tank	AR046F

The general service air reservoir supplies compressed air to the general service air system and the general service air compressors will operate to maintain the desired pressure within the operating air reservoir.

e) Operate the working air system as required with air being taken from service outlets as needed. The valves for services are shown as open in the table above but this is the condition when air is needed. When air is not required the valve will be closed.

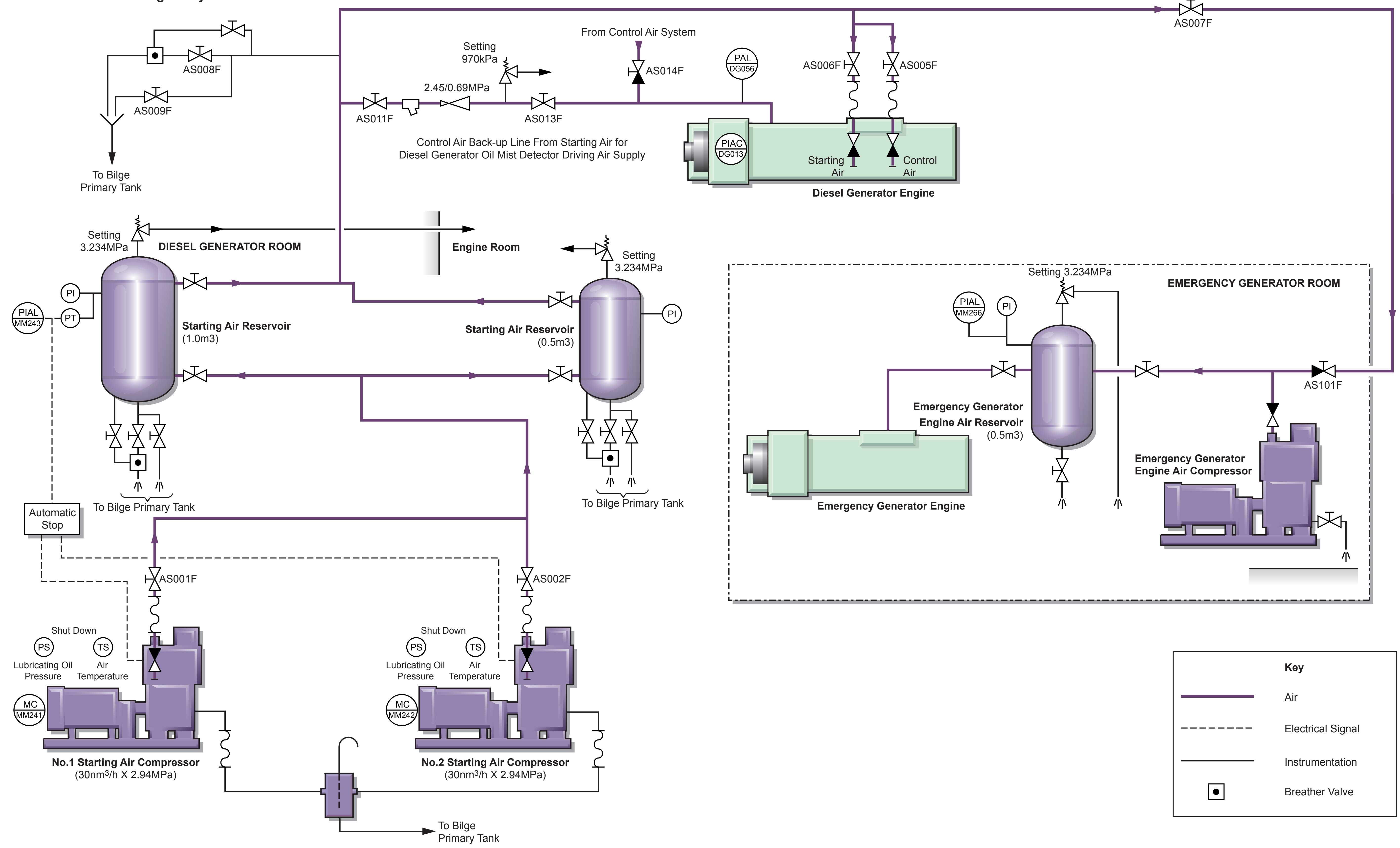
f) Check that the system drain traps are operational.

g) Check that the compressors start and stop automatically supplying air as required.

h) Ensure that remote user outlets are receiving air. Air valves to user locations should be opened periodically to blow them through in order to remove condensate and prevent seizure.

(**Note:** Some general service air outlets do not have supply shut-off valves in the engine room. Shut-off valves for the steering gear room, air handling room, CO_2 room and deck workshop are located in these spaces.)

Illustration 2.9.3a Starting Air System



2.9.3 STARTING AIR SYSTEM

Starting Air Compressors

Maker:	J.P. Sauer
No. of sets:	2
Type:	WP 33 L - air cooled
Capacity:	$30m^3/h$ at a pressure of 2.94MPa

Emergency Air Compressor

Maker:	J.P. Sauer
No. of sets:	1
Type:	WP 15 L - air cooled, diesel engine driven
Capacity:	$15.5m^3/h$ at a pressure of 2.94MPa

Introduction

The diesel generator engine starting air system is supplied by two starting air compressors which provide air to the two starting air reservoirs. It is also supplied to the emergency diesel generator starting air reservoir. The starting air reservoirs for the main diesel generator are of different capacity, the main reservoir has a volume of $1.0m^3$ and the auxiliary reservoir has a volume of $0.5m^3$. The emergency diesel generator air reservoir also has a volume of $0.5m^3$.

Both main compressors supply air to both main diesel generator starting air reservoirs and they are provided with an automatic start and stop facility which is activated by the pressure switch on the main starting air reservoir. Normally the main starting air reservoir is open to allow for immediate starting of the diesel generator engine when it is set to standby duty. The auxiliary starting air reservoir is fully charged and its inlet and outlet valves closed.

(**Note:** There are no non-return valves between the main and auxiliary reservoirs. Any loss of pressure in the main reservoir would cause a loss of pressure in the auxiliary reservoir if the inlet and outlet valves are left open.)

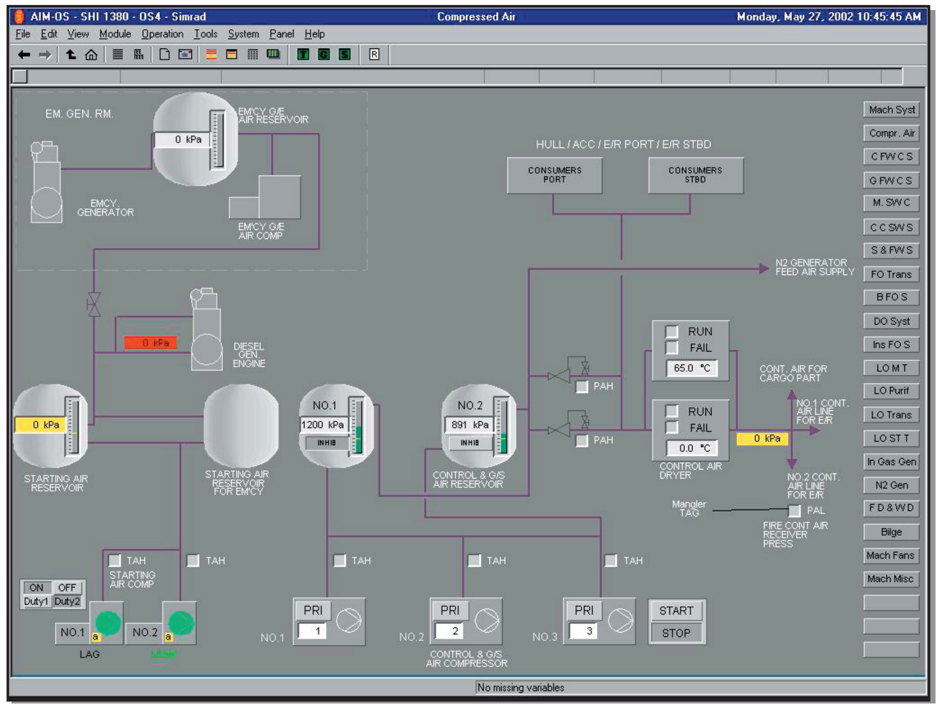
The compressors are each fitted with two safety valves, one after the first stage compression and the other after the second stage compression. The cylinder block is finned to allow for air cooling. A pressure switch connected to the automatic control system stops the compressor should the LO pressure fall below a predetermined value. The bearings are lubricated by a gear pump fitted at the end of the crankshaft. A high temperature sensor is located at the compressor outlet and this will trip the compressor if the air temperature exceeds a predetermined limit. Each compressor has an automatic unloader arrangement which operates when the compressor starts and stops. This allows the compressor to start and stop off load, thus reducing the loading on the electric drive motor and the compressor running gear.

Automatic start and stop is provided for the operating compressor(s) by means of a pressure switch. The lead compressor will start when the reservoir pressure falls to 882kPa and the lag compressor will start if the pressure falls to 686kPa. The compressors are placed in automatic operation and priority duty from the IAS. At the graphic display screen the compressor can be selected for automatic operation in which case it will be started and stopped by the air reservoir pressure switches.

If the duty compressor fails to maintain the desired pressure in the starting air reservoir the 2nd priority compressor is started by the control system. The emergency starting air reservoir can be filled at the same time as the main starting air reservoir by opening the cross connecting valve AS007F.

Before a compressor is started the compressor outlet and air reservoir filling valves must be open. Instrumentation and pressure switch valves must also be open in order to allow the compressor to be controlled automatically. The main and auxiliary reservoirs may both be filled together in order for the automatic compressor stop system to function.

Air reservoirs are fitted with automatic drain traps and the valves for these must be open at all times.



Procedure for Filling the Generator Engine Starting Air Reservoirs and Supplying the Generator Engines with Starting Air

a) Ensure that all pressure gauge and instrumentation valves are open and that gauges and instruments are reading correctly.

b) Check the oil level in the compressors.

c) Check the compressor sumps for water.

d) Set up valves as in the following table:

Assuming that both compressors are operational.

Position	Description	Valve
Open	No.1 compressor discharge valve	AS001F
Open	No.2 compressor discharge valve	AS002F
Open	Main starting air reservoir inlet valve	
Open	Auxiliary starting air reservoir inlet valve	
Open	Main starting air reservoir drain valves	
Open	Auxiliary starting air reservoir drain valves	
Open	Main starting reservoir outlet valve	
Closed	Auxiliary starting air reservoir outlet valve	
Open	Starting air line drain trap inlet valve	AS008F
Closed	Starting air line manual drain valve	AS009F
Open	Diesel generator engine starting air inlet valve	AS006F
Open	Diesel generator engine control air inlet valve	AS005F
Open	Line valve to emergency generator engine air reservoir	AS007F
Open	Emergency generator engine air reservoir non-return line valve	AS101F

e) Check that all automatic drain traps are operational and that the unloader gear is functioning.

f) Check that the starting air reservoir automatic drains are functioning correctly and that the compressor automatic drains are functioning correctly.

g) Check the compressors and when satisfied set them to REMOTE operation at the local control panel and then at the IAS screen select them for AUTO operation with one selected as the lead compressor and the other as the lag compressor.

h) Drain any liquid from the reservoirs and oil/water separator.

(Note: Once the main and auxiliary air reservoirs have been charged to the compressor cut-out pressure, ensure that the auxiliary air reservoir inlet valve is closed and the reservoir remains fully charged.)

Alarm

Tag	Description	Low
MM243	Start air pressure	2.256MPa
MM266	Emergency generator start air pressure	2.256MPa

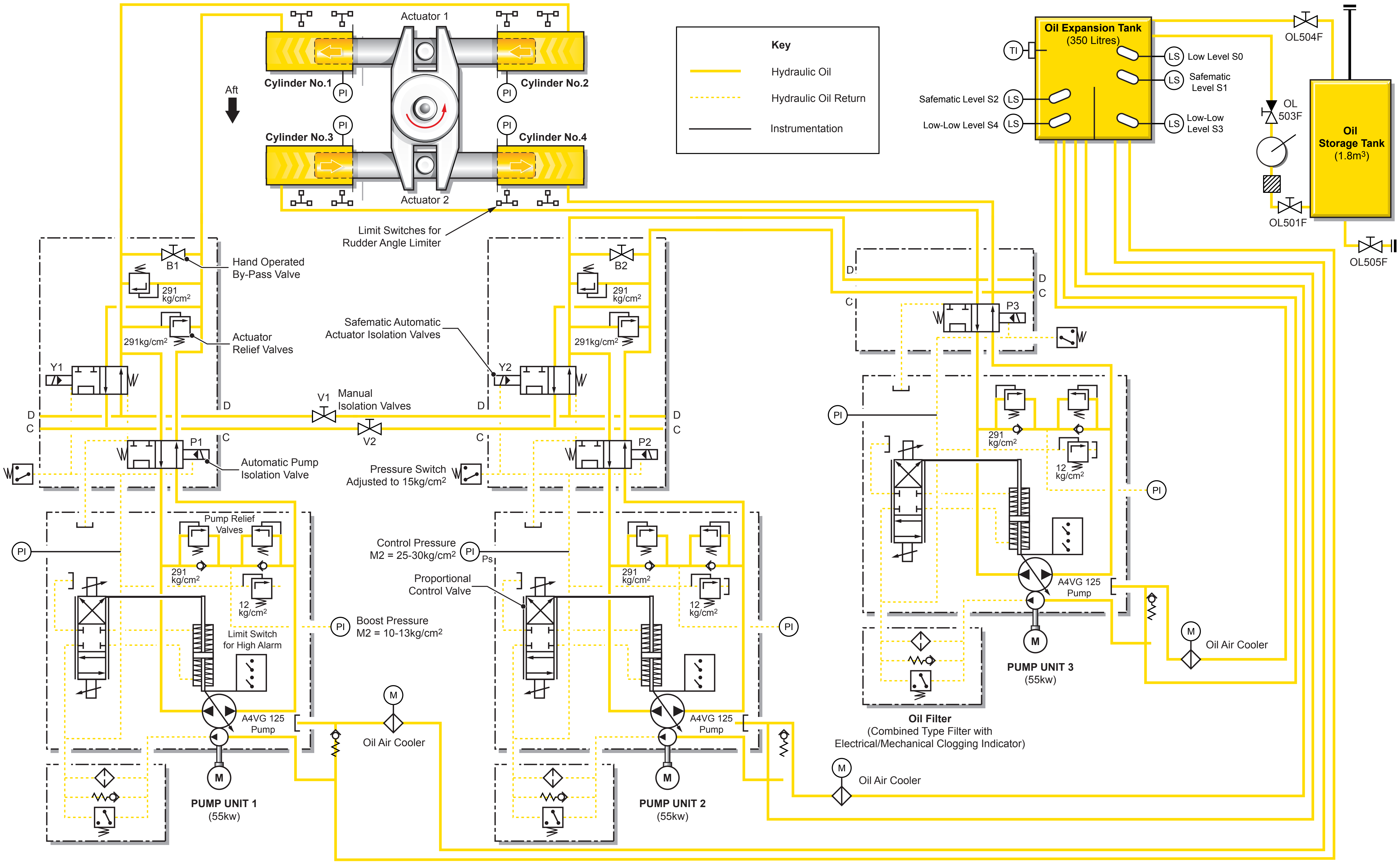
Diesel Generator Starting Air Compressors

Emergency Generator Starting Air Compressors

2.10 Steering Gear

Illustrations

Illustration 2.10a Steering Gear Fluid Flow



2.10 STEERING GEAR

System Capacities and Ratings

Maker:	Samsung-Hatlapa
Type:	R4ST 700H - four cylinder
Variable displacement pumps:	Mannesmann Rexroth A4VG
No. of sets:	3
Nominal pressure:	400 bar
Motors	55kW
System oil capacity:	1150 litres - including 350 litres in expansion tank

General Description

The Samsung-Hatlapa steering gear is a Rapson Slide type and consists of 2 rams, 4 cylinders, 3 pump units driven by electric motors and 1 expansion tank fitted with level switches. The expansion tank has a division plate, which will effectively separate the tank into two and thus operate as two totally isolated steering systems. Pump No.1 takes its supply from one side of the division plate whilst No.2 and 3 are from the other. Each pump unit is capable of generating a rudder laying speed of 56 seconds. With two pump units it will take 28 seconds and with all three running the rudder will travel through 65° in 21 seconds.

Eight electrical switches, four fitted at an angle of 35° and four more at 45°, limit the rudder angle. Should these fail, mechanical stoppers are fitted at 47°.

Each pump unit consists of an independent electric motor driving a variable displacement pump of the axial piston-swashplate design. Output flow increases with swivel angle from zero to its maximum value. Swivelling the pump past the centre position will change the fluid direction. Relief valves are fitted to the high-pressure side of the pump to protect against overloads.

The electrical supply for the motors is fed from the main and emergency switchboard to independent starter cabinets and the No.2 motor takes its supply from the emergency switchboard in case of electrical failure.

Under normal conditions, all four cylinders will be in use with one pump running and one on standby. When manoeuvring or whilst operating in confined waters, it is necessary to have two motors running to achieve the recommended rudder laying speed of 28 seconds as laid down by IMO.

When a pump unit is started oil will be drawn from the expansion tank to pressurise the system. Signals from the bridge will energise the proportional valves, thus adjusting and directing the pump delivery to the cylinders. The direction and extent to which the rudder turns is dependent on the control signal and the rudder position feedback transmitters.

Automatic Isolation System

The automatic isolation system or SAFEMATIC system is a design which covers the Single Failure Criteria Steering System required by law for tankers and passenger ships. The system consists of automatic actuator isolation valves on pump No.1 and 2 only which are operated by the level switches fitted in the expansion tank. These level switches activate the alarm and implement the division of the system should a loss of hydraulic fluid occur by energising the automatic isolation valves Y1 and Y2 and so isolating the defective system.

The system consists of, but not limited to the following:

- Isolating and bypass valves. Designed to divide the circuit, isolating a hydraulic failure and putting on bypass for the non-working side.
- Servo pump and motor. The servo pump with its own electric motor provides hydraulic pressure to operate the isolating and bypass valves.
- Pilot valves. Solenoid operated valves to direct the servo pressure to the isolating and bypass valve.
- Low level oil switches. Installed to sense any significant drop in oil level. These switches activate the alarm and implement the division of the system.
- System test valves. Enable immediate pre-sailing checks to be made on the system.
- Test buttons. Prove safe operation of the system.

Basic Operation

Assuming pump unit 1 is running.

If the oil level in the expansion tank drops an audible and visual alarm will sound in both the machinery space and on the navigation bridge.

Should the level continue to drop and energise the SAFEMATIC switch S1, then pump unit 1 will shut down and pump unit 2 will start, unless it is already running. At the same time isolation valve Y2 will be commanded to close.

If the oil level remains constant then no further action is taken by the SAFEMATIC system.

The fault must be readily identified and the necessary repairs carried out.

If the level continues to drop and thus energises the second SAFEMATIC switch S2 then pump unit 2 will stop and pump unit 1 will restart.

At the same time isolation valve Y2 will be commanded to re-open whilst isolation valve Y1 will close.

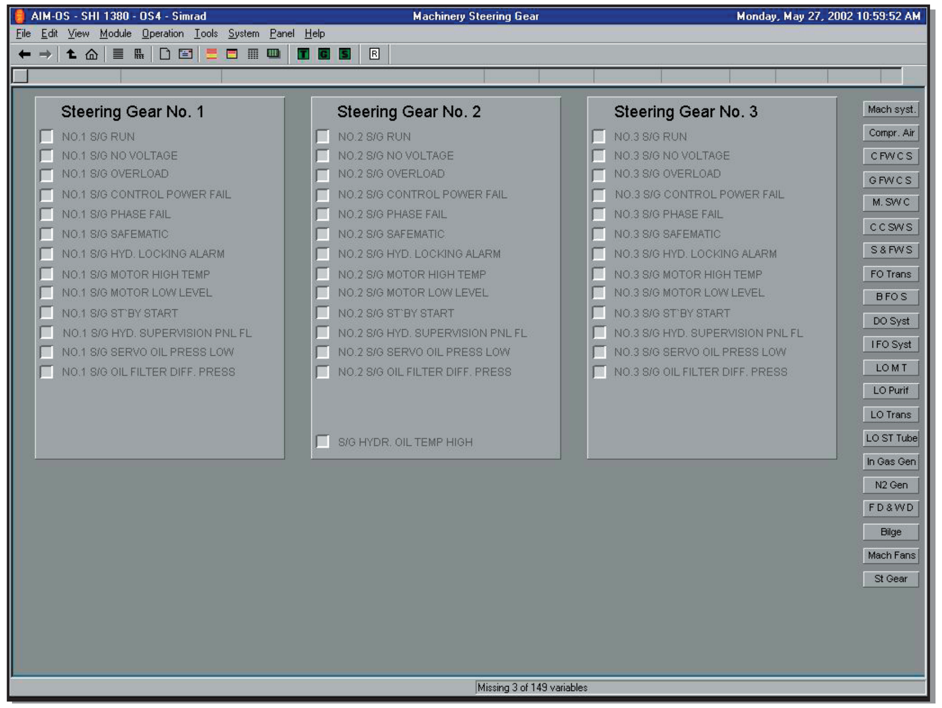
If No.2 pump is running and No.1 is stopped, No.1 and No.2 pumps and Y1 and Y2 isolation valves are reversed in the above sequence.

Should the SAFEMATIC system operate then the ship's speed reduced to about 70% of maximum speed. As only 50% of the torque for the steering gear is available then the steering gear must be operated carefully.

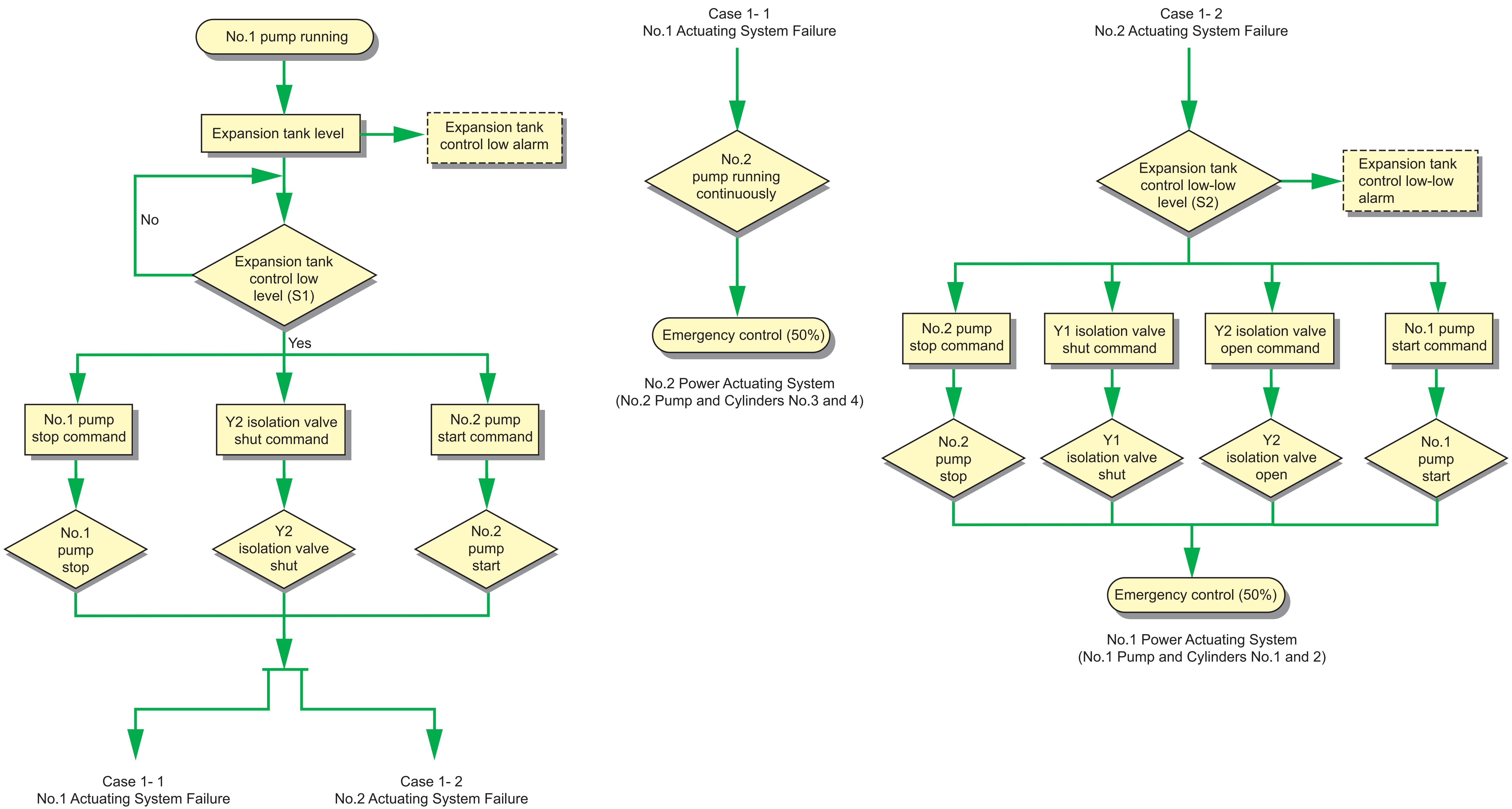
(**Note:** The SAFEMATIC system should be checked periodically to prove that it is working satisfactorily.)

The steering gear is remotely controlled from one of two automatic pilots but can also be controlled manually from the bridge and locally.

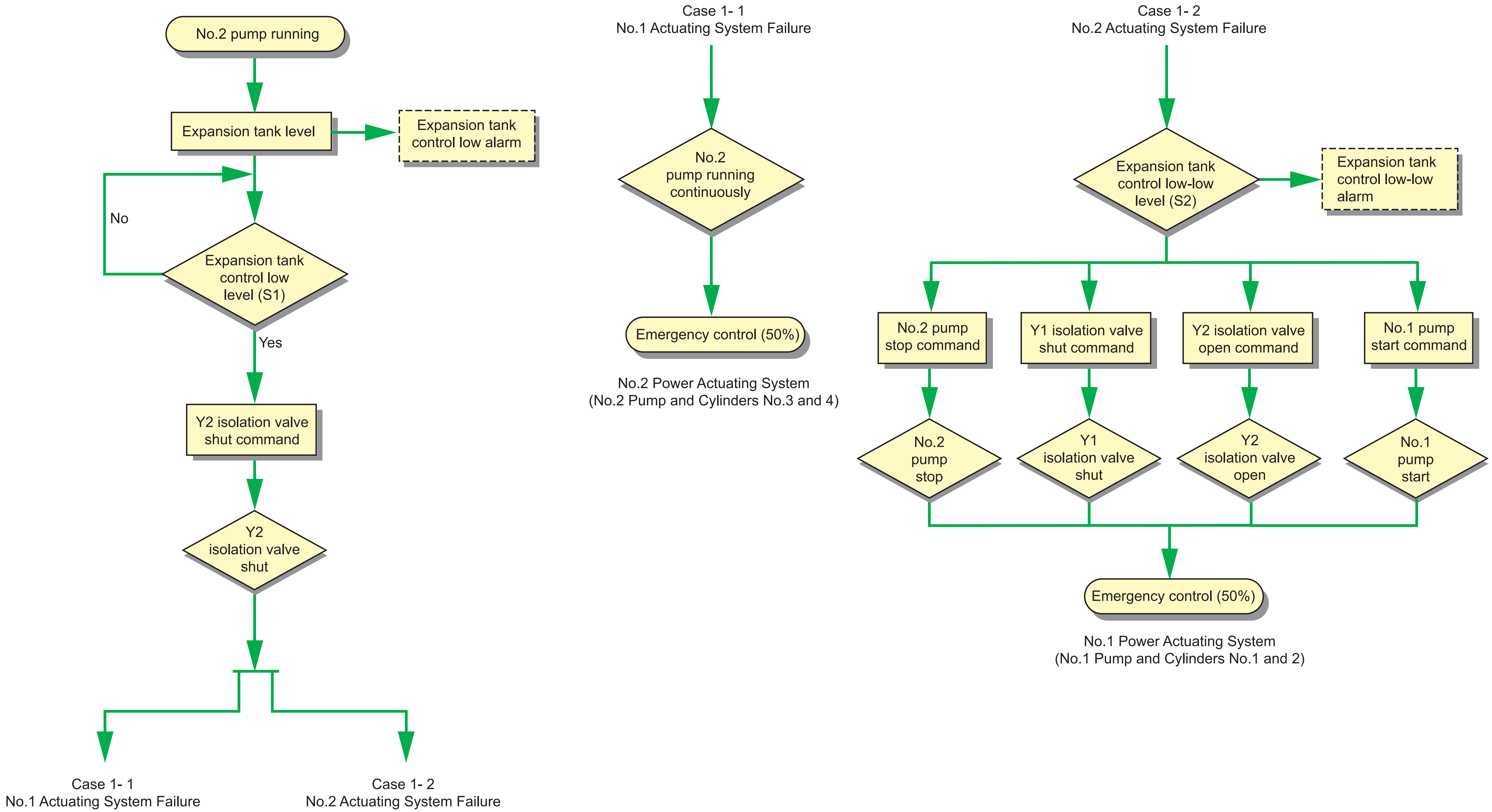
For instructions on using emergency control refer to the instruction plate that will be situated near to the steering gear.



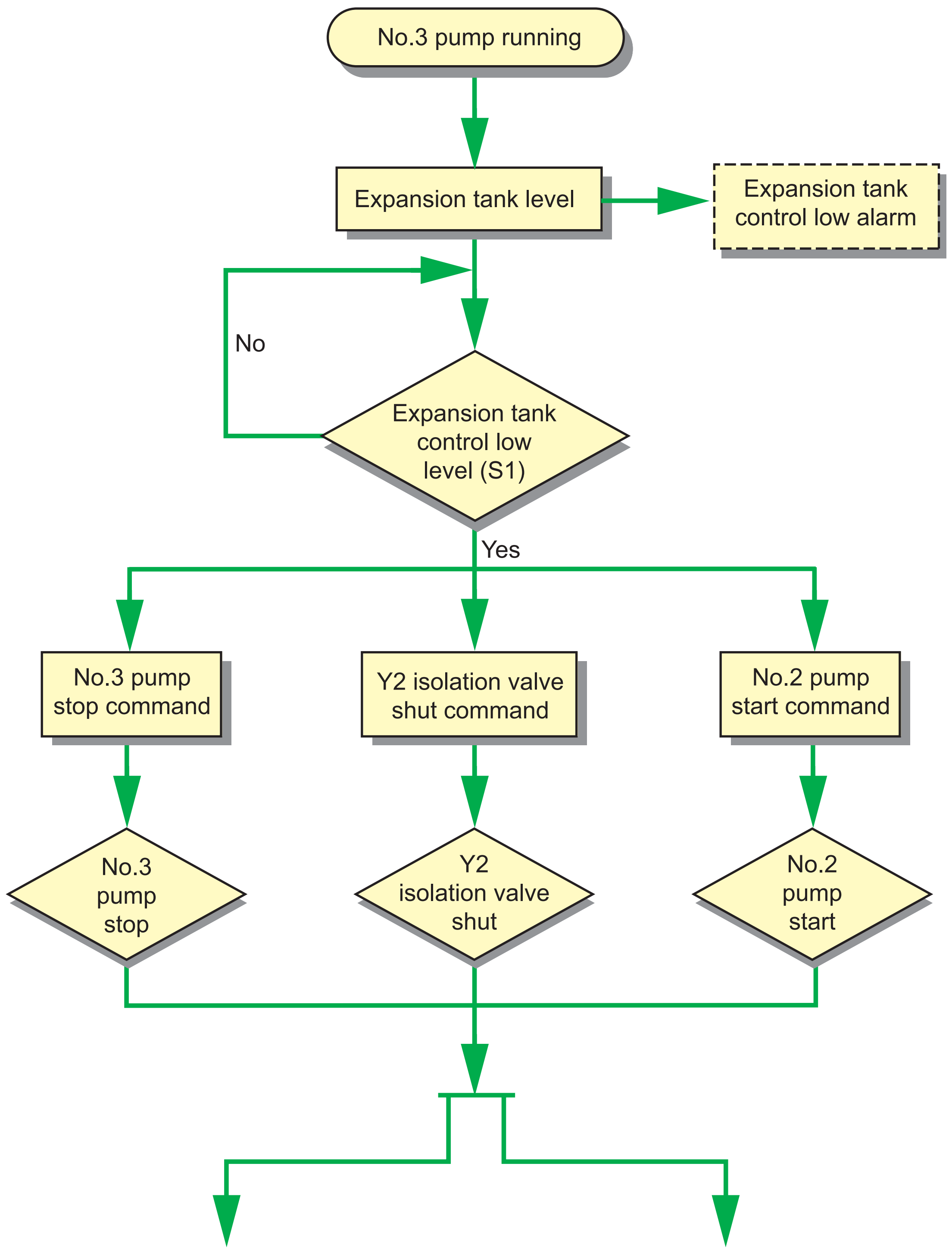
Case 1: No.1 Pump Running

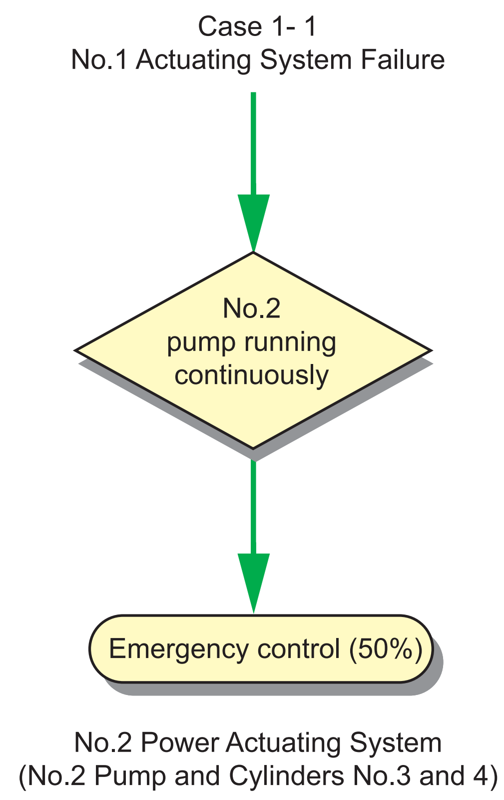


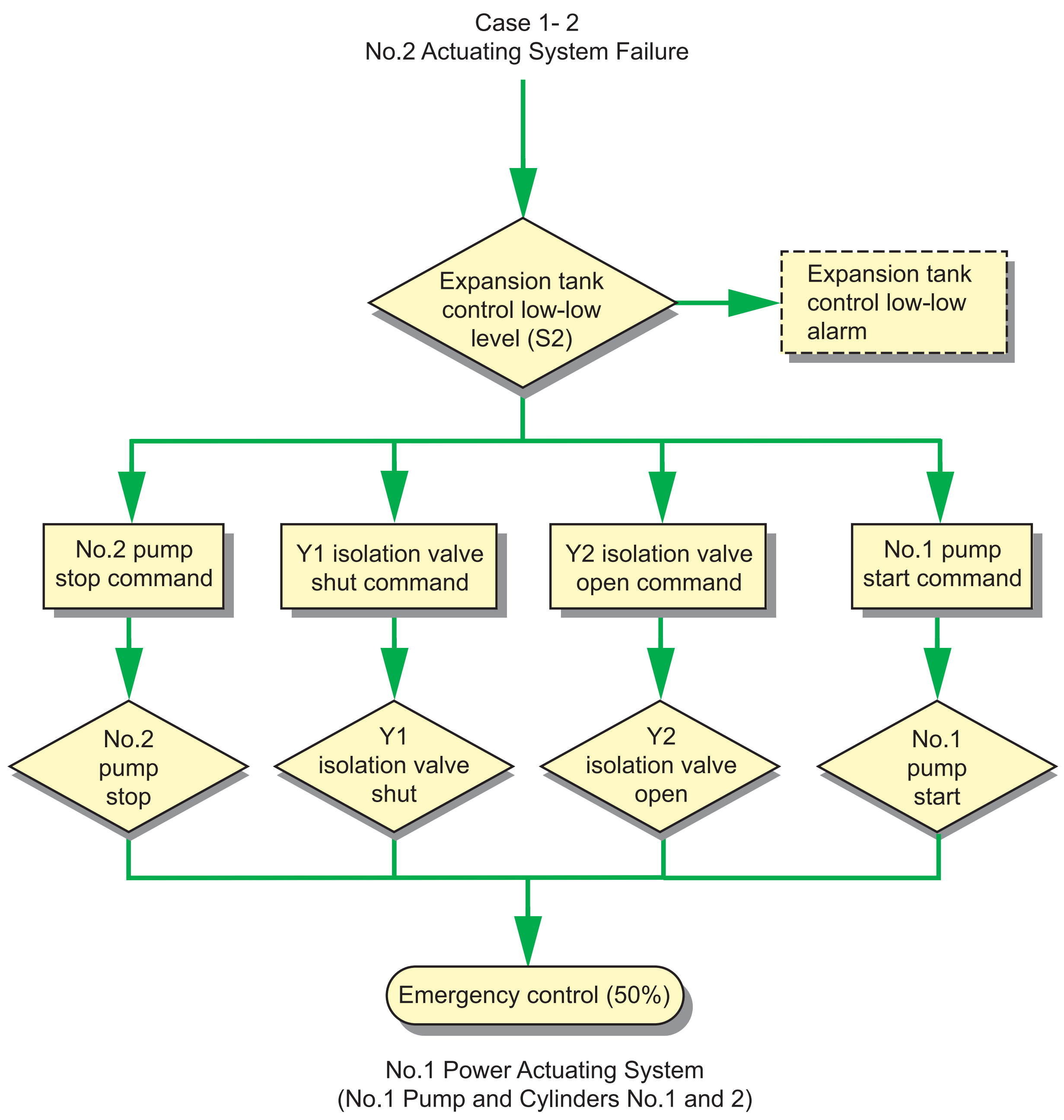
Case 2: No.2 Pump Running



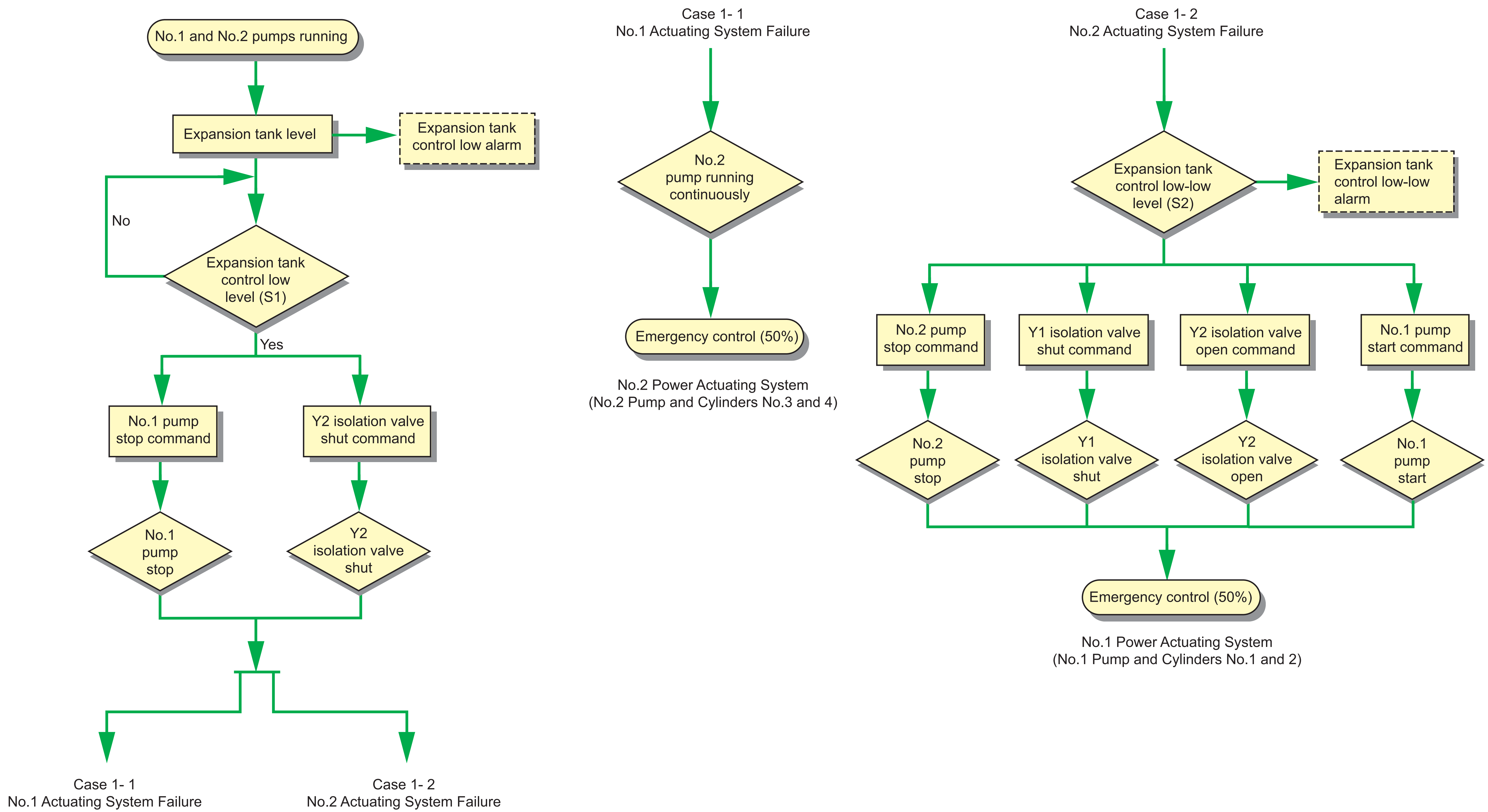
Case 3: No.3 Pump Running



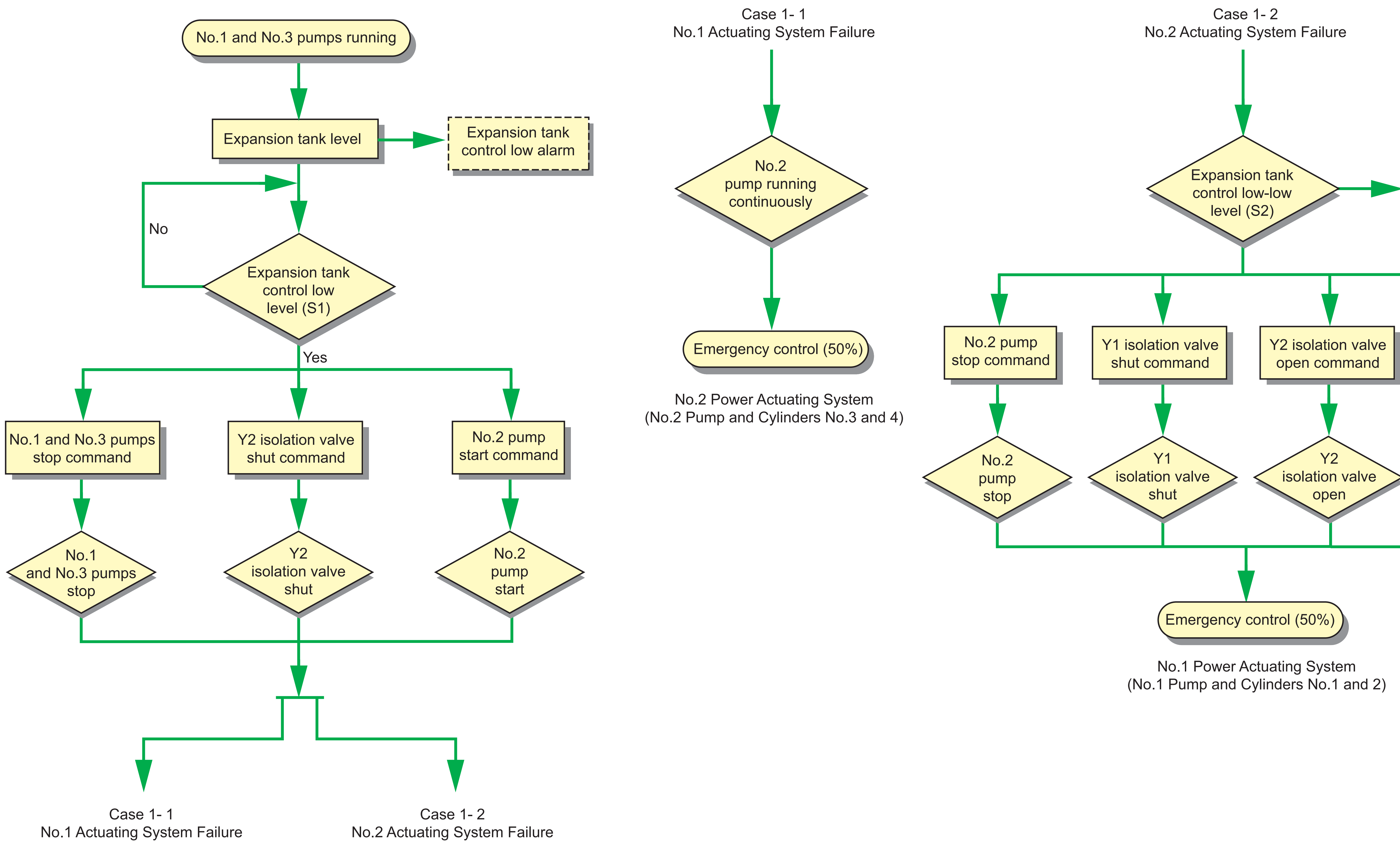




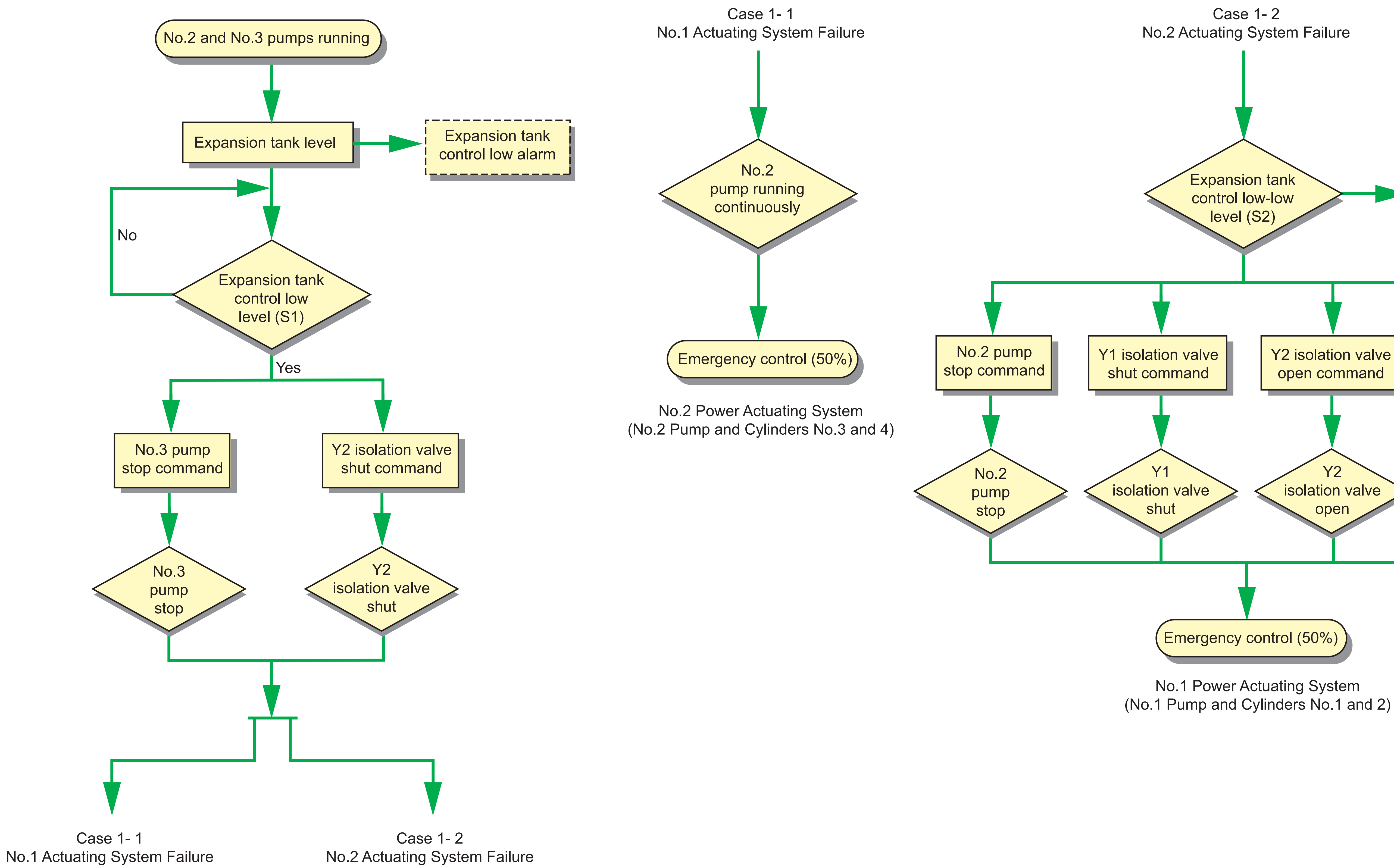
Case 4: No.1 and No.2 Pumps Running



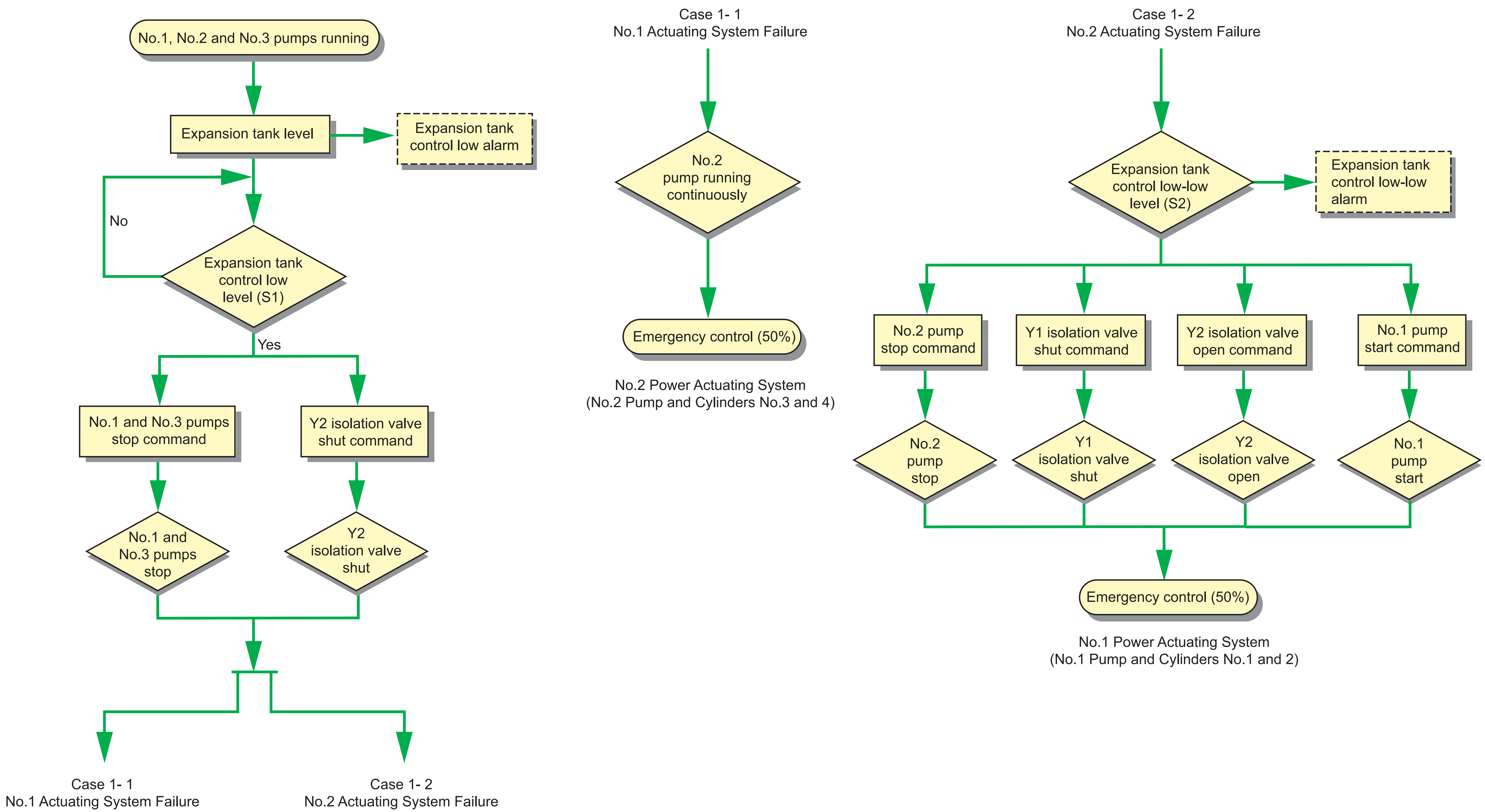
Case 5: No.1 and No.3 Pumps Running



Case 6: No.2 and No.3 Pumps Running



Case 7: No.1, No.2 and No.3 Pumps Running



Operating Procedures

Putting the steering gear into operation

a) Check level of oil in expansion tank and top up if required.

b) Start the electro-hydraulic pump unit.

c) Visually inspect the whole system for leaks and listen for any abnormal noise.

d) Carry out pre-departure tests as laid down in company instructions and statutory instrument.

e) Check operating pressures.

When operating the steering gear from the local position

b) Follow the instructions from the bridge.

c) At the control panel for each steering gear turn off the PROPORTIONAL AMPLIFIER which stops the remote control of each pump.

d) Operate the steering gear in response to requests from the bridge by operating the solenoid valves of the running pump using the T bar on the port/starboard pushbuttons.

Steering Gear Test Procedure

For freedom of movement during communication with the bridge it is recommended that the UHT transceivers are used. Confirm communication with the bridge utilising the telephone headset and the sound powered telephone headset.

Check the oil and grease levels and ensuring that all is in good order. Proceed with the following tests and confirm the procedure with the bridge, ensuring that the correct alarms sound and that the correct indicator lights illuminate and extinguish.

(**Note:** Hydraulic supervision panels, one located on the bridge panel and one in the steering gear room must be switched on prior to commencing the tests. Ensure that the panel dimmers are adjusted to allow indicator lamps to be observed on the bridge panel.)

Step 1

With all the steering gears off, confirm that the Hydraulic Lock Alarms are active.

Illustration 2.10b Steering Gear - Emergency Operation Valve Positioning Plan

Mode of Operation	Positioning of Valves												Actuating system
Description	Pump units in operation			Automatic pump isolating valves			'Safematic' Automatic system isolation valves		Hand operation of system isolation valves (V) and bypass valves (B)				
	No.1	No.2	No.3	P1	P2	P3	Y1	Y2	V1	V2	B1	B2	Actuator
Normal operation	●	○	○	●	○	○	○	○	○	○	●	●	Actuator 1 & 2
	○	●	○	○	●	○	○	○	○	○	●	●	
	○	○	●	○	○	●	○	○	○	○	●	●	
	●	●	○	●	●	○	○	○	○	○	●	●	
	●	○	●	●	○	●	○	○	○	○	●	●	
	○	●	●	○	●	●	○	○	○	○	●	●	
	●	●	●	●	●	●	○	○	○	○	●	●	
Emergency auto isolation	●	○	○	●	○	○	●	○	○	○	●	●	Actuator 1
	○	●	○	○	●	○	○	●	○	○	●	●	Actuator 2
Emergency manual isolation	●	○	○	●	○	○	○	○	●	●	●	○	Actuator 1
	○	●	○	○	●	○	○	○	●	●	○	●	Actuator 2
	○	○	●	○	○	●	○	○	●	●	○	●	Actuator 2
Legend;	●	on		energised					closed				
	○	off		not energised					open				

Start No.1 steering motor, the system automatically selects the standby unit, which should be No.2. Confirm on the steering gear alarm panel that No.2 unit is indicated as on standby.

Select the FU position on the main console selector panel and at the steering stand, utilising the wheel, swing the rudder hard over to port and hard over to starboard. The steering gear local operator is to confirm with the bridge that the rudder angle corresponds to the actual position of the rudder at various angles of helm, noting the time taken to complete the rudder movement. Ensure that all rudder angle indicators are checked during the following.

1. Select NFU Steering Stand mode at the main console and utilising the steering stand, repeat the hard to port and hard to starboard test.
2. Repeat 1. selecting NFU MAIN mode at the main console and utilising the NFU lever at the main console.
3. Select AUTOPILOT 1 mode at the main console and using the lever at the main console, repeat the hard to port and hard to starboard test.
4. Repeat test 3 utilising AUTOPILOT 2 mode at the main console.

Step 2

At the steering gear room SAFEMATIC Switch panel, press TEST EMERGENCY OPERATION WITH PUMP 2 pushbutton. The following should occur:

- No.1 pump will stop
- Y2 isolation valve closes
- No.2 steering motor starts

Press the RESET EMERGENCY OPERATION WITH PUMP 2

Step 3

Change over to No.2 steering motor with No.3 as standby and repeat step 1 rudder movements.

Step 4

At the steering gear room SAFEMATIC switch panel, press the TEST EMERGENCY OPERATION WITH PUMP 1 pushbutton. The following should occur:

- No.2 steering motor stops
- No.1 steering motor starts
- Y1 isolation valve closes
- Y2 isolation valve opens

Press the RESET EMERGENCY OPERATION PUMP 1 pushbutton.

Step 5

Change over to No.3 steering motor, with No.1 as standby and repeat step 1 rudder movements.

Step 6 (Case 1 Flow Chart)

With No.1 steering motor running, lift the arm of the low level switch 'SO' on the oil expansion tank. Confirm that the alarm operates on the bridge steering gear alarm panel and on the IAS.

Release the low level switch arm and lift the SAFEMATIC level switch 'S1' and confirm the following:

- No.1 steering motor stops
- Y2 isolation valve closes
- No.2 steering motor starts

Release S1 and if the system remained stable from this condition, No.2 pump would remain running with cylinders 3 and 4 in use, but the steering system would be restricted to 50% and in Emergency Control Mode.

Lift the SAFEMATIC level switch S2 and confirm the following:

- No.1 steering motor starts
- No.2 steering motor stops
- Y1 isolation valve closes
- Y2 isolation valve opens

From this condition No.1 pump would remain running with cylinders 1 and 2 in use, but the steering system would be restricted to 50% and in Emergency Control Mode. Release S2 and the resets on the steering gear SAFEMATIC panel.

Step 7 (Case 2 Flow Chart)

Change back onto No.2 steering motor, lift the SAFEMATIC level switch S1 and confirm the following:

- No.2 steering motor remains running
- Y2 isolation valve closes

Release S1 and if the system remained stable from this condition No.2 pump would remain running with cylinders 3 and 4 in use, but the steering system would be restricted to 50% and in Emergency Control Mode.

Lift the SAFEMATIC level switch S2 and confirm the following:

- No.1 steering motor starts
- No.2 steering motor stops
- Y1 isolation valve closes
- Y2 isolation valve opens

From this condition No.1 pump would remain running with cylinders 1 and 2 in use, but the steering system would be restricted to 50% and in Emergency Control Mode. Release S2 and the resets on the steering gear SAFEMATIC panel.

Step 8 (Case 3 Flow Chart)

Change back onto No.3 steering motor, lift the SAFEMATIC level switch S1 and confirm the following:

- No.3 steering motor stops
- Y2 isolation valve closes
- No.2 steering motor starts

Release S1 and if the system remained stable from this condition No.2 pump would remain running with cylinders 3 and 4 in use, but the steering system would be restricted to 50% and in Emergency Control Mode.

Lift the SAFEMATIC level switch S2 and confirm the following:

- No.1 steering motor starts
- No.2 steering motor stops
- Y1 isolation valve closes
- Y2 isolation valve opens

From this condition No.1 pump would remain running with cylinders 1 and 2 in use, but the steering system would be restricted to 50% and in Emergency Control Mode. Release S2 and the resets on the steering gear Safematic panel.

Step 9 (Case 4 Flow Chart)

Start No.1 and No.2 steering motors, lift the SAFEMATIC level switch S1 and confirm the following:

- No.2 steering motor remains running
- Y2 isolation valve closes

Release S1 and if the system remained stable from this condition No.2 pump would remain running with cylinders 3 and 4 in use, but the steering system would be restricted to 50% and in Emergency Control Mode.

Lift the SAFEMATIC level switch S2 and confirm the following:

- No.1 steering motor starts
- No.2 steering motor stops
- Y1 isolation valve closes
- Y2 isolation valve opens

From this condition No.1 pump would remain running with cylinders 1 and 2 in use, but the steering system would be restricted to 50% and in Emergency Control Mode. Release S2 and the resets on the steering gear SAFEMATIC panel.

Step 10 (Case 5 Flow Chart)

Start No.1 and No.3 steering motors, lift the SAFEMATIC level switch S1 and confirm the following:

- No.1 steering motor starts
- No.2 steering motor stops
- Y1 isolation valve closes
- Y2 isolation valve opens

Release S1 and if the system remained stable from this condition No.2 pump would remain running with cylinders 3 and 4 in use, but the steering system would be restricted to 50% and in Emergency Control Mode.

Lift the SAFEMATIC level switch S2 and confirm the following:

- No.1 steering motor starts
- No.2 steering motor stops
- Y1 isolation valve closes
- Y2 isolation valve opens

From this condition No.1 pump would remain running with cylinders 1 and 2 in use, but the steering system would be restricted to 50% and in Emergency Control Mode. Release S2 and the resets on the steering gear SAFEMATIC panel.

Step 11 (Case 6 Flow Chart)

Start No.2 and No.3 steering motors, lift the SAFEMATIC level switch S1 and confirm the following:

- No.2 steering motor remains running
- Y2 isolation valve closes

Release S1 and if the system remained stable from this condition No.2 pump would remain running with cylinders 3 and 4 in use, but the steering system would be restricted to 50% and in Emergency Control Mode.

Lift the SAFEMATIC level switch S2 and confirm the following:

- No.1 steering motor starts
- No.2 steering motor stops
- Y1 isolation valve closes
- Y2 isolation valve opens

From this condition No.1 pump would remain running with cylinders 1 and 2 in use, but the steering system would be restricted to 50% and in Emergency Control Mode. Release S2 and the resets on the steering gear SAFEMATIC panel.

Step 12 (Case 7 Flow Chart)

Start No.1, No.2 and No.3 steering motors, lift the SAFEMATIC level switch S1 and confirm the following:

- No.1 steering motor stops
- No.3 steering motor stops
- Y2 isolation valve closes

Release S1 and if the system remained stable from this condition No.2 pump would remain running with cylinders 3 and 4 in use, but the steering system would be restricted to 50% and in Emergency Control Mode.

Lift the Safematic level switch S2 and confirm the following:

- No.1 steering motor starts
- No.2 steering motor stops
- Y1 isolation valve closes
- Y2 isolation valve opens

From this condition No.1 pump would remain running with cylinders 1 and 2 in use, but the steering system would be restricted to 50% and in Emergency Control Mode. Release S2 and the resets on the steering gear SAFEMATIC panel.

Step 13

Operate the low-low level switches S3 and S4 in turn, confirming operation of the low-low level alarms on the bridge steering gear panel and the IAS.

Step 14

Test the No-Volt and Control Power Failure alarms. With the steering motors stopped, switch the main breaker on each local starter panel to the OFF position, which should activate the above alarms.

(**Note:** The following tests to be completed with the breakers in the OFF position.)

Step 15

Test the Motor Overload Alarm
In each local starter panel remove relay 51MX to activate the alarm
Ensure that the relay is correctly refitted upon completion of the test.

Step 16

Test the Motor Phase Failure Alarm
In each local starter panel remove relay 46MX to activate the alarm
Ensure that the relay is correctly refitted upon completion of the test.

Step 17

Test the Motor High Temperature Alarm
In each local starter panel remove relay 49MX to activate the alarm
Ensure that the relay is correctly refitted upon completion of the test.

Step 18

Test the Oil Differential Pressure High Alarm
In each local starter panel remove relay 33X3 to activate the alarm
Ensure that the relay is correctly refitted upon completion of the test.

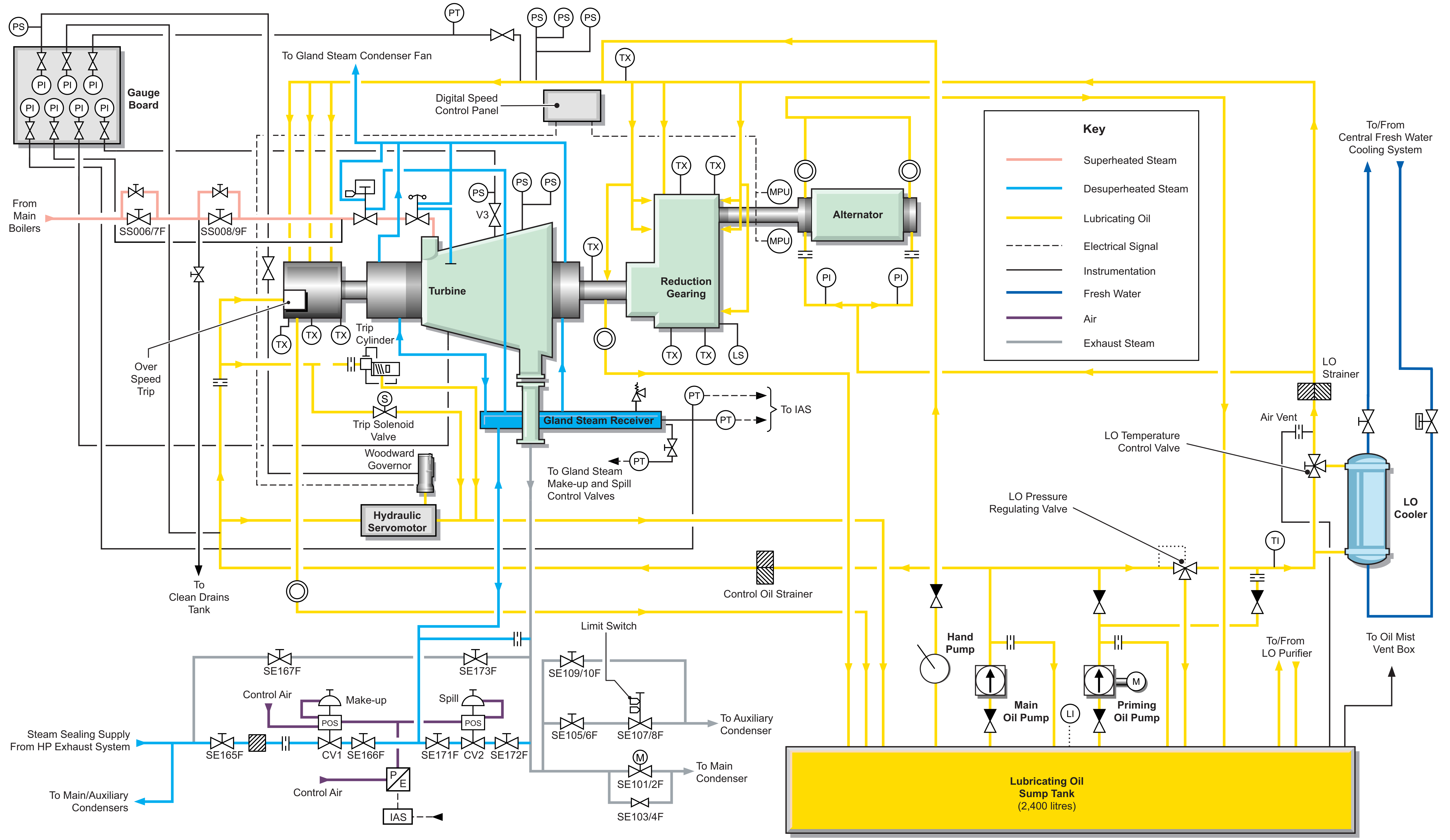
Step 19

Test the Servo Oil Pressure Low Alarm
Press the pushbutton on the front of relay 63X with the power off the cabinet.

2.11 Electrical Power Generators

Illustrations

Illustration 2.11.1a Turbine Generator - Schematic



2.11 ELECTRICAL POWER GENERATORS

2.11.1 TURBINE GENERATORS

Specification

Maker:	Shinko Industries Co. Ltd
No. of units:	2
Type:	Shinko RG 92-2
Details:	Single cylinder, impulse, multistage, condensing
Rated output:	3,450kW
Normal output:	1,700kW
Main steam pressure:	5.77MPa
Main steam temperature:	520°C
Exhaust vacuum:	-94.7kPa
Revolutions:	8,145 rpm
Critical speed:	1,050 rpm
Direction of rotation:	Anti-clockwise viewed from alternator end
Number of stages:	9
Gearing:	Single reduction, single helical
Alternator revolutions:	1,800 rpm
Frequency:	60Hz
Voltage:	6,600V
Power factor:	0.8

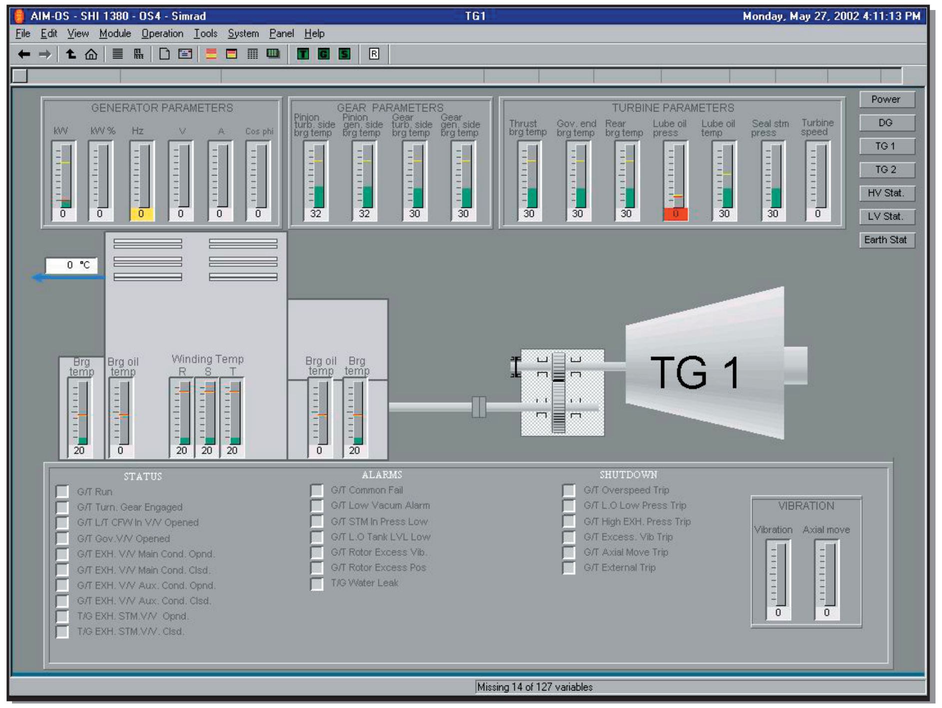
Description

The Shinko RG 92-2 turbine generator consists of the steam turbine, reduction gear, alternating current generator and auxiliaries mounted on a common bedplate. The bedplate incorporates the lubricating oil (LO) sump tank.

The steam turbine is of the nine stage impulse type with a hydraulic constant speed governor controlling steam flow. The steam passes through a trip valve, designed to shut off the steam instantly should a trip condition occur and then through the nozzle control valves. The turbines normally exhaust to the main condenser under vacuum conditions but can be set to exhaust to the auxiliary condenser.

Labyrinth type seals are used at the end of the turbine rotors to prevent the steam in these regions from leaking to atmosphere and, more importantly, to prevent air from entering the turbine where its internal pressure is less than atmospheric. The seals are formed by radially slotting sections of labyrinth into the packing rings, which themselves are likewise slotted radially into the turbine upper and lower casings. The peak and trough edges of these labyrinths are located adjacent to corresponding square radial grooves machined into the rotor shaft.

The clearances between the labyrinth edges and the rotor are minimised to reduce steam leakage between the inner (high gland steam pressure) areas and the outer (low gland steam pressure) areas. Adjacent axial clearance between the rotor and the labyrinths allow for the designed relative axial movement and expansion between the rotor and the casing.



Steam is supplied to the glands from a packing steam receiver mounted adjacent to the unit. At the high pressure end of the turbine, where the internal steam pressure is higher than the pressure in the gland housing, steam will enter the series of diaphragms from the turbine, and is effectively throttled across each stage causing its pressure to drop. The final low pressure steam is led away to the gland steam condenser as gland lea-off steam.

At the low pressure end of the turbine the gland will require sealing steam to be supplied from the gland steam receiver. This would normally be the case where the load on the unit was light, placing the low pressure end of the turbine under vacuum. In this case the pressure in the gland steam receiver is greater than the internal turbine pressure at the shaft exit point, therefore the steam available from the gland steam receiver will be drawn through the gland effectively sealing it and preventing the ingress of air.

During periods of high turbine loading the reverse will happen, the steam from inside the casing flowing over the glands and exiting to the gland steam receiver. The gland steam receiver will therefore need to spill steam at times of high turbine loading, and receive make-up steam at periods of low turbine loading. At times of average loading the steam spilled from the high pressure end may satisfy the demand from the low pressure end and the system is in equilibrium. To cope with this fluctuating demand, the gland steam receiver spills excess steam through a control valve to the condenser or receives steam from a make-up controller supplied from the HP exhaust steam range.

The reduction gear is of the single reduction, single helical type, its pinion being coupled with the turbine rotor by a Thomas type flexible coupling. The gearing is supported by four oil lubricated bearings. The alternating current (AC) generator has four poles and is connected to the gear by a gear type flexible coupling at its shaft end.

The LO system is supplied from a motor driven priming pump when the turbine is stopped or starting up. The priming pump starts when the LO pressure falls to 40kPa and cuts out when the turbine reaches 80% of its normal operating speed (90-150kPa). A gear-driven integral LO pump supplies the system when the turbine is running normally. The pressure is regulated to the bearings and gears by a regulating valve, full delivery oil pressure is supplied to the trip valve.

The governing system consists of a Woodward UG-10D governor, actuator, hydraulic servo motor and turbine nozzle valve. The governor has a very fast response to load change and is designed to prevent the turbine overspeeding even in the event of the generator circuit breaker tripping. The governor reacts to changes in speed by moving a linkage to the hydraulic servomotor which in turn opens or closes the steam inlet to the turbine nozzles.

Cooling of the LO and the generator windings is supplied from the central fresh water cooling system. The system supplies both sets and therefore a problem in the cooling supply will affect both sets simultaneously. In an emergency the generator windings can be cooled by opening the covers and allowing air to pass through, drawn in by the fan mounted on the generator rotor shaft.

Alarms and Trips

The trip valve protects the turbine in the event of a serious problem by closing and immediately shutting off the steam to the turbine. The trip valve is held open by oil pressure acting upon a piston within the valve body. In the event of a trip condition occurring, the oil supply is cut off and the oil pressure under the piston is relieved to the sump.

The following table details the protective alarm and trip and set points:

Item	Alarm Set Point	Trip Set Point
Mechanical overspeed		2,000 rpm
Electronic overspeed		1,980 rpm
High exhaust pressure (vacuum mode)	-40kPa	-13.5kPa
Sentinel valve	70kPa	
LO pressure	60kPa	50kPa
LO supply temperature	53°C	
Bearing temperatures	75°C	
Turbine rotor axial movement	0.5mm	0.7mm
Turbine rotor vibration	80um	140um
LO sump level	-60mm from normal	
Gland steam low pressure	0 - 13.5kPa	
Turning gear LO interlock	15kPa	
Inlet steam low pressure	5.2MPa	

2.11.1b Turbine Generator Operating Procedure

The LO priming pump is permanently on AUTO and the turning gear is permanently in use. Confirm that the bearing oil pressure is between 50kPa and 60kPa. Check and top up the LO sump tank as necessary

Open the cooling water valves in and out of the generator windings cooler and the LO cooler (see section 2.4.1 Central Fresh Water Cooling System). Vent any air from the coolers.

The main steam valves SS006F and SS007F are permanently open with superheated steam up to the main stop valves.

Commence warming through by opening the drain valve on the main superheated steam supply line and opening the bypass valve on the main steam stop valve SS008F.

Observe the gradual rise in the steam line temperature and pressure. This will warm through, drain and slowly bring the system up to working pressure and temperature as far as the governor valve.

With the gland steam system operational (see section 2.1.6 Gland Packing and Leak-Off System), check that all the drain traps on the system are open.

Slowly open the gland steam make-up and spill control inlet and outlet valves, SE163F and SE169F and SE168F and SE162F, together with the outlet valve ST254F. Set the gland steam controller to 14kPa.

When the steam pressure is at 5.8MPa, slowly open the main stop valve SS008F and close the bypass valve. Check that all the instrumentation and gauges are open and reading zero when appropriate.

Open the bypass valve SE103F around the motorised exhaust valve SE101F to the main condenser.

Allow the vacuum to develop within the system without adversely affecting the main condenser vacuum. Check that the main condenser vacuum does not fall.

When the vacuum on the local gauge registers -0.07MPa, operate the motorised exhaust valve on the local panel. Close the exhaust valve bypass valve SE103F

Stop the turning gear motor and disengage the turning gear.

Reset the trips by pressing the TRIP RESET pushbutton on the local control panel, the lamp should go out. Slowly open the main trip valve by hand.

Run the turbine at 400 rpm for about 20 minutes to allow thorough warming through. Continue to check for unusual noises or problems with any ancillary systems.

Gradually increase the turbine speed, taking a total of about 15 minutes to reachfull speed. Avoid lingering around the critical speed zone of 1,050 rpm. Confirm that the LO priming pump stops at 1,440 rpm. Observe the governor linkage moving down when the governor takes control. When the main trip valve is fully opened, shut it back in about half a turn to prevent it jamming.

Close the steam line drains, main steam stop bypass valve.

Reset the trips at the IAS screen.

Connect the generator to the main switchboard by clicking on the TG icon on the IAS screen to call up the menu. Click on CONNECT on the menu and the generator will parallel with the main switchboard.

The generator can also be connected manually at the main switchboard panel by using the following procedure:

Turn the Remote/Auto switch to the LM (Local/Manual) position.

Lower or raise the generator speed until the synchroniser light slowly revolves in the + direction.

Turn the breaker Trip/Close switch to the CLOSE position to connect the generator to the main switchboard when the synchroniser light passes the top position..

Turn the Remote/Auto switch to the RA Remote/Auto position to allow the IAS to control the generator and balance the load with the No.1 turbine generator.

Disconnect the generator from the main switchboard by clicking on the TG icon on the IAS screen to call up the menu. Click on DISCONNECT on the menu and the generator will disconnect from the main switchboard.

Shut the main trip valve by operating one of the trip functions. This gives a good opportunity to test the function of the trips, operate a different one each time the turbine is stopped.

Confirm that the LO priming pump starts as the set slows down.

Shut the stop steam valve SS008F. Open the main steam line drain.

Close the exhaust valve SE101F to the main condenser.

Once the turbine stops engage and start the turning gear.

Close the gland steam make-up and spill control outlet valves, SE163F and SE169F, gland steam make-up control valve inlet isolating valve SE162F, the gland steam spill control valve inlet isolating valve SE168F and the gland steam leak-off valve ST254F.

The following table details the normal operating parameters:

Item	Normal Operating Range
LO pressure	100 - 150kPa
LO supply temperature	35 - 45°C
Bearing temperature	46 - 74°C
Gland steam pressure	1 - 20kPa

Operating Procedure, using No.1 Turbine Generator

The LO priming pump is permanently on AUTO and the turning gear is permanently in use. Confirm that the bearing oil pressure is between 50kPa and 60kPa. Check and top up the LO sump tank as necessary.

The main steam valves SS006F and SS007F are also permanently open with superheated steam up to the main stop valves.

a) Open the cooling water valves in and out of the generator windings cooler and the LO cooler (see section 2.4.1 Central Fresh Water Cooling System). Vent any air from the coolers.

b) Commence warming through by opening the drain valve on the main superheated steam supply line and opening the bypass valve on the main steam stop valve SS008F.

Observe the gradual rise in the steam line temperature and pressure. This will warm through, drain and slowly bring the system up to working pressure and temperature as far as the governor valve.

c) With the gland steam system operational (see section 2.1.6 Gland Packing and Leak-Off System), check that all the drain traps on the system are open.

d) Slowly open the gland steam make-up and spill control inlet and outlet valves, SE163F and SE169F and SE168F and SE162F, together with the outlet valve ST254F.

e) Set the gland steam controller to 14kPa.

f) When the steam pressure is at 5.8MPa, slowly open the main stop valve SS008F and close the bypass valve. Check that all the instrumentation and gauges are open and reading zero when appropriate.

g) Open the bypass valve SE103F around the motorised exhaust valve SE101F to the main condenser.

This allows the vacuum to develop with in the system without adversely affecting the main condenser vacuum. Check that the main condenser vacuum does not fall.

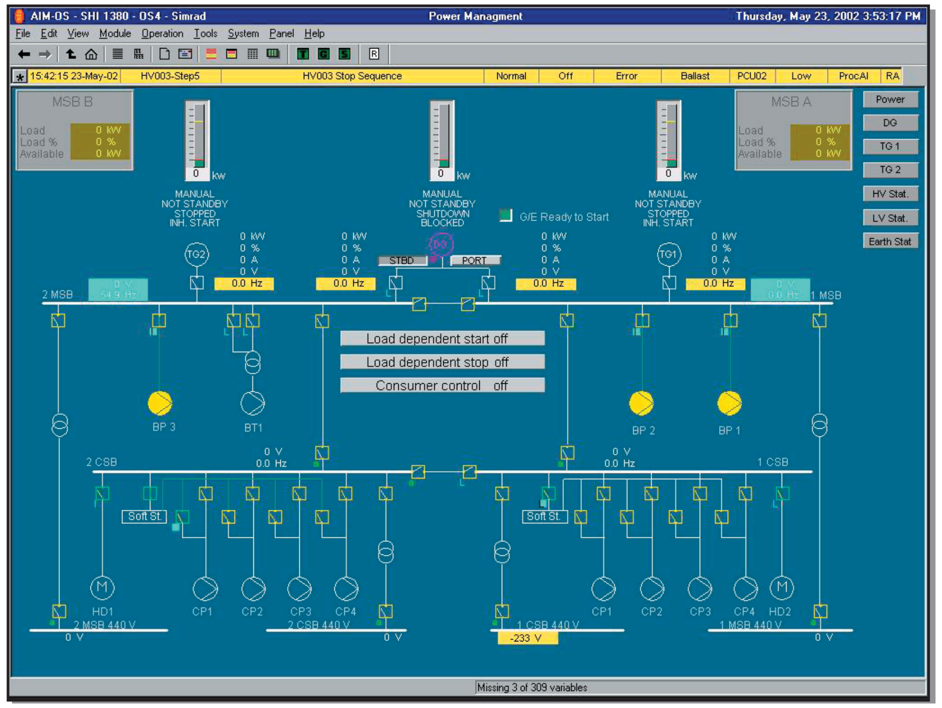
h) When the vacuum on the local gauge registers -0.07MPa, operate the motorised exhaust valve on the local panel. Close the exhaust valve bypass valve SE103F.

i) Stop the turning gear motor and disengage the turning gear.

j) Reset the trips by pressing the TRIP RESET pushbutton on the local control panel, the lamp should go out.

k) Slowly open the main trip valve by hand.

l) Run the turbine at 400 rpm for about 20 minutes to allow thorough warming through. Continue to check for unusual noises or problems with any ancillary systems.



m) Gradually increase the turbine speed, taking a total of about 15 minutes to reach full speed. Avoid lingering around the critical speed zone of 1,050 rpm. Confirm that the LO priming pump stops at 1,440 rpm. Observe the governor linkage moving down when the governor takes control. When the main trip valve is fully opened, shut it back in about half a turn to prevent it jamming.

n) Close the steam line drains, main steam stop bypass valve.

o) Reset the trips at the IAS screen.

Connect the generator to the main switchboard by clicking on the TG icon on the IAS screen to call up the menu. Click on CONNECT on the menu and the generator will parallel with the main switchboard.

The generator can also be connected manually at the main switchboard panel by using the following procedure:

a) Turn the Remote/Auto switch to the LM (Local Manual) position.

b) Lower or raise the generator speed until the synchroniser light slowly revolves in the + direction.

c) Turn the breaker Trip/Close switch to the CLOSE position to connect the generator to the main switchboard when the synchroniser light passes the top position.

d) Turn the Remote/Auto switch to RA Remote/Auto position to allow the IAS to control the generator and balance the load with the No.1 turbine generator.

Procedure to Stop the Turbine Generator

Disconnect the generator from the main switchboard by clicking on the TG icon on the IAS screen to call up the menu. Click on DISCONNECT on the menu and the generator will disconnect from the main switchboard.

a) Shut the main trip valve by operating one of the trip functions. This gives a good opportunity to test the function of the trips, operate a different one each time the turbine is stopped.

b) Confirm that the LO priming pump starts as the set slows down.

c) Shut the stop steam valve SS008F.

d) Open the main steam line drain.

e) Close the exhaust valve SE101F to the main condenser.

f) Once the turbine stops engage and start the turning gear.

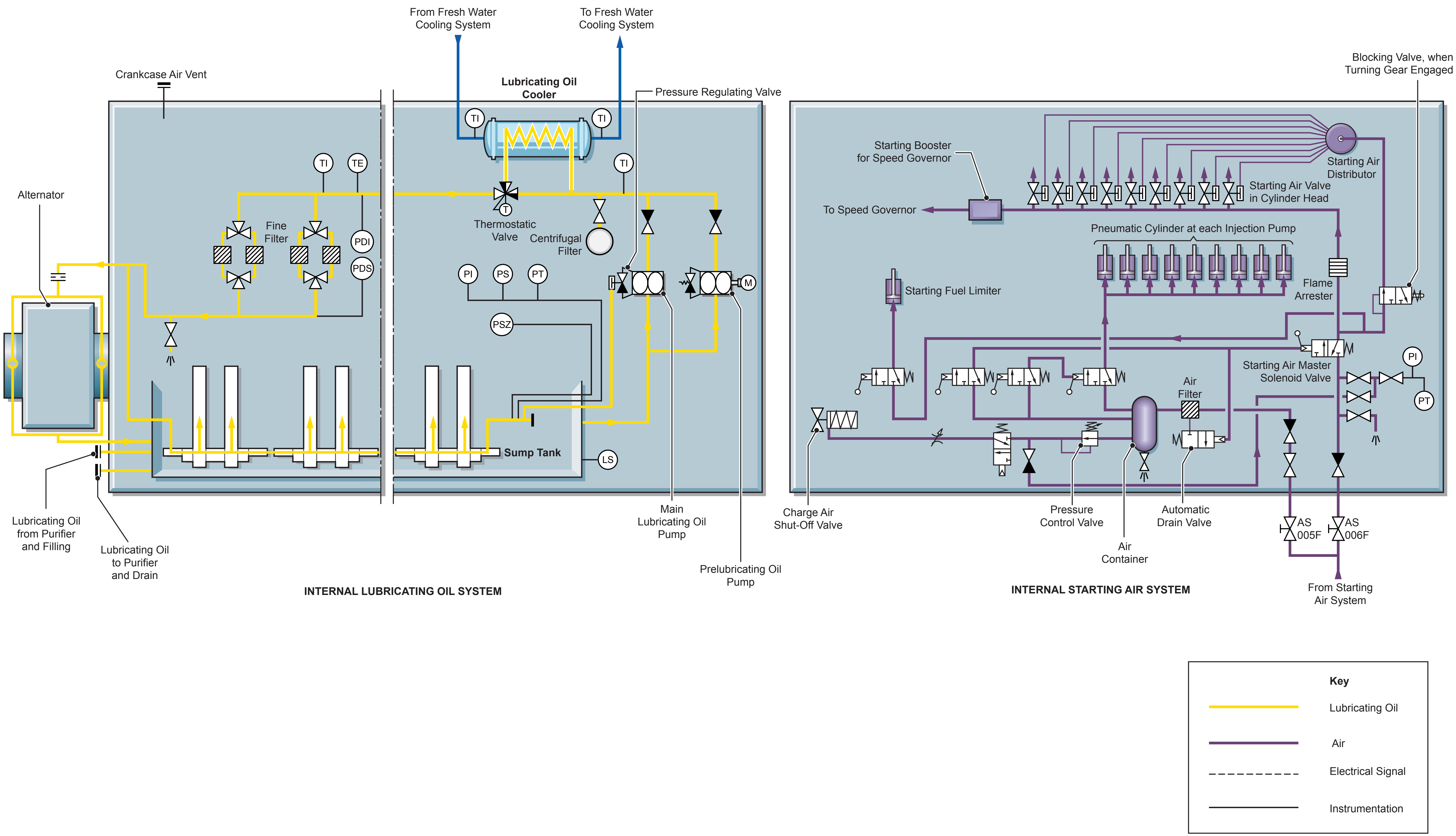
g) Close the gland steam make-up and spill control outlet valves, SE163F and SE169F.

h) Close the gland steam make-up control valve inlet isolating valve SE162F.

i) Close the gland steam spill control valve inlet isolating valve SE168F.

g) Close the gland steam leak-off valve ST254F.

Illustration 2.11.2a Diesel Generator - Schematic Starting Air and Lubricating Oil



2.11.2 DIESEL GENERATOR

Maker:	Wartsila
Type:	9R32LNE
No. of cylinders:	9
Bore:	320mm
Stroke:	350mm
Speed:	720 rpm
Capacity:	3,645kW

Turbocharger

Maker:	ABB
Type:	VTR 354

Governor

Maker:	Woodward
Type:	PGG 58

Alternator

Maker:	ABB
Type:	AMG 0900SM10 LSEA
Capacity:	4,313kVA at 6.600V

Introduction

There is one 3,645kW capacity diesel generator, operating in the medium speed range, which supplies electrical power for the ship.

The engine is of the unidirectional trunk piston type, has nine in-line cylinders, is turbocharged, operates on the four stroke cycle and is normally powered by marine diesel oil.

The diesel generator is used as required and is on automatic standby when stopped. Under normal circumstances the turbine generators supply electrical power and the diesel generator is set to cut in should the turbine generators fail to meet the electrical demand, or is started if the turbine generators are shut down for any reason.

Starting Air System

The engine is started by means of starting air valves located in the cylinder covers. A blocking valve prevents the air start system from operating when the turning gear is engaged.

A starting air distributor directs pilot air to each of the cylinder starting valves in order to actuate the valve and direct compressed air into the cylinder for starting.

The master starting air solenoid is activated when the start signal is sent by the power management system for an automatic start or a manual start is initiated. The master solenoid valve directs main air to the cylinder starting valve and pilot air to the starting air distributor. A flame arrester is located in the main air supply line to the cylinder starting valves.

Turbocharger System

The engine is fitted with an exhaust gas driven turbocharger. The turbocharger draws air from the engine room via a suction filter and passes it through a charge air cooler, before supplying the individual cylinders through air inlet valves.

Cooling Water System

All cooling water requirements for the generators are provided by water from the central fresh water cooling system.

An engine driven pump circulates the jacket spaces, cylinder heads and the turbocharger. The engine is kept warm when on standby by circulating the jacket water through an electric preheater. The preheater has two pumps, only one of which is operating at any time. The duty pump is arranged for automatic start when the engine is stopped and the second pump is set as the standby pump to cut in automatically should the duty pump fail when the engine is stopped.

The engine driven jacket cooling water pump discharges through the engine jacket, cylinder head and turbocharger cooling water spaces and then to a thermostatically operated valve.

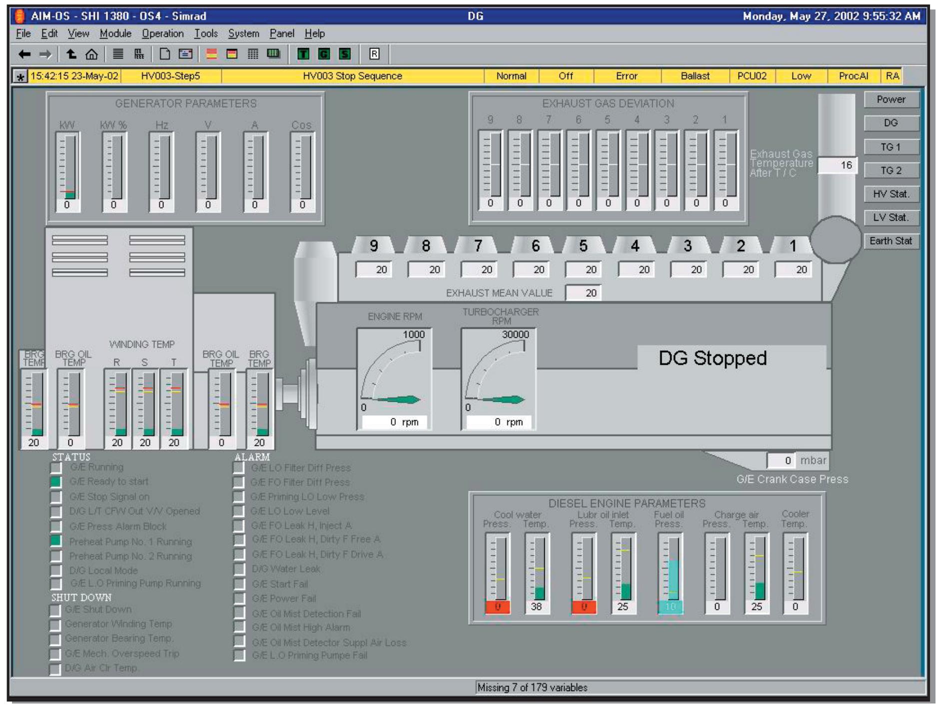
If the temperature of the cooling water leaving the engine is below the normal operating temperature, the thermostatically controlled three-way valve will direct the cooling water back to the pump suction. When the cooling water outlet temperature reaches operating temperature, the thermostat will begin to direct the water to the central fresh water cooling system and the pump will partly take its suction from the central fresh water cooling system, thus maintaining a constant temperature. The engine cooling system vents to the cooling fresh water expansion tank.

When the engine is stopped The preheater supplies water to the generator, taking suction from the circulation system after the engine and immediately before the three-way valve.

The charge air cooler, LO cooler and alternator air cooler are circulated with water from the central fresh water cooling system, the supply line air operated valve WF301V being opened automatically on starting of the generator engine.

Fuel System

The engine fuel oil supply rail, under normal circumstances, is supplied from the diesel oil service tank via a filter unit. The generator engine has a fuel feed pump which supplies the fuel rail. The fuel supply line between the diesel oil service tank and the engine is electrically trace heated.



The high pressure fuel injection pumps take suction from the fuel supply rail. The injection pumps deliver the fuel oil under high pressure through the injection pipes to the injection valves. Cams on the camshaft operate the injection pumps.

The fuel feed pump delivers more fuel than the engine uses and the excess flows back to the diesel oil service tank via the diesel oil return pipe, against a back pressure created by a pressure regulating valve. This arrangement ensures that there is always sufficient fuel supplied to the engine no matter what the load and that the fuel rail is always pressurised thus preventing gassing of the fuel injection pumps.

The discharge of the fuel feed pump passes through a duplex fuel oil filter. Both filters are normally in use, only shutting one off for maintenance. Turning the top handle two turns cleans the filters. Any sediment can be drained off.

Lubricating Oil System

All running gear of the engine is force lubricated by the engine driven gear type pump. The pistons are also supplied by oil as a cooling medium. A prelubrication pump is also fitted to supply oil to the bearings and other running gear before the engine starts. This reduces wear on the engine by ensuring that all bearing parts are adequately lubricated when the engine is started.

The prelubrication pump runs continuously when the engine is on standby and cuts out when the engine has started and the engine driven LO pump is delivering the correct LO pressure.

The engine driven pump and the electrically driven prelubrication pump both take suction from the engine sump and discharge through a cooler and duplex filter to the engine oil supply rail. A pressure regulating valve on the engine driven pump discharge relieves any excess pressure back to the pump suction, thus controlling the supply pressure. The temperature is controlled by a three-way temperature control valve, which regulates how much of the oil passes through the cooler. The alternator bearings are supplied from the main LO system.

The main LO filter is supplemented by a bypass centrifugal filter located just before the cooler inlet. During operation a part of the lubricating oil supplied from the engine driven LO pump enters the centrifugal filter and returns to the oil sump in the base frame.

The filter is driven by the oil supply. The filter relies on centrifugal force and can remove high density sub micron particles.

Procedure to Prepare the Diesel Generator Engine for Starting

a) Set the engine to LOCAL control.

b) Set up the fuel oil service system as described in section 2.6.2.

c) Set up the central fresh water cooling system as in section 2.4.1.

d) Check the level of oil in the sump and top up as necessary with the correct grade of oil.

e) Switch the generator engine prelubricating oil pump to AUTOMATIC operation and check that the lubricating oil pressure builds up. The engine should be prelubricated at least 2 minutes prior to start.

f) Check the pressure before and after the filters.

g) Check the governor oil level.

h) Check the air pressure in the starting air reservoir.

i) Turn the engine at least one complete revolution using the turning gear with the cylinder indicator cocks open. Remove the turning gear.

j) Vent the jacket cooling water space.

(**Note:** Ensure that the charge air cooler outlet air vent valve WF311F and jacket water outlet vent valves WF312F and WF313F are left fully open.)

If any part of the engine has been drained for overhaul or maintenance, check the level in the central fresh water cooling expansion tank and refill with fresh water if necessary.

k) Open the vent on the cooling water outlet line on the generator air cooler, and close it again when all air has been expelled.

If maintenance work has been carried out on the engine, start the engine locally as below, prior to switching the engine to automatic operation.

l) Check that all fuel pump indexes are at index ‘0’, when the regulating shaft is in the STOP position.

m) Check that all fuel pump control linkages are free to move full distance and return to their original stop positions when released.

n) Switch the engine to AUTOMATIC operation.

Procedure to Start the Diesel Generator Engine Locally

a) Ensure that the engine is ready for starting by completing the procedure above.

b) At the local control panel turn the selector switch from REMOTE to LOCAL and manually start the engine by pressing the pushbutton on the main starting valve. Allow it to run up to normal speed.

(**Note:** A pneumatically operated start fuel limiter optimises fuel injection during the acceleration period; the speed of the engine controls the start fuel limiter.)

c) Make a thorough check of the engine to ensure that there are no leaks and the engine is running smoothly and firing on all cylinders.

d) Check that the LO pressures and temperatures are normal.

e) Check that the pressure drop across the filters is normal.

f) Check that the FO pressure and temperature is normal.

g) Connect the diesel generator to the switchboard.

h) Ensure that the engine temperatures and pressures remain within normal limits as the load is applied to the engine and the engine heats up.

i) Check the exhaust gas temperatures for deviation from normal.

j) Check the exhaust gas for smoke.

k) Keep the charge air temperature under control.

(**Note:** The engine may be started manually from the engine control room by operating the IAS power management screen. Click on the DG icon and select START from the menu which activates the starting solenoid valve.)

Procedure to Manually Stop the Diesel Generator Engine

a) Before stopping, run the engine off load for a few minutes for cooling down purposes.

b) Actuate the local stop device.

Under normal circumstances the diesel generators will be started and stopped by the power management system as explained in section 2.12.2.

The engine may be stopped manually by means of the stop solenoid built into the speed governor or the solenoid valve controlling air supply to the fuel injection pump pneumatic cylinders. In the latter case, shutting off air to the fuel injection pump pneumatic cylinders causes the fuel pumps to the no fuel position; this fuel pump stop system is independent of the governor control. Operation of one or both of the above solenoids for 60 seconds will cause the engine to stop.

Emergency Stops

The engine is automatically shut down in the event of:

- Low lubricating oil pressure: 245kPa
- Cooling water outlet high temperature: 105°C
- Overspeed: 792rpm
- Charge air shut-off flap activation

The charge air shut-off flap is closed in the event of engine overspeed or an emergency shut down request.

The engine is fitted with a number of alarms for various systems such as lubricating oil pressure and temperature, cooling water pressure and temperature, charge air temperature, etc.

Engine Control

The diesel generator starting and stopping is normally controlled by the power management system. See section 2.12.2 page 9 for details.

Oil Mist Detector

Maker: Schaller Automation
Type: Visatron

The engine oil mist detector samples the atmosphere in each section of the crankcase and activates an alarm, if the LO mist increases beyond the allowable concentration, or the detector should fail. The engine will trip if the LO mist concentration reaches the HIGH HIGH level.

Engine Safety System

The diesel generator safety system monitors the following signals:

Tag	Description	High Alarm	Low Alarm
DG002	Charge air inlet temperature	70°C	
DG003	Turbocharger exhaust gas outlet temperature	500°C	
DG004	No.1 cylinder exhaust gas outlet temperature	500°C	
DG005	No.2 cylinder exhaust gas outlet temperature	500°C	
DG006	No.3 cylinder exhaust gas outlet temperature	500°C	
DG007	No.4 cylinder exhaust gas outlet temperature	500°C	
DG008	No.5 cylinder exhaust gas outlet temperature	500°C	
DG009	No.6 cylinder exhaust gas outlet temperature	500°C	
DG010	No.7 cylinder exhaust gas outlet temperature	500°C	
DG011	No.8 cylinder exhaust gas outlet temperature	500°C	
DG012	No.9 cylinder exhaust gas outlet temperature	500°C	
DG013	Starting air pressure		1.7MPa
DG014	Fuel oil pressure		196kPa
DG018	Lubricating oil pressure		345kPa
DG019	Crank case pressure low		0.6kPa
DG020	Lubricating oil temperature	80°C	
DG025	HT water inlet pressure		196kPa
DG026	LT water inlet pressure		196kPa
DG027	HT water outlet temperature	100°C	

Description	High Alarm	Low Alarm
Turbocharge rpm	30,000	
Engine rpm	1,000	
Alternator air cooler FW outlet temperature		

The diesel generator safety system will shut down the engine in response to the following signals:

Tag	Description	High High Alarm	High Alarm
DG042	Alternator winding R temperature	150°C	140°C
DG043	Alternator winding S temperature	150°C	140°C
DG443	Alternator winding T temperature	150°C	140°C
DG045	Alternator DE bearing temperature	100°C	90°C
DG046	Alternator NDE bearing temperature	100°C	90°C
DG047	Alternator air cooler inlet temperature	55°C	50°C
DG048	Alternator drive end LO temperature	100°C	90°C
DG049	Alternator non-drive end LO temperature	100°C	90°C

Illustration 2.11.3a Emergency Diesel Generator - Schematic

Engine

Maker: Ssangyong-Cummins

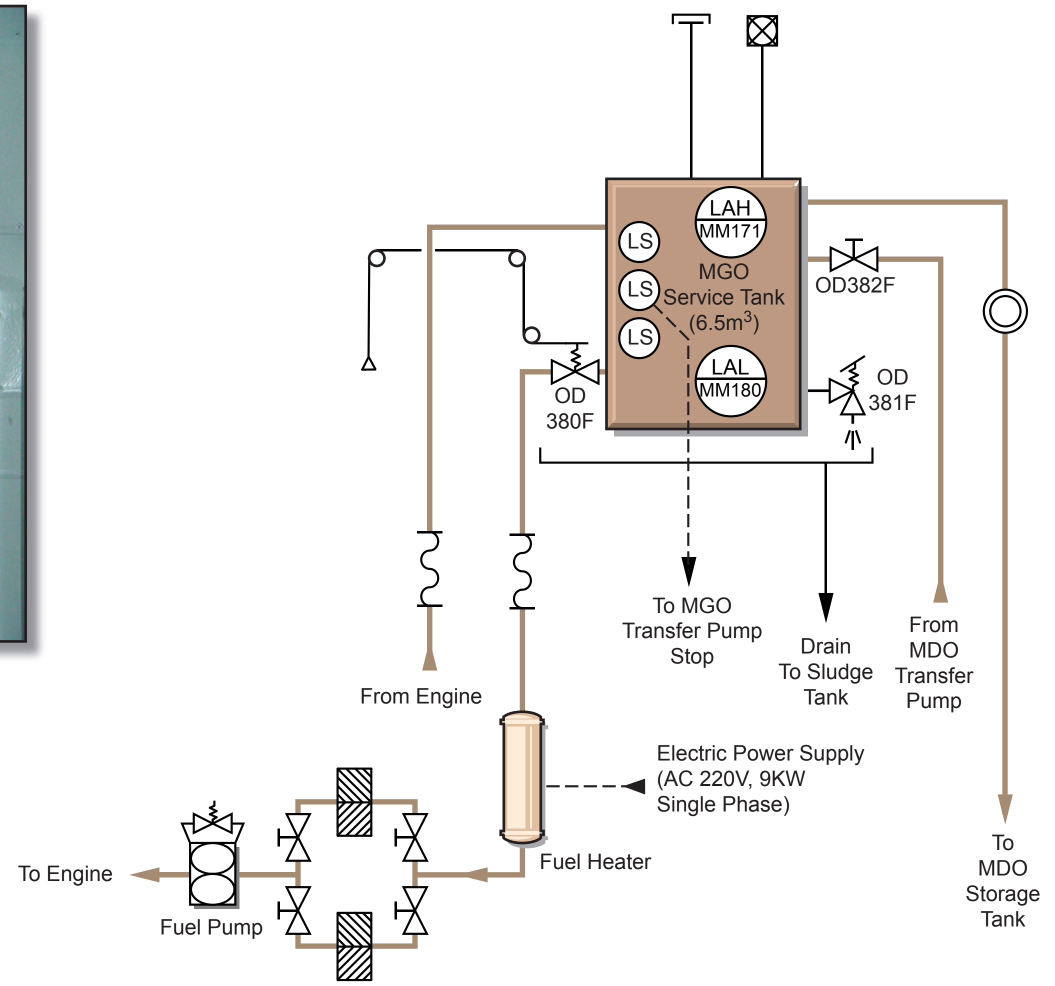
Type: KTA38-DMGE

Alternator

Maker: Reloy Somer

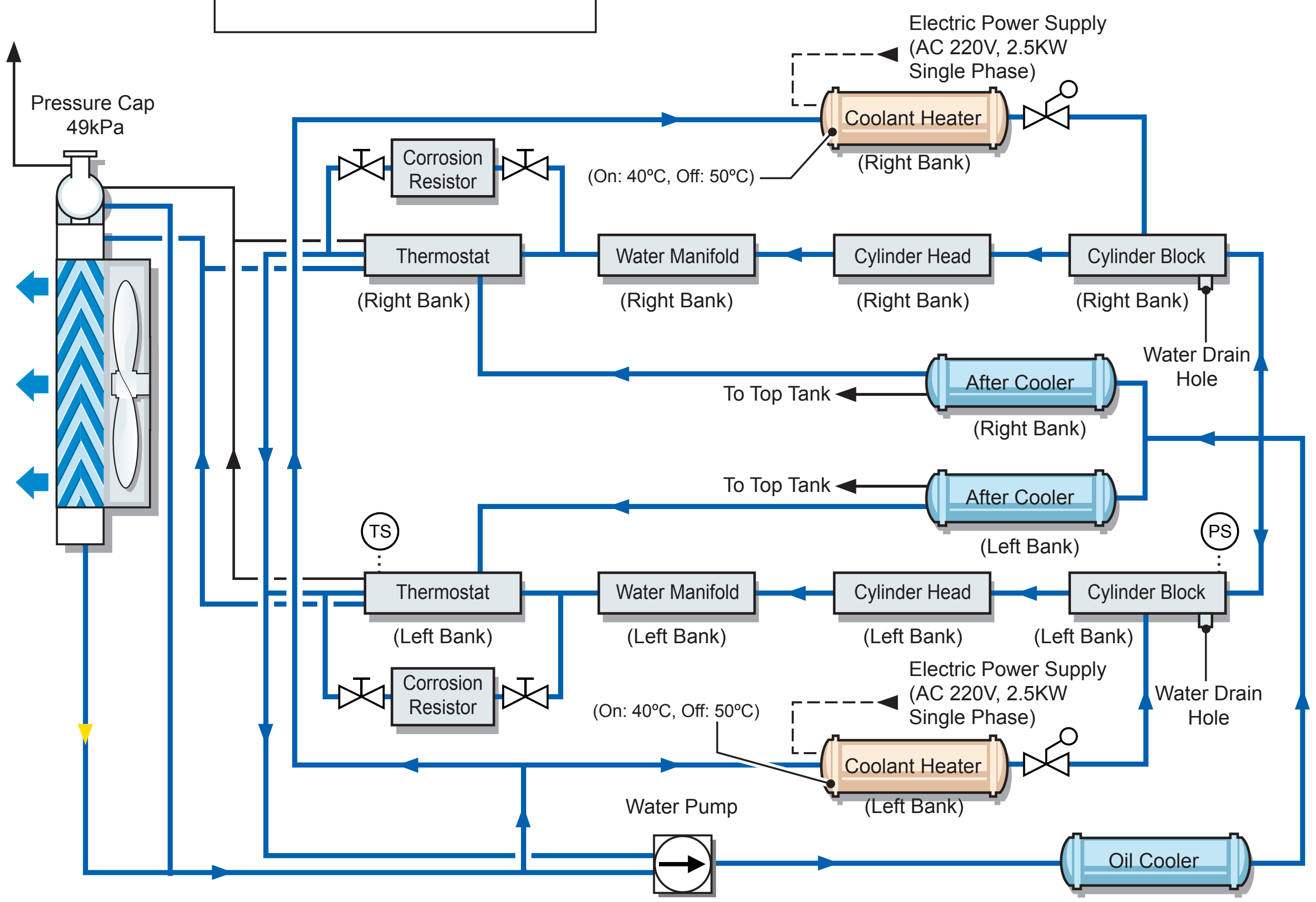
Capacity: 850kW, 1,365A, 450V, 1,062kVA

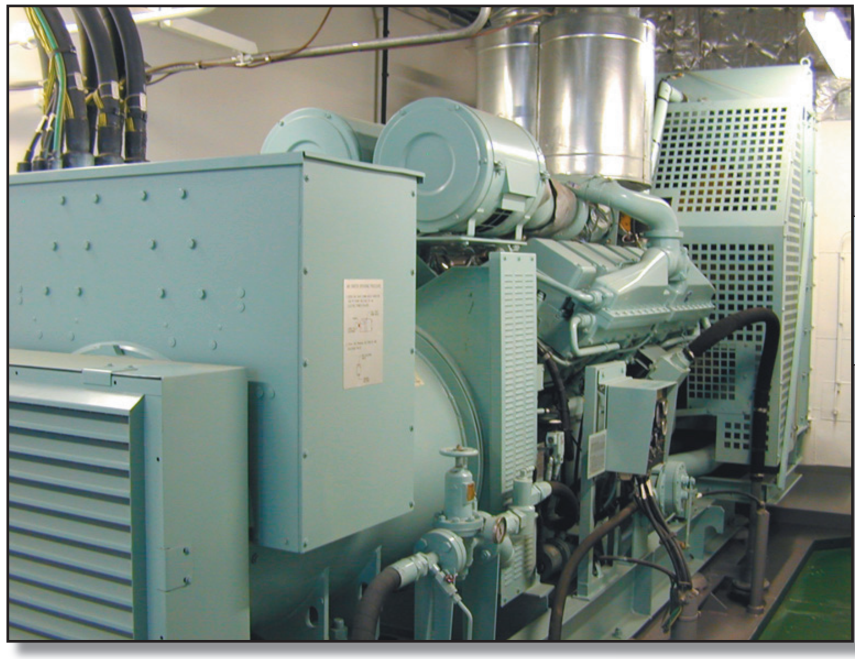
Local Start Panel



Key

———	Fresh Water
———	Marine Diesel Oil
- - - - - -	Electrical Signal
··············	Instrumentation





Emergency Generator

Instument Panel

2.11.3 EMERGENCY DIESEL GENERATOR

Engine

Maker:	Ssangyong Heavy Industries Co (Cummins)
Type:	4 stroke, 12 cylinder, V type, turbocharged diesel engine
Model:	KTA38DMGE
Output:	850kW at a continuous speed of 1,800 rpm

Alarms and Trips

Item	Alarm Set Point	Trip Set Point
Cooling water temperature	102°C	106°C
Cooling water pressure	69kPa	
LO low pressure	124kPa	83kPa
LO high temperature	117°C	
Engine overspeed		2,070rpm

Introduction

The emergency diesel generator is a self-contained diesel engine located in a room on port side of B deck of the engine room casing.

The generator set will start automatically on power failure from the main electrical supply system and couple to the emergency switchboard to maintain an electrical supply to essential services.

The generator set will also be used to get the ship under power from dead ship condition. It will enable power to be supplied to essential services selectively without the need for external services such as starting air, fuel oil supply and cooling water.

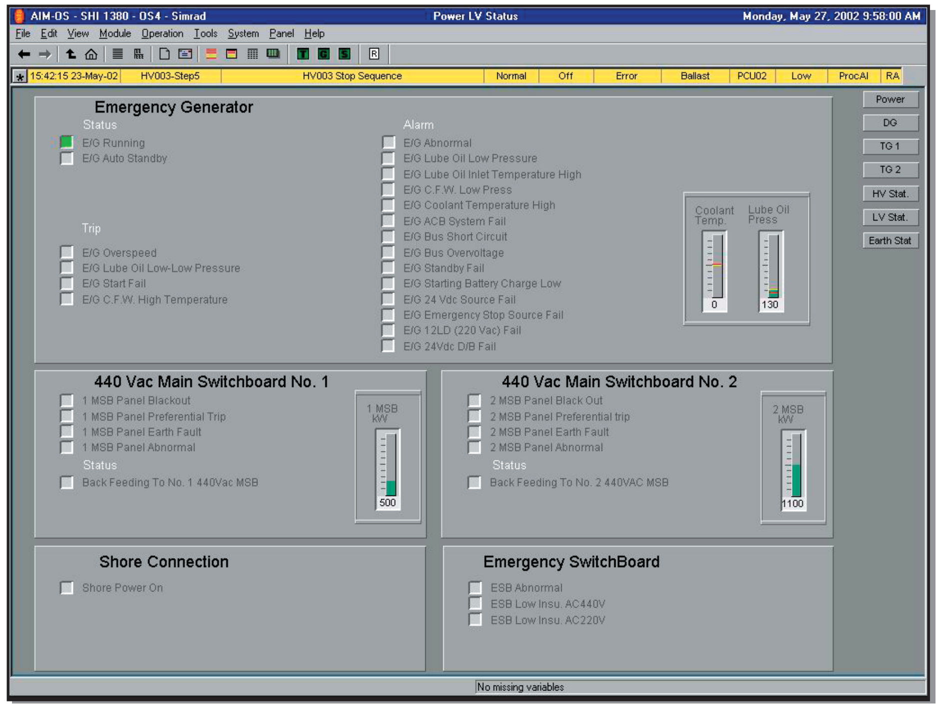
The engine is a 12 cylinder, V type, turbocharged engine with a self-contained cooling water system. The cooling water is radiator cooled, and circulated by an engine driven pump. A thermostat maintains a water outlet temperature of 82°C to 93°C. Air is drawn across the radiator by an engine driven fan.

Electric heaters are fitted for each cylinder bank to keep the cooling water at 40°C to 50°C when the engine is on automatic standby.

The engine running gear is force lubricated, an engine driven gear pump drawing oil from the integral sump and pumping it through a filter before being supplied to the lubricating oil rail.

The engine is started by means of an electric starter motor, power to the motor being supplied by batteries, which are on constant charge while the ship is in service. The engine can be manually started locally using the electric starter motor but is normally set to automatic operation.

The engine may also be started locally using the air starter motor. There is an emergency generator starting air reservoir which may be replenished from the main generator starting air system or by the emergency starting air compressor. The emergency generator starting air receiver is maintained at the maximum pressure at all times, from the GS air system, in order to ensure that starting air is available should that be necessary.



An air starter motor drives the engine toothed flywheel and is engaged automatically whenever an air start is activated. The air starter motor is automatically disengaged from the flywheel when the air starter motor is deactivated.

The engine should be started at least once a week and run up to full load monthly.

Whenever the engine has been started, the fuel oil tank must be checked and refilled if the level has dropped to or below the 24 hour operation level. The engine operates on marine gas oil and the tank is replenished as described in section 2.6.2 Diesel Oil Purifying and generator Engine Diesel Oil Service System.

Alarm and supervisory information for the emergency generator is available at the IAS.

Procedure to Prepare the Emergency Diesel Engine for Automatic Starting

a) At the emergency generator control panel turn power source switch to the ON position, the engine start is switched to AUTO control and the cooling water and LO trip switch is in the AUTO position.

b) Check the level of oil in the engine sump and top up as necessary with the correct grade of oil.

c) Check the level of water in the radiator and top up as necessary with clean distilled water.

d) Check the level of diesel oil in the emergency alternator diesel oil service tank and top up as required.

e) Ensure that the cooling water heaters are on. They are normally on when the engine is stopped.

f) Open the fuel oil supply to the diesel engine. It is normally open when the engine is stopped.

g) The IAS emergency diesel generator graphic screen will indicate the status of the emergency generator showing whether in automatic standby or local/manual control.

The emergency diesel generator is now ready for starting and it will start automatically and supply power should there be an interruption of power from the main electrical supply.

Procedure to Manually Start the Emergency Diesel Engine using the Electric Starter

a) At the engine local panel turn the start switch to the MANUAL position and the cooling water and LO trip switch to the ENABLE position.

b) Check the level of oil in the engine sump and top up as necessary with the correct grade of oil.

c) Check the level of water in the radiator and top up as necessary with clean distilled water.

d) Check the level of diesel fuel oil in the emergency generator diesel oil service tank and top up as required.

2.11.3b Emergency Generator Starting Procedures

To Prepare the Emergency Generator for Starting

1. At the emergency generator control panel turn power source switch to the ON position, the engine start is switched to AUTO control and the cooling water and LO trip switch is in the AUTO position.
2. Check the level of oil in the engine sump and top up as necessary with he correct grade of oil.
3. Check the level of water in the radiator and top up as necessary with clean distilled water.
4. Check the level of diesel oil in the diesel oil service tank and top up as required. Open the fuel oil supply to the diesel engine. It is normally open when the engine is stopped.
5. The IAS emergency diesel generator graphic screen will indicate the status of the emergency generator showing whether in automatic standby or local/manual control.
6. The emergency diesel generator is now ready for starting and it will start automatically and supply power should there be an interruption of power from the main electrical supply.

To Manually Start the Emergency Generator Using the Electric Starter

1. At the engine local panel turn the start switch to the manual position and the cooling water and LO trip switch to the ENABLE position.
2. At the emergency switchboard turn the mode switch to the MANUAL position.
3. At the engine control panel press the green START pushbutton to start the engine.
4. Check that the engine is firing smoothly. Check the engine oil pressure, cooling water pressure and rpm. Investigate any abnormalities.
5. Check that the cooling water heaters switch off as the engine heats up, and that the thermostats operate, to allow cooling water to flow to the radiator as the engine heats further.
6. Allow the engine to idle for 5 minutes before stopping to allow the cooling water and lubricating oil to carry away heat from the combustion chambers, bearings, shafts etc. It is particularly important for the turbocharger where a sudden stop can lead to a 40°C rise, which could damage the bearings and seals.

To Manually Start the Emergency Generator Using the Air Starter

1. At the emergency switchboard, turn the mode select switch to the MANUAL position.
2. At the engine local panel turn the start switch to the manual position and the cooling water and LO trip switch to the ENABLE position.
3. Open the air reservoir outlet valve.
4. Turn the screw on the fuel pump in the clockwise direction, which is situated on the inboard side of the engine. This blocks the manual signal and allows the engine to start.
5. Press downwards on the air start knob, situated on the outboard side of the engine.
6. The engine should start and can be loaded, unloaded and stopped as required.
7. Allow the engine to idle for 5 minutes before stopping to allow the cooling water and lubricating oil to carry away heat from the combustion chambers, bearings, shafts etc. It is particularly important for the turbocharger where a sudden stop can lead to a 40°C rise, which could damage the bearings and seals.
8. Return the engine to the automatic start condition by unscrewing the fuel pump knob, turning the local switches to the AUTO positions and the main switchboard switch to the AUTO position.
9. Ensure the air bottle is recharged, using the emergency air compressor, in preparation for the next air assisted start. Before starting the emergency air compressor, open the engine exhaust drain valve to check if there is any water present and close before starting the compressor.

e) At the emergency switchboard turn the mode switch to the MANUAL position.

f) At the engine control panel press the green START pushbutton to start the engine.

g) Check that the engine is firing smoothly.

h) Check the engine oil pressure, cooling water pressure and rpm. Investigate any abnormalities.

i) Check that the cooling water heaters switch off as the engine heats up, and that the thermostats operate, to allow cooling water to flow to the radiator as the engine heats further.

j) Allow the engine to idle for 5 minutes before stopping to allow the cooling water and lubricating oil to carry away heat from the combustion chambers, bearings, shafts etc. It is particularly important for the turbocharger where a sudden stop can lead to a 40°C rise, which could damage the bearings and seals.

k) Stop the engine by pressing the red STOP pushbutton on the local control panel.

l) When the engine has stopped, check that the heaters switch on. Turn the start switch to the AUTO operation, the cooling water and LO trip switch to the AUTO position and the emergency switchboard turn the mode switch to the AUTO position.

The emergency diesel generator is now ready for starting and it will start automatically and supply power should there be an interruption of power from the main electrical supply.

Procedure to Manually Start the Emergency Diesel Engine using the Air Starter

a) At the emergency switchboard, turn the mode select switch to the MANUAL position.

b) Check the engine as for the manual electric start procedure.

c) At the local panel, turn the start switch to MANUAL and the cooling water and LO trip switch to ENABLE.

d) Open the air reservoir outlet valve.

e) Turn the screw on the fuel pump in the clockwise direction, which is situated on the inboard side of the engine. This blocks the manual signal and allows the engine to start.

f) Press downwards on the air start knob, situated on the outboard side of the engine.

The engine should start and can be loaded, unloaded and stopped as required.

Return the engine to the automatic start condition by unscrewing the fuel pump knob, turning the local switches to the AUTO positions and the main switchboard switch to the AUTO position.

Ensure the air bottle is recharged, using the emergency air compressor, in preparation for the next air assisted start. Before starting the emergency air compressor, open the engine exhaust drain valve to check if there is any water present and close before starting the compressor.

Procedure to Test the Automatic Start for the Emergency Diesel Engine using the 'Emergency Generator Sequence Test' Switch without Connecting to the Emergency Switchboard

The engine will be set for an automatic start if required in an emergency.

a) Check the engine as for the manual electric start procedure.

b) Open the lower inboard panel on the emergency switchboard and turn the EG SEQUENCE TEST switch to the ENG position and hold until the engine starts.

The engine will run for approximately one minute before stopping.

Procedure to Test the Automatic Start for the Emergency Diesel Engine using the 'Emergency Generator Sequence Test' Switch and Connecting to the Emergency Switchboard

The engine will be set for an automatic start if required in an emergency.

a) Check the engine as for the manual electric start procedure.

b) Inform the bridge that an electrical interruption may take place.

c) Ensure that the cooling water and LO trip ENABLE/AUTO switch on the local panel remains is in the AUTO position and the BACK FEED switch on the emergency switchboard remains in the OFF position.

d) Open the lower inboard panel on the emergency switchboard and turn the EG SEQUENCE TEST switch to the ENG &ACB position.

The bus tie breaker will trip and the engine will start. The battery charger and power supply alarms have to be accepted at the engine local panel.

This simulates a blackout situation and starts the emergency generator. The generator ACB will close and connect with the emergency switchboard and restore the emergency supply.

e) After a 30 minutes test run, disconnect the emergency generator from the emergency switchboard as follows:

- Switch on the synchroscope
- Slow the generator down using the governor control potentiometer.
- Unload the generator by turning the ACB Control spring loaded handle to the OPEN position when the synchroscope dial reaches '12 o'clock'.

h) The emergency generator will automatically stop after approximately 3 minutes.

i) Reset the alarm by pressing the reset button on the local control panel.

j) Ensure the heater is on by pressing the red START pushbutton. (The engine will not start as the selection switch is in the AUTO position).

The engine is now set for an automatic start if required in an emergency.

Engine Safety System

The emergency diesel generator safety system monitors the following signals:

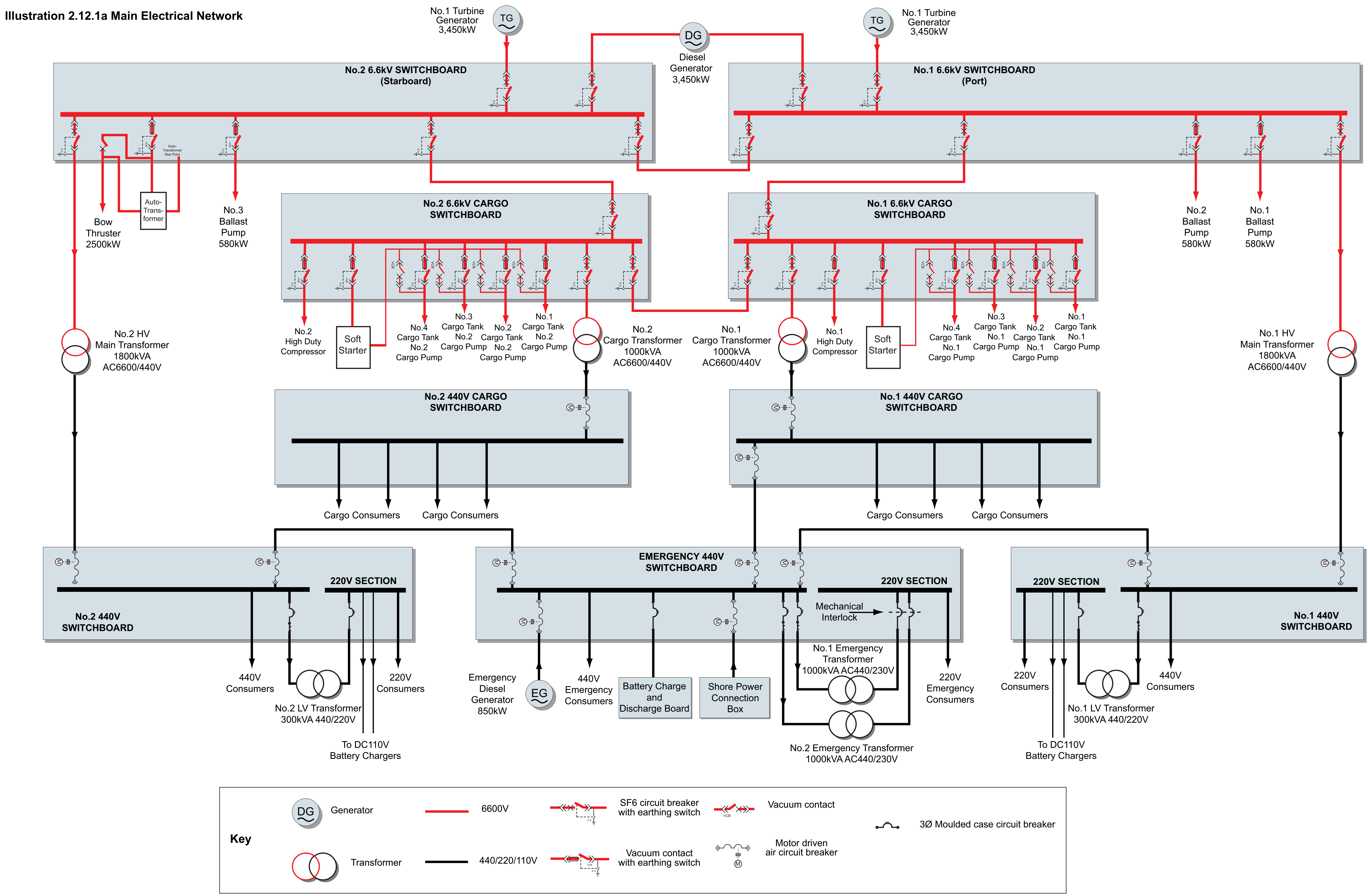
Tag	Description	High Alarm	Low Alarm
LV015	Coolant temperature	120°C	106°C

Tag	Description	Low Alarm	Low low Alarm
LV016	LO pressure	124kPa	83kPa

2.12 Electrical Power Distribution

Illustrations

Illustration 2.12.1a Main Electrical Network



2.12 ELECTRICAL POWER DISTRIBUTION

2.12.1 ELECTRICAL EQUIPMENT

Generating Plant

The electrical power generating plant consists of the following:

Main Steam Turbine Generators No.1 and No.2

Rating: 6,600V AC, 3Ø, 60Hz, 3,450kW, 377.3A

Main Diesel Generator

No. of sets: 1
Rating: 6,600V AC, 3Ø, 60Hz, 3,450kW, 377.3A

Emergency Diesel Generator

No. of sets: 1
Rating: 440V AC, 3Ø, 60Hz, 850kW, 1,364A, 1062kVA

Only one steam turbine generator is used during normal sea going conditions. Two generators are required when manoeuvring, using the HD compressors and unloading cargo.

Power Distribution System

From illustration 2.12.1a, it can be seen that the main network consists of two main 6.6kV switchboards, two main 440V switchboards, the 440V emergency switchboard and two cargo 6.6kV and two cargo 440V switchboards.

The normal operating condition of the network is as follows:

- No.1 and No.2 main 6.6kV switchboards will be linked, ie, the bus-tie breakers will be closed effectively forming one 6.6kV switchboard. One or both of the turbine generators and/or the diesel generator can feed the network.
- No.1 and No.2 main 440V switchboards are fed via No.1 and No.2 High Voltage (HV) 6,600/440V transformers respectively.
- The vacuum contact breakers between the main 6.6kV and the cargo 6.6kV switchboard will be closed to feed the cargo consumers via the 6.6kV cargo switchboards. The 440V cargo switchboards will be fed via the 6,600/440V No.1 and No.2 cargo transformers.

Control of the safety interlocks is provided by the Power Management System (PMS) to prevent an undesirable closed loop in the network on the primary side of the main or cargo transformers. If in local control, the breakers are interlocked to prevent this situation.

The tie lines provide both redundancy and supply continuity in the event of any system failures.

Main Switchboards

The No.1 main 6.6kV switchboard consists of 8 panels:

- Panel 1, the No.1 and No.2 ballast pumps' supply panel
- Panel 2, the adaptor panel
- Panel 3, the No.1 6,600/440V transformer supply panel
- Panel 4, the No.1 6.6kV cargo switchboard feeder panel
- Panel 5, the No.1 turbine generator incomer panel
- Panel 6, the diesel generator incomer panel
- Panel 7, the bus bar measuring panel
- Panel 8, the transfer breaker to switchboard No.2 panel

The No.2 main 6.6kV switchboard consists of 9 panels:

- Panel 1, the transfer breaker to switchboard No.1 panel
- Panel 2, the bus bar measuring panel
- Panel 3, the diesel generator incomer panel
- Panel 4, the No.2 turbine generator incomer panel
- Panel 5, the No.2 6.6kV cargo switchboard feeder panel
- Panel 6, the No.2 6,600/440V transformer supply panel
- Panel 7, the adaptor panel
- Panel 8, the No.3 ballast pump supply panel
- Panel 9, the bow thruster supply panel

The main 6.6kV turbine generator panels are equipped with an ammeter, dual voltmeter, wattmeter, dual frequency meter, power factor meter. The generator panels also have an operation and display unit for the REM545 generator control unit fitted. This display unit is the operator interface and display for the generator and PMS.

The No.1 main 440V switchboard consists of the following panels:

- Panel 1A, the No.1 6,600/440V transformer incomer panel
- Panels 1B and 1C, the 440V feeder panels
- The No.1 group starter panel
- Panel 1D, the 220V feeder panel

The No.2 main 440V switchboard consists of the following panels:

- Panel 2A, the No.2 6,600/440V transformer incomer panel
- Panels 2B and 2C, the 440V feeder panels
- The No.2 group starter panel
- Panel 2D, the 220V feeder panel

The emergency switchboard consists of 6 panels:

- Panel A, the emergency generator incomer panel
- Panels B, C and D, the 440V feeder panels
- The emergency group starter panel
- Panel E, the 220V feeder panel

No.1 or No.2 main 440V switchboards feed the emergency switchboard via motor driven air circuit breakers (ACB). The emergency switchboard room is located on B deck. The main 440V switchboards have 220V sections which are fed from the 440V switchboard via two 300kVA transformers.

The PMS controls the load sharing of the turbine generators and the starting, connecting and load sharing of the diesel generator. In the event of a blackout the diesel generator will start automatically and feed the main switchboard. If the diesel generator fails, the emergency generator will start automatically and feed the emergency switchboard.

Group starter and distribution boards are provided in suitable positions to supply the various power, heating, lighting, communication and navigation equipment throughout the vessel.

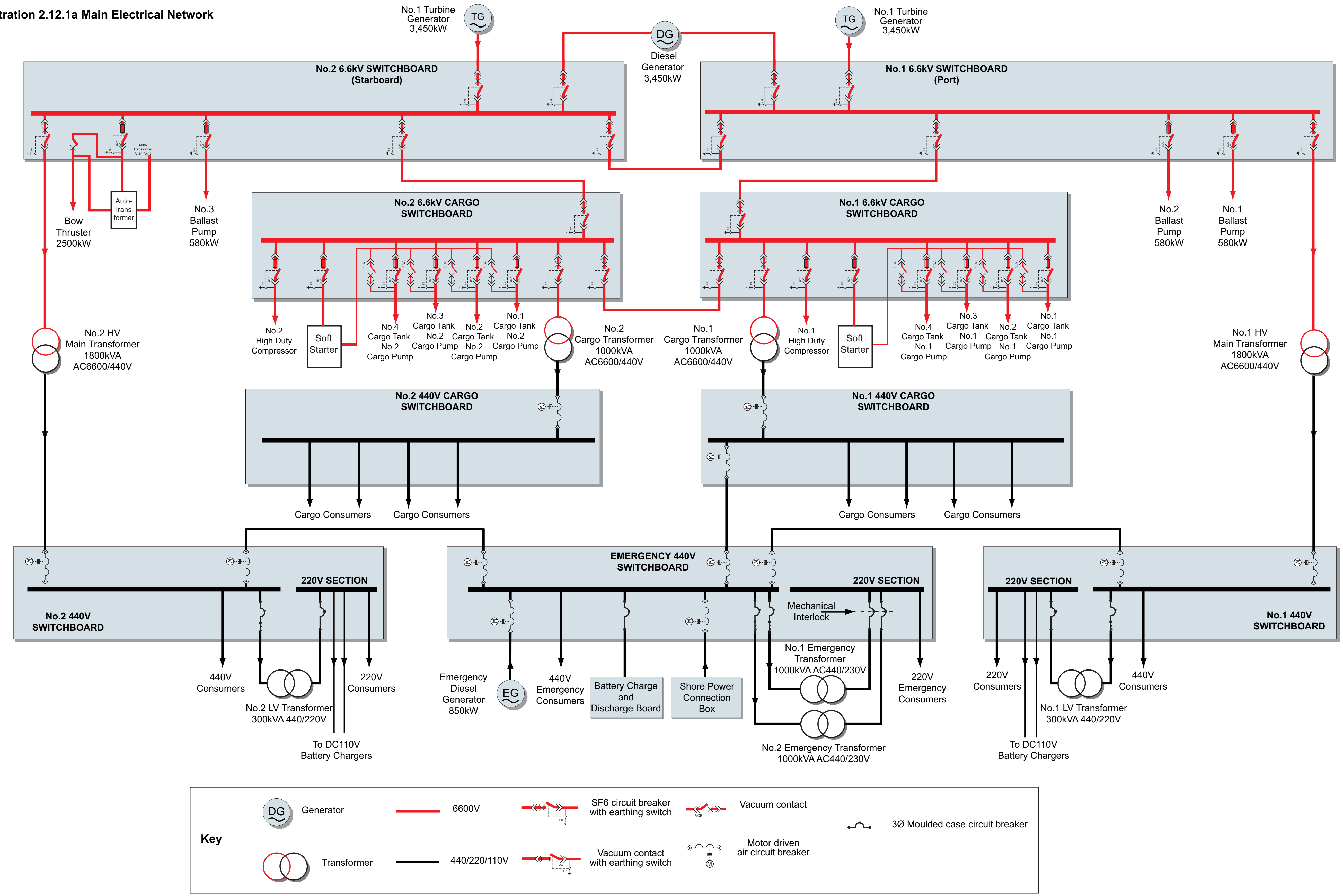
Each 440V or 220V distribution circuit is protected against overcurrent and short circuit current by a moulded case circuit breaker. These are fitted on the switchboard or panel board with inverse time overcurrent and instantaneous short circuit trip units enclosed within the casing.

The three steering gear motors are each fed from an independent circuit; two motors are fed from the main 440V switchboards and the third from the emergency 440V switchboard.

The Integrated Automation System (IAS) is fed from its own dedicated Uninterruptible Power Supplies (UPS) which are in turn fed from the main and emergency networks. A general service 24V battery charging switchboard, located in the electrical equipment room, supplies essential low voltage services.

Each supply system, ie, 6.6kV, 440V, 220V, 24V mains or emergency, is provided with a device for continuously monitoring the insulation level to earth, raising an audible and visual indication of an abnormally low insulation level.

Illustration 2.12.1a Main Electrical Network



Large Motor Starters

The following 6.6kV motors, No.1, No.2 and No.3 ballast pumps as well as the No.1 and No.2 high duty compressors are controlled using direct-on-line starters which utilise Vacuum Circuit Breakers (VCB) in the main and cargo 6.6kV switchboards to start and stop the motors. The starters are fitted with an earthing device which will earth the outgoing circuit (and hence the motor itself) when maintenance is required at the specific motor/pump/thruster/compressor, etc. The 6.6kV bow thruster motor is started and stopped using an auto-transformer starter. The 6.6kV cargo pumps have starting and bypass contact systems as well as a soft starter group start.

Standard Motors

The 440V motors are generally of the squirrel cage induction type with a standard frame designed for AC 440V three phase 60Hz supply. The exceptions are the motors for domestic service and small capacity motors of 0.4kW or less. Where continuously rated motors are used, the overload setting ensures the motor trips at 110% of its full load current. The motors in the engine room are of the totally enclosed fan cooled type.

440 Volt Starters

The starters are generally arranged in group control panels. Motor starters are arranged in group starter panels located throughout the vessel. Duplicated equipment starters are split between different switchboards supplied from separate port or starboard sides of the main switchboard. Interlocked door isolators are provided for all starters. For group starter boards, this switch is the moulded case circuit breaker which functions as both disconnecting means and overcurrent protection of the motor circuit.

Sequential Restarting

Essential service motors, which were in service before a blackout, are started automatically on recovery of the main bus voltage. They will start according to the predetermined restarting sequence. Motors that were selected for duty before the blackout are automatically returned to duty after the blackout. Similarly, motors selected for standby are automatically returned to standby. See section 2.12.7 for further information.

Preference Tripping

Non-essential loads are interrupted automatically in the case of an overcurrent on any one of the main generators. This provides continuity of supply to the essential consumers. See section 2.12.7 for further information.

Power Management System (PMS)

Maker: Kongsberg Norcontrol

The main generators are each fitted with an ABB multi-function protection relay type REM545. These modules are independent of each other and have their own settings. Utilising an RS-485 connection, they are interfaced with the IAS power management system via a SPA or LON communications bus. Data from the REM545 units is displayed on the relevant IAS generator screen mimic.

This system has various functions to ensure the continuous supply of the ship's electrical systems. The system automatically controls the generators for efficient operation.

The PMS can start and stop the main diesel generator to provide extra generating capacity as required. The steam turbine generators cannot be started and stopped automatically due to the nature of their local starting and stopping procedures. The turbines are started and stopped locally.

The PMS performs the following main control functions:

- Generator control and monitoring
- Load dependent start
- Blackout restart
- Load sharing / net frequency control
- Start blocking of heavy consumers

The generator PMS has the following facilities:

- Short circuit, overcurrent, overload and reverse power tripping protection for the generators and network via operation of the circuit breaker, circuit breaker undervoltage trip or network preferential trips
- Power, voltage, frequency and current measurement (local and remote) of the generators and main bus/network
- Earth monitoring
- Control of the number of running generators in accordance with the ship's power demand
- Automatic blackout restart and connection of generators
- Adjustment and storage of operational values, settings and alarms via panel display and keypads
- The blocking of large motors until the number of running generators is sufficient to supply the motor start current and ship's power demand. In this case, the standby diesel generator is started and synchronised automatically and shut down once the low demand is re-established
- Frequency. Automatic control ensures the supply frequency remains at 60Hz independent of load

The REM545 unit is normally left in the automatic mode. The unit must be in the automatic mode to enable all the automatic starting and stopping facilities for power management.

The generator circuit breaker and synchronising controls must also be set to automatic at the generator control switch on the generator panel of the respective generator's main switchboard.

The REMs can be manually operated as follows:

a) Press the L/R pushbutton.

b) A password is requested.

c) Enter the password.

d) Press ENTER.

e) Press the L/R pushbutton again.

f) Indicator light changes to L.

g) Press the 'circular arrow' pushbutton until the 1/0 STOP/START box is highlighted.

h) Press 1 to start or press 0 to stop.

i) Press the 'circular arrow' pushbutton to highlight the R reset icon.

j) Press 1 to reset if the interlock trips.

l) Press the L/R pushbutton until REMOTE light is displayed.

Alarms

Tag	Description	High	High High
MM154	No.1 6.6kV main transf. R winding temp.	140°C	145°C
MM155	No.1 6.6kV main transf. S winding temp.	140°C	145°C
MM156	No.1 6.6kV main transf. T winding temp.	140°C	145°C
MM157	No.2 6.6kV main transf. R winding temp.	140°C	145°C
MM158	No.2 6.6kV main transf.r S winding temp.	140°C	145°C
MM159	No.2 6.6kV main transf. T winding temp.	140°C	145°C
CM086	No.1 6.6kV cargo transf. R winding temp.	140°C	
CM087	No.1 6.6kV cargo transf. S winding temp.	140°C	
CM088	No.1 6.6kV cargo transf. T winding temp.	140°C	
CM106	No.2 6.6kV cargo transf. R winding temp.	140°C	
CM107	No.2 6.6kV cargo transf. S winding temp.	140°C	
CM108	No.2 6.6kV cargo transf. T winding temp.	140°C	

2.12.2 MAIN SWITCHBOARD AND GENERATOR OPERATION

POWER MANAGEMENT SYSTEM (PMS)

Generator Breaker Control

When a turbine generator is started and the alternator voltage is established, the alternator can be connected to the switchboard. When receiving a CONNECT command from the operator station, the PMS will activate the synchronising unit which will perform the turbine speed adjustment and volt/frequency/phase check before closing the circuit breaker.

When closing the circuit breaker onto a dead bus the synchronising unit is bypassed by internal HV switchboard logic.

A synchronising time-out alarm is given if the breaker is not closed within 90 seconds, 2 seconds during a blackout.

Breaker Connection for the Diesel Generator

When the main diesel generator is started, the operator has to select which side (port or starboard) of the switchboard to connect the diesel generator to before closing the breaker. Which ever side is selected the system will send out a digital signal to switch on the AVR for the side selected.

Turbine Generator PMS Panel

In the event of an automatic start request, from the PMS or the diesel engine safety system, the synchronising unit will be activated automatically and the generator will connect without operator intervention.

Breaker Disconnection for the Diesel Generator

A DISCONNECT command given by the operator will cause an automatic load reduction of the generator, provided the load sharing mode is either SYMMETRIC or ASYMMETRIC. When the generator load is less than 10% the PMS will give a signal to the switchboard to trip the generator circuit breaker. If the generator stops due to an automatic stop request, such as a low load, the generator downloading and breaker trip will be performed automatically.

Interlock of a Generator Breaker Operation

The generator breaker will be blocked from closing by the PMS if any of the following conditions apply:

- Generator speed control in manual mode
- Bus bar earth knife closed
- Generator breaker not ready
- Port or starboard side if the switchboard selected

Bus Tie Breaker Operation

The transfer breakers operate in pairs, except between MSB1 and MSB2, which has an active synchronisation. Logic in the switchboards send a LOWER or RAISE signal to the appropriate governor when the system synchronises MSB1 and MSB2.

Load Dependent Start/Stop

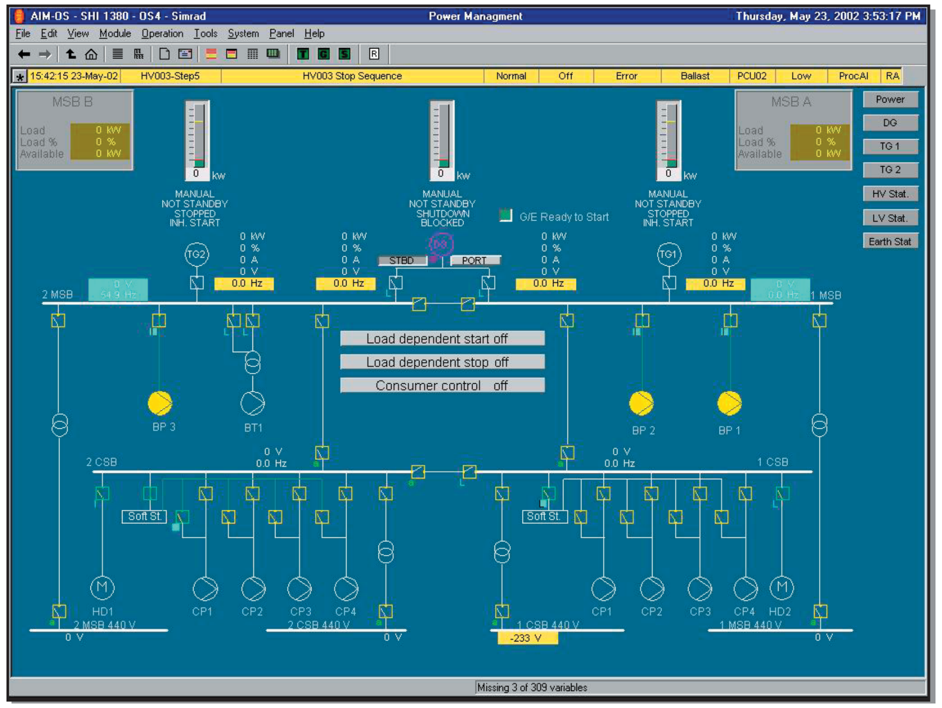
To enable the load dependent start/stop system, the load dependent start and the load dependent stop functions must be switched on and the main diesel generator set to STANDBY.

The load dependent start/stop function is based on the % load (kW) of the connected generator(s). The table below shows the initial parameters for the load dependent start/stop function for the main diesel generator.

No. of Generators Connected	Start limit 1	Delay time	Start limit 2	Delay time	Stop limit	Delay time
1 (turbine generator)	84%	30 sec	90%	10 sec		
2 (turbine generator)	86%	30 sec	91%	10 sec	65%	15 min
3 (diesel generator)					60%	15 min

Start Blocking of Heavy Consumers

When an electric motor start request is made from the IAS, the PMS will check whether the available power is sufficient to allow a start of the electric motor. If not, a standby generator start request is given. When the capacity of the power plant is sufficient and other start conditions are fulfilled, an electric start order is given. If sufficient capacity is not reached within the time-out specified time, the motor start order is timed-out (start has failed).



The system will prevent more than one heavy consumer starting at a time. To prevent overloading the power generation plant, the PMS will start block the following consumers:

Description	Blocking Limit	No. of Generators	Required Time-out
Starboard side			
Cargo pump 1S	522kW	1	120 seconds
Cargo pump 2S	522kW	1	120 seconds
Cargo pump 3S	522kW	1	120 seconds
Cargo pump 4S	522kW	1	120 seconds
Ballast pump 3	580kW	1	120 seconds
Bow thruster	2,500kW	2	120 seconds
HD compressor 1	770kW	2	120 seconds

Description	Blocking Limit	No. of Generators	Required Time-out
Port side			
Cargo pump 1P	522kW	1	120 seconds
Cargo pump 2P	522kW	1	120 seconds
Cargo pump 3P	522kW	1	120 seconds
Cargo pump 4P	522kW	1	120 seconds
Ballast pump 1	580kW	1	120 seconds
Ballast pump 2	580kW	1	120 seconds
HD compressor 2	770kW	2	120 seconds

The heavy consumers start block function can be switched on or off from an operator station.

(**Note:** If the heavy consumers start block is switched off, the consumer will be started without checking the power available.)

Blackout Restart

In the event of a blackout on the 6.6kV switchboard, the PMS will immediately give a start order to the diesel generator. It will be connected to the dead bus bar because the synchronising unit is bypassed by the DIRECT CLOSE signal from the PMS. If there is a blackout on the port and starboard switchboards, the PMS will connect the diesel generator to the port switchboard.

All circuit breakers are equipped with undervoltage relays and the PMS will reconnect the breakers after the diesel generator has started.

Load Sharing

The load sharing mode can be selected individually for each generator and is based on active power (kW) measurements. Speed increase/decrease signals are sent to the speed governor during load sharing and net frequency control.

The IAS Power Management System allows the following load sharing options:

1. Symmetric load sharing. In this mode, the load of the generators running in parallel will be equal with a small (1%) dead band of rated power.

2. Asymmetric load sharing. The intention of the asymmetric load sharing function is to burn off carbon accumulated during low load operation on the diesel generator. The diesel generator can be loaded to 80% (master) while the turbine generators (slave) will share the remaining load. The diesel generator will be master for 4 hours before it changes over to the next generator. If the remaining load on the slave generator drops to below 30%, the load on the master generator will be reduced. If the load on the slave generator exceeds 80%, the load will be shared symmetrically between the generators.

3. Manual load sharing. In this mode the PMS performs no active load sharing of the generator. Manual load sharing cannot be selected when the generator is on standby mode.

4. Fixed load. This mode is sometimes required during a maintenance period when the generator is required to run with a steady load. The set value is selected by the operator and maintained by the PMS. The fixed load mode cannot be selected when the generator is in standby mode.

Load Shedding

Load shedding is not part of the IAS and will be done by the switchboard logic. An alarm will be activated in the IAS when the load is increased to above 90%.

Switchboard Internal Parameters

The following internal parameters and alarms are available in the PMS.

Switchboard Module

Nominal frequency:	60Hz
Nominal voltage:	6,600kV
Asymmetric load:	80%
Asymmetric main period:	4 hours
Asymmetric top-up minimum load:	25%
Reconnection after blackout:	All available engines in standby mode

Internal Generated Alarms

Standby Start Failure

When a diesel generator start request is made from a load dependent start, heavy consumer, blackout or from engine safety system and the diesel engine is not on standby mode.

Failure Mode Analyses

This offers protection against the following:

- Switchboard frequency measurement, when it is >54Hz and <66hz will result in no frequency corrections
- Switchboard voltage measurement, when voltage is > -10v will prohibit blackout detection and Direct In functions
- Generator power measurement
- Process control unit stop
- Input/output card failure
- Sensor failure

TURBINE GENERATOR POWER MANAGEMENT SYSTEM

Turbine Generator Control and Alarm Monitoring

Unlike the diesel engine the turbines must be started locally.

The control from the IAS is similar for both turbine generators and consists of the following main control functions:

1. Boiler Interaction

When the boiler steam pressure drops to below 45 bar, an alarm will be activated and the diesel generator standby start will be initiated.

2. Monitoring of the Turbine and Generator

The monitoring includes:

- LO temperatures and pressures of the turbine, gearing and generator bearings
- Generator winding temperatures

3. Turbine Speed Detection

Speed detection is performed by means of an external tachometer providing an analogue signal to the IAS.

(**Note:** The speed measurement is from the generator shaft not the turbine shaft.)

4. Turbine Stop

A normal stop sequence of the turbine can be caused by:

- A stop request from the IAS operator station after the generator has been downloaded to 10% load and the breaker has been disconnected
- The safety system of the generator is activated

Alarm Monitoring

The following alarms are generated:

1. A 'Disconnect Failure' is given if the 'circuit breaker opened' feedback is not confirmed within 5 seconds after the open command.

2. An 'RPM Failure' alarm is given if the running indication disappears while the generator voltage is normal or the generator breaker is closed.

3. An 'Inconsistency' alarm sounds if the circuit breaker is closed and the turbine generator is stopped.

4. An 'Error' alarm sounds if the turbine generator is started/stopped in remote mode without the corresponding command, or the circuit breaker position is changed without command.

5. A 'Synchronising Time-out' alarm will be given if the synchronising time exceeds 90 seconds.

Generator Breaker Connect/Disconnect

Connect by the IAS

The generator breaker connect can be initiated when a connect request is sent from an operator station.

The generator breaker can be closed when all the following conditions apply:

- Turbine is running
- Circuit breaker in remote mode
- Voltage established
- No interlocks active

The breaker will be prevented from closing when the following apply:

- Breaker in local control
- Turbine generator not reset (e.g. after a synchronising timeout)
- Breaker interlocked

Disconnect by the IAS

The breaker disconnect can be initiated when the following apply:

- Disconnect request from an operator station
- Load dependent stop (if the generator is in standby mode)
- Safety system of the connected generator activated (if the generator is in standby mode)

(**Note:** If the turbine safety system is activated, the generator breaker will be disconnected regardless of any external/internal disconnect blocking or generator load.)

The breaker will be prevented from disconnecting when the following apply:

- Breaker in local control
- Internal blocking (e.g. not reset after downloading time-out)
- Disconnect interlocked

The opening of the generator breaker is possible when:

- Generator load <10% of generator nominal load
- No interlock active

Two types of load reduction can be defined for the turbine generators:

1. Ramp down (%/second) and disconnect when the generator load is <10% of the nominal load. The ramp setting is set to 2%/second (% of nominal load).

2. Reduce the load as fast as possible and disconnect when the generator load is <10% of the nominal load.

A disconnection failure alarm is given if the 'Circuit Breaker Opened' feedback is not confirmed within the reduced load time-out time (60 seconds).

DIESEL GENERATOR POWER MANAGEMENT SYSTEM

Diesel Engine Control and Monitoring

The diesel generator PMS consists of four main control functions:

1. Engine start and stop, on request or automatically from the PMS. The engine start sequence can be activated if it is in standby mode and as a result of the following conditions:

- Start request from operator station (will start and connect to the bus bar)
- Bus bar blackout (will start and connect to the bus bar)
- Load dependent start (will start and connect to the bus bar and share the load with the running turbine generator)
- Start request from heavy consumers (will start and connect to the bus bar and share the load with the running turbine generator)
- Low voltage on main bus bar (will start and connect to the bus bar after the turbine generator breaker has tripped)
- High voltage on main bus bar (will start and connect to the bus bar after the turbine generator breaker has tripped)
- Low frequency on main bus bar (will start and connect to the bus bar and share the load with the running turbine generator)
- Low/low frequency on main bus bar (will start and connect to the bus bar after the turbine generator breaker has tripped)
- Circuit breaker abnormal on running turbine generator (will start and connect to the bus bar and share the load with the running turbine generator)
- Overcurrent on running turbine generator (will start and connect to the bus bar and share the load with the running turbine generator)
- Boilers tripped or low/low steam pressure at turbine generator (will start and connect to the bus bar and share the load with the running turbine generator)

In order to start the diesel engine, the IAS gives a start signal of 10 seconds. If the engine does not start in this time, a waiting time of 60 seconds is activated before another start is attempted.

If the engine fails to start, a FAIL START alarm is sounded and the start failure must be reset on the diesel module before a new start can be performed.

The IAS will fail to start the engine due to start blocking if:

- The engine is in local control
- Not reset from a previously corrected alarm
- The safety system has caused a shutdown (pre-lubrication oil pressure is low)
- The turning gear is engaged

Once the generator starts the voltage will normally rise to 6,600V before the generator is available to connect to the bus bar.

The generator will be downloaded either automatically, or manually from an operator station, to 10% of the nominal load before the breaker disconnects and the stop signal is given. If a load dependent stop is initiated, a cooling down period will be activated between the breaker disconnecting and the engine stop signal.

The IAS blocks the engine from stopping if the engine is in local control or not reset from a previously corrected alarm

A normal stop sequence of the engine can be caused by:

- Stop request from an operator station
- Load dependent stop from the PMS if the generator is in standby mode

Generator Breaker Connect / Disconnect

Connect by the IAS

The generator breaker connect can be initiated if the generator is in the standby mode and as a result of the following:

- When a connect request is sent from an operator station
- Load dependent start
- Start request from heavy consumer
- Bus bar blackout
- Safety system of a turbine generator is activated
- Alarm start of any connected generator

The generator breaker will be prevented from closing if a 'Connect Blocking' signal has been activated. It can be caused by the following:

- Generator breaker in local control
- Connect interlock criteria
- Internal blocking criteria due to failure to reset after synchronising timeout

The breaker can be closed when:

- Engine is running
- Circuit breaker is in the remote mode
- Voltage has been established
- There are no interlocks active

Dead Bus Operation

- When a dead bus is detected the on MSB1 (HV048) the AVR for MSB1 will be selected and the synchronisation device will be bypassed and the breaker will close
- When a dead bus is detected the on MSB2 (HV063) the AVR for MSB2 will be selected and the synchronisation device will be bypassed and the breaker will close
- If there is a total blackout of MSB1 and MSB2 the diesel generator connect to MSB1

A synchronising timeout alarm will be given if the synchronising time exceeds 90 seconds.

Generator Breaker Disconnect by the IAS

A generator breaker disconnect can be initiated as a result of the following conditions:

- A disconnect request from the operator station
- A load dependent stop (if the generator is in standby mode)
- The safety system is activated (if the generator is in standby mode)

The breaker will be prevented from disconnecting when the following apply:

- Breaker in local control
- Internal blocking (e.g. not reset after downloading time-out)
- Disconnect interlocked
- Generator load >10% of the nominal load

The opening of the generator breaker is possible when:

- Generator load <10% of generator nominal load
- No interlock active

Two types of load reduction can be defined for the diesel generator:

- Ramp down (%/second) and disconnect when the generator load <10% of the nominal load. The ramp setting is set to 2%/second (% of nominal load).

- Reduce the load a s fast as possible and disconnect when the generator load <10% of the nominal load.

A disconnection failure alarm is given if the 'Circuit Breaker Opened' feedback is not confirmed within the reduced load timeout time (60 seconds).

2. Diesel engine safety system, which when activated will result in the following immediate actions:

- A stop command signal to the engine
- Emergency stop command to the engine
- Open command to the circuit breaker

When the shutdown system has been activated, a reset command from the operator station keyboard is required before any new start of the engine can be performed.

3. Control of auxiliary systems includes the starting and stopping of the pre-lubrication oil pump in response to the 'Engine Run' feedback signal.

4. Alarm and monitoring of the engine (see also section 2.11.2 page 161).

The software generated alarms are as follows:

- RPM FAILURE alarm is given if the 'Engine Run' indication disappears while the generator voltage is normal and the generator breaker is closed
- START FAILURE alarm is given when the 'Engine Run' feedback signal is not confirmed 30 seconds after the start command
- DISCONNECTION FAILURE alarm is given when the 'Circuit Breaker Open' feedback signal is not confirmed within 5 seconds after the open command
- STOP FAILURE alarm is given when the 'Engine Run' feedback signal is not lost within 60 seconds after the open command
- INCONSISTENCY ALARM is sounded if the circuit breaker is closed and the engine is stopped
- ERROR alarm sounds when is in remote mode and it is started or stopped without the corresponding command, or the circuit breaker position is changed without the corresponding command
- VOLTAGE NOT ESTABLISHED alarm will sound if, after a successful engine start, the voltage does not rise to 6,600V within 15 seconds
- SYNCHRONISED TIMEOUT alarm will sound if the synchronising time exceeds 90 seconds

Procedure to Start the Diesel Generator Engine and Parallel with the Main Switchboard from the IAS

a) Ensure that the engine is ready for starting by completing the procedure mentioned in section 2.11.2.

b) At the local control panel in the diesel generator room, ensure that the selector switch is in the REMOTE position.

c) At the IAS in the ECR, select the Power Management screen and click on the DG icon to reveal a menu list.

d) On the menu list click on START to start the diesel generator engine.

e) Once the diesel generator engine has started, return to the diesel generator room to ensure that the engine is running satisfactorily and without any leaks or excessive noise.

f) Allow the engine to run for 10 minutes before deciding to parallel the generator with the main switchboard.

g) To parallel the diesel or turbine generator, select the Power Management screen and click on the DG or TG icon to reveal a menu list.

h) On the menu list click on the CONNECT button to parallel the generator with the main switchboard.

If on test, allow the diesel generator to be paralleled for at least 30 minutes.

Procedure to Disconnect the Diesel or Turbine Generator from the Main Switchboard and Stop the Diesel Engine from the IAS

a) Click on the DG or TG icon to reveal a menu list.

b) On the menu list click on the DISCONNECT button to disconnect the generator from the main switchboard.

(**Note:** The following procedure is for the diesel generator only.)

c) Before stopping, allow the engine to run for a few minutes for cooling down purposes, such as the exhaust gas temperatures.

d) Finally, click on the DG icon to display the menu and click on STOP on the menu to stop the engine.

Ensure that the LO pump starts when the engine stops.

Procedure to Manually Connect the Diesel or Turbine Generator to the Main Switchboard

a) At the main 6,600V switchboard power management panel, turn the Remote/Auto switch to the LM (Local/Manual) position.

The synchroscope lights will turn on to indicate if the generator is turning too fast + or too slow -.

b) Raise or lower the speed of the generator, using the Lower/Raise switch until the synchroscope light revolves slowly in a clockwise + direction.

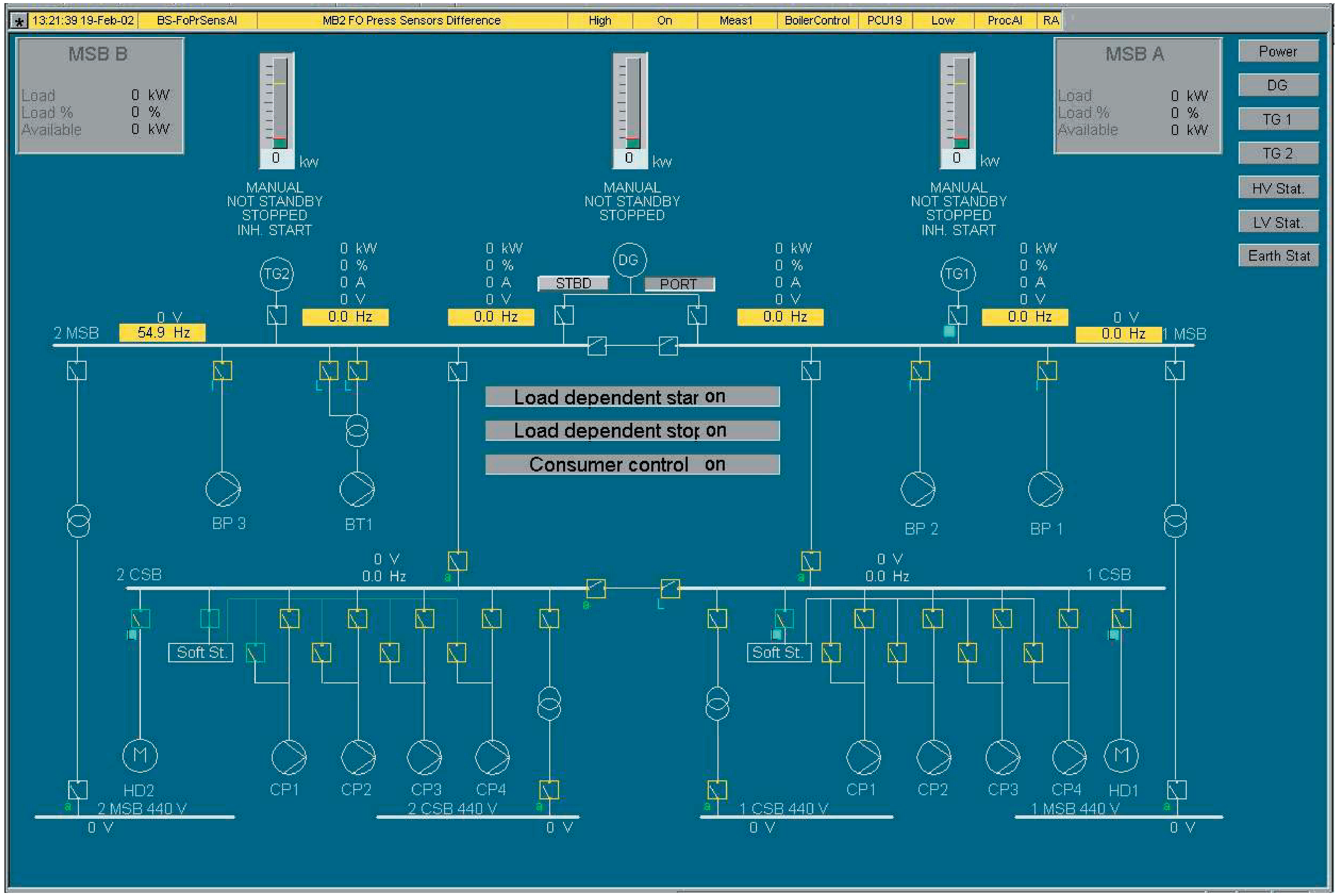
c) Turn the CB Trip/Close switch to the CLOSE position and the generator will connect to the main switchboard when the revolving light reaches the top position on the synchroscope.

d) Turn the Remote/Auto switch to the RA (Remote/Auto) position.

The synchroscope lights will turn off and the power management system will control the generator to remain in parallel with the main switchboard.

Diesel Generator PMS Panel

Illustration 2.12.2c Integrated Automation System Power Management Mimic



2.12.3 ELECTRICAL DISTRIBUTION

Illustration 2.12.3a Main 440V Distribution

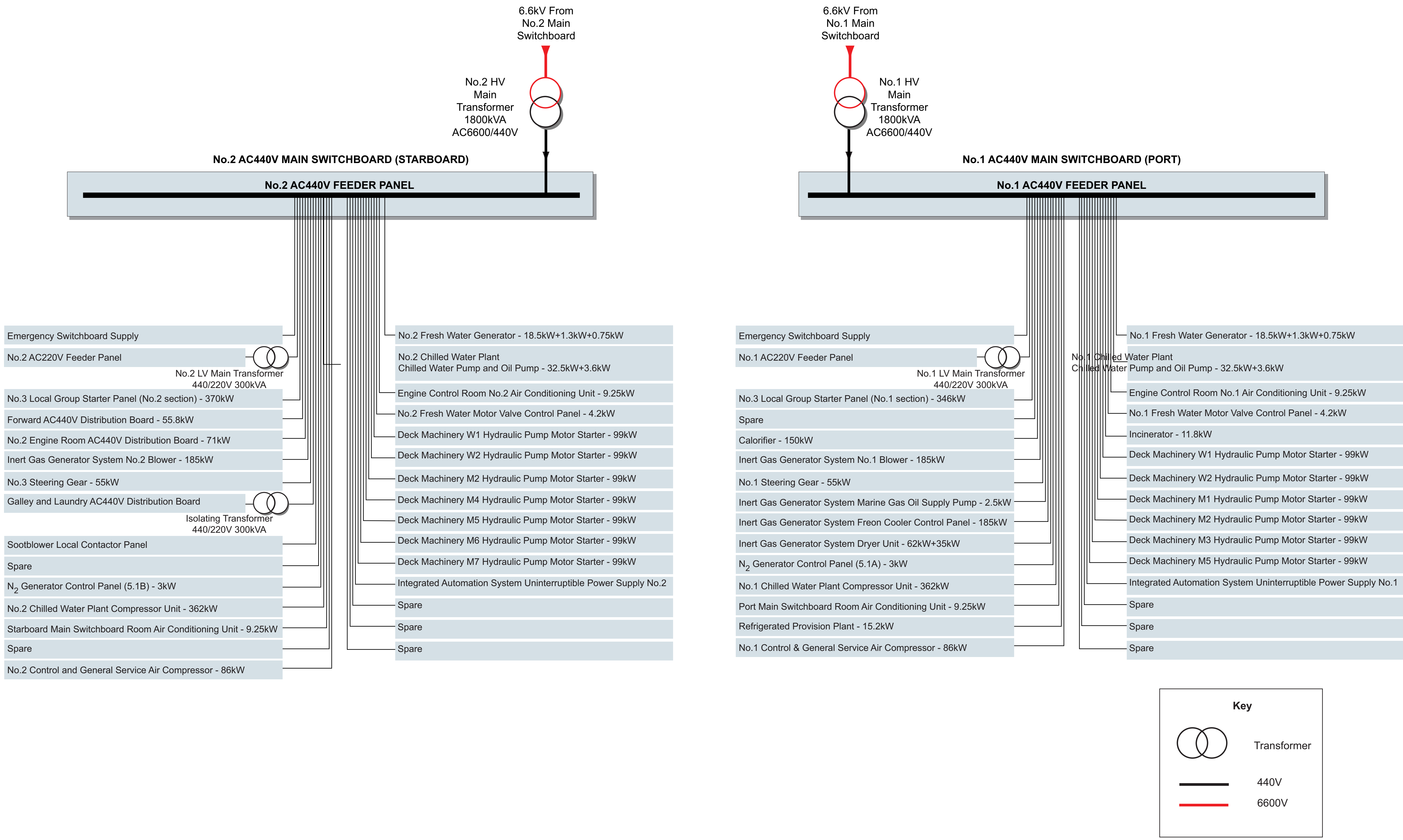


Illustration 2.12.3b Main 440V Switchboard: Group Starters

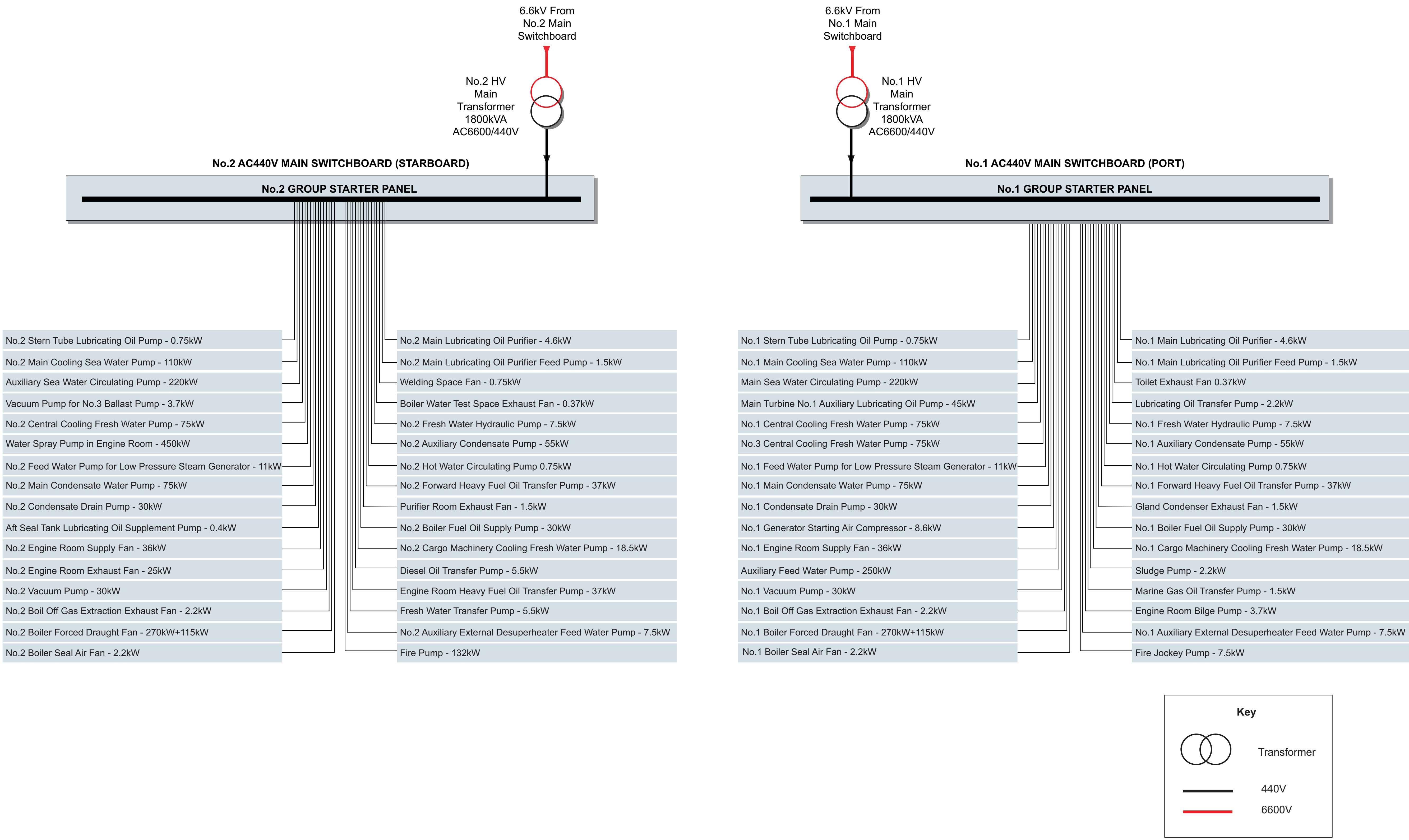


Illustration 2.12.3c Main 220V Distribution

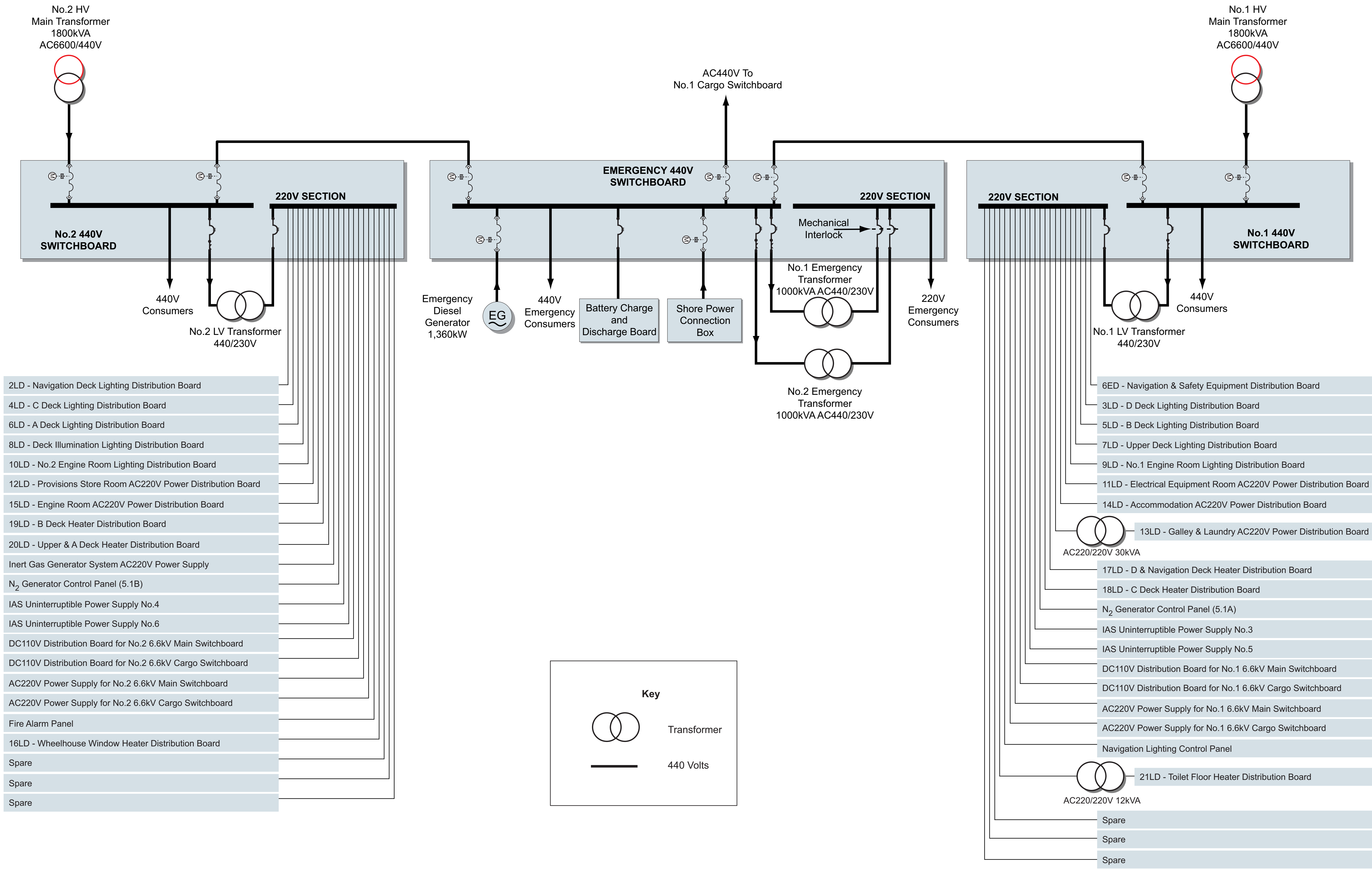


Illustration 2.12.3d Cargo 6600V and 440V Distribution

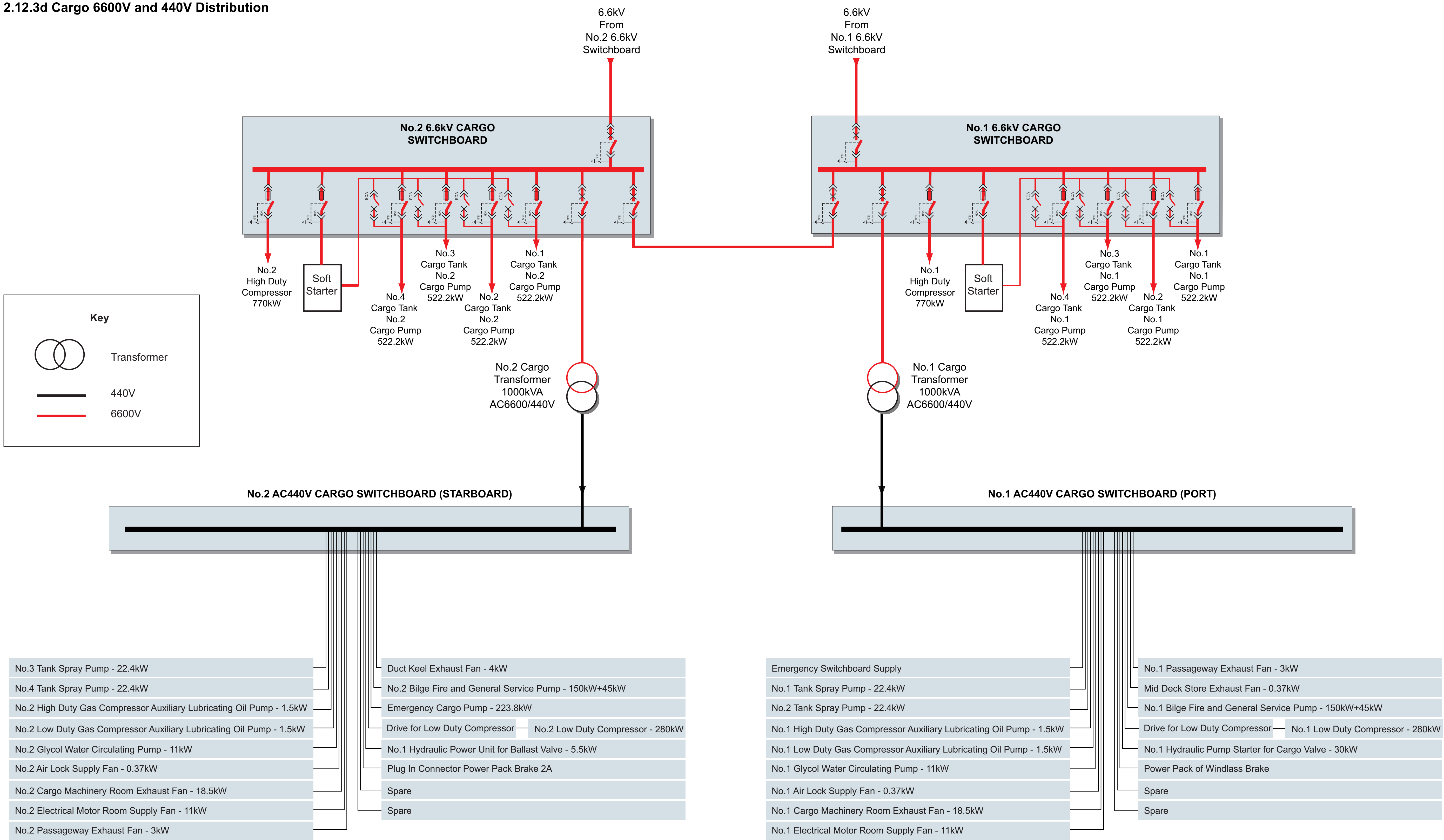
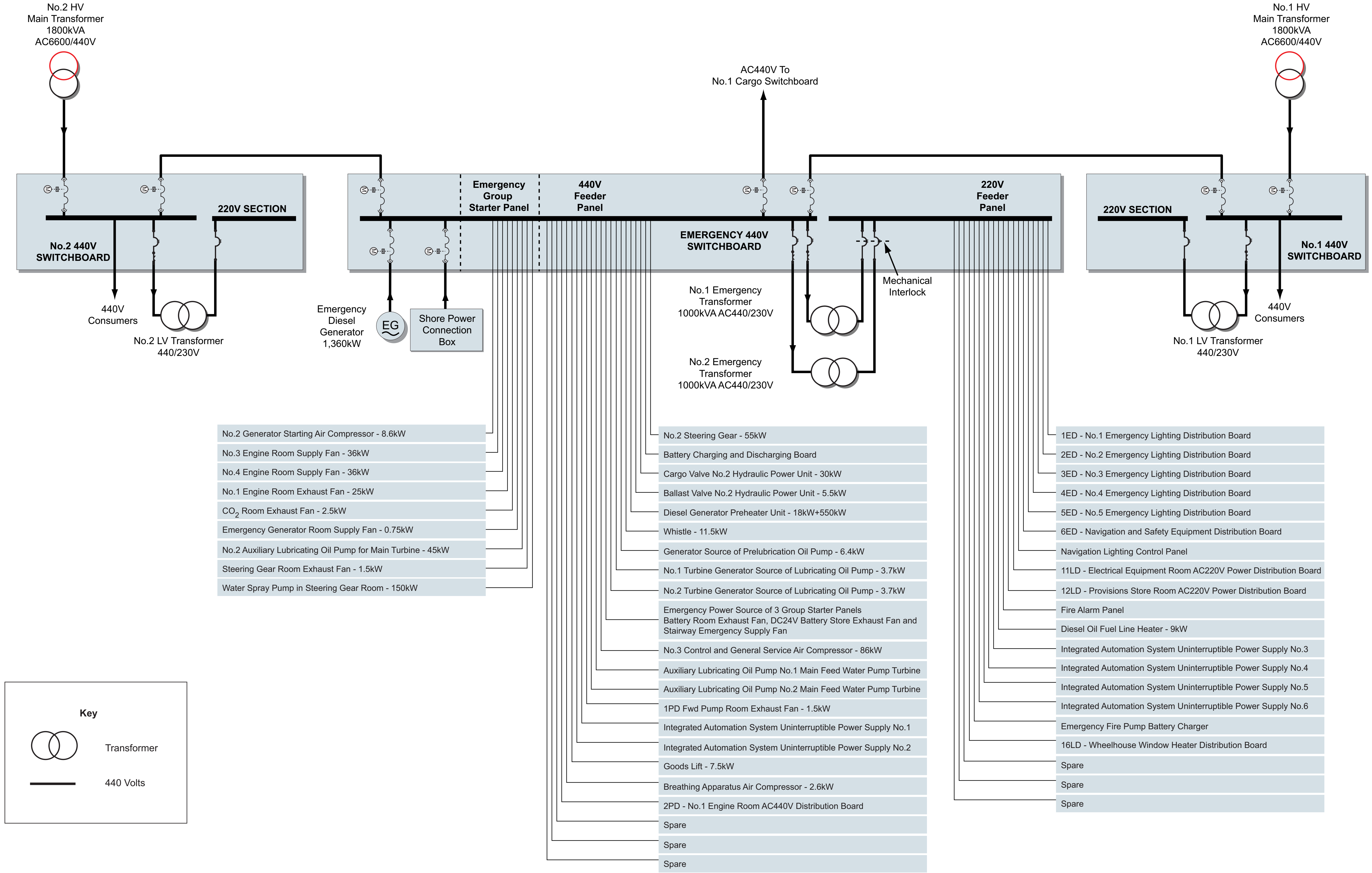


Illustration 2.12.3e Emergency 440V and 220V Distribution



2.12.4 SHORE POWER

A shore connection box, which is wrapped in a tarpaulin for protection against the weather, is located on the upper deck between the accommodation and the engine room casing and accepts power cables during refits/dry docks, etc. The shore connection box connects, via a breaker, to the emergency 440V switchboard. The maximum current is 1,400 amps. When the emergency switchboard is powered from the shore, the 440V switchboards can then be supplied through the tie breakers by utilising the feedback mode.

The monitoring instruments and lamps for the shore supply are located on the shore supply panel section of the emergency switchboard.

A phase sequence monitoring system is fitted on the shore supply connection box. The sequence should be checked before connecting shore power to the main switchboard. If the phase sequence is correct, the P1 lamp will be bright, if incorrect, the P2 lamp will be bright. In this case the shore supply must be isolated and two supply phases changed over. The supply should then be reinstated and the phase sequence checked again.

Procedure for the Operation of Shore Power Reception

The vessel is being supplied by the diesel generator.

a) Isolate all non-essential services, including the sequential restart system. Reduce the load at the main 440V switchboards to the absolute minimum. Set the PMS to manual to ensure that the diesel generator does not start when the vessel blacks out.

b) Isolate the emergency generator to ensure it does not start.

c) At the shore connection box turn the shore power switch on.

d) At the emergency switchboard, turn the amperes, volts and frequency switches to the SHORE position to monitor the incoming power.

e) At the emergency switchboard, turn the feedback switch to AC440V MSB. The emergency switchboard blacks out.

f) Close the shore connection breaker SC-001 at the emergency switchboard. The shore supply now feeds the emergency switchboard.

g) At the No.2 6,600V switchboard open breaker No.6 and at No.1 6,600V switchboard open breaker No.3 to blackout the 440V switchboards. Stop the diesel generator.

h) At the emergency switchboard close the breakers 1P-001 to feed No.1 440V MSB and 2P-002 to feed No.2 440V MSB.

i) At the 440V switchboards close the breakers 1P-001 to feed No.1 440V MSB and 2P-002 to feed No.2 440V MSB

j) Proceed to supply essential services such as fire detection, lighting, etc. Stop any diesel generators at the main switchboards.

k) If no maintenance is scheduled for the emergency generator, it may left on auto standby. The emergency generator will then feed emergency lighting, etc, in the case of failure of the shore supply.

l) The shore supply should be closely monitored to ensure the 1,400A current limit is not exceeded.

Procedure for Transfer from Shore Supply to Diesel Generator

a) Isolate the emergency generator to ensure that it does not start.

b) Isolate all non-essential services. Ensure the sequential restart system is still isolated. Reduce load at the main 440V switchboard to the absolute minimum. Ensure the PMS is still set to manual to ensure that the diesel generator does not start when the vessel blacks out.

c) Run up the diesel generator on local control.

d) At the power management panel turn the Remote/Auto switch to the LM (Local Manual) position.

e) Lower or raise the generator speed until the synchroniser light slowly revolves in the + direction.

f) Turn the breaker Trip/Close switch to the CLOSE position to connect the generator to the main switchboard when the synchroniser light passes the top position.

g) At the emergency switchboard open the breakers 1P-001 to blackout No.1 440V MSB and 2P-002 to blackout No.2 440V MSB.

h) At the 440V switchboards close the breakers 1PT-001 to feed No.1 440V MSB and 2PT-002 to feed No.2 440V MSB from the main transformers.

i) At the No.2 6,600V switchboard close breaker No.6 and at No.1 6,600V switchboard close breaker No.3 to feed the 440V switchboards via the main transformers.

j) Supply consumers as required and return the switchboard and generators to automatic operation, if conditions allow.

k) At the emergency switchboard, open the shore supply breaker, the emergency switchboard blacks out.

l) At the emergency switchboard close the breakers 1P-001 to feed from No.1 440V MSB and 2P-002 to feed from No.2 440V MSB.

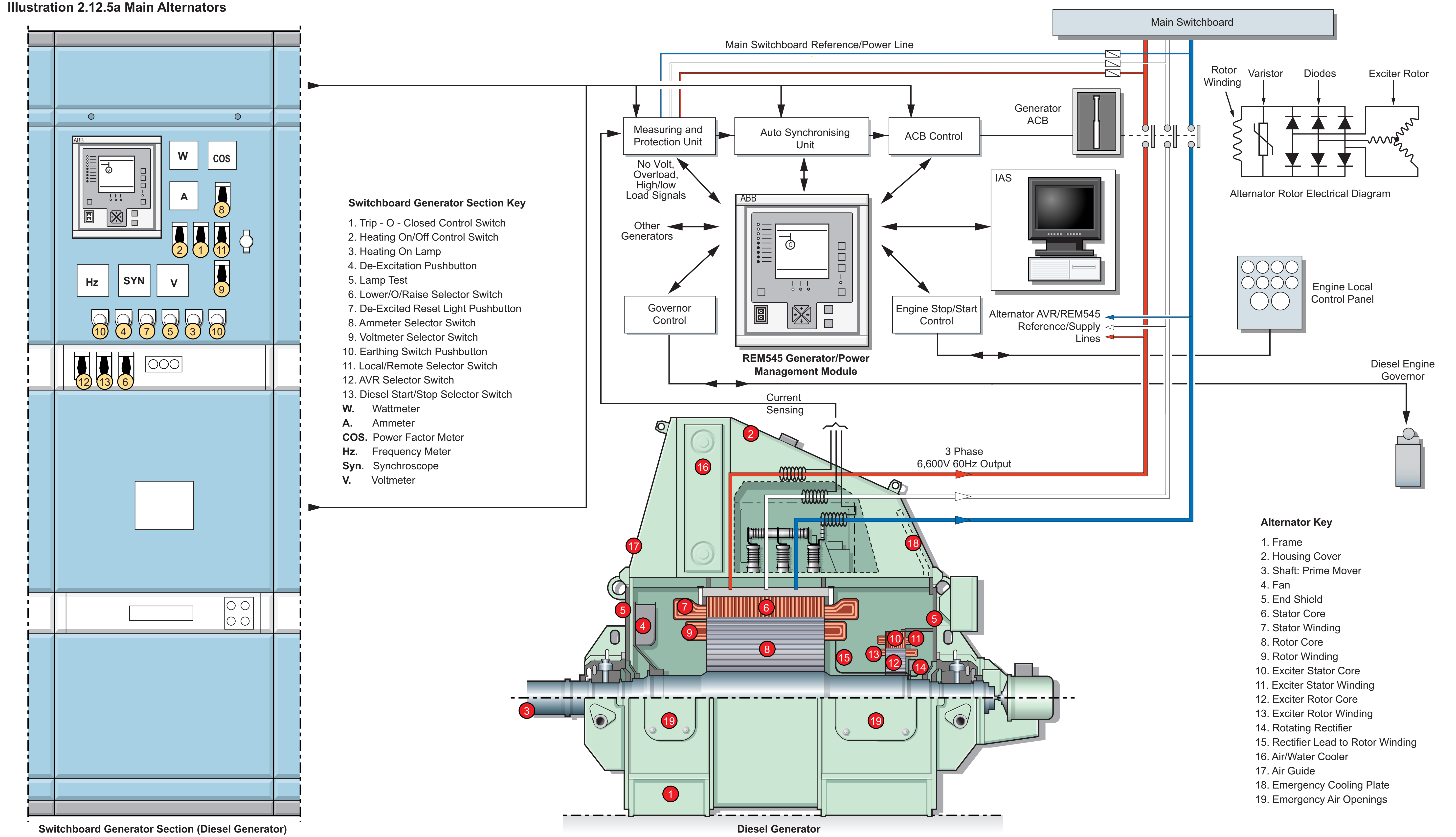
m) Ensure the emergency generator is returned to normal automatic start mode.

n) Supply emergency and main consumers as required.

WARNING

Do not close the circuit breaker for the shore power source while the main transformers or the emergency generator are supplying power to the main switchboards. Do not close the circuit breaker for the main transformers or the emergency generator while the shore power is supplying power to the main switchboards.

Illustration 2.12.5a Main Alternators



Switchboard Generator Section Key

1. Trip - O - Closed Control Switch
2. Heating On/Off Control Switch
3. Heating On Lamp
4. De-Excitation Pushbutton
5. Lamp Test
6. Lower/O/Raise Selector Switch
7. De-Excited Reset Light Pushbutton
8. Ammeter Selector Switch
9. Voltmeter Selector Switch
10. Earthing Switch Pushbutton
11. Local/Remote Selector Switch
12. AVR Selector Switch
13. Diesel Start/Stop Selector Switch

W. Wattmeter
A. Ammeter
COS. Power Factor Meter
Hz. Frequency Meter
Syn. Synchroscope
V. Voltmeter

Alternator Key

1. Frame
2. Housing Cover
3. Shaft: Prime Mover
4. Fan
5. End Shield
6. Stator Core
7. Stator Winding
8. Rotor Core
9. Rotor Winding
10. Exciter Stator Core
11. Exciter Stator Winding
12. Exciter Rotor Core
13. Exciter Rotor Winding
14. Rotating Rectifier
15. Rectifier Lead to Rotor Winding
16. Air/Water Cooler
17. Air Guide
18. Emergency Cooling Plate
19. Emergency Air Openings

2.12.5 MAIN ALTERNATORS

Turbine Alternators

Maker:	ABB
Type:	AMG630 L4 MT
Capacity/rating:	6,600V, 3ph, 60Hz, 3,450kW, 377A, 4,313kVA 0.8pf, 4 pole, IP44
Speed:	1,800 rpm
Weight:	12,580kg
Heating:	230V, 800W

Diesel Generator

Maker:	ABB
Type:	AMG0900SM10 LSEA
Capacity/rating:	6,600V, 3ph, 60Hz, 3,450kW, 377A, 4,313kVA 0.8pf, IP44
Speed:	720 rpm
Weight:	20,600kg
Heating:	230V, 800W

Description

Two main steam turbine generators and one main diesel generator are fitted. They are all of the totally enclosed, cylindrical rotor, self-excited, brushless type fitted with an integral air to fresh water cooler.

Generator cooling is provided by passing air over the integral fresh water cooler, using a closed circuit air supply. The cooler is constructed of double tubes, the outer tube has internal grooves. The grooves drain any leakage water from the primary tubes, which is drained out via a clearance between the primary and secondary tube plate to the leakage detector, which will raise an alarm via the IAS alarm system.

Space heaters are fitted which are energised when the generator circuit breakers are open. These protect against internal condensation during shutdown periods. Six PT100 sensors are embedded in the stator to monitor the temperature in each phase winding, three are active and three are spare. These temperatures can be monitored from the Integrated Automation System (IAS) screen mimics and will raise alarms when the temperature set points are exceeded.

Bearings

The main bearings are of the sleeve type. A forced lubrication system with a lubricating oil cooler, as part of the prime mover LO system, is used on each alternator.

The bearings also have temperature sensors which can be monitored from the IAS screen mimic and will raise alarms when the temperature set points are exceeded.

Electrical

The alternator output voltage is kept constant by a microprocessor based automatic voltage regulator (AVR). The Digital Excitation Control System (DECS) controls the current into the generator exciter field. Input power to the DECS is from a multi-pole, high frequency permanent magnet generator. This unit also provides over and under-excitation limitation as well as over-fluxing control. In the event of an AVR failure, manual voltage control can be carried out using the MVC300 control device. To use manual voltage control the commutator switch SA1 must be set to the MANUAL position. Switch SA1 should only be operated when the generator is stopped.

The AVR unit/cabinets are situated on the port and starboard side of the main switchboard room.

An Exciter Diode Monitoring device (EDM 200) is fitted to monitor the operation of the rotating diodes of the exciter. In the event of a diode open-circuit or short-circuit, this unit will raise an alarm and initiate a generator shutdown if necessary.

Three current transformers (CTs) used for monitoring are mounted inside the generator terminal box.

One steam generator normally provides electrical power under normal conditions at sea and in harbour, with the diesel generator on standby. During standbys, manoeuvring or cargo operations, two turbine generators should be on load supplemented by a diesel generator if required.

The priority order of the standby generator is selected at the IAS generator screen mimic.

In any of the above cases where two or more generators are on load, one generator has enough capacity to supply the total load after the operation of the preference trips.

Emergency Cooling

If the cooling system fails the alternator may still be run on reduced load with the emergency ventilation in place, as follows:

a) Open all side cover plates on both sides of the generator.

b) Remove the plates but do not remove the nets behind them.

c) Close the emergency cooling plate on the top of the generator to block the top module airflow.

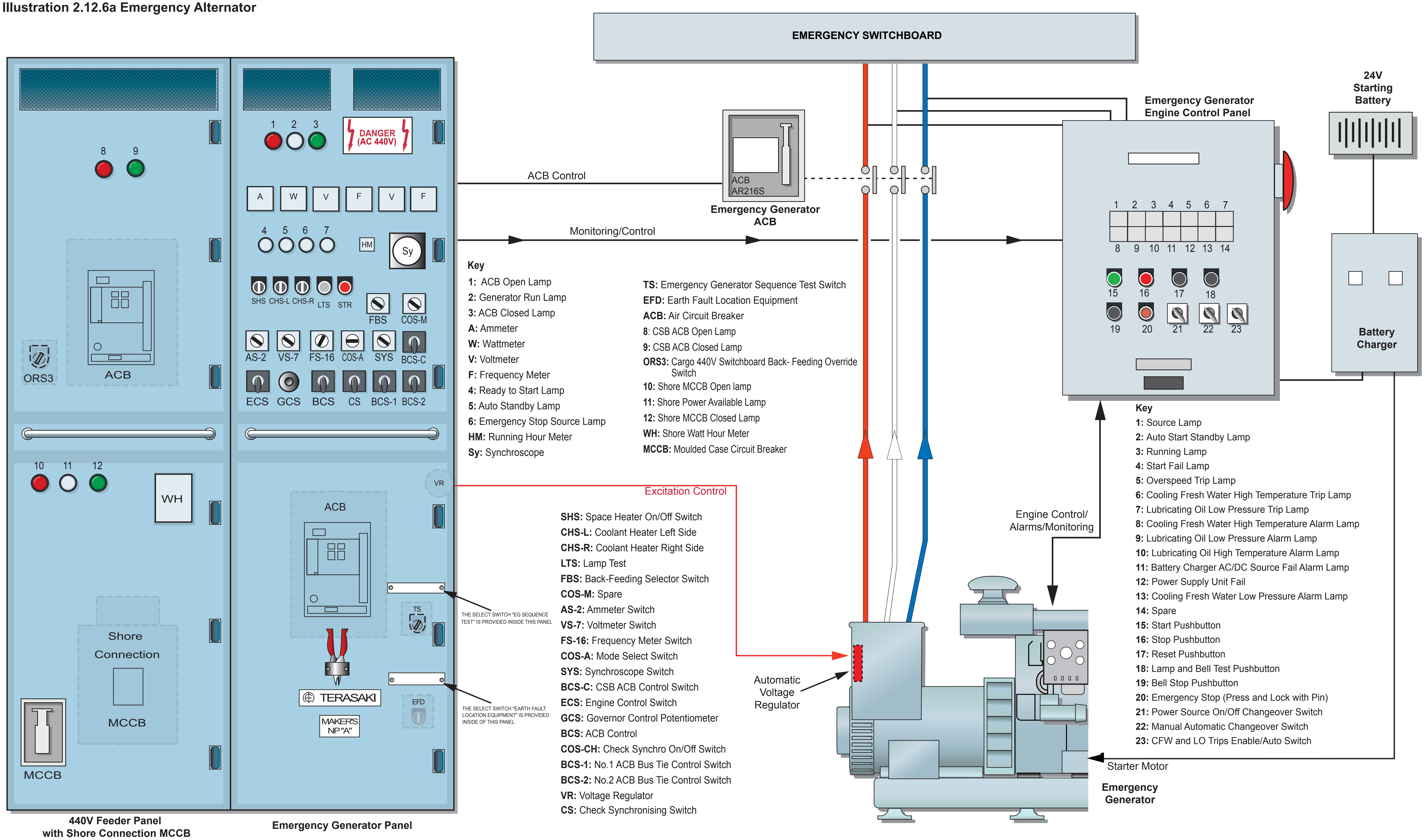
During emergency cooling the generator protection is lowered to IP 21, therefore the ingress of dirt must be kept to a minimum. The winding temperatures must be closely monitored when operating in this condition.

Alarms

Tag	Description	High	High high
GP041	Air cooler FW outlet temperature	40°C	
GP042	R winding temperature	165°C	170°C
GP043	S winding temperature	165°C	170°C
GP044	T winding temperature	165°C	170°C
GP045	Drive end bearing temperature	90°C	95°C
GP046	Nondrive end bearing temperature	90°C	95°C
GP055	Drive end LO temperature	90°C	95°C
GP056	Nondrive end LO temperature	90°C	95°C
GP060	Turbine rotor vibration	160um	
GP061	Turbine rotor axial movement	2mm	-2mm

Tag	Description	Low
HV012	Circuit braker current	377 amps

Illustration 2.12.6a Emergency Alternator



2.12.6 EMERGENCY ALTERNATOR

Maker:	Leroy Somer
Type:	LSA 50 IM6
Capacity/rating:	450V, 3ph, 60Hz, 850kW, 1,365A, 1062.5kVA 0.8pf, 4 pole, IP44
Speed:	1,800 rpm
Weight:	2,500kg
Heating:	220V, 250W

General Description

A self-contained emergency diesel generator, rated at 850kW, is fitted in the emergency switchboard room on B deck for use in an emergency or during refit. The generator is of the self-excited, brushless type and can be set for manual or automatic operation. Automatic mode will be normally selected, with the manual setting being used for testing the generator.

The emergency switchboard is normally supplied from either of the main 440V switchboards. When automatic mode is selected, the emergency generator is started automatically by detecting zero volts on the emergency switchboard bus bars. The emergency generator air circuit breaker (ACB) will connect automatically to the emergency switchboard after confirming the continuation of no-voltage. As well as supplying the main 440V switchboards, the No.1 cargo 440V switchboard can be back-fed from the emergency switchboard.

The emergency generator is designed to restore power to the emergency switchboard within 30 seconds. The bus tie breakers on the emergency switchboard, which connect to the main 440V switchboards, are opened automatically when zero volts is detected on the switchboards.

The alternator's automatic voltage regulator (AVR) is fitted within the alternator terminal cover. There is a potentiometer inside the generator cubicle to enable the voltage to be manually adjusted.

The generator ACBs undervoltage trip (UVT) has an energising switch fitted inside the generator cubicle which will close the UVT and enable the ACB to be closed under certain fault conditions.

The generator is fitted with a space heater to prevent condensation when the generator is stationary or idling. The heater is interlocked with the generator ACB.

The generator has sufficient capacity to enable the starting of the required machinery to power up the vessel from a dead condition.

Manual Operation: Generator Start and Connection onto Dead Bus

a) The emergency generator interlocks are normal, the engine is ready to start the fuel handle is in the RUN position, the turning bar is in the SET position and any engine trouble is RESET.

b) The emergency generator operation switch is set to MANUAL at the generator engine control panel.

c) At the engine control panel, the operator presses the ENGINE START pushbutton. The generator starts via its electric starter.

d) When the emergency generator speed >350 rpm, the READY TO START lamp is switched off. When 95% voltage is established, the emergency generator running lamp is illuminated.

e) At the generator panel of the emergency switchboard, the operator turns the ACB BREAKER CONTROL switch to the CLOSE position. The generator ACB closes and the emergency generator ACB CLOSED lamp is illuminated.

The emergency generator now feeds the emergency switchboard. The generator may also be manually started from the switchboard as follows:

a) The emergency generator interlocks are normal, the engine is ready to start the fuel handle is in the RUN position, the turning bar is in the SET position and any engine trouble is RESET.

b) The emergency generator operation switch is set to REMOTE at the generator engine control panel.

c) At the generator panel of the emergency switchboard, the operator turns the ENGINE CONTROL switch to the START position. The generator starts via its electric starter motor.

The sequence now follows d) and e) as before.

Emergency Generator Auto Start and Auto ACB Closure onto Dead Bus

a) The emergency generator interlocks are normal, the engine is ready to start the fuel handle is in the RUN position, the turning bar is in the SET position and any engine trouble is RESET.

b) The emergency generator operation switch is set to REMOTE at the generator engine control panel.

c) The emergency generator control mode switch is set to AUTOMATIC at the generator panel on the emergency switchboard.

d) The main switchboard bus tie breaker opens due to a zero volt situation (440V switchboard blackout).

e) The emergency switchboard bus voltage drops to zero, the emergency generator receives a start command.

f) When the emergency generator speed >350 rpm, the READY TO START lamp is switched off. When 95% voltage is established, the emergency generator running lamp is illuminated.

g) If the emergency switchboard bus voltage is still zero, the emergency generator ACB closes. The emergency generator ACB CLOSED lamp is illuminated.

The emergency generator now feeds the emergency switchboard.

Main Switchboard Power Restoration

The following is the procedure to manually change the emergency switchboard back to normal supply after the restoration of mains power following a blackout or similar situation. This procedure ensures continuity of supply to the emergency consumers.

a) The emergency switchboard is supplied by the emergency generator.

b) The main 440V switchboard(s) recover mains power. The emergency switchboard tie breaker is closed at No.1 or No.2 440V switchboard.

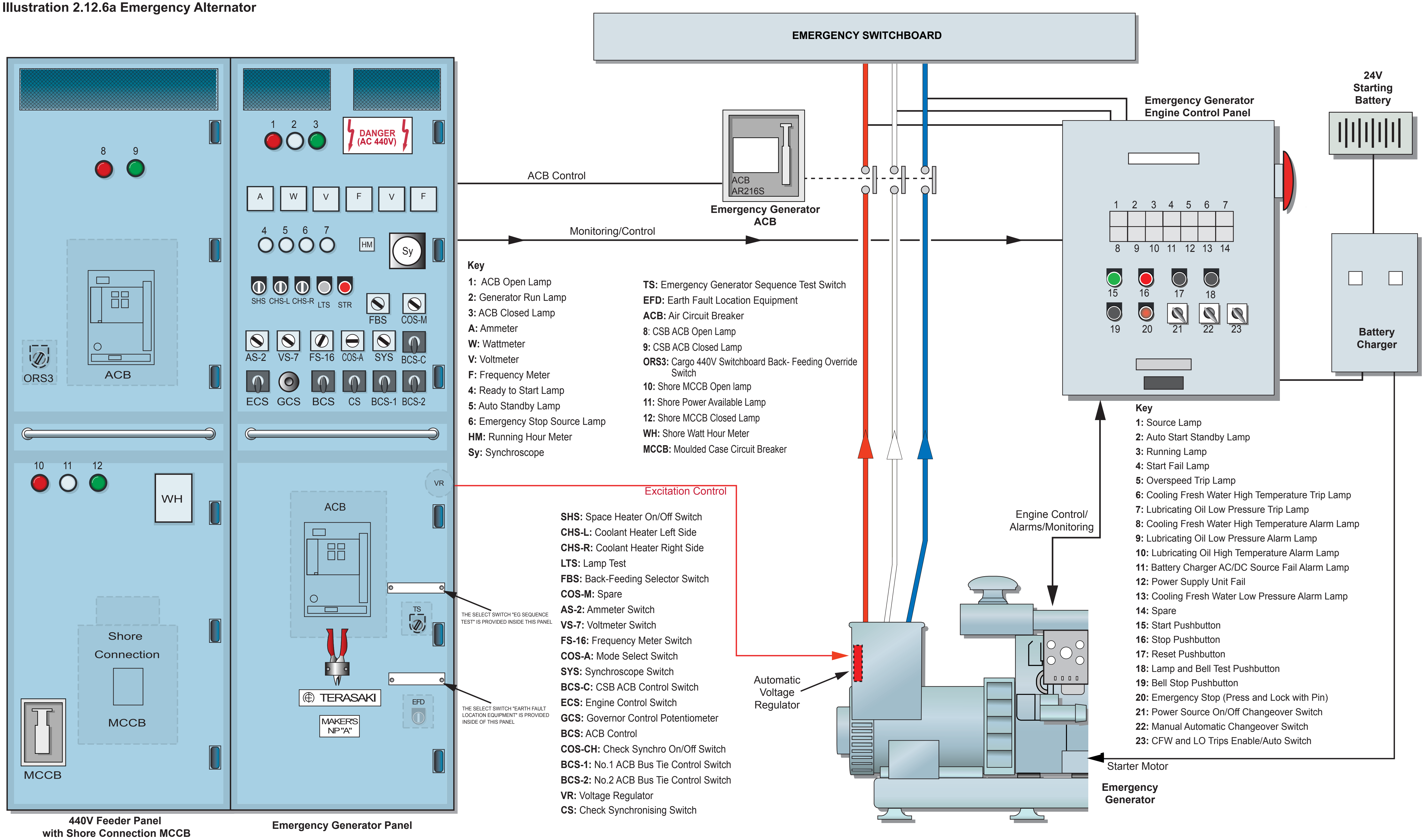
c) At the emergency switchboard synchronising panel, turn the SYNCHRONISING SELECTION switch to the No.1 or No.2 BUS TIE BREAKER position.

d) Turn the CHECK SYNCHRONISER switch to the ON position.

e) Use the emergency generator GOVERNOR CONTROL switch to raise or lower the generator's speed, for synchronisation.

f) At synchronisation (the 12 o'clock position on the synchroscope), turn the No.1 or No.2 ACB bus tie control switch to the CLOSE position.

Illustration 2.12.6a Emergency Alternator



g) The No.1 or No.2 440V emergency switchboard bus-tie breaker closes. Half a second later, the emergency generator ACB automatically opens. The emergency switchboard is now supplied from the main switchboard.

h) The emergency generator automatically stops after approximately one minute.

Ensure the emergency generator is set up for automatic start.

Emergency Generator Testing

The generator ACB will not close in this situation. The procedure to test the emergency generator engine is as follows:

a) The emergency generator interlocks are normal, the engine is ready to start the fuel handle is in the RUN position, the turning bar is in the SET position and any engine trouble is RESET.

b) The emergency generator operation switch is set to REMOTE at the generator engine control panel.

c) The emergency generator control mode switch is set to AUTO at the generator panel on the emergency switchboard.

d) The operator turns the SEQUENCE TEST SWITCH, located behind the front panel in the emergency switchboard generator section, to the ENG position. The emergency generator receives a start signal.

e) When the emergency generator speed >350 rpm, the READY TO START lamp is switched off. When 95% voltage is established, the emergency generator RUNNING lamp is illuminated.

f) Check the generator voltage and frequency (440V and 60Hz).

g) When the test is complete, the operator turns the SEQUENCE TEST SWITCH to the NORMAL position.

h) Stop the emergency generator manually by pressing the STOP pushbutton.

Manual Back-Feeding Operation to No.1 440V Cargo Switchboard

In the following emergency procedure the emergency switchboard is being supplied by the emergency generator or from shore power. This would enable one only 6,600V ballast/cargo pump motor to be started in an emergency.

a) No.1 main switchboard (CSB) bus bar is at zero volts.

b) At the emergency switchboard, turn the BACK-FEEDING switch to the No.1 AC 440V CSB position.

c) At the emergency switchboard, manually close 1CPT-002 breaker.

d) At the No.1 440V cargo switchboard, manually close 1CPT-002 breaker and also manually close 1CPT-001 breaker, which connects to the No.1 cargo transformer.

e) At the 6,600V cargo switchboard, manually close 1HCP-006 breaker, which connects to the No.1 cargo transformer.

e) Both the emergency switchboard bus and the No.1 cargo switchboard bus are now supplied by the emergency generator or the shore supply.

See cargo section 7.8 Running one Cargo Pump from the Emergency Generator.

Manual Back-Feeding Operation to No.1 or No.2 Main 440V Switchboard

In the following procedure the emergency switchboard is being supplied by the emergency generator or from shore power. This enables a limited amount of power to enable the starting of a central cooling pump, sea water cooling pump, main turbine lubricating oil pump, turning gear and other essential services.

a) Ensure that No.1 or No.2 main 440V switchboard bus bar is at zero volts.

b) At the emergency switchboard, turn the BACK-FEEDING switch to the No.1 AC440V MSB or the No.2 AC440V MSB position.

c) At the emergency switchboard, manually close 1P-001 or 1P-002 breaker.

d) At either No.1 or No.2 440V main switchboards, manually manually close 1P-001 or 1P-002 breaker.

e) Both the emergency switchboard bus and the selected main 440V switchboard bus are now supplied by the emergency generator or the shore supply.

2.12.7 Preferential Tripping and Sequential Restarting

Preferential Tripping

The power management system matches the generator capacity to the power requirements of the vessel. However, should an overcurrent occur for any main generator, non-essential services will be tripped.

If the current on a running generator exceeds 120% of the rated current:

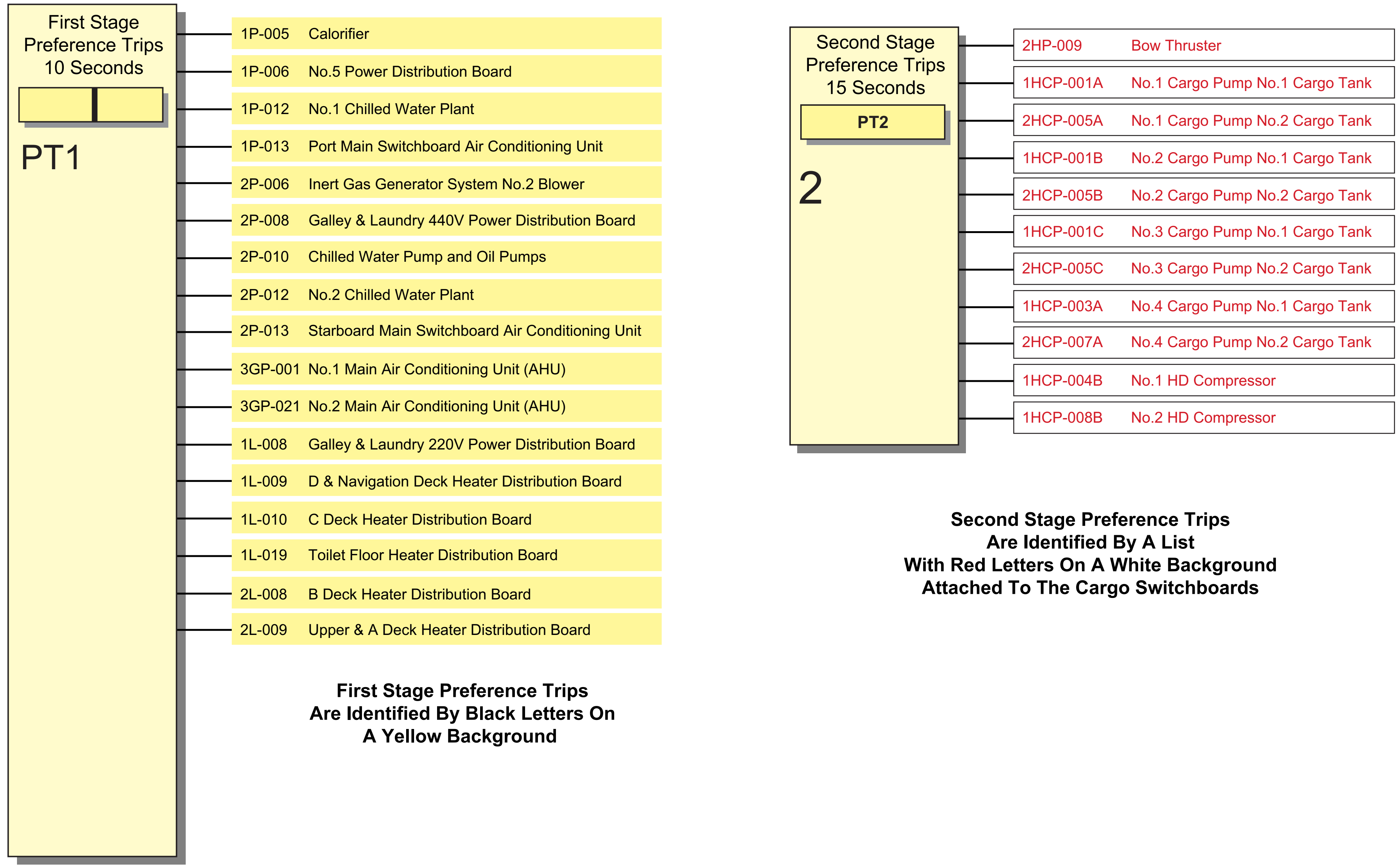
- Turbine generator: 852A
- Diesel generator: 2,823A

for a period of 10 seconds, the PMS will initiate the release of the stage 1 preferential trips, thereby providing protection against the overcurrent which would otherwise trip the ACB.

If the current still exceeds 120% after a further 5 seconds, the stage 2 preferential trips are released.

When normal conditions resume, the above breakers must be manually reset.

Illustration 2.12.7a Preferential Tripping



Sequential Restart Sequence

The sequential restart system controls the linking tie breakers between the following switchboards

- No.1 and No.2 6,600V main switchboards and No.1 and No.2 6,600V cargo switchboards
- No.1 and No.2 6,600V main switchboards and No.1 and No.2 440V main switchboards, via the main transformers
- No.1 and No.2 6,600V cargo switchboards and No.1 and No.2 440V cargo switchboards, via the cargo transformers
- No.1 and No.2 6,600V main switchboards

(**Note:** The tie breakers between the No.1 and No.2 6,600V cargo switchboards are available but are not used, due to the creation of a closed 6,600V loop when the 6,600V main switchboards are connected.)

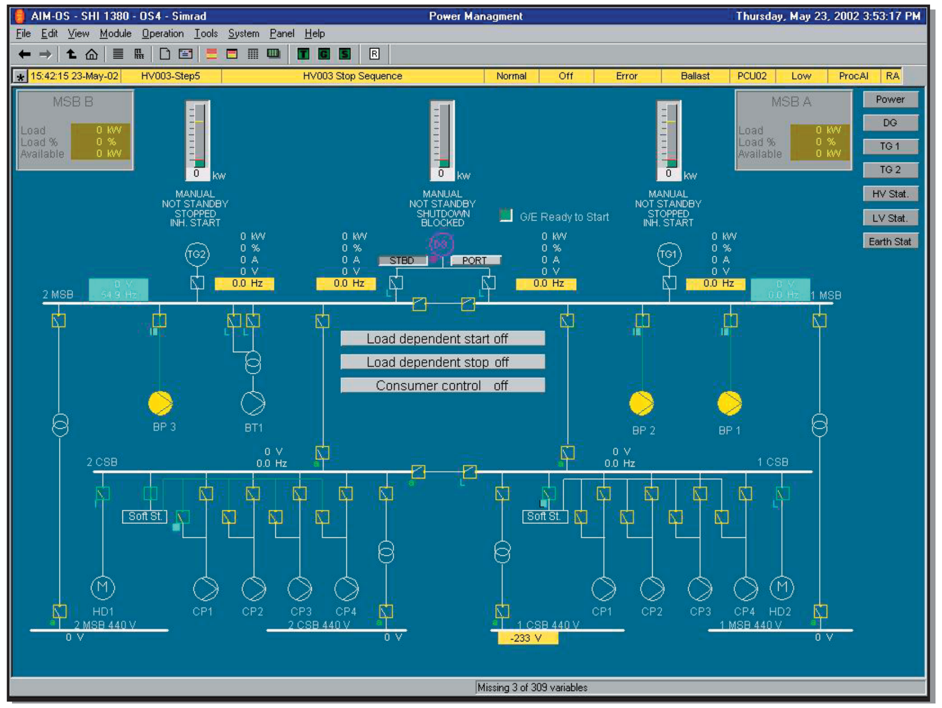
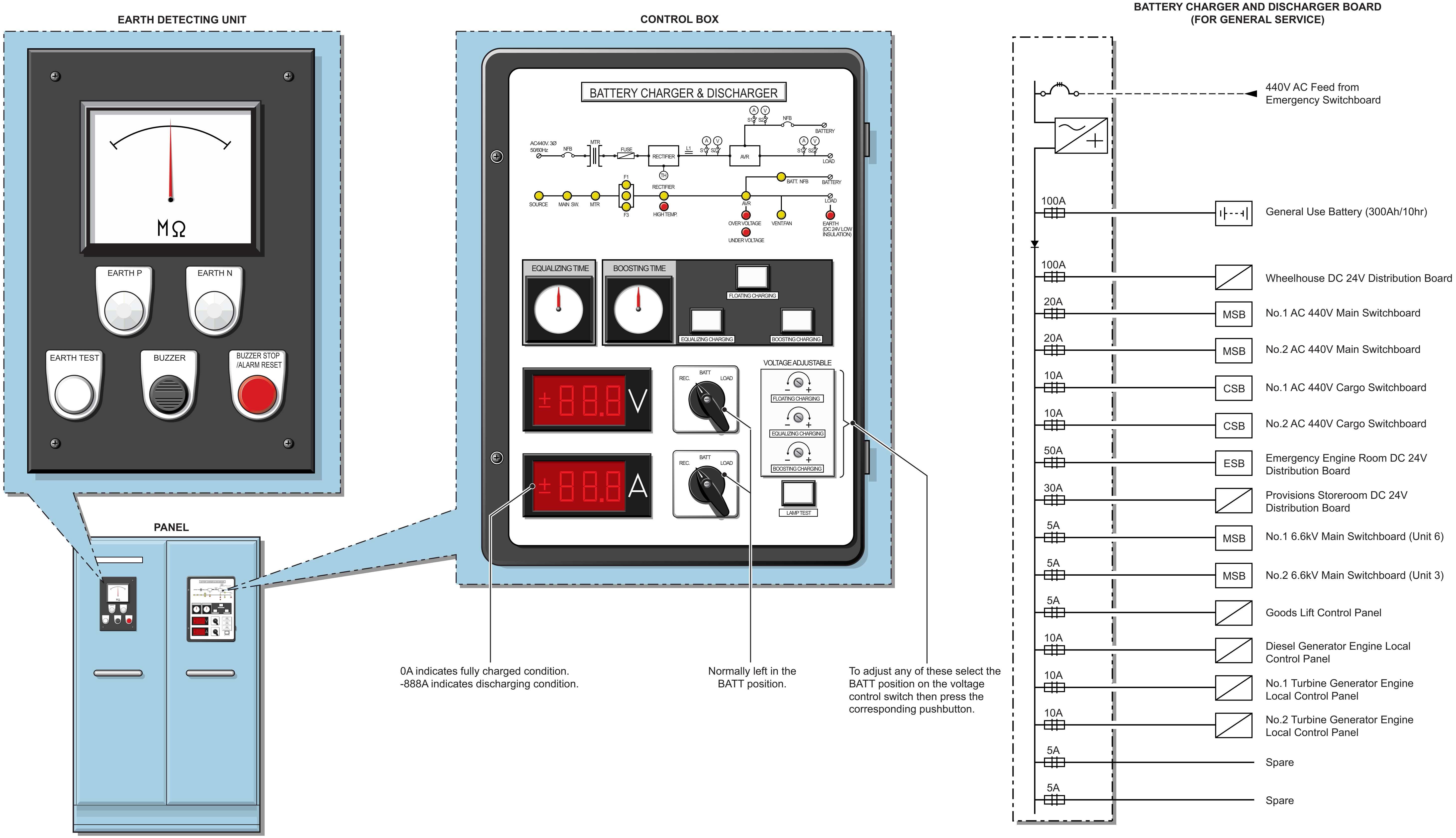


Illustration 2.12.7b Sequential Restart List

Breaker Identification	Bus Tie	Blocking Time	Remarks
1HP-008	No.1 6.6kV Main Switchboard To No.2 6.6kV Main Switchboard	0 seconds	Tie Breakers Between No.1 and No.2 6.6kV MSB
2HP-001	No.1 6.6kV Main Switchboard To No.2 6.6kV Main Switchboard	0 seconds	
1HP-004	No.1 6.6kV Main Switchboard To No.1 6.6kV Cargo Switchboard	1 seconds	
1HLP-007	No.1 6.6kV Main Switchboard To No.1 6.6kV Cargo Switchboard	1 seconds	
2HP-005	No.2 6.6kV Main Switchboard To No.2 6.6kV Cargo Switchboard	1 seconds	
2HCP-002	No.2 6.6kV Main Switchboard To No.2 6.6kV Cargo Switchboard	1 seconds	
1HLP-008	No.1 6.6kV Cargo Switchboard To No.2 6.6kV Cargo Switchboard	1 seconds	Available But Not Used Due To Creation Of Closed Loop
2HLP-001	No.1 6.6kV Cargo Switchboard To No.2 6.6kV Cargo Switchboard	1 seconds	
2HP-006	No.2 6.6kV Main Switchboard To No.2 440V Main Switchboard	2 seconds	Via No.2 Main Transformer
2PT-001	No.2 6.6kV Main Switchboard To No.2 440V Main Switchboard	2 seconds	
1HP-003	No.1 6.6kV Main Switchboard To No.1 440V Main Switchboard	2 seconds	Via No.1 Main Transformer
1CPT-001	No.1 6.6kV Main Switchboard To No.1 440V Main Switchboard	2 seconds	
2HCP-003	No.2 6.6kV Cargo Switchboard To No.2 440V Cargo Switchboard	3 seconds	Via No.2 Cargo Transformer
2CPT-001	No.2 6.6kV Cargo Switchboard To No.2 440V Cargo Switchboard	3 seconds	
1HLP-006	No.1 6.6kV Cargo Switchboard To No.1 440V Cargo Switchboard	3 seconds	Via No.1 Cargo Transformer
1CPT-001	No.1 6.6kV Cargo Switchboard To No.1 440V Cargo Switchboard	3 seconds	

Illustration 2.12.8a Emergency Battery Charging and 24V Distribution



2.12.8 24 VOLT BATTERY SYSTEM AND UNINTERRUPTIBLE POWER SUPPLY

The vessel's essential consumers are fed from local 24V DC distribution boards as well as Uninterruptible Power Supply (UPS) units. The ship's battery/UPS systems are as follows:

- There are three 24V DC distribution boards as follows:
  - Wheelhouse distribution board
  - Electrical equipment distribution board
  - Provision storeroom distribution board
- The emergency generator starter. A separate 24V battery and charger system is provided for the emergency generator starting arrangements.
- The IAS system is fed from six UPS units. Two are fed from the main 440V supply backed up by the emergency 440V supply the other four are fed from the main 220V supply backed up by the emergency 220V supply.
- The radio/GMDSS equipment has its own 24V battery back-up supply, situated in the locker at the back of the wheelhouse.

Battery Charger/24V DC Distribution Board

Charger Board

Make:	Hyun Jin Co. Ltd
Rating/capacity:	24V 200A
Output voltage:	24.4V (total)
Voltage (maximum):	30V

Batteries

Make:	Global and Yuasa Battery Co. Ltd
Rating/capacity (each):	24V 300Ah
Type:	Maintenance-free sealed lead acid
Model:	MSB300
Voltage (nominal):	2.0V per cell
Total number of cells:	12, 2 sets of 6

The 24V emergency system consists of three battery distribution boards supplied from the battery discharger panel. The distribution boards are located in the wheelhouse, electrical equipment room and the provision storeroom. The batteries are normally on a floating charge with the rectifier supplying the load.

The charger has a facility to adjust the charging voltage. This, however, should not be altered once the charger has been commissioned. While the storage batteries are fully charged, they are subjected to a floating charge. In this condition, the charger supplies the 24V consumers. A constant voltage is applied to the battery, regardless of any load, power or temperature variation and the charging current varies according to the charged state, maintaining the battery in a fully charged condition.

If the batteries have been on load due to a power failure, on restoration of the power supply the battery charger is automatically transferred to an equalising charge and this rapidly charges the batteries. As soon as the batteries become fully charged, it reverts to a floating charge. This mode may also be manually selected by a pushbutton on the charging panel. The charge performed after the recovery from a power interruption is controlled by the automatic control system, which protects the batteries and charging circuits from excess current.

When an earth is present on an outgoing circuit, the earth leakage alarm will sound. Operation of the earth test pushbutton will cause one earth lamp to glow bright and the other earth lamp to dim. Careful isolation of the outgoing circuits (mindful of essential consumers), will locate the faulty circuit, the lamps returning to equal brilliance and the alarm clearing once the faulty circuit is isolated. There is also a meter fitted as a further check.

IAS UPS Units

Make:	Powerware
Rating:	400V 30kVA
No. of sets:	2 (No. 3 and 4)
Location:	Electrical workshop on D deck
Type:	PW9305-301-N-M-O
Output voltage:	400V AC
Rating:	230V 8kVA
No. of sets:	2 (No.1 and 2)
Location:	Process station on engine room 2nd deck and electrical equipment room on A deck
Type:	PW9150-01-STX-M_O
Output voltage:	230V AC
Rating:	220V 3kVA
No. of sets:	2 (No.5 and 6)
Location:	Main switchboard room on engine room 2nd deck
Type:	Main turbine control
Output voltage:	220V AC

Batteries

Rating/capacity (total): 228V DC 38Ah

The IAS has two of these units, UPS1 and UPS2 situated in the electrical equipment room and the process station room respectively. Under normal conditions, UPS1 is supplied with 440V from No.1 or No.2 main 440V switchboard via breaker IP-027 and UPS2 from the emergency switchboard via breaker EP-018.

UPS1 bypass supply comes from the emergency 440V switchboard via breaker EP-017 and UPS2 bypass supply comes from the main switchboard via breaker 2P-027.

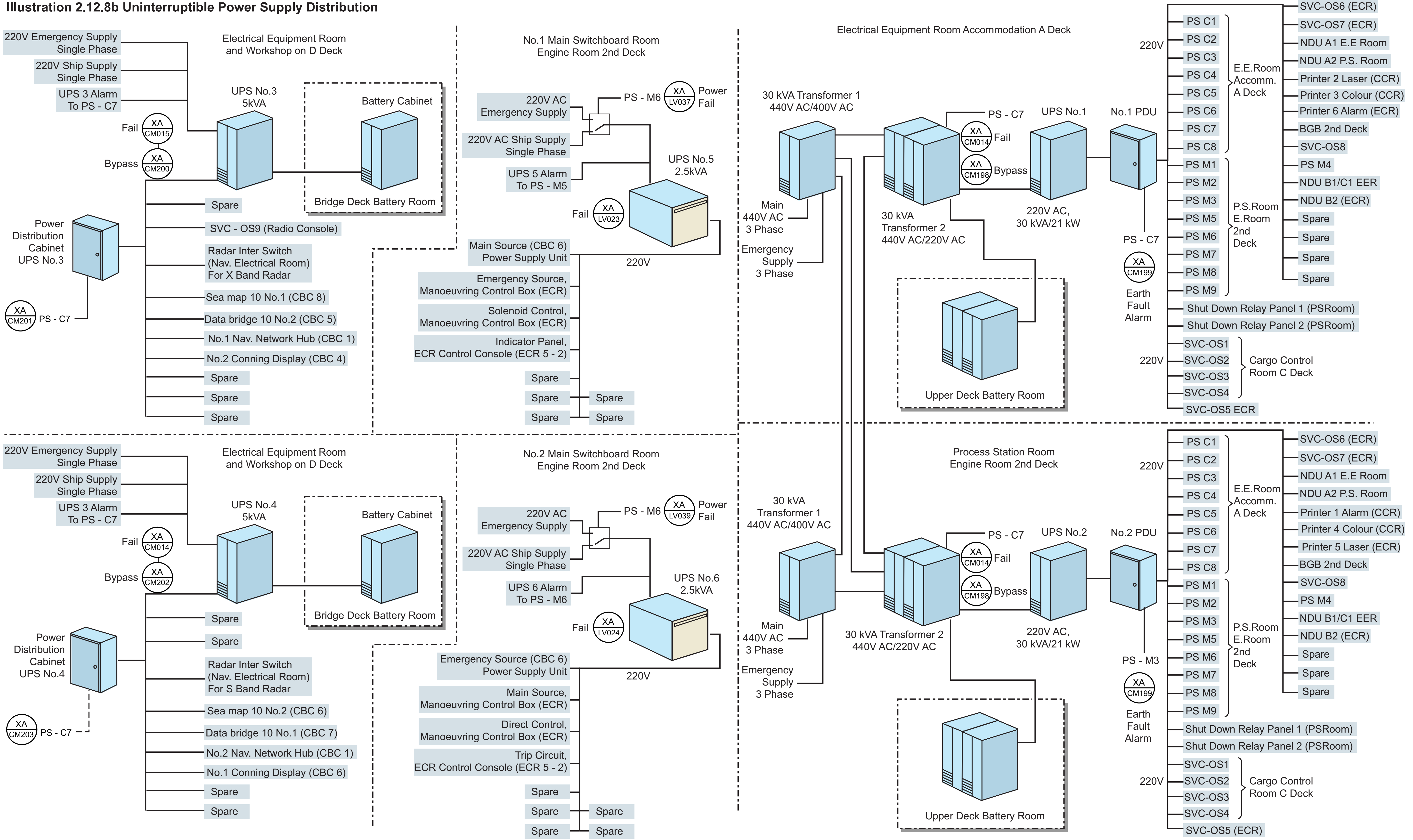
The output from the UPS is fed via a 400V AC/220V AC 30kVA transformer to Power Distribution Units (PDU). The power distribution units in turn supply the process control stations and the operator stations of the IAS.

The charger is fitted with a battery voltage monitoring facility which will raise an alarm if the battery voltage moves above or below a preset level or the battery current rises above a preset level. The unit is also fitted with mains failure, UPS failure and battery discharge failure alarms. The unit also indicates mains and inverter operation via the IAS system.

The UPS charger is a fully automatic charging device which automatically charges the storage batteries. The inverter and batteries may be manually bypassed in the event of an inverter failure or for specific maintenance.

As well as the two main UPS units there are two 5kVA UPS units located in the navigation deck electronics room and two 2.5kVA units in the process station room. These units are fed from the main 220V switchboard under normal conditions and from the emergency 220V switchboard in an emergency using the static bypass switch. Operation and indication of these units is as described for the 30kVA unit above.

Illustration 2.12.8b Uninterruptible Power Supply Distribution



Emergency Generator Starting Batteries

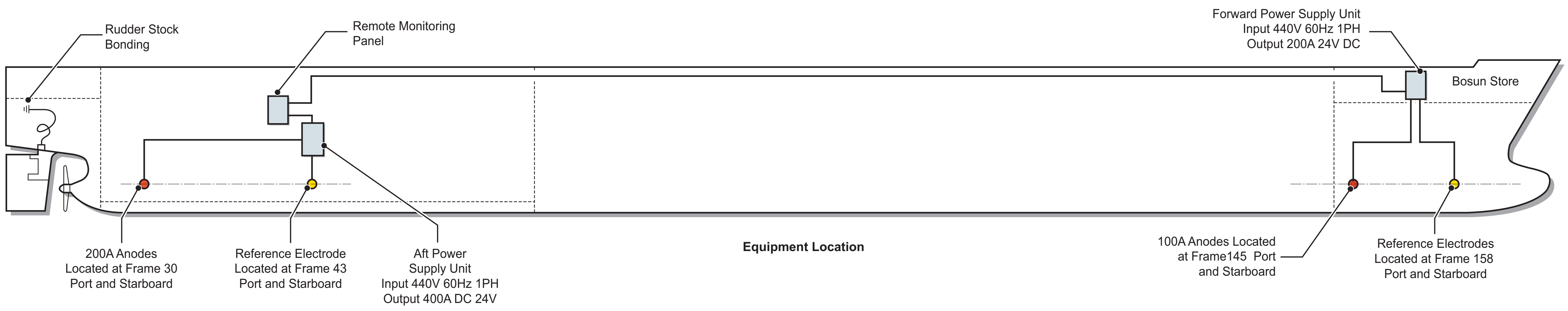
These batteries are charged from a bulkhead-mounted battery charger located in the emergency generator room. The charger is fitted with an ammeter and voltmeter to monitor the charging supply.

The charger is automatic in operation with floating and equalising charging modes, indicated by lamps on the front panel. If the battery is discharged, the charger automatically transfers to the equalising mode and rapidly charges the battery. As soon as the battery becomes fully charged, it reverts to a floating charge. The charge performed after the recovery from a power interruption is controlled by the automatic control system, which protects the battery and charging circuits from excess current. The mode may also be manually selected via a toggle switch on the front panel. The charger is fitted with battery low voltage and charger failure alarms. These will raise an alarm via the emergency generator local control panel in the event of any abnormal conditions.

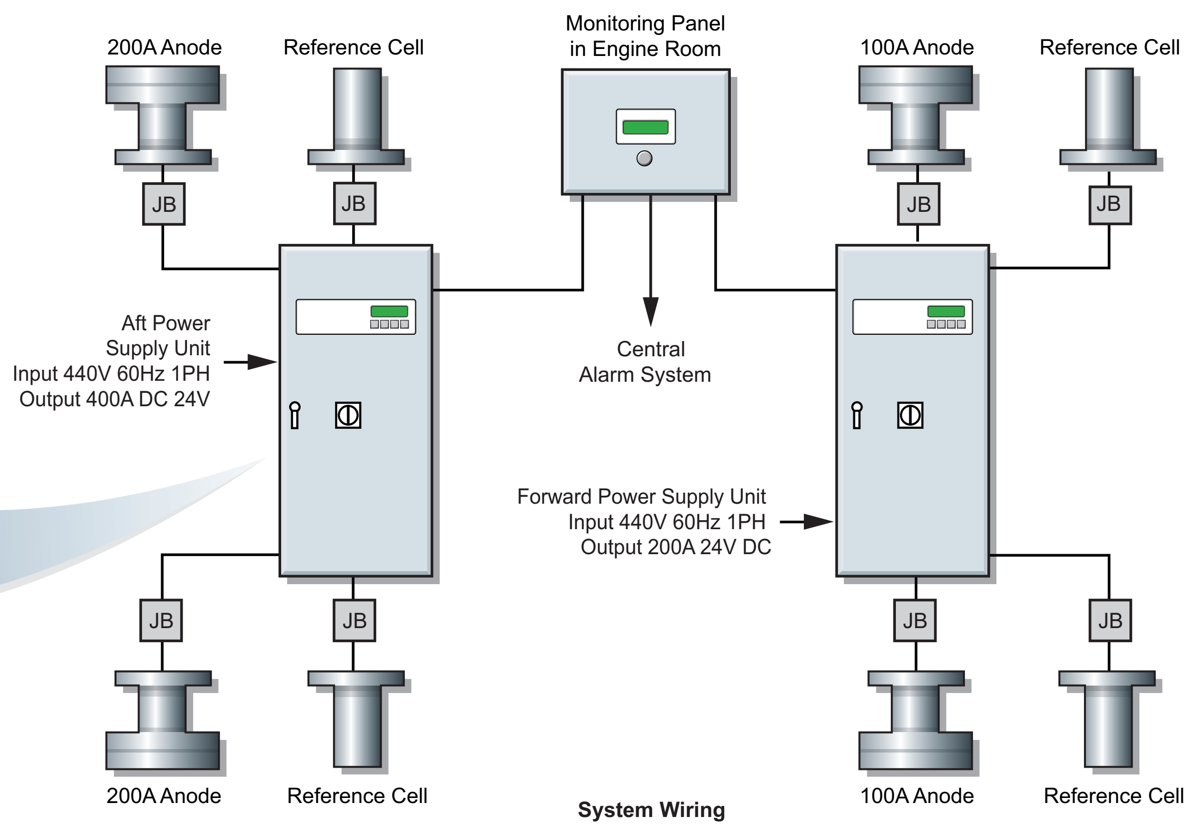
The boards and chargers are designed for continuous operation and are practically maintenance free. However, the units should be kept clean and dry and a visual inspection of connection integrity, cable condition etc, made once a year. At this time the charging voltages should be checked using a high quality digital voltmeter. All batteries should be kept clean and dry. The battery poles and connections must be kept covered with acid free vaseline. The cell voltages should be checked and logged once a month and the connection terminals checked for tightness once a year.

UPS in Main Switchboard Room

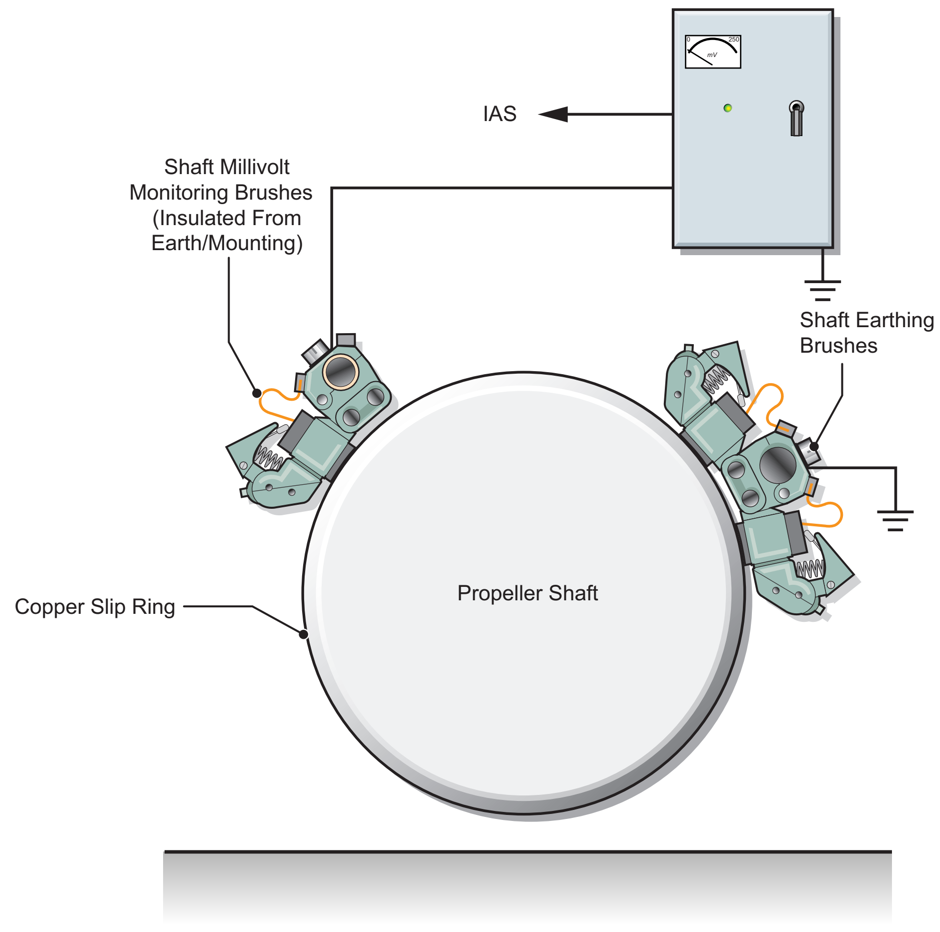
Illustration 2.12.9a Cathodic Protection System



Equipment Location



System Wiring



Propeller Shaft Earthing and Monitoring Assembly

2.12.9 CATHODIC PROTECTION SYSTEM

Maker : Korea Cathelco
Type: Impressed Current
Power Supply: AC 440V, 60Hz,

The vessel is provided with an Impressed Current Cathodic Protection (ICCP) system. This method of corrosion protection automatically controls electrochemical corrosion of the ship's hull structure below the waterline. Cathodic protection can be compared to a simple battery cell, consisting of two plates in an electrolyte. One of the battery plates in the electrolyte will waste away through the action of the flow of electrical current, if the two battery electrodes are connected electrically. When two metals are immersed in sea water, which acts as the electrolyte, one of the metals acts as the anode and will waste away. Which metal, in any pair, acts as the anode depends upon their relative positions in the electrochemical series but steel will act as an anode to copper, brass or bronze. The strength of the electric current generated in the corrosion cell, and hence the rate at which wastage takes place, depends upon the metals involved and the strength of the electrolyte.

If a third electrode is added to the cell and current is forced to flow, the third electrode acts as the cathode and the old anode will act as the new cathode. This is how an impressed current cathodic protection system functions. When a vessel is fitted with ICCP, the hull steel is maintained at an electrical potential more negative that the surrounding sea water. For this reason, loading and discharging terminals normally comply with the ISGOTT Recommendation 20.6, Earthing, Bonding and Cathodic Protection. This states, referring to IMO recommendations for the safe transport, handling and storage of dangerous substances in port areas, that ship shore bonding cables should be discouraged. Hence, high currents that can occur in earthing cables and metallic connections are avoided. These are due to potential differences between ship and terminal structure particularly due to the residual potential difference that can exist for up to 24 hours after the shipboard ICCP has been switched off. These terminals usually utilise insulating flanges on hose connections to electrically isolate the ship and terminal structure. During preparations for berthing at terminals where such insulation is not employed, or where earth connections are mandatory by local regulation, or when bunker barges come alongside, the ICCP should be switched off at least 24 hours in advance.

Fresh Water Operation

When the vessel enters a river estuary, the fresh or brackish water may limit the spread of current from the anodes, due to the higher resistance of the water. Normally, the voltage output increases to compensate for this and would be accompanied by very low current levels and the reference electrode potentials may indicate under-protection. However, in this system, the output is adjusted automatically and the system returns the hull to the optimum protection level when the vessel returns to sea water.

Principal of Operation

Protection is achieved by passing low voltage DC current between the hull metal and anodes, insulated from the hull, but in contact with the sea water. The electrical potential of the hull is maintained more negative than the anodes, ie, cathodic. In this condition corrosion is minimised. Careful control is necessary over the flow of impressed current, which will vary with the ship's speed, salinity and temperature of the sea water and the condition of the hull paint work. If the potential of the hull is made too negative with respect to the anode, then damage to the paint film can occur electrolytically or through the evolution of hydrogen gas between hull steel and paint. The system on this vessel controls the impressed electrical current automatically to ensure optimum protection. Current is fed through titanium anodes situated port and starboard on the ship. The titanium prevents the anodes themselves from corroding and the surfaces are streamlined into the hull. Fixed zinc reference electrodes, port and starboard, are used to compare the potential of the hull with that normally found between unprotected steel and zinc electrodes. Sufficient current is impressed via the anodes to reduce this to a level of between 150 and 250mV.

Operation

Once the unit is switched on, the unit's transformer rectifier converts the ship's 440V AC supply to a low voltage, finely controlled DC current. The DC positive is connected to the anodes and the DC negative is connected to the ship's hull. The system is completely automatic in normal use. In the normal operating mode the display will show the following readings:

- Anode current and voltage
- Reference cell millivolt reading

The system should be regularly monitored and the readings taken once a day. The monitoring unit has a changeover switch to enable the display of the forward or aft system readings.

Electrical Installation

The system consists of a monitoring panel and two power supply units. The power supply units, one forward and one aft, are wired to port and starboard reference electrodes and port and starboard anodes. The monitoring unit is also equipped with facilities to raise an external alarm to give warning of any system abnormalities, via the IAS system.

The forward system is fed from the 440V switchboard feeder section, circuit 1 PD-003 situated in the bosun's store.

The aft system is fed from the 440V switchboard feeder section, circuit 3 PD-003 situated on the engine room 4th deck aft of the auxiliary condenser.

Propeller and Rudder Stock Earthing

To avoid electrolytic corrosion of the propeller, a slip ring is clamped to the shaft and is earthed to the hull via brushes. A second set of brushes, insulated from earth, monitors the shaft mV potential and this signal is fed to a millivolt meter. To ensure efficient bonding, the slip ring should be cleaned on a regular basis. The shaft potential value should ideally remain below 75mV.

The rudder stock is also earthed for protection via a 70mm^2 flexible earth cable between the deckhead and rudder stock to minimise any electrolytic potential across the bearings and bushes.

Routine checks

- Record the output current and all voltages on a daily basis
- Check the reference electrode voltage on a daily basis
- Check and clean the propeller shaft slip ring and brushes every week or as indicated on the earthing meter
- Inspect the rudder stock earth strap every month
- Return completed log sheets to the manufacturer for scrutiny every month
- Inspect and clean the power supply unit cooling fans and grills every three months

The anodes and reference cells must be externally inspected every dry dock period. The anodes are fitted with an insulating shield cover to prevent excessive local over-protection and the condition of this shield must be closely inspected at this time.

Detailed instructions are available in the manufacturer's manual.

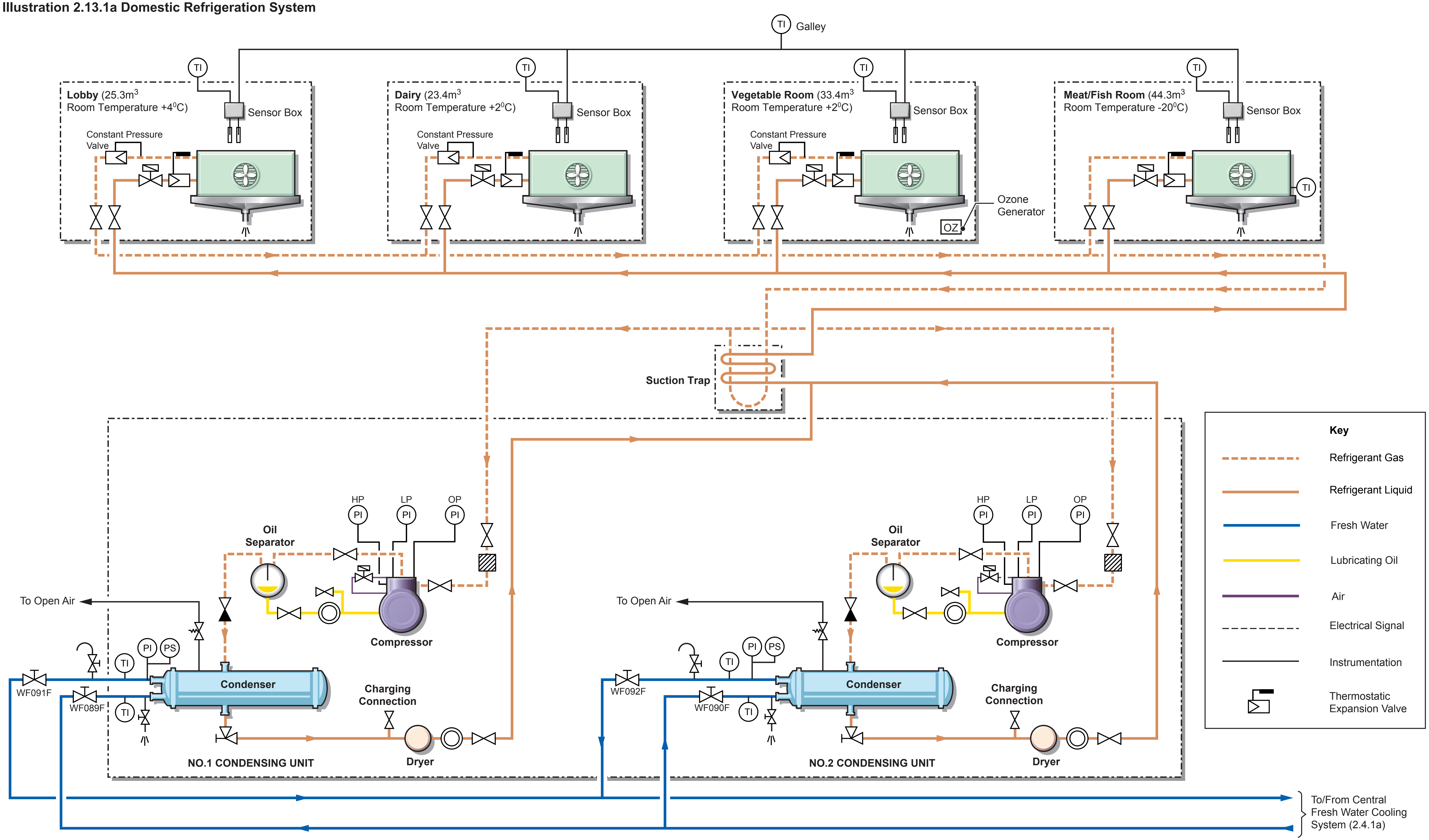
Sacrificial Anodes

The areas of the hull shielded from the hull face, such as the thruster tunnel, rudder and sea water intakes, receive only limited protection from the ICCP system. These areas are therefore fitted with separate sacrificial anodes. Several sacrificial zinc anodes are provided within the water ballast tanks including the fore peak tank.

2.13 Accommodation Systems

Illustrations

Illustration 2.13.1a Domestic Refrigeration System



2.13.1 DOMESTIC REFRIGERATION SYSTEM

Refrigeration Plant

Maker:	Technotherm
Type:	R-404a
No. of sets:	2

Compressor

Maker:	Bock
Model:	AMX4/466
Type:	Reciprocating
No. of cylinders:	4

Condenser

No. of sets:	2
Model:	8 5/8 F28
Type:	Horizontal shell and tube

Introduction

Cooling for the meat/fish room, vegetable room, dairy room and lobby is provided by a direct expansion R-404a system.

The plant is automatic and consists of two compressors, two condensers and an evaporator coil in each of the four cold rooms. During operation one compressor will operate all the cold rooms while the other serves as standby, but left on manual start up, with all its valves shut until required.

Air in the cold rooms is circulated through the evaporator coils by electrically driven fans.

The meat/fish room evaporator is 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.

The plant is not designed for parallel operation of the two compressor systems because of a risk of transfer of lubricating oil between the compressors.

The compressor draws R-404a vapour from the cold room evaporators and pumps it under pressure to the fresh water cooled condenser where the vapour is condensed.

The liquid refrigerant is returned through a dryer unit and passed to the cold room evaporators via a suction trap heat exchanger.

This is a heat exchanger element in which some of the heat in the vapour returning to the compressor from the evaporators is removed by the liquid refrigerant flowing to the evaporators. This cooling of the returning vapour improves the efficiency of the system.

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, so as to reduce the number of starts and 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 constant pressure valves.

When all the solenoid valves at the air coolers are closed by the room thermostats, the low pressure switches will stop the compressors.

Back pressure controlled constant pressure valves are included in the lobby, vegetable and dairy rooms to prevent these rooms dropping too far below the normal set point, which would damage the provisions, should the inlet solenoid valve fail to close properly.

Any leaks of refrigerant gas from the system will result in the system becoming undercharged. The symptoms of the system undercharge will be low suction and discharge pressures with the system eventually becoming ineffective. Bubbles will appear in the sight glass at the condenser refrigerant outlet.

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 separated out and returned to the sump. During operation the level as shown in the condenser level gauge will drop. If the system does become undercharged the whole system should be checked for leakage using the test lamp.

When required, 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 is dried before entering the system, due to the location of the charging connection being before the dryer. Any trace of moisture in the refrigerant system will lead to problems with the thermostatic expansion valves icing up and subsequent blockage.

Operating Procedures

To Start the Refrigeration Plant

a) All stop valve in the refrigerant line, except the compressor suction, should be opened and fully back seated to prevent the pressure in the valve reaching the valve gland.

b) The crankcase heater on the compressor to be used should be switched on a least 6 hours prior to starting the compressor.

c) Check that the oil level is correct.

d) Start up the ancillaries and pumps.

e) Open the valves for the cooling water supply to the refrigeration units, see section 2.4.1, No.1 provision refrigeration condenser inlet valve WF089F and outlet valve WF091F, No.2 provision refrigeration condenser inlet valve WF090F and outlet valve WF092F. Check that there is sufficient flow through the condensers and compressors.

f) Open the refrigerant supply to the cold rooms.

g) Open the refrigerant returns from the cold rooms.

h) Check the settings for the safety automatics on the compressor.

i) Shut the valve in the oil return pipe and open when the compressor has warmed up.

j) Open the suction valve one turn.

k) Start the compressor.

l) 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. If the oil in the crankcase foams or knocking noises are heard from the compressor, indicating that droplets of liquid are being fed in with the suction gas, throttle the suction valve immediately.

m) Increase the capacity stepwise by opening more rooms to refrigeration, thus allowing the compressor to adjust to the new conditions before switching to the next stage.

n) Check that the oil return pipe from the oil separator is warm.

Whilst running

- Check the refrigerant pressure and temperature readings
- Check the oil level and oil pressure
- Check for leakages
- The settings of the safety controls

Shutting Down the Refrigeration Plant

a) Shut off the liquid outlet valve from the condenser and pump down the evaporators.

b) If necessary reduce the low pressure cut-out setting during evacuation.

c) Allow the temperature in the evaporators to rise, then repeat the evacuation.

d) When the suction pressure is slightly above atmospheric, allow the compressor to trip on low pressure and then trip the compressor breaker. Shut the suction and discharge valves and shut the oil return valve.

e) Shut off the cooling water supply to the condenser.

f) Shut the gas inlet valve to the condenser.

g) Isolate the electrical supply.

Defrosting Procedure

The air coolers in the meat/fish room are fitted with an electrical defrosting system and the 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 procedure is as follows:

a) All solenoid valves in the system close and the compressor stops.

b) The fan in the meat/fish room is stopped working but the fans in the vegetable and dairy rooms continue the circulation of the air over the coolers, in this way keeping the cooling surfaces free from ice.

c) The electric heating elements in the meat/fish room switch on.

d) As long as the cooler is covered with ice, the melting takes nearly all of the heat supplied and the temperature of the cooler and the refrigerant is constantly kept near zero. When the ice has melted, the refrigerant temperature rises in the meat/fish room. When the temperature reaches the set point (approximately.+10°C) of the defrosting thermostat, the heating elements are switched off.

e) The compressor starts and the solenoid valves open, depending on control from the respective room thermostat.

f) When the coil surface temperature has gone below freezing point, the fans in the meat and fish room start.

The system is now back on the refrigerating cycle again. If defrosting is not complete at the expiration of the predetermined defrosting period, the defrosting will be restarted by the timer and a new cycle will commence.

As the operating temperatures of the lobby, dairy and vegetable rooms is above zero the evaporators do not require defrosting.

Room Temperatures

Temperatures of the individual rooms are controlled by means of room thermostats. These activate solenoid valves mounted in the liquid line to the respective room air cooler. When no cooling is required the thermostat closes the solenoid valve and the refrigerant liquid supply to the evaporator is stopped. Although the room thermostats may be changed they should normally be set as in the following table.

Room	Capacity	Temperature
Meat/fish room	44.3m^3	-20°C
Vegetable room	33.4m^3	+2°C
Dairy room	23.4m^3	+2°C
Lobby	25.3m^3	+4°C

System Running Checks at Regular Intervals

- Lubricating oil levels in the crankcase
- Lubricating oil pressure
- Moisture indicators
- Suction and discharge pressure and temperature and any unusual variations 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
- Lubricating oil trip

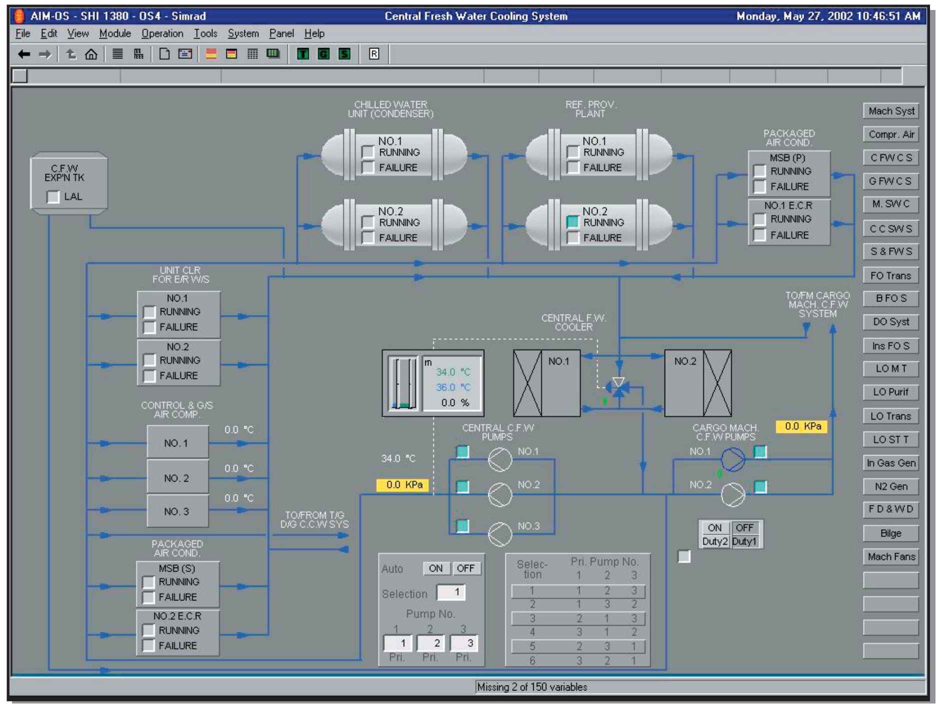
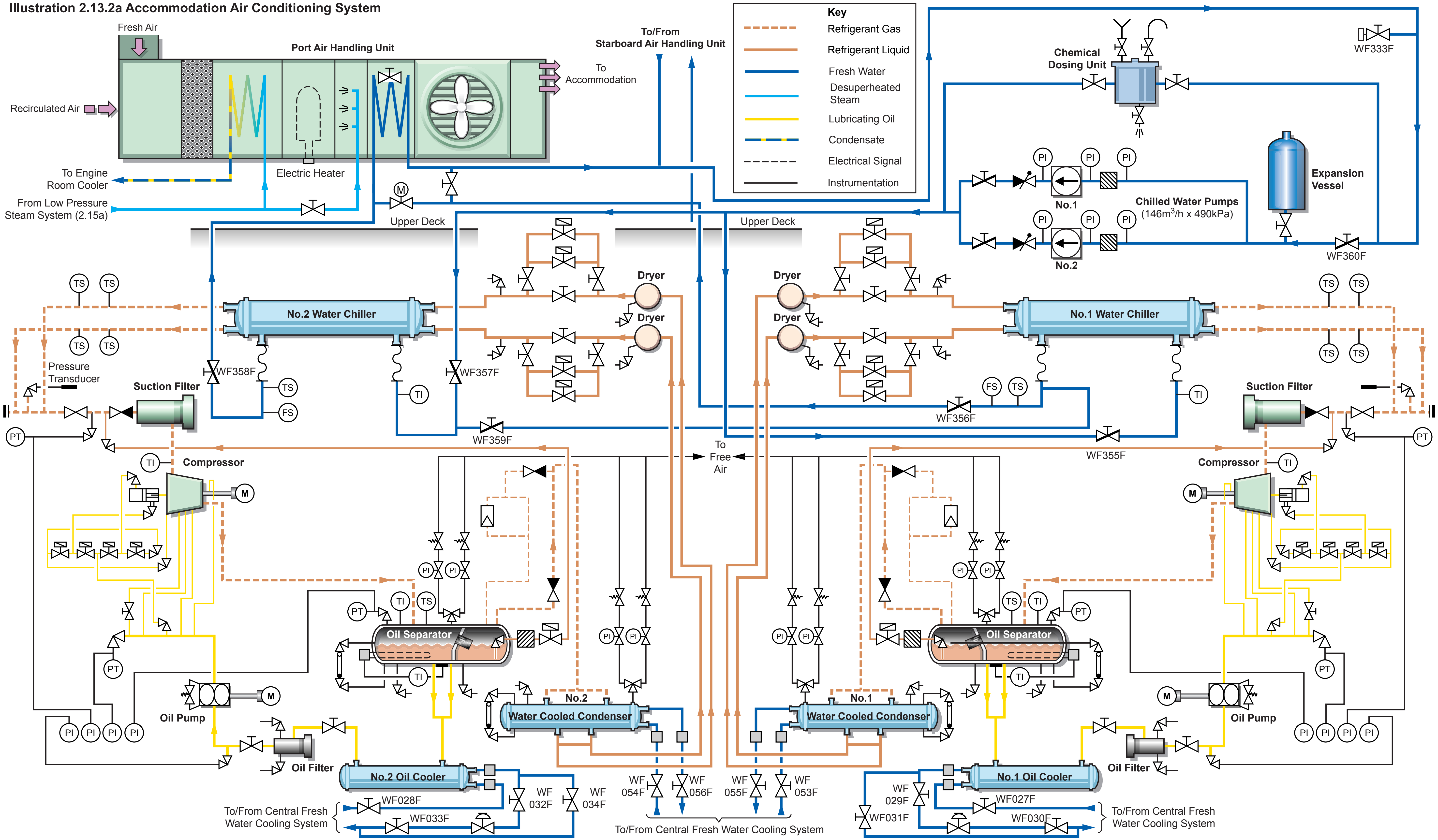


Illustration 2.13.2a Accommodation Air Conditioning System



2.13.2 ACCOMMODATION AIR CONDITIONING PLANT

Air Conditioning Plant

Maker:	ABB

Air Handling Unit

Type:	EU64
No. of sets:	2

Fan Coil Unit

Type:	FCUA
No. of sets:	1

Chilled Water Pumps

Maker:	Teknotherm/Shinko
Model:	SVA 125-2
Type:	Centrifugal
No. of sets:	2
Capacity:	193m^3/h at 392kPa
Motor:	30kW at 1,720 rpm

Refrigeration System for Chiller

Maker:	Teknotherm
No. of sets:	2
Secondary refrigerant:	Water with 10% glycol

Refrigerating Compressor

Maker:	Mycom
Model:	F200VL
Type:	Screw
No. of sets:	2
Primary refrigerant:	R-404a
Refrigerant capacity:	1,270kW
Motor power:	362kW at 3,550 rpm

Introduction

The air handling units, as part of the air conditioning system, provides facilities for air heating, air cooling, air filtration and air humidification. The circulation fan is belt driven from an electric motor. Heating may be by means of steam or electricity and humidification is by means of steam injection into the air flow.

Air cooling is by means of chilled water and two refrigeration water chillers are provided in order to chill the water; the water contains 10% glycol in order to prevent the formation of ice.

A fan coil unit is located on the bridge and provides cooled air circulation by means of an integral fan and chilled water coil.

The air is supplied to the accommodation by the two air handling units located in the air conditioning room in the accommodation upper deck. The air handling units consist of an electrically driven fan drawing air through the following sections:

- Mixing chamber for fresh and recirculated air
- Filter
- Heating coil (steam)
- Heating element (electric)
- Humidifier nozzles
- Cooling section (chilled water)
- Water trap

The air is forced into the distribution trunking which supplies the accommodation. Air may be drawn into the system either from outside or from the accommodation via recirculation trunking.

The amount of fresh air from outside may be varied as required by means of the manually operated damper in the inlet trunking. 100% recirculation of air may be used in exceptional circumstances if necessary and as required by local regulations in load/discharge ports.

The inlet filters are of the washable mat type and heating is provided by coils supplied by steam from the 588kPa system.

Chilled Water Units

Cooling is provided by a chilled water system. Two chilled water units are provided and these employ a direct expansion R-404a refrigeration system. Each refrigeration unit supplies its own chilled water cooler and water is circulated through the chillers by the chilled water pumps. There are two chilled water pumps, one acting as the duty pump and the other as the standby pump. In normal circumstances one chilled water unit will be operating but in exceptional circumstances both units can be operated in parallel.

The chilled water units act like refrigeration units with direct expansion of refrigerant gas cooling circulating water in an evaporator. The water contains 10% glycol in order to prevent freezing. Each chilled water unit may be treated as a separate item and there is no connection between the gas sides of the units.

The refrigeration compressor takes suction from the returning superheated gas from the evaporator coils. After compressing and raising the pressure of the gas, it leaves the chilled water compressor as a superheated gas which is passed through an oil separator to the condenser where it is condensed to a liquid. The liquid is then passed to a receiver, via a dryer, where the receiver is effectively the evaporator water chiller unit.

The liquid R-404a is then supplied to the water chiller by means of two separate refrigerant gas circuits. Each gas circuit has a filter/dryer and two electronic expansion valves with a manual bypass expansion valve fitted for emergency use. There are two return gas lines to the compressor suction filter.

The capacity regulation of the compressor is controlled by the suction pressure and is infinitely variable between 100% and 10%.

The condenser and oil cooler are cooled by the central fresh water cooling system (see section 2.4.1).

The compressor is protected by a high and low refrigerant pressure cut-out switch, a high lubricating oil temperature trip and a low lubricating oil pressure trip.

Any leakage of refrigerant gas from the system will result in the system becoming undercharged. The symptoms of system undercharge are low suction and discharge pressure and the system eventually becoming ineffective. During operation the liquid level, as shown in the condenser level gauge, will drop. If the system does become undercharged, the whole system pipework should be checked for leakage.

When required, additional gas can be added through the charging line, after first venting the connection between the gas bottle and the charging connection. Care must be taken to ensure that no moisture or dirt is drawn into the system when charging and so a filter and dryer are fitted in the charging line.

Any trace of moisture in the refrigerant may lead to problems with icing of the thermostatic expansion valve and subsequent blockage.

Chilled water is pumped to the air handling units and the fan coil unit by one of the two chilled water pumps. The chilled water circuit is separate from any other water circulation system and has its own expansion vessel and chemical dosing tank. The water is treated chemically to prevent corrosion and 10% glycol is added in order to prevent ice formation in the water.

Operation of the Air Conditioning System

The air conditioning system is designed to run with one or both chilled water units supplying chilled water to the two air handling units and the fan coil unit. There is only one chilled water circuit and only one of the chilled water pumps is required to operate.

The second pump is available to act as the standby pump. Capacity control of the refrigeration unit supplying each chilled water unit is automatic.

Procedure for Starting the Ventilation System

a) Check that the air filters are clean.

b) Set the air dampers to the outside position.

c) Start the supply fans.

Procedure for Operating the Chilled Water System

a) Ensure that the chilled water circuit is fully charged with water and that the water is treated with 10% glycol.

b) Check that the central FW cooling system is operating and supplying cooling water to the chilled water units. Cooling water must be flowing through the chilled water unit condensers and lubricating oil cooler.

c) Set the chilled water system FW cooling valves as in the following table.

Position	Description	Valve
Open	No.1 chilled water unit LO cooler inlet	WF027F
Open	No.1 chilled water unit LO cooler outlets	WF029F, WF030F
Closed	No.1 chilled water unit LO cooler outlet control valve bypass	WF031F
Open	No.2 chilled water unit LO cooler inlet	WF028F
Open	No.2 chilled water unit LO cooler outlets	WF032F, WF033F
Closed	No.2 chilled water unit LO cooler outlet control valve bypass	WF034F
Open	No.1 chilled water unit condenser inlet	WF053F
Open	No.1 chilled water unit condenser outlet	WF055F
Open	No.2 chilled water unit condenser inlet	WF054F
Open	No.2 chilled water unit condenser outlet	WF056F

d) Set the chilled water system valves as in the following table.

Position	Description	Valve
Open	Chilled water pump unit suction valve	WF360F
Open	No.1 chilled water pump outlet valve	
Open	No.2 chilled water pump outlet valve	
Open	No.1 chilled water evaporator inlet valve	WF355F
Open	No.1 chilled water evaporator outlet valve	WF356F
Open	No.2 chilled water evaporator inlet valve	WF357F
Open	No.2 chilled water evaporator outlet valve	WF358F
Closed	Balance valve between evaporator water circuits	WF359F
Closed	Make-up water valve	WF333F
Closed	Chemical dosing pot valves	
Open	Inlet valve to No.1 air handling unit	
Open	Outlet valve from No.1 air handling unit	
Open	Inlet valve to No.2 air handling unit	
Open	Outlet valve from No.2 air handling unit	
Open	Inlet valve to fan coil unit	
Open	Outlet valve from fan coil unit	
Open	Inlet/outlet valve from/to expansion vessel	

e) Start the selected chilled water pump and ensure that water is circulating throughout the chilled water circuit. When the chilled water circuit has been checked and is operating correctly the refrigeration unit(s) may be operated as below.

Procedure for Operating the Chilled Water Unit Refrigeration System

a) Ensure that the central fresh water cooling system is operating and supplying water to the condenser and lubricating oil cooler.

b) All stop valves in the refrigerant line should be opened and fully back seated to prevent the pressure in the valve reaching the valve gland.

c) Check that the oil level in the oil separator is correct. The level should be visible in the sight glass. Ensure that the oil heater is switched on.

d) Throttle in the compressor suction valve.

e) Check the settings of the safety controls.

f) Check that the oil pump is operating correctly.

g) Open the suction valve slowly taking care not to allow liquid into the compressor and keeping the suction pressure above the cut-out point.

h) Check that the evaporator unit is operating correctly and that the water temperature in the chilled water circuit is being reduced to +14°C at the inlet and +6°C at the outlet.

i) Check that the evaporator solenoid valve operates correctly in response to the water temperature change and that the temperature of the chilled water is maintained at the desired value.

Whilst running

- Check the refrigerant pressure and temperature readings
- Check the oil temperature and oil pressure
- Check for leakages
- The settings of the safety controls

Compressor Running Checks (Daily)

- Lubricating oil pressure
- Lubricating oil temperature
- Compressor suction and discharge pressures
- Compressor and oil pump motor bearing temperatures
- Any undue leakage at the shaft seal

ALARMS AND TRIPS

Description	Setting
Capacity regulator temperature	6°C
Capacity regulator neutral zone	1°C
Low pressure limit	4 bar
Minimum capacity regulator time	1 second
Maximum capacity regulator time	3 second
Interval capacity regulator time	20 seconds
Enable valves 3 and 4	5%

Description	Setting
Differential enable valves 3 and 4	10%
High refrigerant pressure alarm	20 bar
Low LO pressure alarm	1.5 bar
High discharge temperature alarm	75°C
High LO temperature alarm	65°C
Low discharge temperature alarm	45°C
Low LO temperature alarm	5°C
High discharge temperature alarm	75°C
Temperature alarm delay	10 minutes
Flow switch alarm delay	5 seconds
Restart delay	10 minutes
Low discharge pressure trip	2 bar
High discharge pressure - unload	19.5 bar
Water temperature - common	9°C
Hysteresis temperature	3°C
Differential temperature	3°C
Differential time	5 minutes
Water temperature - chiller No.1	3°C
Water temperature - chiller No.2	3°C

Procedure To Stop the Compressor for Short Periods

a) Shut the refrigerant liquid outlet valve from the condenser.

b) Allow the compressor to operate and pump out the system so that the low level pressure cut-out operates.

c) Isolate the compressor motor.

d) Close the compressor suction valve.

e) Close the compressor discharge valve.

f) Close the FW cooling water inlet and outlet valves on the condenser.

g) Close the FW cooling water inlet and outlet valves on the oil cooler.

Procedure To Shut Down the Compressor for a Prolonged Period

If the air conditioning 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 receiver.

Leaving the system with full refrigerant pressure in the lines increases the tendency to lose charge through the shaft seal.

a) Shut the refrigerant liquid outlet valve from the condenser.

b) After a period of time the suction pressure may rise, in which case, the compressor should be allowed to pump down again, until the suction pressure remains low.

c) Close the compressor suction and discharge valves.

d) Close the inlet and outlet valves on the cooling water to the condenser and lubricating oil cooler.

e) Close the refrigerant inlet valve to the condenser.

f) The compressor refrigerant system should be marked as isolated and the compressor motor isolated, to prevent possible damage.

Procedure for Operating the Air Conditioning System

The air conditioning system will cool the air if required, will provide heating to the air if needed, will remove excess moisture from the air if necessary and will humidify the air to the correct level for comfort. A comfortable atmosphere is a combination of temperature and humidity and both must be controlled.

The cooling effect on the air as it passes over the evaporator coil removes moisture and a level of humidity is important for comfort so it is necessary to humidify the air by spraying steam or water into the circulating air flow. Humidity is detected by a sensor and the steam/water is introduced automatically. Humidity is increased before the cooling coil and excess moisture is removed from the air at the cooling coil as moisture condenses on the cold surfaces of the cooling coil. A water trap is located at the cooling coil section in order to allow for the draining of condensate. Such water must be removed from the air handling unit in order to avoid problems of legionella bacteria and the moisture collecting area must be dosed with hypochlorite at weekly intervals.

Steam heating provides for primary heating of the air should that be necessary and the electric heater may be used as required where steam is not available.

The ratio of fresh air to recirculated air may be adjusted by means of dampers at the inlet to the air handling unit.

The greater the amount of fresh air used the greater will be the heating or cooling requirement but the better will be the environment within the vessel. Ideally at least 70% fresh air should always be used but in exceptional circumstances the vessel may operate with 100% recirculated air for short periods of time.

a) Switch on the air conditioning control system and start the fan. Check that the air circulation fan is operating correctly. If there is any recirculation of air check that the desired amount is being achieved by adjusting the damper controls.

b) Check that the air conditioning compressor system and the chilled water system are functioning correctly if cooling of the air is required.

c) If heating is required, open the steam supply valve to the air conditioning unit from the steam system. (Electric heating would only be used if steam was not available).

d) Check that the humidifying steam supply valve is open.

e) If the air needs heating, check that the steam heating inlet and outlet valves are open. Steam supply to the AHU is regulated by temperature control valves. The drain valves must be open.

f) Set the temperature control on the chilled water control panel to give the desired temperature. The chilled water outlet valve from the air handling unit is motor controlled and will regulate the supply of chilled water flowing through the unit. The chilled water inlet and outlet valves must be open, and the chilled water bypass valve must be throttled for each air handling unit.

g) Set the desired humidity level. The steam valve will operated as required to inject steam into the air flow.

h) Ensure that the drains from the evaporator unit are working satisfactorily and that no water is lying in the drain tray.

CAUTION

It is essential that no water should be lying in the air conditioning system as this can become a breeding ground for legionella bacteria which can have serious, or even fatal, consequences. The drain should be kept clear and areas where water can lie should be sterilised at frequent intervals.

Procedure for Operating the Fan Coil Unit

The fan coil unit is located in the wheelhouse. The unit fan draws air into the unit from the wheelhouse and returns filtered and cooled air back to the wheelhouse. The cooling coil is supplied with chilled water from the chilled water system.

a) Switch on the fan coil unit power supply and check that the control panel lamps are illuminated.

b) Start the fan coil unit fan and check that air is flowing through the unit.

c) Select the desired temperature at the control panel.

d) Ensure that the chilled water inlet and outlet valves are open and that the bypass valve is throttled. Check that chilled water is flowing through the fan coil unit.

e) Check that cooled air flows from the fan coil unit outlet and that the controlled chilled water outlet valve operates to maintain the desired temperature.

f) Check that the water trap is operating effectively and that water is draining from the unit.

CAUTION

It is essential that no water should be lying in the air conditioning system as this can become a breeding ground for legionella bacteria which can have serious, or even fatal, consequences. The drain should be kept clear and areas where water can lie should be sterilised at frequent intervals.

2.13.3 ENGINE CONTROL ROOM/MAIN SWITCHBOARD ROOM AIR CONDITIONING UNIT

Package Air Conditioning Unit

Maker:	Century
No. of sets:	4. Two for ECR and two for main switchboard room
Model:	MP-G15HF3
Type:	Cooling with R404c refrigerant unit
Cooling capacity:	45,000kcal/h

Introduction

The units each have two refrigeration compressors, condenser and evaporator. The refrigeration units are located at the bottom of the air conditioning cabinet and the evaporators are located above the refrigeration section. Above the evaporator coils is the fan. The fan draws air from the designated space and passes it over the evaporator coils before discharging it back into the designated space. A suction filter is fitted at the air inlet to the package air conditioning unit. This filter must be cleaned at frequent intervals in order to ensure that the air flow across the cooler is adequate. Each refrigeration unit operates separately and their operation is dictated by the cooling demand on the unit.

The condenser unit is cooled by water circulating from the central fresh water cooling system and this must be operating and the supply and return valves opened before the package unit can be put into operation.

The control at the front of the package air conditioning unit contains a power switch and when this is turned on the unit is available for operation. A STOP pushbutton allows the unit to be stopped and a PBS FAN pushbutton starts the fan. The fan may be operated alone in order to provide ventilation. Pressing the COOL pushbutton starts the cooling system operating.

Each refrigeration system is provided with a dual high/low pressure cut out switch and there is a fusible plug fitted to the condenser which will fail should the temperature become excessive.

An oil heater is started when the main power switch is turned to the ON position.

The adjustable air outlet thermostat has a range of 0 - 35°C. The HP trip operates at 2.205MPa and is manually reset. The LP cut out operates at 265kPa and automatically resets at 490kPa.

Procedure for Operation of the Unit Coolers

a) Prior to operating the unit coolers the cooling water inlet and outlet valves from the central fresh water cooling system must be opened. as follows:

Description	Valve
No.1 ECR Unit	
Cooling fresh water inlet valve	WF045F
Cooling fresh water outlet valve	WF046F
No.2 ECR Unit	
Cooling fresh water inlet valve	WF047F
Cooling fresh water outlet valve	WF048F
Port Main Switchboard Unit	
Cooling fresh water inlet valve	WF049F
Cooling fresh water outlet valve	WF050F
Starboard Main Switchboard Unit	
Cooling fresh water inlet valve	WF051F
Cooling fresh water outlet valve	WF052F

b) Ensure that cooling water is flowing through the condenser of the air conditioning units.

c) Ensure that electrical power to the air conditioning unit is switched on. The power should be turned on for some time before the unit is started in order to warm the lubricating oil.

d) At the thermostat, select the desired room temperature.

e) Press the PBS START pushbutton to start the fan and check that the fan is working correctly.

f) Press the COOLING pushbutton to start the cooling system operating.

The package air conditioning unit will operate automatically and maintain the desired temperature in the room. Gauges are provided at the front of the unit showing the compressor discharge pressure and the evaporator pressure.

A thermostat regulates the electric heater from overheating and an overcurrent relay is fitted to the circuit to protect it in the event of excess current.

Maintenance of the unit under normal operation should be limited to a monthly check for refrigerant loss and cleaning of the air filter. A more intensive inspection should be carried out every year which should include a check of the fan belt tension and condition.

Daily checks should be made for vibration, inability to maintain the desired temperature and refrigerant gas pressures.

More detailed information is available in the manufacturer’s handbook for this equipment.

Engine Control Room AC Unit

2.13.4 ENGINE ROOM WORKSHOP PACKAGE AIR CONDITIONING UNITS

Workshop Package Air Conditioning Unit

Maker:	Century
No. of sets:	2
Model:	MP-G10HF3
Type:	Cooling with R404c refrigerant unit
Cooling capacity:	30,000kcal/h

Introduction

The units have a refrigeration compressor, condenser and evaporator. The refrigeration unit is located at the bottom of the air conditioning cabinet and the evaporator is located above the refrigeration section. Above the evaporator coil is the fan. The fan draws air from the workshop and passes it over the evaporator coils before discharging it back into the workshop. A suction filter is fitted at the air inlet to the package air conditioning unit. This filter must be cleaned at frequent intervals in order to ensure that the air flow across the cooler is adequate.

The condenser unit is cooled by water circulating from the central fresh water cooling system and this must be operating and the supply and return valves opened before the package unit can be put into operation.

The control at the front of the package air conditioning unit contains a power switch and when this is turned on the unit is available for operation. A STOP pushbutton allows the unit to be stopped and a PBS FAN pushbutton starts the fan. The fan may be operated alone in order to provide ventilation. Pressing the COOL pushbutton starts the cooling system operating.

The refrigeration system is provided with a dual high/low pressure cut out switch and there is a fusible plug fitted to the condenser which will fail should the temperature become excessive.

An oil heater is started when the main power switch is turned to the ON position.

The adjustable air outlet thermostat has a range of 0 - 40°C. The HP trip operates at 2.205MPa and is manually reset. The LP cut out operates at 265kPa and automatically resets at 490kPa.

Procedure for Operation of the Unit Coolers

a) Prior to operating the unit coolers the cooling water inlet and outlet valves from the central fresh water cooling system must be opened as follows:

Description	Valve
Workshop Air Conditioning Unit No.1	
Cooling fresh water inlet valve	WF035F
Cooling fresh water outlet valve	WF036F
Workshop Air Conditioning Unit No.2	
Cooling fresh water inlet valve	WF037F
Cooling fresh water outlet valve	WF038F

b) Ensure that cooling water is flowing through the condenser of the air conditioning units.

c) Ensure that electrical power to the air conditioning unit is switched on. The power should be turned on for some time before the unit is started in order to warm the lubricating oil.

d) At the thermostat, select the desired room temperature.

e) Press the PBS START pushbutton to start the fan and check that the fan is working correctly.

f) Press the COOLING pushbutton to start the cooling system operating.

The package air conditioning unit will operate automatically and maintain the desired temperature in the room. Gauges are provided at the front of the unit showing the compressor discharge pressure and the evaporator pressure.

A thermostat regulates the electric heater from overheating and an overcurrent relay is fitted to the circuit to protect in the event of excess current.

Maintenance of the unit under normal operation should be limited to a monthly check for refrigerant loss and cleaning of the air filter. A more intensive inspection should be carried out every year which should include a check of the fan belt tension and condition.

Daily checks should be made for vibration, inability to maintain the desired temperature and refrigerant gas pressures.

More detailed information is available in the manufacturer’s handbook for this equipment.

2.13.5 INCINERATOR AND GARBAGE DISPOSAL

Incinerator

Maker:	Teamtec (Golar)
Type:	OGS 400C
Capacity:	400 litres of solid waste per charge
	65 litres/h (waste oil)
	500,000kcal/hour

Introduction

The incinerator can burn solid garbage waste and engine room waste oil and diesel oil can be burned to assist the total combustion when required. The unit is capable of burning 65 litres of waste oil per hour or 400 litres per charge of compacted solid waste or a combination of both to a maximum of 500Mcal/h.

The incinerator consists of four main parts:

- Combustion chamber with diesel oil burner, sludge burner, pilot fuel heater and electric control panel
- Flue gas fan
- Flue gas damper
- Waste oil circulating pump and tank heater

The combustion chamber is a box chamber with a hinge mounted feeding sluice and an ash door which can only be opened when the incinerator is not burning. The feeding sluice is flare-back safe and can be used during incineration. When it is necessary to burn large amounts the sluice can be opened like a door in order to feed the combustion chamber, but this can only be done when the incinerator is stopped. The control system prevents the door from being opened before the correct cooling down temperature is reached.

The flue gas outlet is located at the top of the chamber. The garbage is ignited by radiant heat from the burner. Remnants of particulate matters in the gas flow are neutralised by the burner. As the fumes leave the chamber, cooling air drawn from the lower part of the casing, is mixed with the flue gases to bring the temperature down to approximately 310°C before discharge.

The burning process is monitored by the PLC (programmed logic controller) and scanned by a photo resistor. The temperatures are also monitored/regulated automatically by the PLC control system. A sight glass in the inspection door is provided to enable the operator to observe the amount of garbage in the chamber and the functioning of the system.

The combustion chamber is of steel construction and insulated. A double steel casing with a cooling air jacket forms the outside of the combustion chamber.

The combustion chamber is equipped with a two-stage diesel oil burner and an atomizing nozzle for sludge. The burner unit is monitored by the PLC and has built in primary air fan and diesel oil pump.

The electrical control panel is installed on the incinerator and it contains fuses, starters, PLC and an operator panel. The operator panel which is located at the right side of the control panel, has an LCD display and keys for selecting burner modes.

The purpose of the flue gas fan is transportation of the flue gas from the combustion chamber and to create a negative pressure in the furnace. The same fan draws ambient air through the cooling jacket on the combustion chamber and the hot gas from the furnace is diluted with the cooling air at the flue gas outlet on the combustion chamber in order to reduce the temperature to approximately 340°C.

The automatic flue gas damper adjusts the gas flow in the flue gas duct and it is controlled from the electric control panel which senses the negative pressure in the furnace and regulates the damper to give the desired pressure.

Waste oil is transferred to the incinerator from the waste oil service tank by means of a circulating pump and the return line ensures an even temperature throughout the waste oil charge. There are two quick-closing suction valves on the waste oil service tank, the upper one being at the 40% level. The tank is provided with level monitoring equipment and a high level switch for stopping the sludge pump.

A heater, controlled by a thermostat, keeps the waste oil temperature around the set point of 60 to 90°C.

A drain valve is fitted for draining off the water.

Summary of Regulations

Annex V of MARPOL 73/78, the regulations for the Prevention of Pollution by Garbage from Ships, controls the way in which waste material is treated on board ships. Although it is permissible to discharge a wide variety of garbage at sea, preference should be given to disposal by utilising shore facilities where available. A summary of the garbage disposal regulations are given below.

The special areas are as follows:

- The Mediterranean Sea
- The Baltic Sea
- The Black Sea
- The Red Sea
- The Persian Gulf
- North West European Waters
- The Gulf of Aden
- The Antartic
- The Wider Caribbean Area

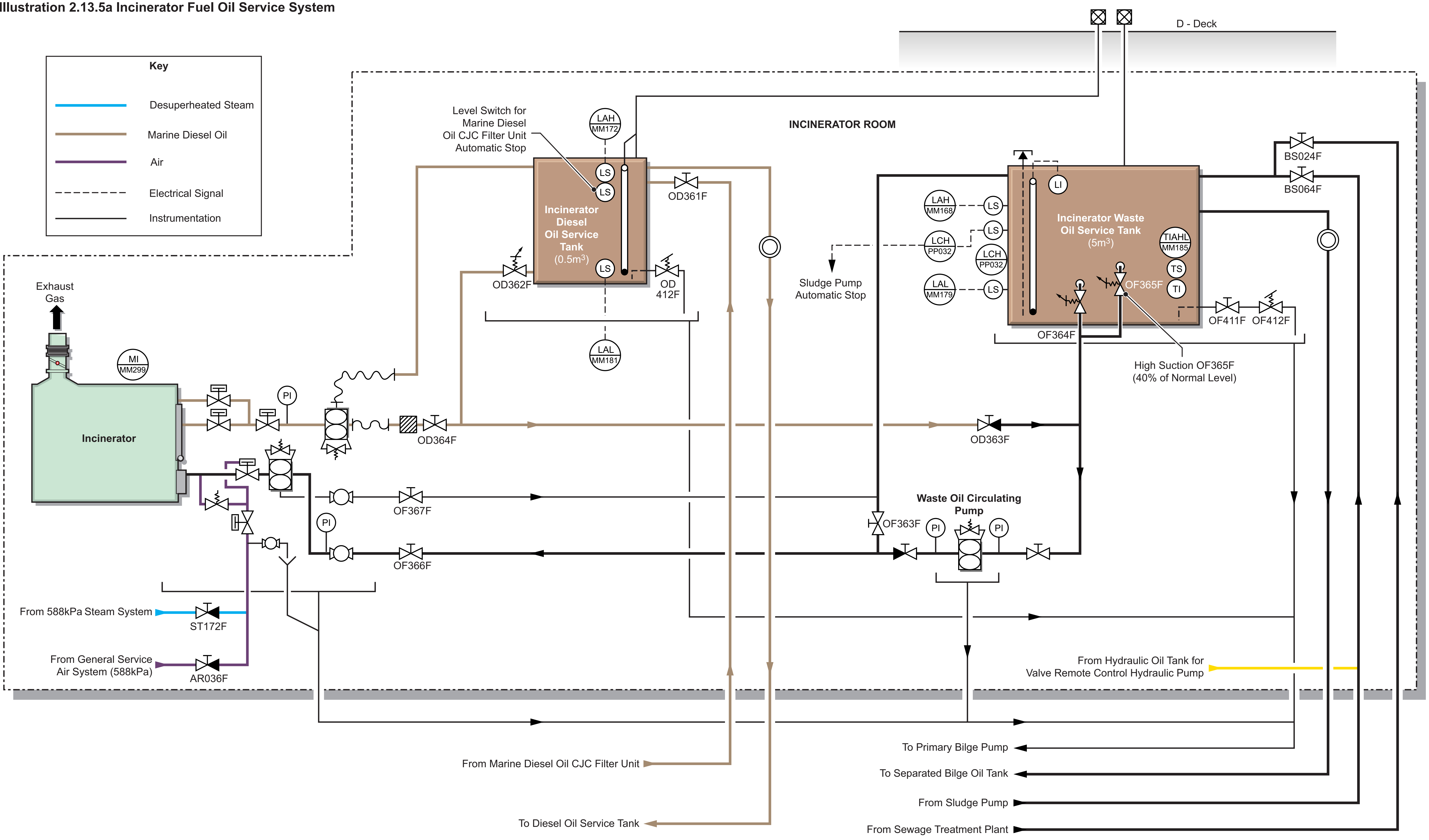
Garbage Disposal Outside Special Areas

- Disposal of plastics including plastic ropes and garbage bags are prohibited.
- Floating dunnage, lining and packaging are allowed over 25 miles offshore.
- Paper, rags, glass, bottles, crockery and other similar materials are allowed over 12 miles offshore.
- All other garbage including paper rags etc. are allowed over 3 miles offshore.
- Food waste can be disposed in all areas over 12 miles offshore.

Due regard should also be taken of any local authority, coastal, or port regulations regarding the disposal of waste. To ensure that the annex to MARPOL73/78 is complied with, waste is treated under the following cases:

- Food waste
- Burnable dry waste, plastic and others
- Non-burnable dry waste
- Other waste, including oily rags and cans, chemical cans and incinerator ash

Illustration 2.13.5a Incinerator Fuel Oil Service System



Garbage Disposal Procedures

Food Waste

Food waste production for approximately 50 people is given as 15 to 25kg per day or 75 to 125 litres per day without compacting.

The daily food waste produced is collected in bags in the galley.

Burnable Dry Waste

Dry waste production for approximately 50 people is given approximately 30kg per day or 1,000 to 1,500 litres per day. The volume can be reduced by a factor of 5 by shredding the waste.

Dry waste from the accommodation is collected, shredded and then transported to the incinerator room for burning.

Dry waste from the engine room is taken directly to the incinerator room.

Non-Burnable Dry Waste

Non-burnable dry waste production for approximately 50 people is given as approximately 20kg per day or 80 to 100 litres per day without compacting.

Non-burnable waste, from the accommodation is collected in the waste management room before overboard dumping or discharge ashore.

Other Waste

- Oily rags may be burnt in the incinerator in small quantities
- Cans that have contained oils or chemicals must be stored before discharge ashore
- Incinerator ash must be stored on board in the location of a special site if less than 12 miles offshore, otherwise the ash can safely be dumped overboard

Procedure for the Operation of the Incinerator

Preparation

a) Clean the waste oil tank strainer and drain any water from the tank.

b) Heat the waste oil tank to 80-100ºC.

c) Open the low waste oil supply valve to the incinerator OF364F (the high level valve OF365F may be used if required) and the return valve OF363. Open the waste oil circulating pump inlet and outlet valves and start the waste oil circulating pump.

d) Inspect the combustion chamber for foreign objects and ash or slag and remove these if necessary.

e) Check the combustion chamber air inlets are clear.

f) Clean the photo cell.

g) Clean the ignitor electrodes.

h) Check the condition of the refractory.

i) Clean the diesel oil burner.

j) Clean the waste oil burner.

k) Supply atomising air to the burner unit.

l) Close the ash door and loading door.

m) The exhaust dampers should be fully opened.

The furnace should be warmed up by burning diesel oil at first, because the best combustion cannot be established in a cool furnace.

The incinerator DO service tank outlet valve OD362F should be open and the DO supply valve to the incinerator OD364F should also be open.

The incinerator may be operated on one of a number of predefined programs which are chosen at the control panel.

Stop
The incinerator is shut down and undergoes the shutdown procedure with all previously selected programs cancelled.

Slagging
To be used when slagging the incinerator.

Solid Waste
Used when burning solid waste in the incinerator. Operation of the incinerator is controlled by the PLC to ensure complete combustion of the garbage loaded into the furnace.

Sludge
Allows for the burning of waste oil at the incinerator's maximum capacity.

Sludge Pump
Allows for manual start of the sludge transfer pump. The pump will stop automatically when the level switch in the tank is activated. The pump may be stopped by pressing the STOP pushbutton or the SLUDGE PUMP pushbutton.

Sludge Service Tank Heating
Allows for manual starting of the waste oil tank heating system.

Detailed instruction for setting these programmes in the incinerator operator panel MAC E300 are given in the incinerator operating manual. Once set the programmes should not be changed without good reason. The manual also provides a full list of alarms, error messages, running information, etc. which may be displayed on the MAC E300 graphic screen.

Burning Solid Waste

a) Turn the main switch on the control panel to the ON position.

b) Load the incinerator and close the incinerator doors

c) At the program controller select the burning time. This depends upon the amount of solid waste but is automatically repeated from the previous burning. If 0 burning time is selected the burning will continue until the STOP button is pressed.

d) If SLAGGING is shown in the display press the STOP button; the flue gas FG fan will stop and READY will appear in line 4 of the display.

e) Press the SOLID WASTE pushbutton and SOLID WASTE will appear in line 4 of the display for 5 seconds. The incinerator program will commence with the flue gas fan and diesel oil burner operating when the conditions are correct. Green LEDs for FG Fan, Burner and Running are illuminated.

f) When the set burning time has expired or the STOP button is pressed the burner will stop and the cooling down sequence will commence. COOLING appears in line 4 of the display.

g) When the temperature of the combustion chamber has fallen to 170^{o}C the flue gas fan will stop and the door interlocks will be released so that the doors may be opened.

Burning Waste Oil

a) Fill the incinerator waste oil service tank (see section 2.6.4.) and activate the tank heater by pressing the SLUDGE HEATER pushbutton. The green SL HEATER LED will be illuminated.

b) Drain water from the incinerator waste oil service tank and start the circulation pump by pressing the SLUDGE PUMP pushbutton. The green SL PUMP LED will be illuminated.

c) Check the atomising air supply pressure is correct between 588kPa - 784kPa.

d) If SLAGGING is shown in the display press the STOP button; the flue gas fan will stop and READY will appear in line 4 of the display.

e) Press the SLUDGE pushbutton and SLUDGE will appear in line 4 of the display for 5 seconds. The incinerator will commence the procedure for burning waste oil and the green FG Fan, Burner, SL Heater, SL Pump and Running LEDs will be illuminated.

f) Waste oil will be burned for a defined burning period if one has been set or until the waste oil circulation pump stops because the low level switch on the incinerator waste oil service tank has been activated.

g) When the time has expired or the stop signal has been activated the burner will stop and the cooling down sequence commences with COOLING being displayed in line 4 of the display.

h) When the temperature of the combustion chamber has fallen to 170^{o}C the flue gas fan will stop and the door interlocks will be released so that the doors may be opened.

Emergency Stops

The incinerator may be stopped in an emergency by turning the main switch on the control panel to the OFF position or by activation of the EMERGENCY STOP pushbutton located outside the incinerator room. The incinerator waste oil quick-closing valves and the incinerator DO service tank quick-closing valve may be tripped by means of the wires located outside the incinerator room or by means of the quick-closing valve system from the fire control station.

In the event of a loss of electrical power during a blackout when the incinerator is running it is important to start the flue gas fan as soon as possible upon restoration of electrical power in order to cool the combustion furnace effectively. The incinerator program automatic restart is set to AUTO and the STOP pushbutton is pressed.

Incineration Of Solid Waste (trash, rags, waste oil filter cartridges etc.)

a) Control the size of charge depending on the type of material.

b) For simultaneous burning of solid and oily wastes, reduce the rate of waste oil burning to avoid an overheat trip.

c) Warm up the furnace as described previously before charging with solid waste.

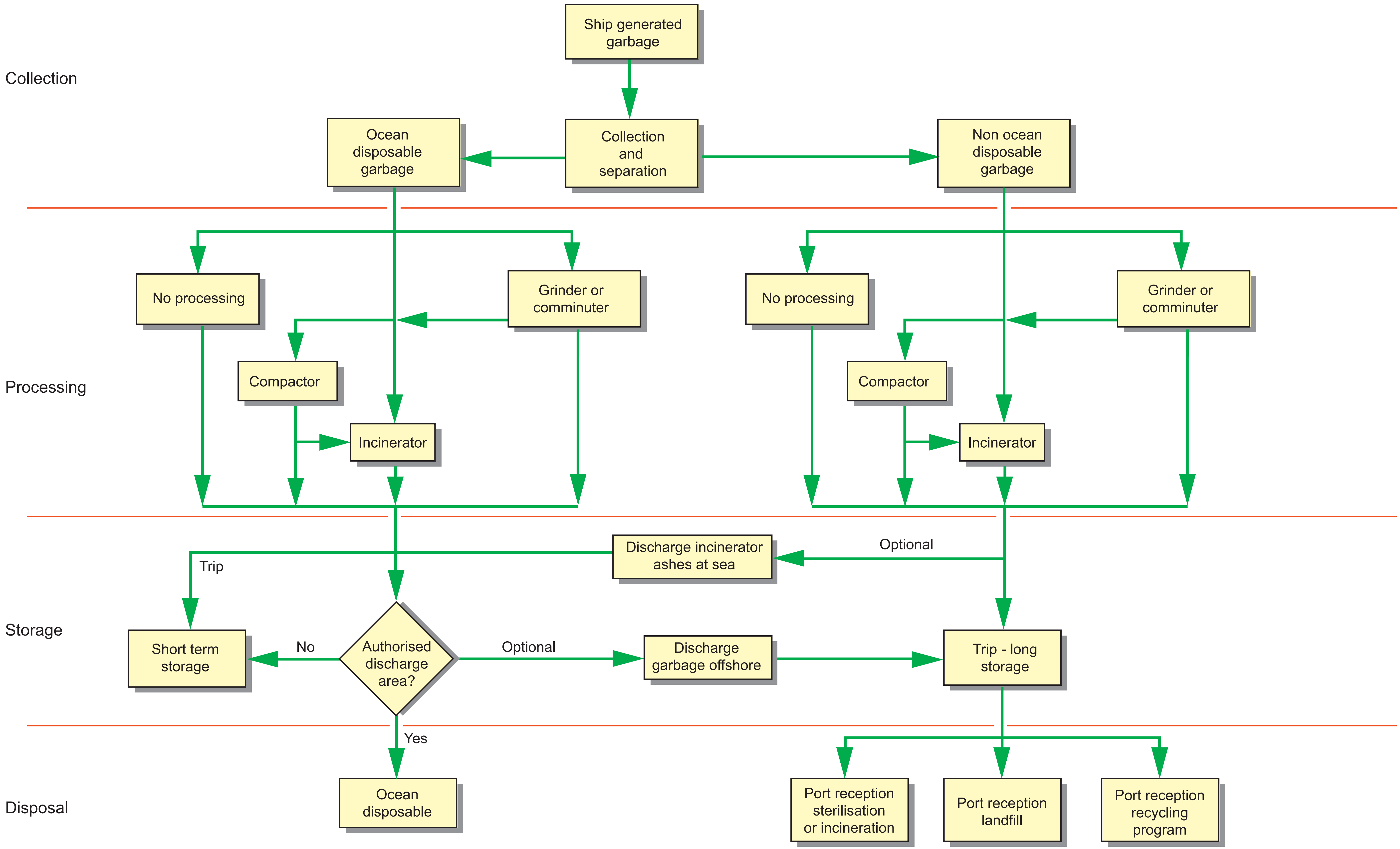
d) Remove ash before running.

e) To avoid damage to the furnace and burner, ensure that the fans are running while solid waste is burning.

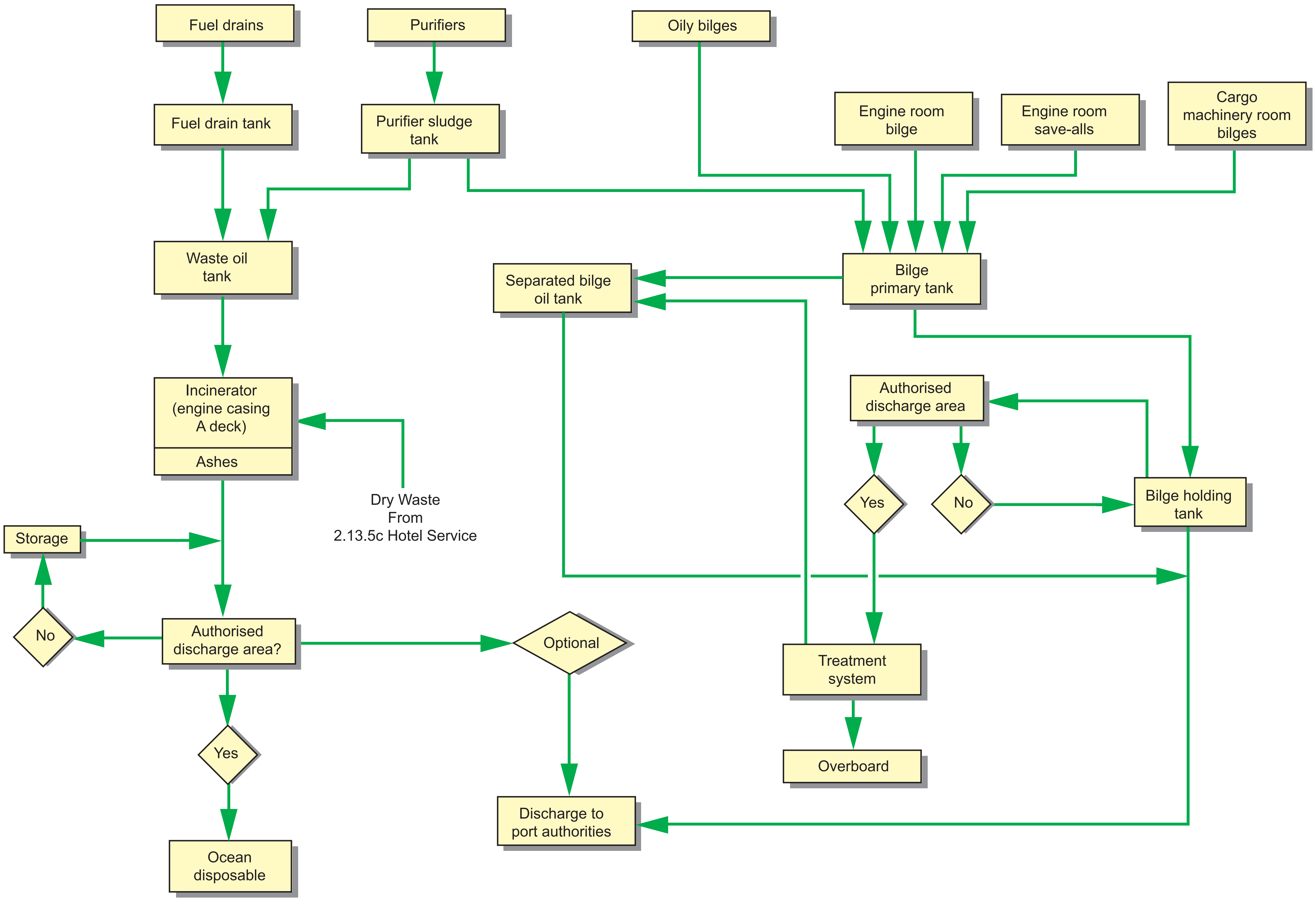
CAUTION

Oily rags etc., must be loaded in small quantities only (approximately 1.5kg per loading) and must not be present in the combustion chamber unless the induced draught fan is running.

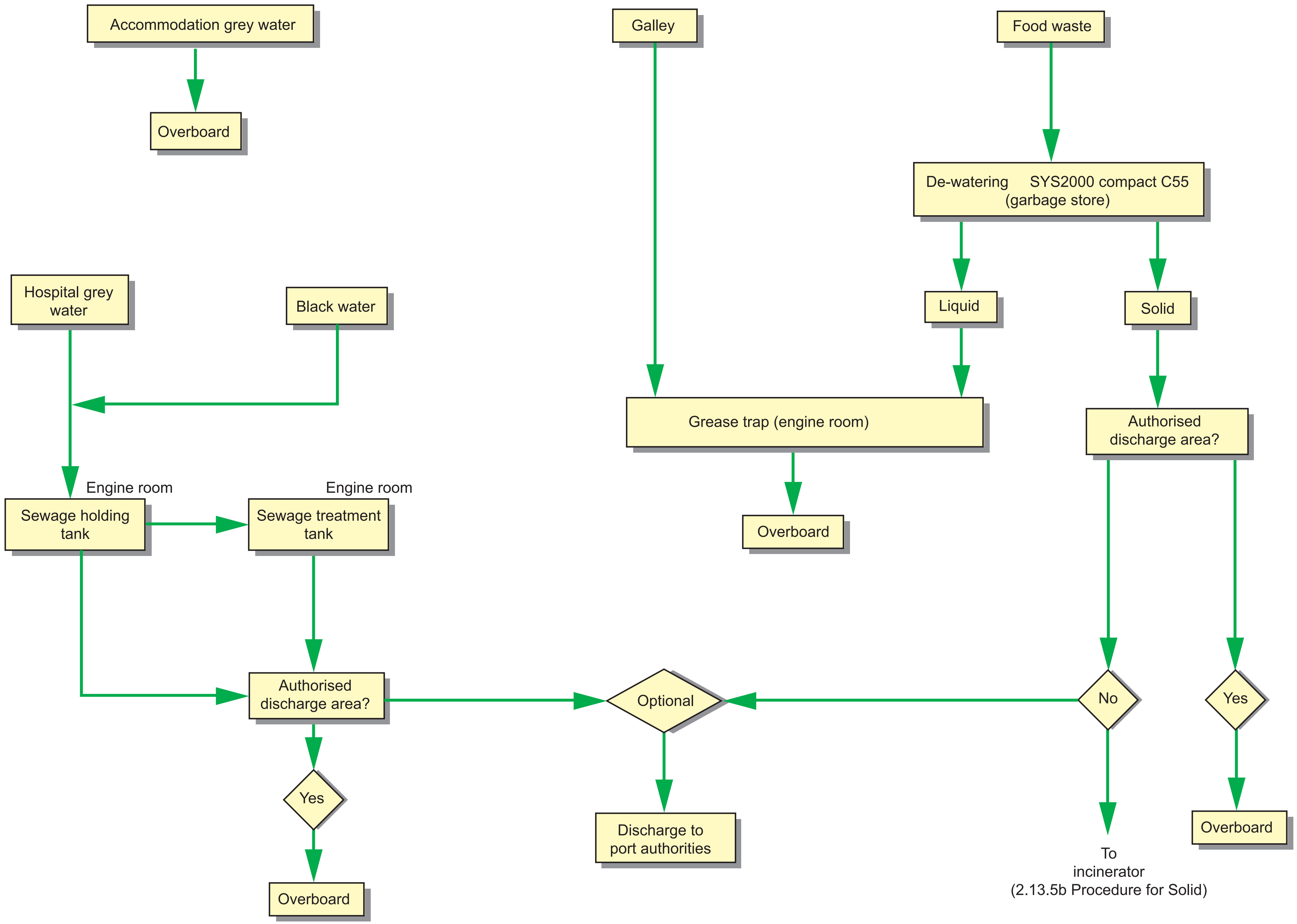
2.13.5b Garbage Treatment Procedure



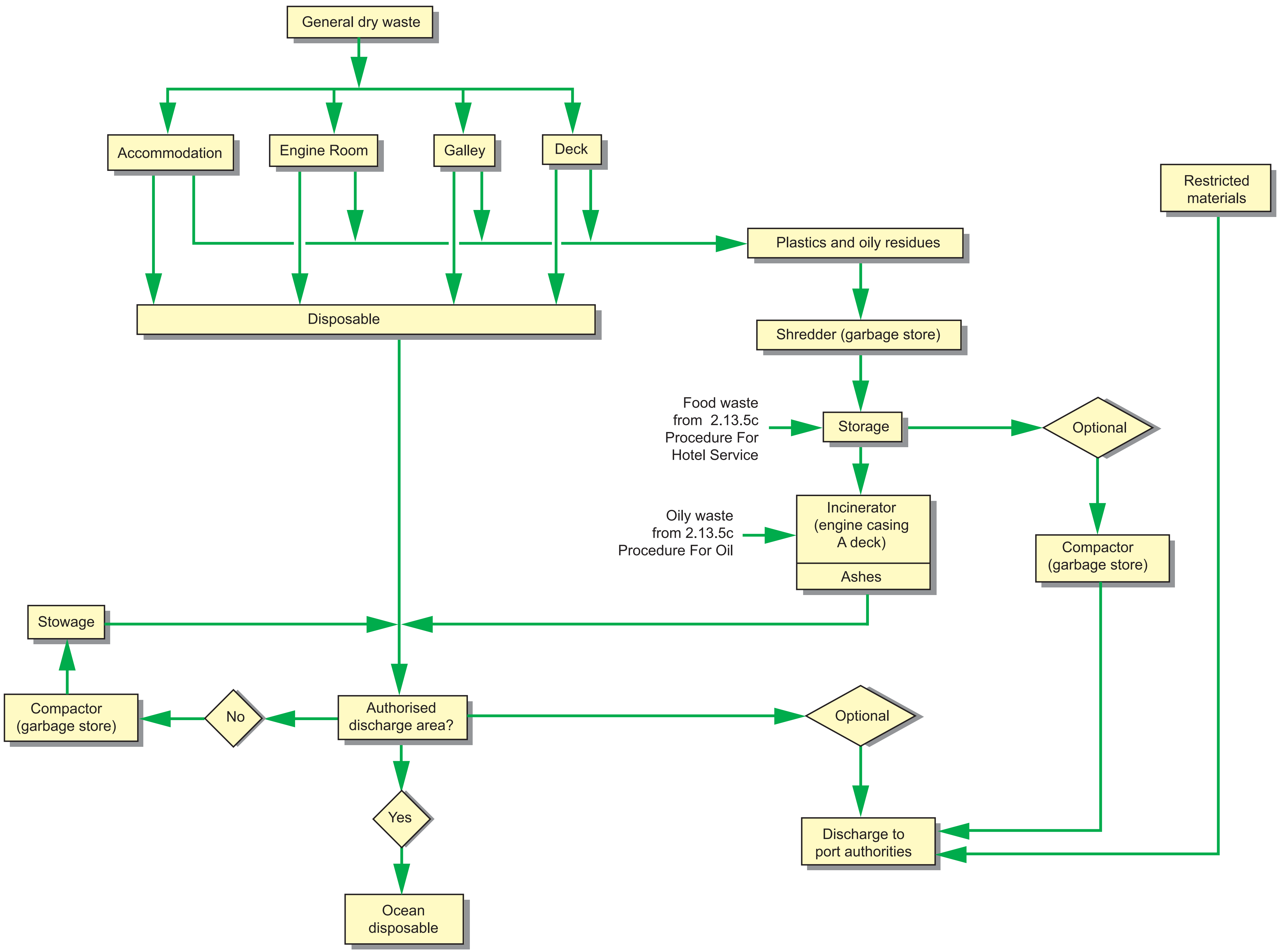
2.13.5c Garbage Treatment Procedure for Oil



2.13.5d Garbage Treatment Procedure for Hotel Services



2.13.5e Garbage Treatment Procedure for Solid Waste



2.13.5f Garbage Treatment Caution Plate

CAUTION

Garbage Type	Outside Special Areas	** Special Areas	*** Offshore Platforms and Associated Vessels
Plastics - Includes Synthetic Ropes, Fishing Nets and Plastic Bags	Disposal Prohibited	Disposal Prohibited	Disposal Prohibited
Floating Dunnage, Lining and Package Materials	> 25 Miles Offshore	Disposal Prohibited	Disposal Prohibited
Paper, rags, Glass, Metal, Bottles, Crockery and Similar Refuse	> 12 Miles Offshore	Disposal Prohibited	Disposal Prohibited
* All Other Garbage Including Paper, Rags Glass, etc. Comminuted or Ground	> 3 Miles Offshore	Disposal Prohibited	Disposal Prohibited
Food Waste Not Comminuted or Ground	> 12 Miles Offshore	> 12 Miles Offshore	Disposal Prohibited
* Food Waste Comminuted or Ground	> 3 Miles Offshore	> 12 Miles Offshore	> 12 Miles Offshore
Mixed Refuse Bags	****	****	****

* Commuted or ground garbage must be able to pass through a screen with a mesh size no larger than 25mm.

** Garbage disposal regulations for special areas shall take effect in accordance with regulation 5(4) (B) of annex V.

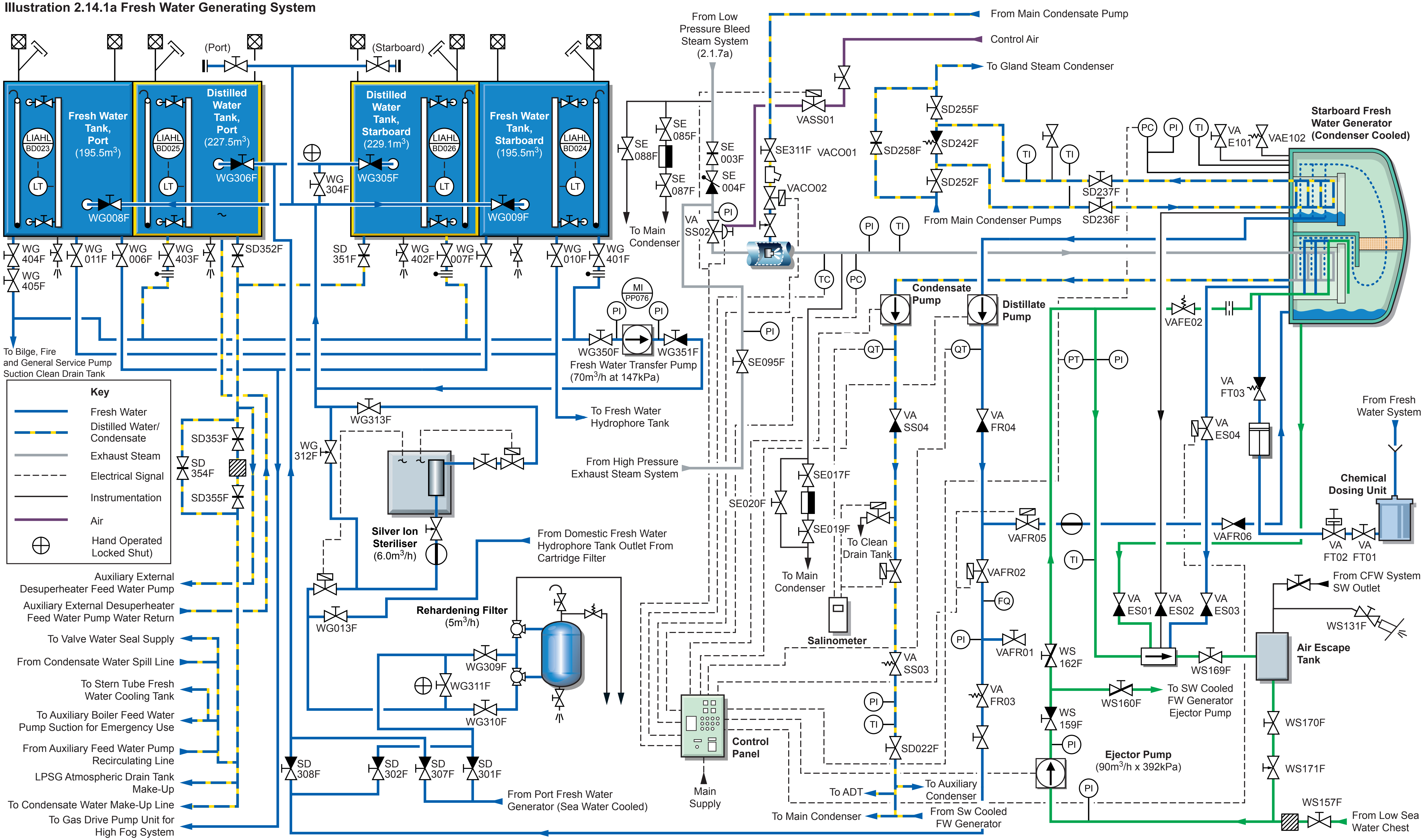
**** When garbage is mixed with other harmful substance having different disposal or discharge requirements, the more stringent requirements shall apply

*** Offshore platforms and associated vessel include all fixed or floating patforms engaged in exploration or exploration of seabed mineral resources and all vessel alongside or within 500 metres of such platforms

2.14 Sanitary and Fresh Water Systems

Illustrations

Illustration 2.14.1a Fresh Water Generating System



2.14 SANITARY AND FRESH WATER SYSTEMS

2.14.1 FRESH WATER GENERATING SYSTEM

Fresh Water Generators

Maker:	Alfa Laval Desalt A/S
No. of sets:	2
Type:	Low pressure
Model:	VPS-36-125
Capacity:	60 tons/day

Fresh Water Hydrophore Pumps

Maker:	Shinko Industries Co.
No. of sets:	2
Type:	Vertical centrifugal
Model:	VJ 50M
Capacity:	$10m^3/h$ at 70mth

Hot Water Circulating Pumps

Maker:	Shinko Industries Co.
No. of sets:	2
Type:	Horizontal centrifugal
Model:	HJ 40M
Capacity:	$2.0m^3/h$ at 10mth

Fresh Water Transfer Pump

Maker:	Shinko Industries Co.
No. of sets:	1
Type:	Vertical centrifugal
Model:	SVS 100M
Capacity:	$70m^3/h$ at 15mth

Steriliser (Silver Ion)

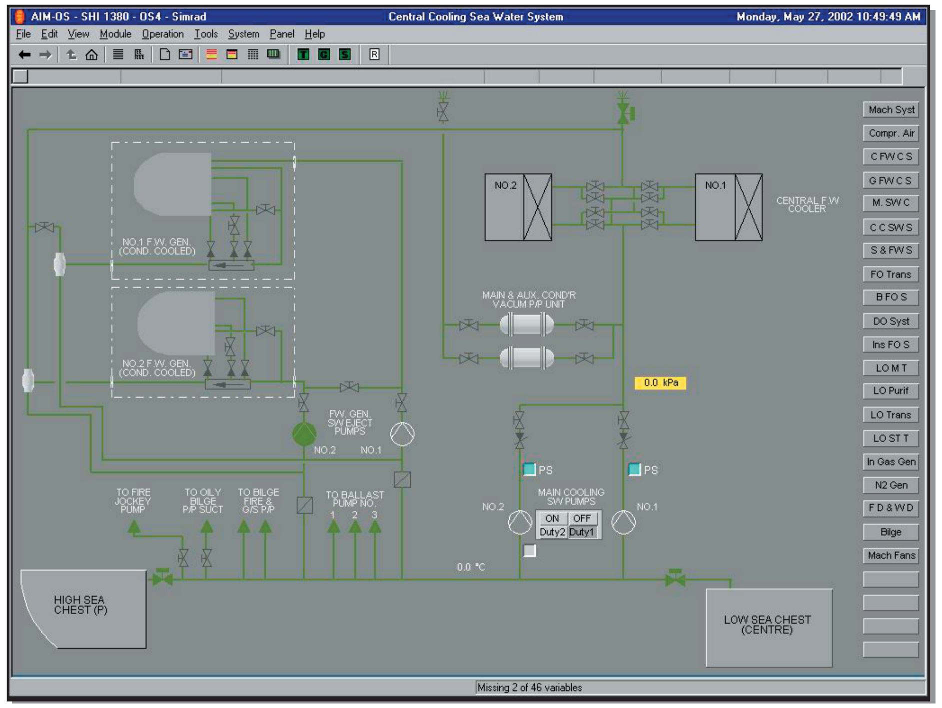
Maker:	Jowa AB
No. of sets:	1
Model:	Jowa AG-S
Type:	Silver ion
Capacity:	$6.0m^3/h$ fresh water

Rehardening Filter

Maker:	Se-Won Industries
No. of sets:	1
Model:	SWM 5.0
Type:	Hardness and pH adjusting
Capacity:	$5.0m^3/h$ fresh water

Calorifier

Maker:	Kangrim Industries
No. of sets:	1
Model:	LF15SEDN-1
Type:	Steam and electric
Capacity:	$2.0m^3/h$, 12,000kCal/h, 150kW



EVAPORATOR/DISTILLATION PLANT SYSTEM

Introduction

There are two fresh water distillation plants installed and these operate at low pressure using desuperheated steam as the heat source (see section 2.1.7). No.2 distillation plant is condensate cooled and No.1 distillation plant is sea water cooled.

Each fresh water generator is self-contained with its own combined brine/air ejector and distillate pump. The combined brine/air ejector is driven by the distillation plant SW feed pump (see section 2.3.2) which creates a vacuum in the system in order to lower the evaporation temperature of the feed water.

The feed water is introduced into the evaporator section through a spring operated regulating valve and is distributed into every second plate channel via the evaporation channels.

Desuperheated steam is distributed into the remaining channels, thus transferring its heat to the feed water in the evaporation channels.

Having reached boiling temperature, which is lower than at atmospheric pressure, the feed water undergoes a partial evaporation and the mixture of generated vapour and brine enters the separator vessel. Here the brine is separated from the vapour and extracted by the combined brine/air ejector.

After passing through a demister the vapour enters every second plate channel in the condenser section.

The sea water supplied by the distillation plant SW feed pump distributes itself into the remaining channels, thus absorbing the heat being transferred from the condensing vapour in the No.1 SW cooled FW generator. This heat transfer is between the generated vapour and main condensate for No.2 condensate cooled FW generator.

The produced fresh water is extracted by the distillate pump and discharged through a salinometer which monitors the salinity of the water. Should the salinity rise above a preset value an alarm is sounded and the condensate is discharged back to the evaporator.

Distillate from the FW evaporator is discharged to the domestic fresh water tanks and the distilled water tanks. Water from the distillation plant flows directly to the distilled water tanks but the supply of water to the domestic fresh water tanks first passes through a rehardening filter and then a silver ion steriliser before flowing to the tanks.

Main Components

A fresh water generator consists of the following components:

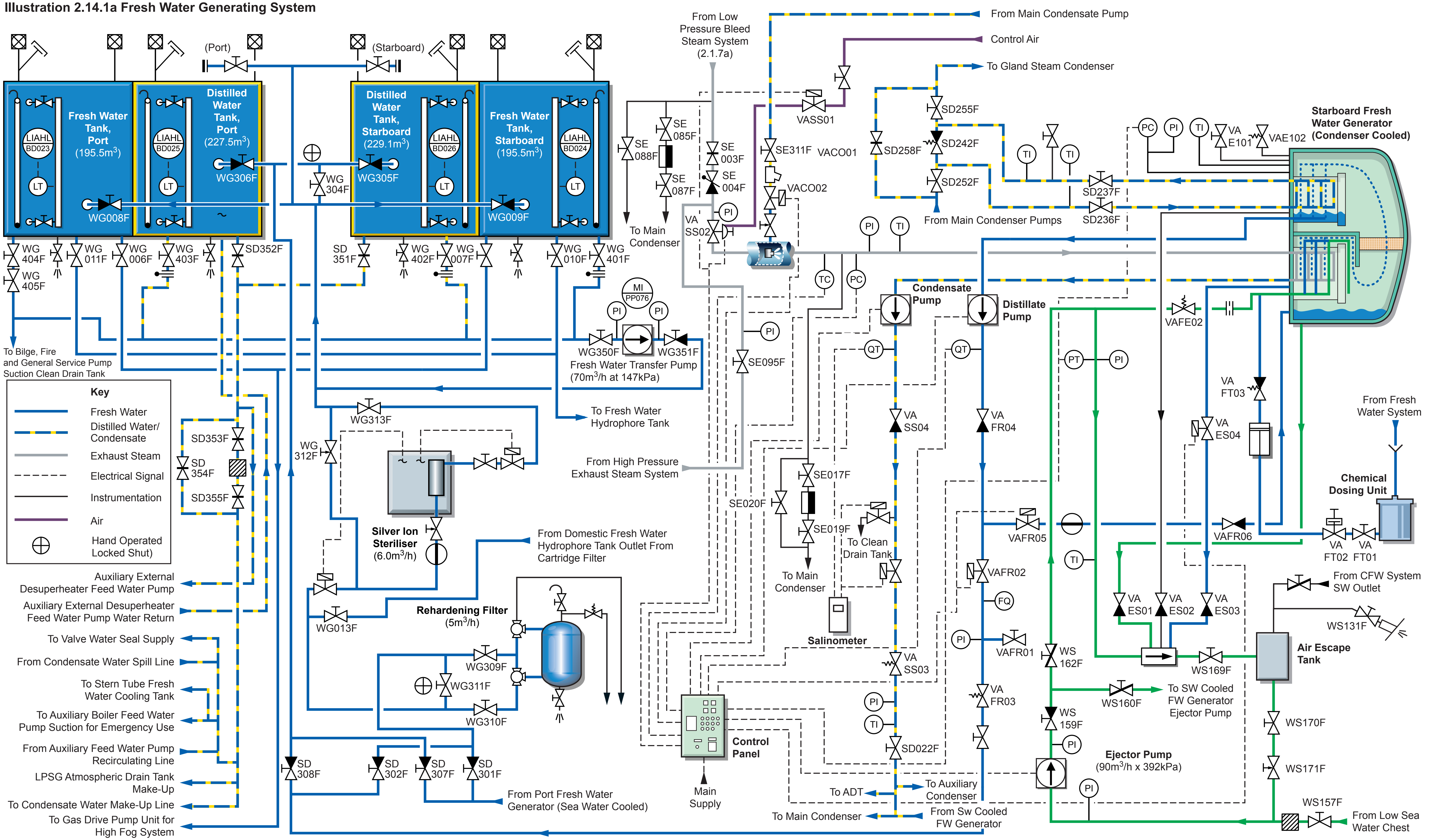
Evaporator Section

The evaporator section consists of a plate heat exchanger and is enclosed in the separator vessel.

Separator Vessel

The separator separates the brine from the vapour.

Illustration 2.14.1a Fresh Water Generating System



Condenser Section

Just like the evaporator section the condenser section consists of a plate heat exchanger enclosed in the condensing vessel.

Combined Brine/Air Ejector

The ejector extracts brine and incondensable gases from the separator vessel and the condensing chamber.

Distillation Plant SW Feed Pumps

The distillation plant SW feed pumps are single-stage centrifugal pumps.

These pump supply the SW cooled FW generator condenser with sea water and the brine/air ejector with motive water, as well as feed water for evaporation.

Distillate Pump

The distillate pump is a single-stage centrifugal pump.

The distillate pump extracts the produced fresh water from the condenser and pumps the water to the fresh water tank.

Salinometer

The salinometer continuously checks the salinity of the produced water and steam heating condensate returns. The alarm set points are adjustable. for the condensate returns, these will be pumped to the clean drains tank if contaminated, otherwise they will be pumped to the ADT or the main condenser.

Control Panel

A control panel contains motor starters, running lights and contacts for remote alarm. A salinity panel is located at the side of the distillation plant with LCD indicators ranging from 0.5 - 20ppm. The panel also contains a 10ppm test function and control buttons to set the alarm point.

Alarms

Tag	Description	High Alarm
MM011/2	Condensate drain salinity	1.5ppm
MM013/4	Distilled water salinity	1.5ppm

Desuperheating System

Steam supplied to the distillation plant comes from the HP exhaust steam system and from the low pressure turbine bleed steam system. The steam valve is a combined steam pressure regulating valve and safety cut-off valve. Steam pressure is regulated during operation by means of the controller mounted on the control panel, the controller receiving an input signal from the steam inlet temperature transmitter. The maximum steam inlet temperature is 100°C.

The desuperheating system ensures that the correct steam conditions exist at the inlet to the heat exchanger. When required, condensate water from the main condensate pump is injected into the steam flow to the heat exchanger.

Operating Procedure

The system described is for No.1 distillation plant, for No.2 plant condensate cooling must be operated, as shown in illustration 2.14.1a.

WARNING
Do not operate the plant in polluted water. Fresh water must not be produced from polluted water, as the produced water will be unsuitable for human consumption.

Starting and Stopping Procedures

a) Ensure that all pressure and temperature gauge root valves are open.

b) Set the No.1 distillation plant SW feed pump valves as described in section 2.3.2., ensuring that the overboard discharge valve WS131F is open. This valve is remotely operated from the ship side valve control screen in the IAS.

c) Close the air screw (vacuum release valve) on the separator.

d) Start the SW feed pump for the distillation plant from the evaporator's IAS display screen to create a vacuum of a minimum of 90%.

e) Open the control air supply to the steam pressure regulating valve and the flow regulating valve.

f) Open the evaporator and condenser eductor air suction valves.

Pressure at the combined brine/air ejector inlet should be a minimum of 350kPa. Back pressure at the combined brine/air ejector outlet should be no more than 60kPa.

Evaporation

When there is a minimum of 90 % vacuum (after maximum 10 minutes).

g) Open valves VA-FT-01/02 for the feed water treatment. Ensure that the chemical dosing tank is full.

h) Open the main condensate inlet valve SD310F for desuperheating.

i) Open the heater condensate valves SD028F and SD029F to the clean drain tank.

j) Open the inlet steam drain valves SE017F and SE019F.

k) Start the heating steam condensate extraction pump.

l) Open the steam supply valve from the HP exhaust steam system.

m) Open the steam pressure regulating valve by adjusting the temperature controller in the control panel until the desired steam temperature is reached (maximum 88°C).

n) Once the quality of heating steam drain condensate is confirmed as good, shut valves SD028F and SD029F and open SD201F to the main condenser

The boiling temperature will now rise while the obtained vacuum drops to approximately 85%, this indicates that evaporation has started. Open the distilled water discharge valve VA-FR-04 from the pump and open the recirculating valve VA-FR-06 to the evaporator and set the salinometer to dump.

When evaporation has commenced:

o) Start the distillate pump.

p) Open the supply valves to the distilled water tanks or fresh water tanks as required.

q) Reset on the salinometer and check its operation.

DISTILLATE TRANSFER SYSTEM

Introduction

Distillate is pumped from the evaporator by the distillate pump and may be discharged to the distilled water tanks or the domestic fresh water tanks. Distillate is pumped directly to the distilled water tanks but if it is to be pumped to the domestic water tanks it is first passed through the rehardening filter and then the silver ion steriliser.

The silver steriliser destroys bacteria and leaves a residue of silver ions in the stored water thus providing for effective sterilisation whilst the water is stored in the tanks. The rehardening filter removes carbonic acid gas from the water to produce a neutral or slightly alkaline condition.

As the water passes between two electrodes in the sterilising unit, through which a small current is passed, the ions are released and sterilise the water. Sterilisation by this method ensures that the water is maintained in a good condition, even when stored in the tanks for a period of time. The silver electrodes should be inspected and changed when all the silver coating has depleted. The dosing of the water is automatic and is set depending on the flow of the water.

Normally one domestic fresh water tank is in use and the other tank is being filled. Domestic fresh water and distilled water tanks may be filled at the same time.

Procedure for Pumping Distillate to the Distilled Water Tanks

a) Operate the FW generator as described above and open the distilled water tank filling valves as required. There are port and starboard distilled water tanks of 227.5m^3 (port) and 229.1m^3 (starboard) which are located in the steering gear compartment. The port tank filling valve is WG306F and the starboard tank filling valve WG305F.

b) Open the distilled water tank line valve from No.1 FW generator WG307F or line valve WG308F from No.2 FW generator.

Procedure for Pumping Distillate to the Domestic Fresh Water Tanks (Capacity 195.5m^3 each)

a) Operate the FW generator as described above and open the domestic fresh water tank filling valves as required, WG008F for the port tank and WG009F for the starboard tank.

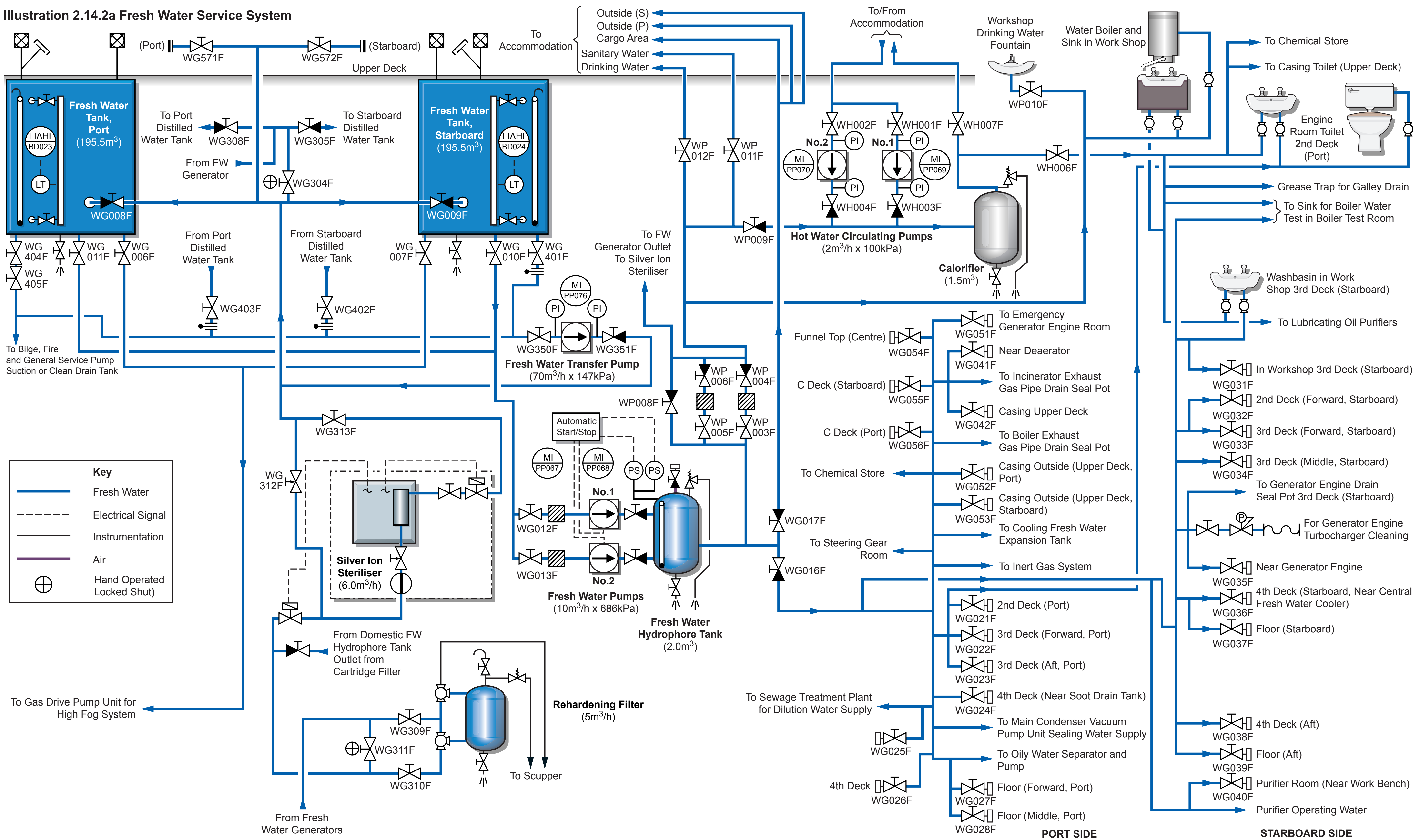
b) Open the FW generator line valves to the rehardening filter, WG301F for No.1 FW generator or WG302F for No.2 FW generator.

c) Open the rehardening filter inlet valve WG309F and outlet valve WG310F and close the bypass valve WG311F (this valve is normally closed).

d) Open the silver ion steriliser outlet valve WG313F and supply electrical power to the silver ion steriliser unit. The control unit will operate the supply solenoid valve when the silver ion steriliser is supplied with power. Flow through the steriliser is regulated by means of the bypass throttling valve WG312F.

(**Note:** The silver ion steriliser solenoid valve is controlled by the silver ion steriliser and this valve prevents water flowing to the domestic fresh water tanks unless the silver ion steriliser is operating.)

Illustration 2.14.2a Fresh Water Service System



2.14.2 FRESH WATER SERVICE SYSTEM

Introduction

The fresh water hydrophore unit provides the ship with cold fresh water for drinking, sanitary, fire fighting and technical services. The fresh water hydrophore unit also supplies water to the calorifier and the hot water circulation pumps supply hot water from the calorifier to the accommodation.

Water may be taken from a shore supply or a barge by means of water load lines located on the port and starboard sides of the ship. The port and starboard water load lines connect with the tank supply lines by means of valves WG571F (port) and WG572F (starboard) which should normally be closed. Taking water from a shore supply or barge requires the blank at the port or starboard connection to be removed, the pipe attached and the load valve opened. This water does not pass through the silver ion steriliser and/or the mineraliser and care must be taken to ensure that the water is fit for human consumption and treated.

Domestic Fresh Water System

There are two fresh water hydrophore pumps which take suction from the domestic fresh water tanks. These pumps deliver fresh water to the fresh water hydrophore tank which is maintained under pressure by air trapped in the hydrophore tank; the tank is initially charged with air from the general service air system. The pressure in the tank controls the starting and stopping of the duty fresh water hydrophore pump which is set to automatic operation by the system controls. Pumps must be set to remote operation at the fresh water pump local control panel. Pumps not set to remote cannot be controlled from the IAS.

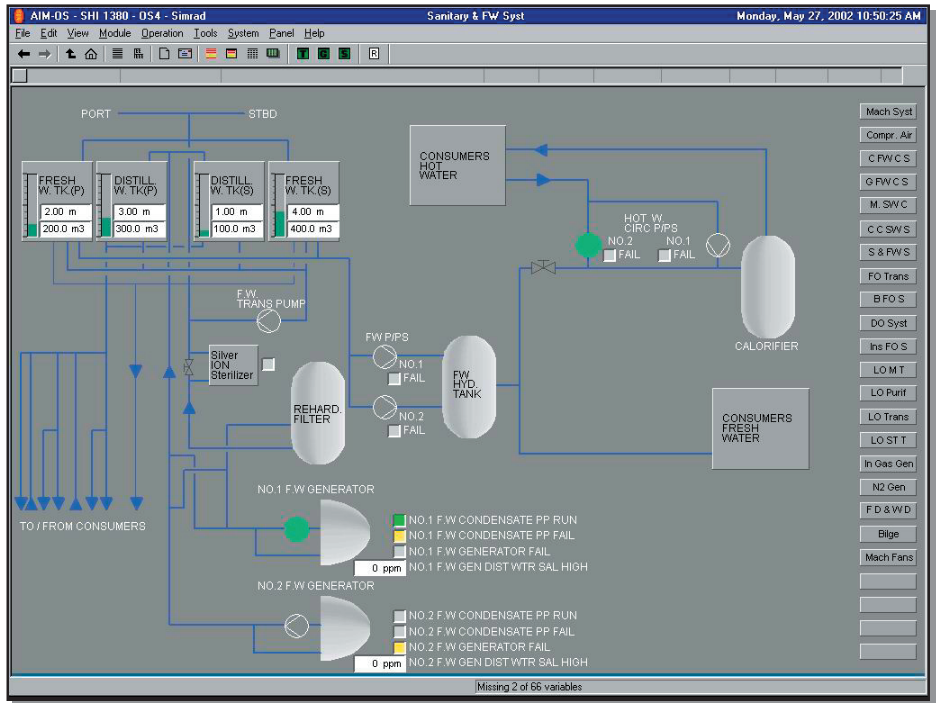
At the local panel there are LOCK and NOR switch positions. When the switch is in the LOCK position the pump motor cannot be started and a tripped indication is given on the IAS screen. With the local selector in the NOR position and the main switchboard starter panel in the MANUAL position the pump motor may be started from the main switchboard starter panel but not from the IAS. The IAS screen indicates local for the pump status. When the main switchboard starter panel selector is in the AUTO position local start is inhibited and the pump motor may only be started from the IAS screen.

At the domestic water system graphic screen the duty pump may be selected and started.

Pumps may be selected for local control and when in local control the pump is started and stopped at the control panel at the pump unit and cannot be started or stopped from the IAS screen.

As the water is used, the tank pressure drops allowing the duty pump to start automatically and refill the tank. As the pressure in the system increases to a predetermined value, the pump will automatically stop. The pump cuts in at 550kPa and cuts out at 650kPa

In the event of a blackout the IAS remembers which pump was operating, provided that it was set to remote, and will start the pump as part of the sequential start system.



Tag	Description	Low	High
BD023	Fresh water tank port level	0.6m	5.4m
BD024	Fresh water tank starboard level	0.6m	5.4m

Procedure for Operation of the Fresh Water System

Port domestic FW tank and No.1 fresh water pump in use.

a) Check that there is sufficient water in the domestic FW tank to meet the immediate demand.

b) Vent the fresh water hydrophore tank and, using the No.1 FW pump in local control, fill it until the water level gauge glass is ¾ full; stop the pump. Suction valves WG012F and WG013F for the fresh water hydrophore pumps must be open together with the pump discharge valves. The suction valve from the port fresh water tank WG008F should be open.

c) Connect the air supply line and open the air supply valve AR046F and the hydrophore tank air valve AR043F to pressurise the hydrophore tank from the general service air supply pressure. The hydrophore tank gauge valves must be open. When the hydrophore tank is at the service air pressure of 1,170kPa, close the air valves and remove the connection pipe.

d) The fresh water hydrophore tank is now operational and fresh water can be supplied to the various users.

(**Note:** The starboard domestic FW tank outlet valve must be closed as this tank will be filling from the evaporator.)

e) At the local control panel set both FW hydrophore pumps to remote and at the IAS screen start No.1 pump. The pump will start and operate in automatic mode with control from the pressure switches stopping and starting the pump as necessary.

f) Set the valves as in the following table:

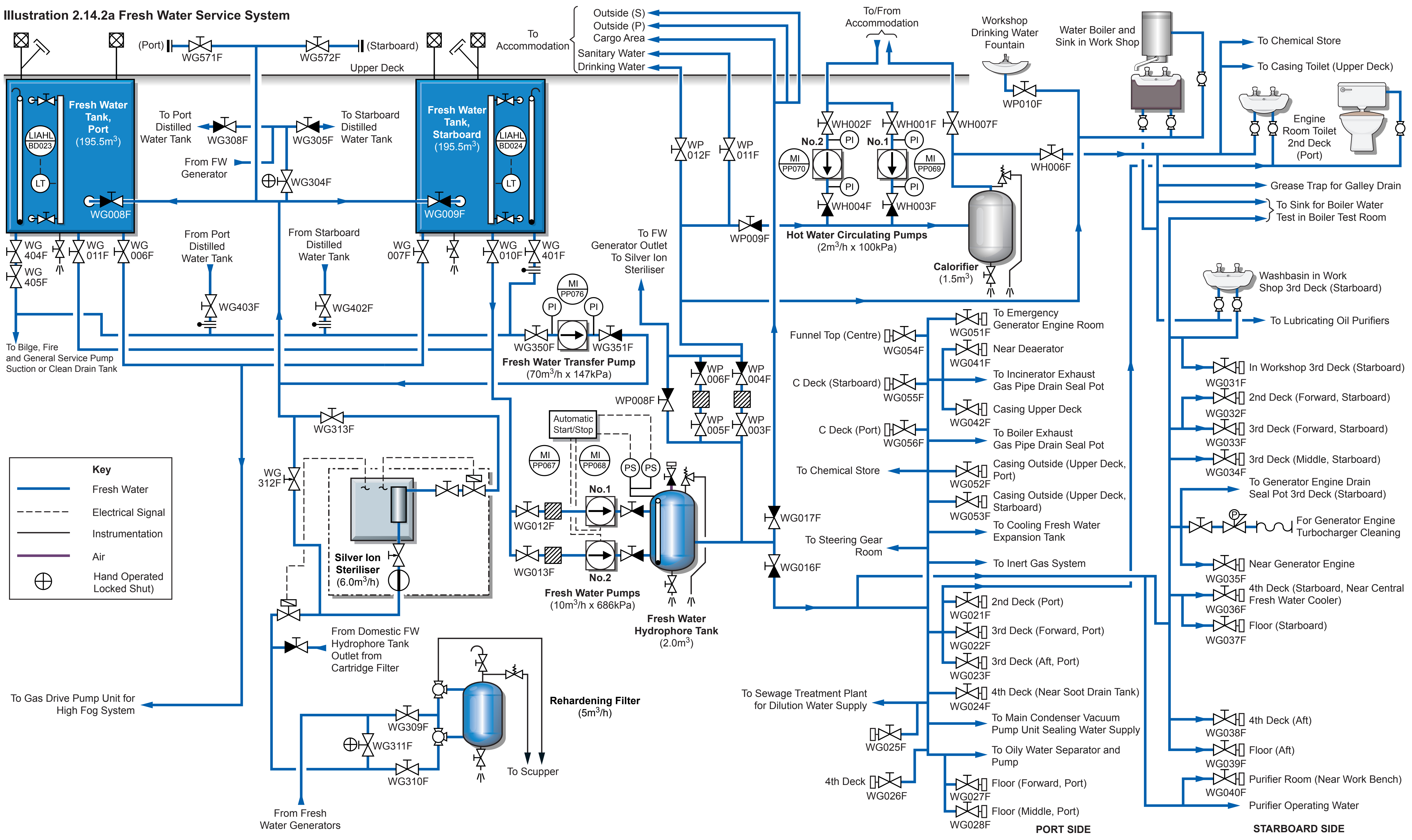
Valves are shown as open but if the service was not being used the valve would be closed.

Position	Description	Valve
Open	No.1 cartridge filter inlet valve	WP003F
Open	No.1 cartridge filter outlet valve	WP004F
Open	No.2 cartridge filter inlet valve	WP005F
Open	No.2 cartridge filter outlet valve	WP006F
Closed	Cartridge filter bypass valve	WP008F
Open	Accommodation drinking water supply valve	WP012F
Open	Accommodation sanitary water supply valve	WP011F
Open	Hot water system supply valve	WP009F
Open	Workshop drinking fountain supply valve	WP010F

Fresh Water Services System

Position	Description	Valve
Open	Deck and accommodation service water valve	WG017F
Open	Engine room water services supply valve	WG016F
Open	Water services outlet (floor, port middle)	WG028F
Open	Water services outlet (floor, port forward)	WG027F
Open	Water services outlet (4th deck)	WG026F
Open	Water services outlet	WG025F

Illustration 2.14.2a Fresh Water Service System



Position	Description	Valve
Open	Water services outlet (4th deck near sootblower)	WG024F
Open	Water services outlet (3rd deck, aft, port)	WG023F
Open	Water services outlet (3rd deck, forward, port)	WG022F
Open	Water services outlet (3rd deck, port)	WG021F
Open	Water services outlet (outside casing upper deck S)	WG053F
Open	Water services outlet (outside casing upper deck P)	WG052F
Open	Water services outlet (outside casing upper deck)	WG042F
Open	Water services outlet (near deaerator)	WG041F
Open	Water services outlet (emergency generator room)	WG051F
Open	Water services outlet (outside casing C deck stbd)	WG055F
Open	Water services outlet (outside casing C deck port)	WG056F
Open	Water services outlet (outside casing funnel top)	WG054F
Open	Water services outlet (purifier room)	WG040F
Open	Water services outlet (floor aft)	WG039F
Open	Water services outlet (4th deck aft)	WG038F
Open	Water services outlet (floor stbd)	WG037F
Open	Water services outlet (4th deck stbd)	WG035F
Open	Water services outlet (near generator engine)	
Open	Water services outlet (generator turbocharger cleaning)	
Open	Water services outlet (3rd deck centre)	WG034F
Open	Water services outlet (3rd deck forward)	WG033F
Open	Water services outlet (2nd deck forward)	WG032F
Open	Water services outlet (3rd deck workshop)	WG031F

There are direct connections with local valves for the boiler test room sink, the generator engine drain sealing pot, the oily water separator, the purifiers, the vacuumarator sealing water tank, the sewage treatment plant water supply, the IG system, the steering gear room, the cooling FW expansion tank and the boiler exhaust gas drain sealing pot.

Water supplied to the deck system ring main feeds outlets on the deck via quick acting self-sealing connectors. The ring water main also supplies decontamination showers at the loading manifolds on the port and starboard sides of the ship.

The fresh water system will operate as required with the duty pump operating in order to maintain pressure in the system.

Domestic Hot Water System

This system supplies the hot water to the accommodation for domestic purposes.

Water is circulated continuously by one of the two the hot water circulating pump, the water being passed through a calorifier, which can be either steam or electrically heated to raise the water to the correct temperature. Top up to the system is from the hydrophore tank. The pumps can be changed over if necessary for maintenance. Pumps are started and stopped locally. Pumps would be changed over periodically in order to avoid one pump having excessive running hours.

The system supplies hot water to the accommodation system, the wash basin in the workshop, the washbasin for boiler water testing, the washbasin in the engine room toilet, the LO purifiers and the galley grease trap drain.

Procedure for Operating the Hot Water System

a) Operate the FW system as above and set the hot water system valves as follows:

Position	Description	Valve
Open	Calorifier supply from cold water system	WP009F
Open	Calorifier outlet valve to accommodation	WH007F
Open	Calorifier outlet valve to engine room and chemical store	WH006F
Open	No.1 hot water circulating pump inlet valve	WH001F
Open	No.1 hot water circulating pump outlet valve	WH003F
Open	No.2 hot water circulating pump inlet valve	WH002F
Open	No.2 hot water circulating pump outlet valve	WH004F

b) After opening the hot water system supply valve from the cold water system, allow the system to fill from the hydrophore tank.

c) Ensure that the hot water circulating pumps are primed.

d) Start one of the hot water circulating pumps at the local starter panel.

e) Open the steam supply or switch on the electrical supply to the calorifier, and set the system temperature.

f) Check that the system is circulating correctly and that the temperature is maintained.

Distilled Water to Domestic Water Transfer

Water may be pumped between the domestic fresh water tanks and the distilled water tanks by means of the fresh water transfer pump.

Water may be taken from the distilled water tanks and discharged to the deck.

Outlet valves from the fresh water and distilled water tanks to the transfer pump suction are provided with spectacle blanks and these must be in the open position before water may be taken from a particular tank. The use of such blanks prevents accidental transfer of water from a tank.

The fresh water transfer pump suction and discharge valves WG350F and WG351F must be open.

For transferring fresh water from one FW tank to another the suction valve on the tank from which water is to be taken must be open, WG401F for the starboard fresh water tank or WG404F and WG405F for the port fresh water tank. The port fresh water tank outlet valve does not have a blank hence the use of double valves. The filling valve on the appropriate fresh water tank, WG008F for the port tank or WG009F for the starboard tank, must be open. The fresh water transfer pump is started and the required amount of water transferred between tanks.

For the transfer of distilled water the tank filling valve for the appropriate tank, WG306F for the port tank or WG305F for the starboard tank, must be open together with the crossover filling valve WG304F, which is normally locked closed. The appropriate distilled water tank suction valve, WG402F for the starboard tank or WG403F for the port tank and the associated blanks, must be open.

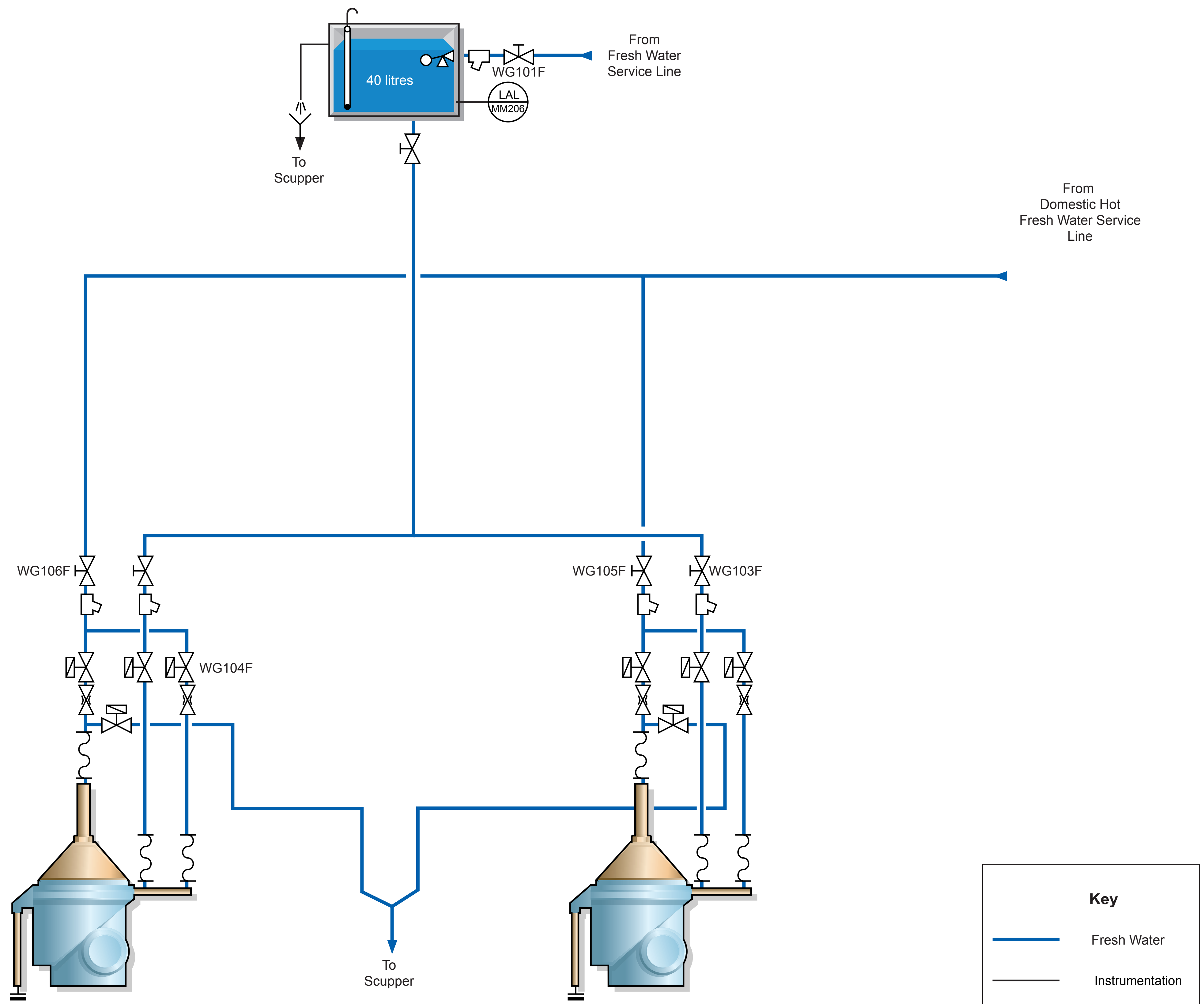
Care must be taken when transferring fresh and distilled water to ensure that the water goes to the tank intended. Transfer of distilled water to fresh water tanks can have serious consequences as the water has not been sterilised.

Fire Fighting Service

The fresh water tanks supply the gas drive pump unit for the high fog system by means of dedicated valves and lines. One of the fresh water tanks must always be open to the high fog system and when changing over tanks for domestic water supply the supply valves for the high fog system should also be changed over. The port domestic water tank valve for the high fog system is WG006F and the starboard tank WG007F.

The fresh water and distilled water tanks may be pumped out by the No.1 port bilge, fire and GS pump via the fresh water transfer pump suction line and the suction valve FD005F on the bilge, fire and GS pump.

Illustration 2.14.2b Purifier Operating Water System



Purifier Operating Water System

Water is supplied to the lubricating oil purifiers for operating the bowls when sludging and for sealing purposes. This water is supplied from the FW hydrophore for the bowl operating system. In order to ensure that the purifier system operates correctly it is essential that the FW hydrophore system is operating and the purifier operating water header tank is maintained at a constant level.

The supply valve to the purifier operating water tank, WG111F, must be open and the float control operating correctly. The outlet valve from the operating water tank supplies water to both LO purifiers. Each of the two LO purifiers has an inlet valve and each must be open in order to ensure that the purifier water operating sytem will function.

Flushing and sealing water for the purifiers comes from the hot water service system. The hot water system must be operating in order to ensure a supply of flushing and sealing water to the purifiers.

The supply valves to individual parts of the purifier system are activated by the purifier control.

No.1 Lubricating Oil Purifier

Operating water supply valve	WG103F
Hot flushing and sealing water supply valve and back flow preventer	WG011F

No.2 Lubricating Oil Purifier

Operating water supply valve	WG104F
Hot flushing and sealing water supply valve and back flow preventer	WG012F

Distilled Water Transfer to Other Tanks

Distilled water may be run down from the distilled water tanks to other tanks or compartments. Because of the location of the distilled water tanks, gravity is used for these transfers.

The outlet valve on the selected distilled water tank is opened; SDO351F for the starboard tank or SD352F for the port tank. There is a direct rundown line to the auxiliary external desuperheater feed water pump but other tanks are supplied via a filter.

The filter inlet valve, SD353F and outlet valve SD355F, are open and the filter bypass valve, SD354F, is closed.

The distilled water tanks supply water to the following:

- Valve water seal supply
- The stern tube cooling fresh water tank
- Emergency boiler feed pump suction
- LPSG atmospheric drain tank make-up
- Condensate water make-up line
- Auxiliary external desuperheater feed water pumps

Procedure for Filling the Stern Tube Cooling Fresh Water Tank with Fresh Water

The tank is filled from either of the distilled water tanks by means of gravity.

a) Check the level of water in the stern tube cooling water tank and assess the quantity of water needing to be transferred.

b) Check the amount of distilled water in the distilled water tank to be used and ensure that it is sufficient for the purpose.

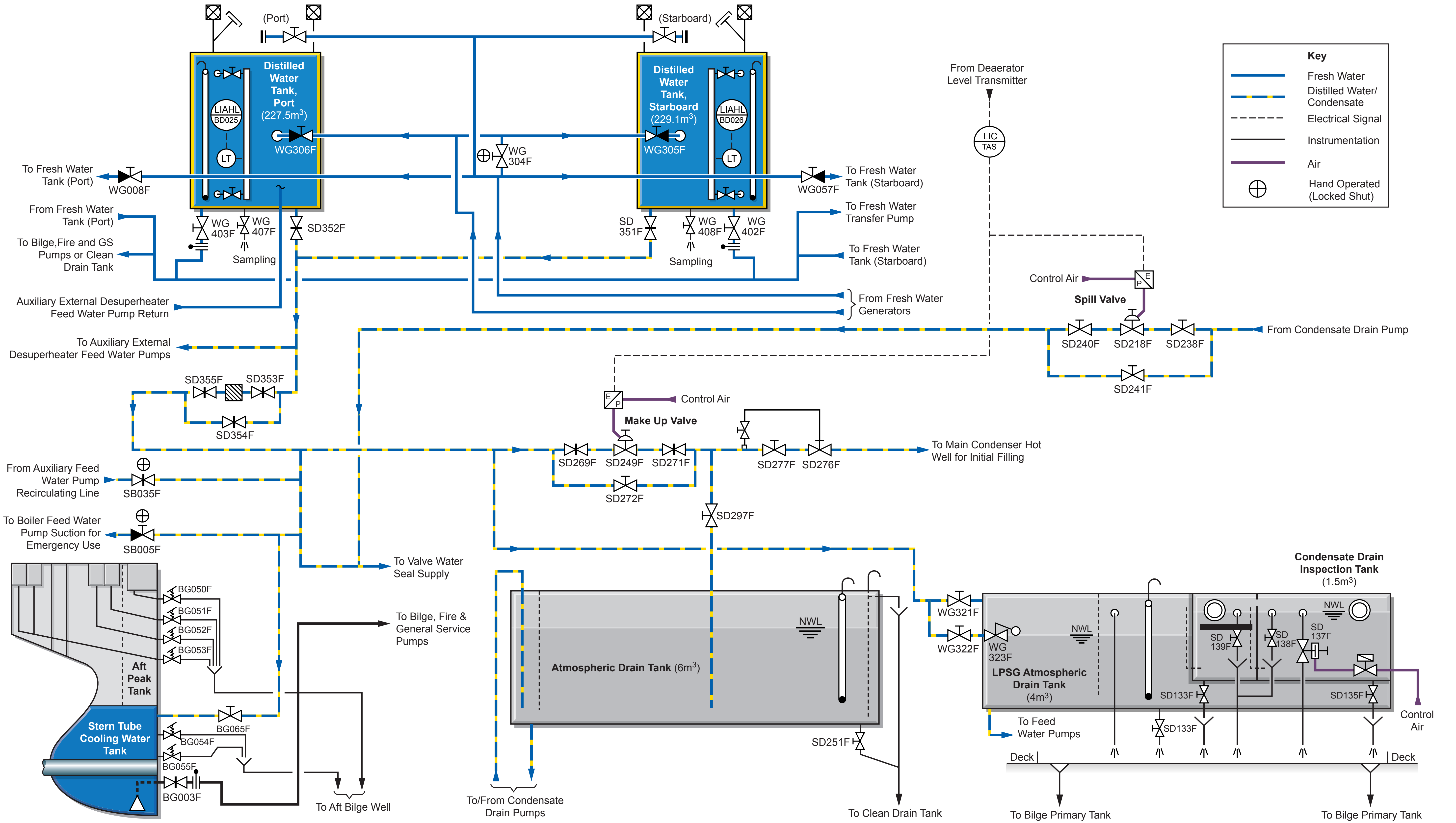
c) Open the outlet valve from the selected distilled water tank, SD351F for the starboard tank or SD352F for the port tank.

d) Check that the filter inlet valve, SD353F and outlet valve SD355F, are open and that the filter bypass valve SD354F is closed.

e) Open the filling valve BG065F to the stern tube cooling water tank. Water will flow by means of gravity from the distilled water tank to the stern tube cooling water tank. When the tank is full close the filling valve and the outlet valve from the distilled water tank.

(**Note:** The stern tube cooling water tank may be emptied by means of the bilge pump or the bilge, fire and GS pumps. See sections 2.8.1 and 5.2.)

Illustration 2.14.3a Distilled Water Service System



2.14.3 DISTILLED WATER SYSTEM

Description

The distilled water which is used in the condensate and feed water systems is stored in two tanks situated on the port and starboard sides of the steering gear. The tank capacities are port 227.5m^3 and starboard 229.1m^3.

Distilled water is pumped into the tanks from the evaporation plant without the addition of any water treatment. Salinity control of the evaporator discharge ensures that the quality of the distillate, once conditioned, is suitable for use in the boilers.

In normal operation one tank will be in use as feed make-up and the other tank either filling from the evaporator or on standby. The intergrated automation system (IAS) CONDENSATE WATER screen displays the tank soundings. The tank outlet valves are manual and cannot be operated from the IAS.

Distilled water from the tank in use passes through a fine mesh filter before distribution to the following services:

- Emergency connection to the boiler feed water pumps via valve SB005F
- Return from the auxiliary feed water pump recirculation line for emergency operation via valve SB035F
- Make-up to the atmospheric drain tank (ADT) via control valve SD249F
- Make-up to the low pressure steam generator atmospheric drain tank via valves WG321F or WG322F and WG323F
- Spill back from the main condensate system via control valve SD218F
- Initial filling water to the main condenser via valves SD276F and SD277F
- Topping up water to the stern tube cooling water tank via valve BG065F
- Gland water sealing to valves operating under vacuum conditions

Operation of all these services is described in the sections of this manual detailing the relevant systems.

When the distilled water tanks are to be inspected, or if they have become contaminated, they can either be drained to the clean drain tank via No.1 GS, fire and bilge pump suction from the clean drain tank, or pumped overboard using the bilge, fire and general service pumps. The tank drain valves are each fitted with a spectacle blank flange, which must first be rotated into the open position in order to pump out the tanks.

Tag	Description	Low	High
BD025	Distilled water tank level port	0.6m	6.3m
BD026	Distilled water tank level starboard	0.6m	6.3m

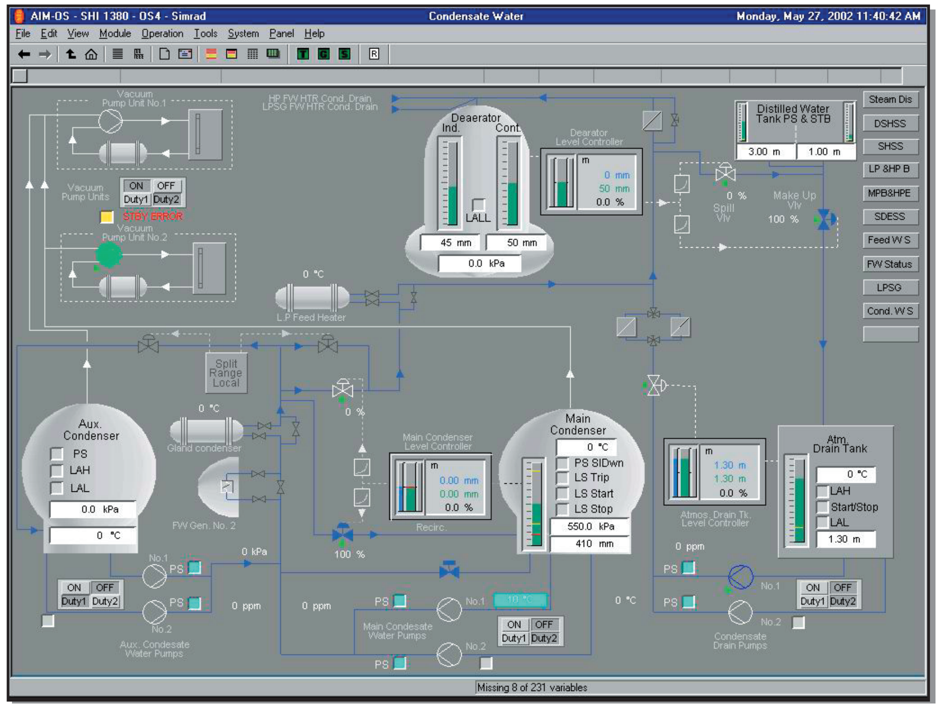
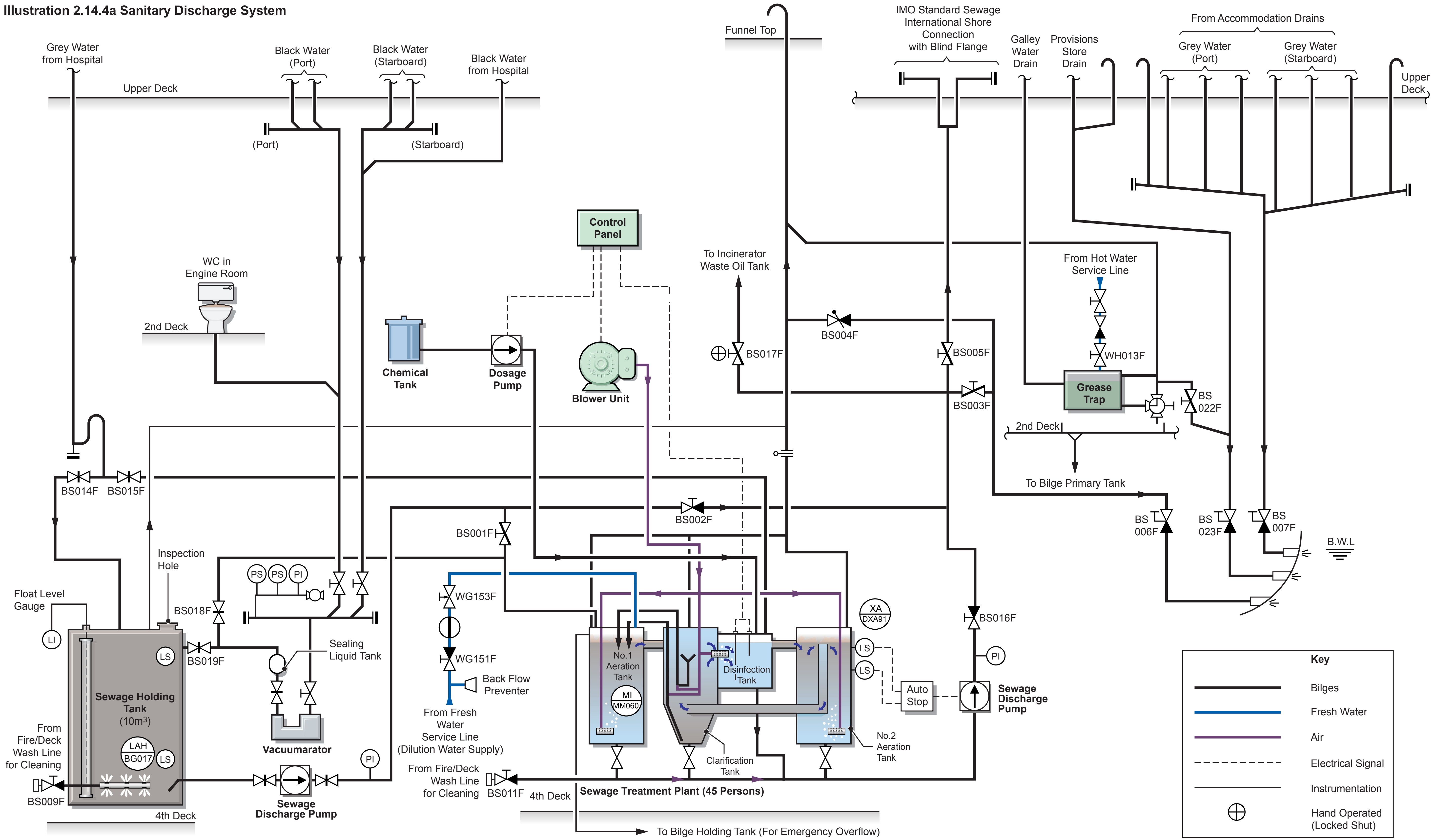


Illustration 2.14.4a Sanitary Discharge System



2.14.4 SANITARY DISCHARGE SYSTEM

Sewage Treatment Plant

Maker:	Jonghap
No of sets:	1
Model:	JMC Bio-Aerob -18
Type:	Biological oxidation and discharge
Capacity:	45 persons/day
Discharge pump:	0.3m^3/min at 25mth
Air blower:	20m^3/h at 360mbar
Dosing pump:	1.92litres/h at 10kg/cm^2

Vacuumarator

Maker:	Jets Vacuum A/S
No of sets:	1
Model:	25 MBA
Capacity:	26m^3/h

Sewage Discharge Pump

Maker:	Jeil Machinery Ind. Co.
No of sets:	1
Model:	AS25-5CB
Capacity:	0.5m^3

Introduction

The sewage collection system is a vacuum system with one vacuumarator providing a vacuum in the collection pipes from lavatory pans throughout the ship. Flushing water is provided at lavatory pans in order to clear the waste and to provide for an effective seal at the lavatory pan. The Jets control valve at each lavatory pan controls flushing and sealing.

Waste from the lavatory pan flows into the waste pipe when it is flushed under the influence of the vacuum in the pipe. The vacuumarator provides and maintains the vacuum, starting when the vacuum has fallen to 35% and stopping when it has risen to 50%. The vacuumarator macerates the waste from the sewage pipe and discharges it the sewage treatment unit aeration compartment. Level switches in the sewage holding tank start and stop the sewage tank discharge pump which pumps the contents of the holding tank to the sewage treatment plant or ashore. The tank has a low level alarm with 20 seconds time delay.

The sewage treatment plant is located on the port side of the 4th deck.

There are two inlet pipes to the vacuumarator, each with its own inlet valve, starboard sewage discharge from the accommodation and port sewage discharge from the accommodation. Hospital black water connects to the starboard pipe and the engine room WC to the port pipe.

The vacuumarator has a single outlet to the sewage holding tank with a branch pipe direct to the sewage treatment plant. Grey water from the hospital flows directly to the sewage holding tank or sewage treatment plant chlorination.

The sewage treatment plant is a biological unit which works on the aerobic activated sludge principle. The plant will treat black and grey water and is fully automatic in operation.

This sewage treatment plant consists of a tank with four main compartments:

- Aeration compartment I
- Aeration compartment II
- Clarification compartment
- Chlorinating and discharge compartment

Aeration Compartment I

The sewage in this compartment is from the lavatory pans and urinals in the accommodation spaces via the vacuumarator or sewage holding tank. The incoming effluent material mixes with the activated sludge already present in this compartment. The gases produced during the bacterial action which takes place is vented to atmosphere. An air blower supplies air to the compartment, which provides the oxygen required by the aerobic organisms for digesting the raw sewage and it also assists in mixing the incoming sewage with the water, sewage sludge and bacteria already present in the compartment.

Aeration Compartment II

In this compartment the bacterial breakdown of the sewage continues when the sewage effluent passes through a screen from aeration compartment I. Aeration compartment II is supplied with air from the blower for further accelerated aerobic bacteria breakdown. The rate of flow through the aeration compartments is designed to be as slow as possible in order to enable maximum bacterial effect. The aeration period is about 12 hours after which the effluent overflows, via an internal pipe, to the clarification tank.

Clarification Compartment

The effluent passes into this compartment and settles out. The water passes into the chlorinating and discharge compartment, whilst the remaining sludge, containing the active bacteria, returns to aeration compartment I for further processing, utilising the air lift principle with air from the air blower 'educting' the sludge. A surface skimmer in the compartment removes floating sludge and debris from the surface and returns it to activation compartment I.

Chlorination and Discharge Compartment

Water from the clarification compartment is mixed with disinfection chemicals and is sterilised. A dosing pump, located at the front of the unit, transfers the required dose of chemical to the compartment in order to sterilise the effluent prior to discharge. The compartment has float operated switches which activate the discharge pump when the high level is reached and stop the pump when the compartment is nearly empty.

The sewage treatment plant works automatically once it is set but periodic attention is required and the unit must be monitored for correct operation.

Grey water discharge from the accommodation is directed overboard. Galley water drains flow overboard via a grease trap; the grease from the trap is directed to the bilge primary tank by means of a three-way valve.

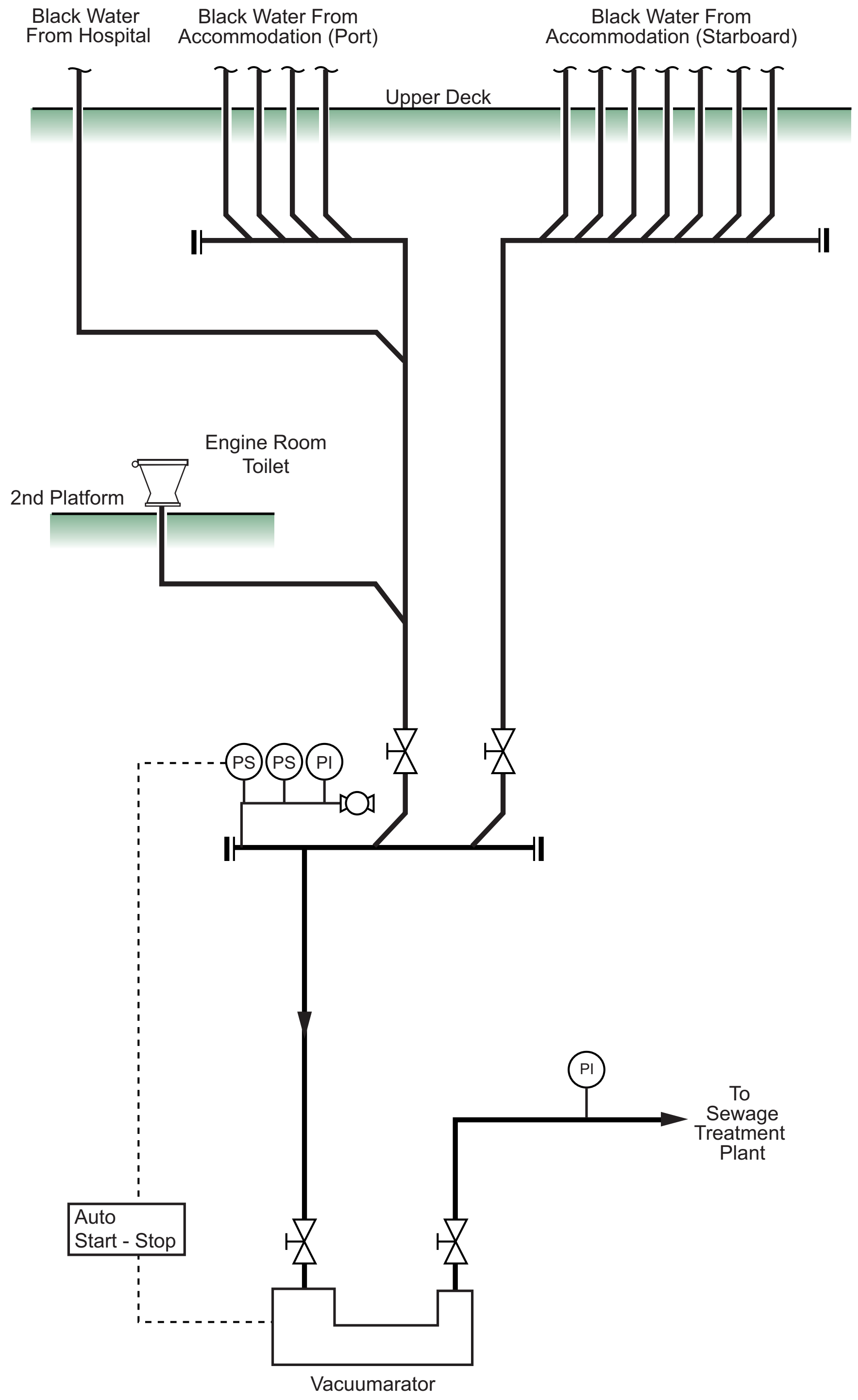
(**Note:** Rules governing the discharge of raw sewage must be complied with at all times and the discharge of raw sewage overboard must only be contemplated should the sewage plant be out of service. The bacterial action requires a regular supply of raw sewage and the discharge of raw sewage overboard can impair effective bacterial action.)

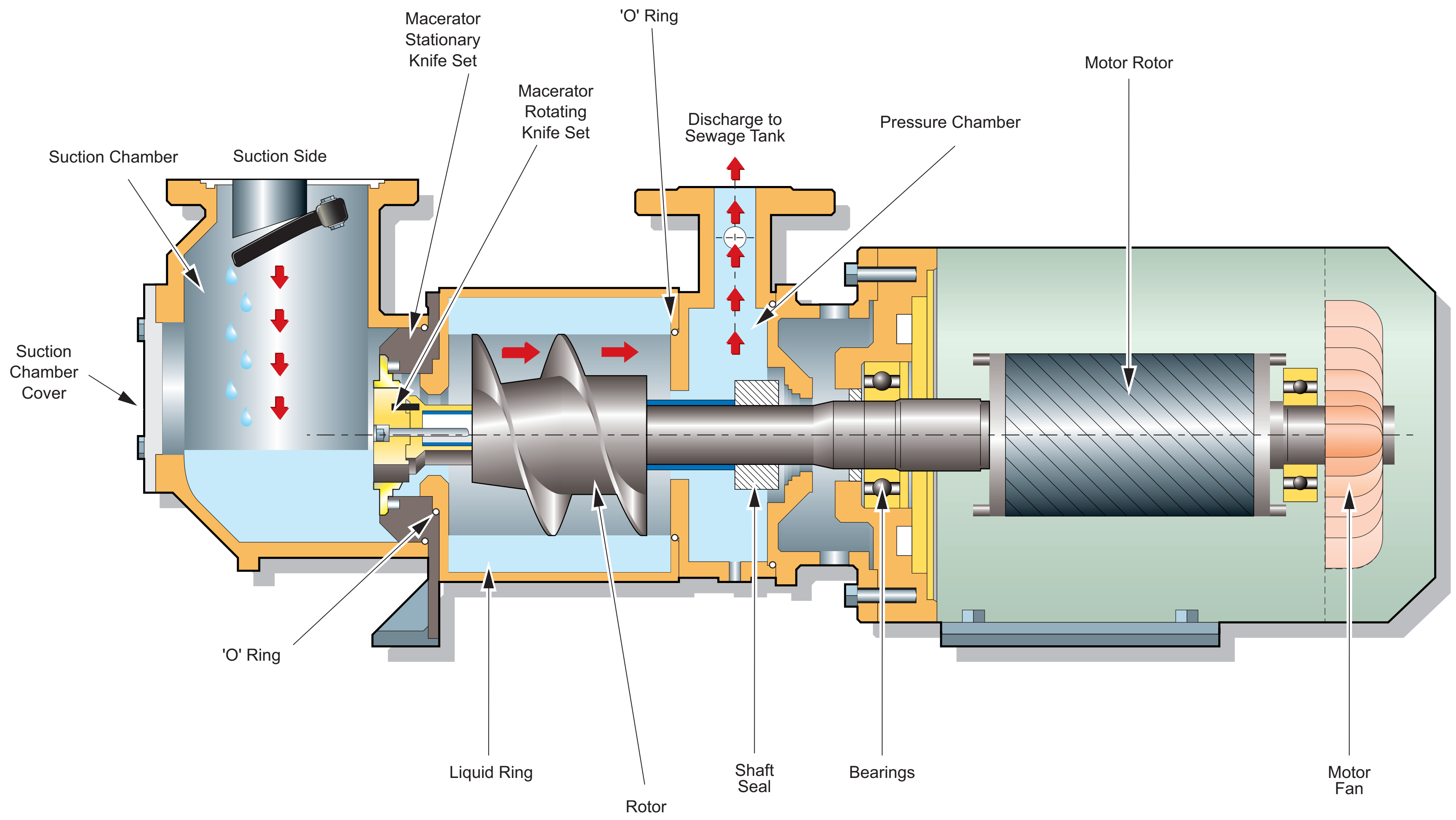
The sewage treatment plant discharge pump normally takes suction from the chlorination and discharge compartment but valves on the other three compartments allow those compartments to be pumped out if necessary. A valve BS011F connects the pump suction pipe with the fire and deck wash line for back flushing purposes.

The holding tank acts as a reserve storage tank for the sewage treatment plant. The holding tank sewage discharge pump normally pumps the contents of the holding tank to the sewage treatment plant but it may also be used to pump the contents of the sewage holding tank overboard when necessary and when conditions allow.

Treated or untreated sewage may also be pumped to the shore discharge connections on the port and starboard sides of the ship and to the incinerator waste oil tank.

Illustration 2.14.4b Sewage Black Water Vacuum Unit





Vacuumarator Unit

Key

———	Sewage Discharge
- - - - -	Electrical

Procedure for Operating the Sewage Treatment Plant

a) The black water lines must be directed to the vacuumarator for the sewage treatment plant. The two black water line valves to the vacuumarator must be opened as must the vacuumarator inlet and outlet valves. Grey water is directed overboard via the overboard discharge valve BS007F.

b) The vacuumarator sealing liquid tank must be filled, the discharge valve to the sewage holding tank, BS019F, closed and the discharge valve to the sewage treatment plant, BS018F, open.

c) Open the sewage grey water from the hospital valve, BS015F, to the holding tank and the holding tank inlet valve, BS014F, from the hospital grey water line.

d) Ensure that there is flushing water available at all WCs and start the vacuumarator. It should cut in when the vacuum falls to 33% and cut out when the vacuum rises to 50%.

e) Close the sewage treatment plant inlet valve from the sewage discharge pump BS001F and close the valve to the discharge line BS002F.

f) Open the outlet valve from the sewage treatment plant discharge pump BS016F and the suction valve from the chlorination chamber; check that other chamber discharge valves are closed.

g) Open the sewage treatment plant discharge line valve to the overboard discharge, valve BS003F, and check that the discharge valves to the deck lines, BS005F and the incinerator waste oil tank BS017F, are closed. Open the overboard discharge valve BS006F.

h) Set the sewage discharge pump to AUTOMATIC operation so that it starts when activated by the chlorination tank high level float switch and stops when activated by the sewage treatment plant chlorination tank low level switch.

(**Note:** The sewage treatment unit should be initially filled with water and activated sludge added if it has been emptied for any reason or when commissioning the plant for the first time. This will not be required when the unit has been operating previously but the description is included for completeness.)

i) Check that there is sufficient dosing chemical in the chemical tank and that the dosing pump rate is set for the correct amount.

(**Note:** There should be no need to adjust the dosing rate of the pump under normal circumstances.)

j) Turn the main switch to the ON position.

k) Turn on the aeration blower to the sewage treatment plant.

l) Check that the blowers and the discharge pump have the correct rotation.

m) Check that ample air is being supplied and that sludge is being returned to the primary aeration tank from the clarification compartment.

n) The sewage treatment plant is now operating. The vacuumarator will maintain vacuum in the sewage discharge lines from the WCs and the vacuumarator will discharge the sewage to the sewage treatment plant.

o) The sewage treatment plant discharge pump will only operate when the chlorination tank is full.

CAUTION
Compartments may only be pumped to sea in waters where such discharge is permitted and permission from the bridge must be obtained before the discharge takes place.

Setting the Chlorination Dosing Unit

Chlorinated isocyanurate pellets are dissolved in water and the solution is dosed into the discharge chamber.

The dosing pump will operate to send a predetermined amount of chlorinated isocyanurate to the discharge chamber every time the discharge pump stops. The discharge pump operates when the upper float switch is activated and stops when the tank level falls to cause the lower float switch to open.

The working period of the dosing pump is set to 40 seconds on the timer unit at the control panel. The amount of sodium hypochlorite directed to the effluent discharge tank depends upon the amount of effluent being discharged at each cycle. The setting knob at the dosing pump must be set to correspond to the amount of effluent discharged each operating cycle of the discharge pump. For a 12% sodium hypochlorite solution requiring 50cm^3/m^3 of effluent the following settings apply.

Position 100 represents a discharge of 1m^3 of effluent and position 10 a discharge of 0.1m^3. This means that for every change 0.1m^3 of effluent discharge the setting knob should be changed by 10 units. A discharge volume of 0.6 m^3 will require a setting of 60. Once set there should be no need to change the setting unless the float switches are changed.

Daily Checks

Check that the sludge is being returned to the activation chamber from the settling chamber, and that the discharge pump and blower are working. Check that the chlorine dosing unit is functioning correctly and replenish the sodium hypochlorite as necessary.

Check the operation of the air lift and the air diffusers through the compartment portholes.

Check that the vacuumarator is maintaining the vacuum between the preset values and that the discharge pump is operating in response to the float switches.

Monthly Checks

Check that air flows are correct and that compartment vents are clear. Clean the blower suction strainer

Grey Water and Scuppers

Scuppers are discharged overboard via overboard discharge valves located on the port and starboard sides of the ship. These valves must be open at all times to allow water to drain.

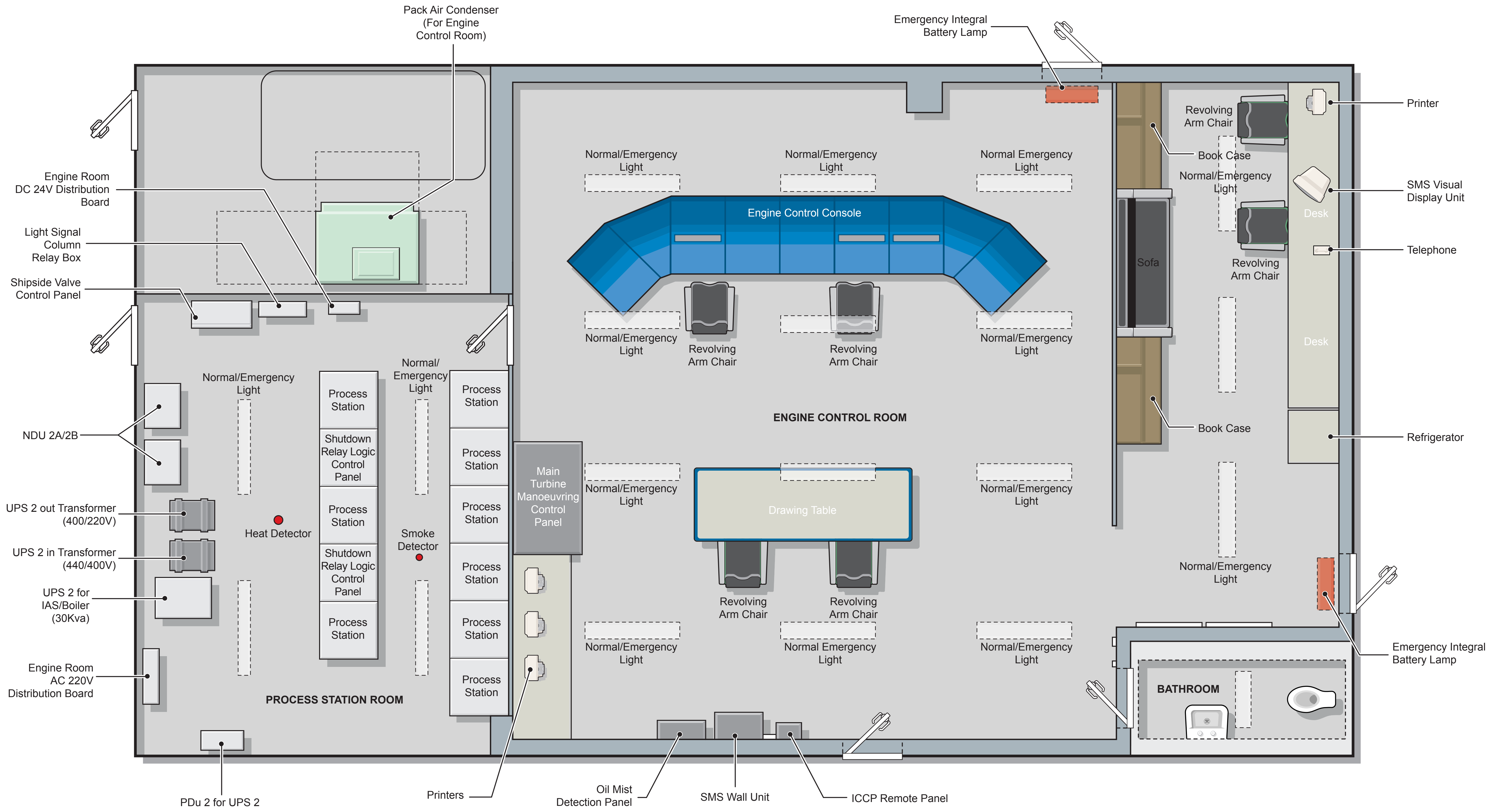
Grey water from the accommodation is discharged directly overboard via the overboard discharge valve BS007F.

The provision store drain flows overboard via the overboard discharge valve BS023F which also provides for the discharge of the galley water drain. The galley water drain flows first to a grease trap; grease from the trap is manually drained to the bilge primary tank by means of a three-way valve. The water outlet valve from the drain trap BS022F must be open.

Part 3: Main Machinery and Control

Illustrations

Illustration 3.1.1a Engine Control Room Layout



3.1 CONTROL ROOM

3.1.1 ENGINE CONTROL ROOM OVERVIEW

Introduction

The engine control room, situated on the 2nd deck, is where the necessary equipment and controls are located which to permit the centralised operation and supervision of the engine room machinery, via the Integrated Automation System (IAS).

The operating consoles ECC1 - 8 include the following:

ECC3 SVC-OS5, ECC4 SVC-OS6 and ECC6 SVC-OS7 has three IAS Information and Control Stations

ECC1 includes
Emergency stop pushbuttons for:

- Turbine generators
- Diesel generators
- Port and starboard boilers
- Boil off gas master valve
- Engine room fuel oil and lubricating oil pumps
- Emergency shut down system
- Inert gas system
- Engine room ventilation fans

General alarm pushbutton

Fire alarm pushbutton

Engineer's call switch

Patrolman start panel

Automatic exchange telephone

Intrinsically safe telephone

ECC2 includes:

Engine room talkback panel and microphone

Deck talkback panel and microphone

ECC5-1 includes the main turbine control panel containing the following

Telegraph

Manoeuvring speed table

Turn switches which operate:

- Astern guard valve
- HP turbine casing drain valve
- HP turbine steam chest drain valve
- HP bleed steam line drain valve
- Manoeuvring valve drain valve
- HP turbine 2nd stage drain valve
- Main turbine auto slowdown override
- Main turbine emergency trip override
- Main turbine emergency trip
- Main turbine over speed preventer
- Main turbine speed increase program control
- Main turbine speed increase program control interlock
- Main turbine auto spin control
- Main turbine control position transfer

Manoeuvring valves position indicator dial

Pushbuttons for

- Main turbine warming through
- Main turbine trip reset
- Alarm buzzer stop
- Panel lamp test

ECC5-2 includes

Turn switches which operate

- Main turbine control mode
- Main turbine ahead and astern direct control
- Main turbine extra nozzle valve

Main shaft rpm dial

Rudder angle indicator

Wind speed

Vessel's distance travelled

Telegraph matching indicator - prior to main turbine control transfer

ECC 7 includes the UHF radiotelephone

ECC8 includes the signal panel for:

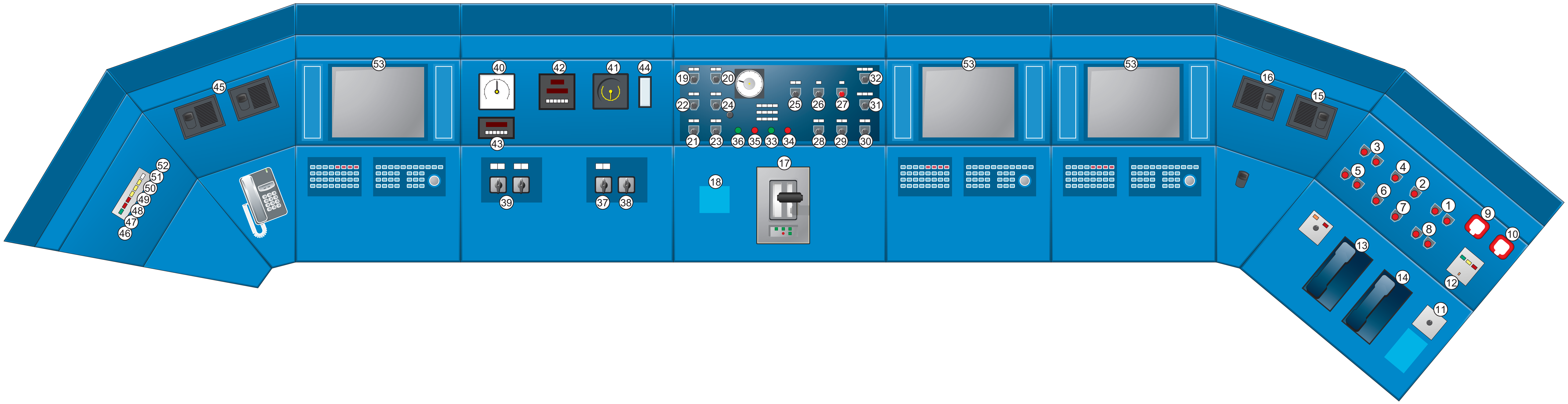
- General alarm
- Fire alarm
- CO_2 alarm
- Engine room machinery alarm
- Cargo gas detection alarm
- Telephone call
- Engine room patrol alarm

The control room also contains:

- The main turbine manoeuvring control cabinet
- The oil mist detector panel
- The SMS unit
- The impressed current remote panel
- Three IAS printers.

The rest area contains a computer workstation and printer, mobile radios with battery charger and cupboards containing four lifejackets and instruction books.

Illustration 3.1.1b Engine Control Room Console



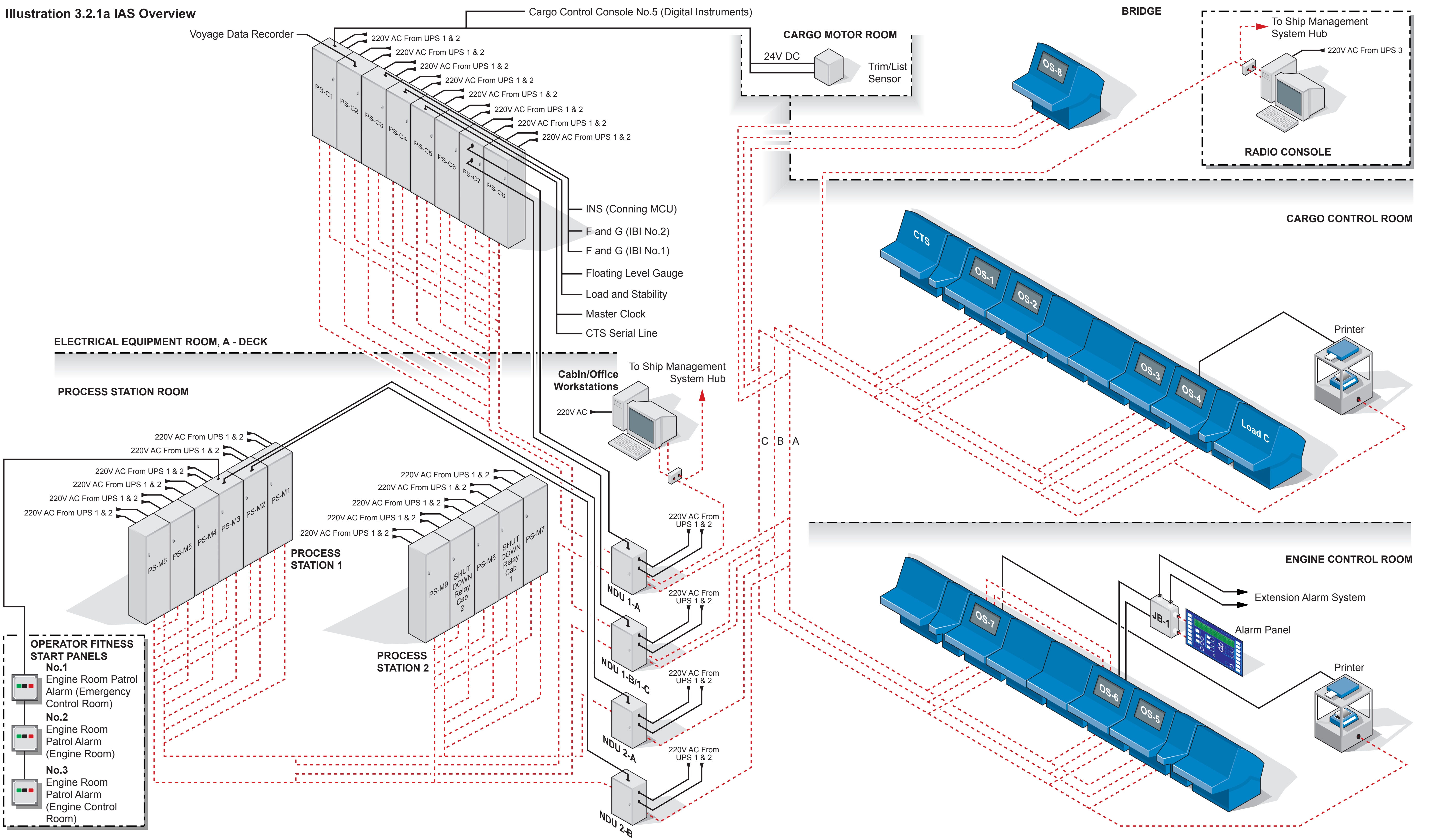
Key

1 - Emergency Stop Button for Turbine Generator
2 - Emergency Stop Button for Diesel Generator
3 - Emergency Stop Button for Port and Starboard Boilers
4 - Emergency Stop Button for Boil-off Gas Master Valve
5 - Emergency Stop Button for Engine Room Fuel Oil and Lubricating Oil Pumps
6 - Emergency Stop Button for Emergency Shut Down System
7 - Emergency Stop Button for Inert Gas System
8 - Emergency Stop Button for Engine Room Ventilation Fans
9 - General Alarm Pushbutton
10 - Fire Alarm Pushbutton
11 - Engineer's Call Switch
12 - Patrolman Start Panel
13 - Automatic Exchange Telephone
14 - Intrinsically Safe Telephone
15 - Engine Room Talkback Panel and Microphone
16 - Deck Talkback Panel and Microphone
17 - Telephone
18 - Manoeuvring Speed Table
19 - Astern Guard Valve Switch
20 - HP Turbine Casing Valve Switch
21 - HP Turbine Steam Chest Drain Valve Switch
22 - HP Bleed Steam Line Drain Valve Switch
23 - Manoeuvring Valve Drain Valve Switch
24 - HP Turbine 2nd Stage Drain Valve Switch
25 - Main Turbine Auto Slowdown Override Switch
26 - Main Turbine Emergency Trip Override Switch
27 - Main Turbine Emergency Trip Switch
28 - Main Turbine Over Speed Preventer Switch
29 - Main Turbine Speed Increase Program Control Switch
30 - Main Turbine Speed Increase Program Control Interlock Switch
31 - Main Turbine Auto Spin Control Switch
32 - Main Turbine Control Position Transfer Switch
33 - Main Turbine Warming Through Pushbutton
34 - Main Turbine Trip Reset Pushbutton
35 - Alarm Buzzer Stop Pushbutton
36 - Panel Lamp Test Pushbutton
37 - Main Turbine Control Mode Switch
38 - Main Turbine Ahead and Astern Direct Control Switch
39 - Main Turbine Extra Nozzle Valves Switch
40 - Main Shaft rpm Dial
41 - Rudder Angle Indicator
42 - Wind Speed Dial
43 - Vessel Distance Travelled Readout
44 - Telegraph Matching Indicator - Prior to Main Turbine Control Transfer
45 - UHF Radio / Telephone
46 - General Alarm
47 - Fire Alarm
48 - CO_2 Alarm
49 - Engine Room Machinery Alarm
50 - Cargo Gas Detection Alarm
51 - Telephone Call
52 - Engine Room Patrol Alarm
53 - IAS Information and Control Station

3.2 Integrated Automation System (IAS)

Illustrations

Illustration 3.2.1a IAS Overview



3.2 INTEGRATED AUTOMATION SYSTEM (IAS)

Maker: Kongsberg Simrad
Model: Simrad vessel control

3.2.1 IAS OVERVIEW

The IAS system is a machinery monitoring and control system which covers all the important plant on board the vessel, such as propulsion, power generation, boilers, auxiliary machinery and cargo/ballast systems etc.

The basic functions include:

- Process and system monitoring
- Event logging and monitoring
- Control functions (motor control, valve control and PIDs)

The main applications to which these functions are applied are:

- Power management
- Thruster/propulsion plant
- Cargo and ballast control
- Watch call system

Main Components

The IAS system is made up of operator and history stations connected by a dual bus to the Network Distribution Units (NDUs) and the process stations. The process stations contain the input/output cards to and from the equipment controlled and/or monitored.

Operator Stations

The operator stations are the main interface between the operator and the processes under the operator’s control. The operator station has a colour monitor, an operator panel with buttons and trackball and a controller computer. These are installed in the cargo control room, the bridge and the engine control room. The duty officer's cabins are fitted with computer work stations which are used to monitor the IAS system screens.

History Station

A history station is a specific computer on the network which runs the operator station software. It also contains the historical database, storing an historical (time/date) series of process (samples). These series are used to produce trends and reports at the operator and history stations.

Communication Network

The network used is a dual Local Area Network (LAN) connecting the operator, history and process stations. All the communication between the operator and the controlled/monitored equipment takes place on this network.

Network Distribution Units

The network distribution units are network hubs for LAN A or LAN B. Each NDU is in its own cabinet housing multiport repeaters and patch panels.

Process Stations

The process stations are interface and processing units. They are related to particular pieces of equipment, or plant, and provide the interface between the IAS system and the actual plant or equipment. Process stations also contain the operating software for the associated equipment.

The IAS system on board is called a distributed processing system, because the process control functions are defined locally in the process stations and not in the operator stations. The operator stations function independently, so they can be located at the ship control centres. This also means that each station is capable of controlling any process, provided it has control of the appropriate command group and the user is logged on with the correct access code.

Each station computer has a hard disk containing the software files for the fitted equipment. Process values to be displayed at the operator stations are generated in the process stations and transferred to each station as required.

The Operator Interface

The graphic displays are shown on the monitor of the operator stations. These displays show all or part of a system or process using standard symbols to represent the actual plant/equipment (valves, motors etc). Events (alarms and messages) are also shown on the displays.

The operator panel is used to interact with the display and control the process. This is achieved by the use of the trackball and buttons to point and click on symbols and menus.

Displays and Views

The system is made up of the following types of views:

- Process
- Flow
- Event
- Trends
- Equipment

The Display and Control of System Processes

The number of views in a system depends upon the equipment under system control. The operator can select views with varying levels of detail.

When a view is selected showing an overall process, there may not be enough room to display all the detail on a single view. To account for this, the system will therefore have a number of views, accessed from the main view, that show these details.

System Peripheral Equipment

Printers

Certain operator stations are connected directly to a dedicated printer for printing out events and may be interfaced to one or more network printers for event and report printing.

An operator station may also have the facility to print to the network colour printer, providing colour screen dumps.

Monitoring and Control

Monitoring and control is performed by software modules. The basic modules are:

- Buttons
- Analogue measurement modules
- Digital measurement modules
- Pulse measurement modules
- Motor/pump control modules
- Valve control modules
- PID controller modules

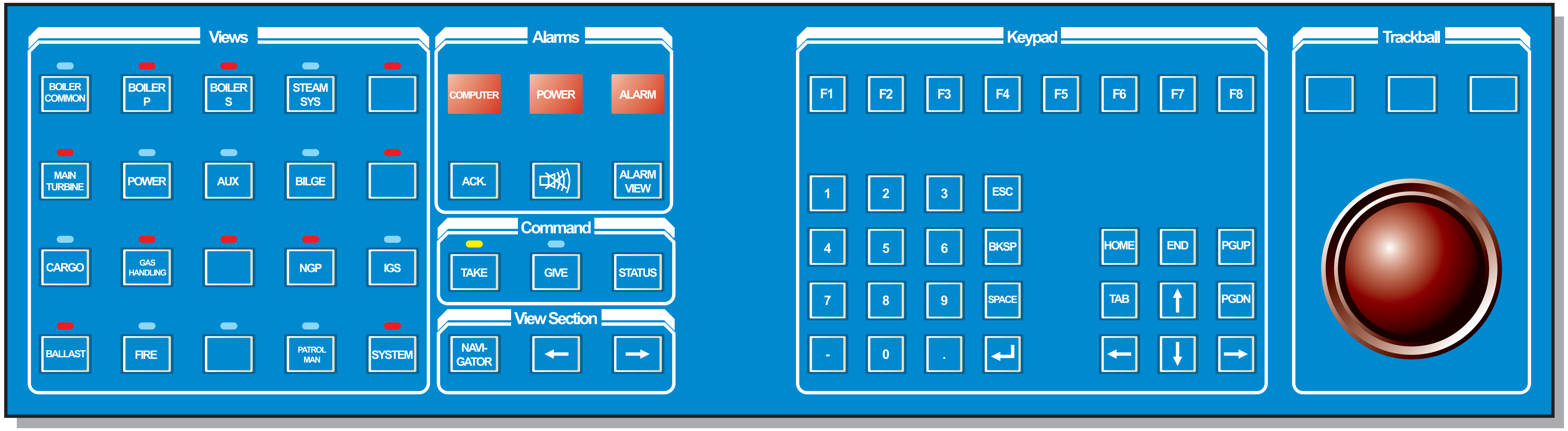
All display views are made up from a set of standard modules. The symbols on the screen are the symbols associated with these modules, valves, motors, measurements etc.

Symbols

The symbols indicate the operational mode and status of the represented equipment (motor/pump etc) by means of tag mark characters and changes in colour and appearance. Illustration 3.2.2b shows the common module symbols used within the system.

Illustration 3.2.2a IAS Operator Stations Panel

Kongsberg Panel



3.2.2 IAS OPERATOR STATION OPERATIONS

Operator Panel

The system's operator/user interface is the monitor screen, control panel and alphanumeric keyboard. The screen displays the system views and the operator panel is used to interact with those views. The alphanumeric keyboard is used for set-up and configuration purposes. The operator panel is used to interact with the views on the screen, display a new view or to act upon an element within a view.

The layout of the pushbuttons, lamps and controls on the operator panel are divided into six functional groups, as shown in illustration 3.2.2a.

Views Group

The buttons of the views group select and display the views representing the various process areas. The most important and commonly used views are assigned to these buttons so that they are instantly accessible from the operator panel. Each button is labelled with the name of the view. To display the views assigned to these buttons, the operator should press the appropriate button.

Above each button is a red status LED, which will flash when any unacknowledged alarms are active in the view assigned to that button. When all the active alarms in the view are acknowledged, the LED illuminates steadily. If there are no active alarms in the view, the LED will be off.

There are are several different ways to navigate through the views of the IAS system:

- Using the views buttons on the operator panel
- Using the previous view and next view buttons on the tool bar
- Using the history navigator which records the last 10 screens viewed
- Using the navigator
- Using hot spots
- Using the context menu of a module

Alarms Group

This group contains three indicator lamps and three buttons that are used to indicate, acknowledge and handle alarms and events. (The COMPUTER and POWER lamps are not used). The ALARM lamp flashes when unacknowledged alarms are active in the system. When all the active alarms in the system are acknowledged, the lamp becomes steadily illuminated. If there are no active alarms in the system, the lamp will be off. The ACK button is used to acknowledge alarms.

The SILENCE button is used to stop the audible alarm that sounds when alarms are raised. The ALARM VIEW button is used to display the alarms event window.

Command Group

This group contains the TAKE, GIVE and STATUS buttons. These buttons allow the operator to transfer control of the process from one operator station to another. The TAKE and GIVE buttons allow the operator to transfer command control between the operator stations. Above each of these buttons there is a green status LED that indicates control transfer status. The STATUS button allows the operator to view the current status of the command control.

View Selection Group

This group contains three buttons that are used to display a map of the existing views and select previous views or related views. The NAVIGATOR button displays the navigator dialog box. The LEFT ARROW button returns the operator to the view displayed before the current one. The RIGHT ARROW button displays the next view listed in the history navigator dialog box.

Keypad Group

This group contains FUNCTION, NUMERIC and CURSOR CONTROL arrow buttons. The function buttons (F1 to F8) are user-definable.

The numerical and keypad buttons (ESC, SPACE etc) are used to enter values into dialog boxes, when setting parameters or required levels.

The cursor control buttons (HOME, END, ARROWS etc) can be used to move between fields in dialog boxes and to scroll through lists.

Trackball Group

This group consists of three unannotated buttons and a trackball. The trackball is used to position the cursor on the screen.

The left button is used to select symbols, open and operate menus and click buttons in the views and dialog boxes displayed on the screen. The right button is used to open pop-up context menus. The middle button is not used. These buttons are similar in action to those in a standard mouse button configuration.

Alphanumeric Keyboard

The alphanumeric keyboard is a standard, QWERTY keyboard that is located in a compartment under the operator panel. A keyboard selection switch is fitted to select the keyboard. When the keyboard is selected, the buttons of the keypad group are disabled. For a desktop operator station, the keyboard selection switch is a toggle switch located on the back of the operator panel.

Displays and Views

The system is made up of the following types of views:

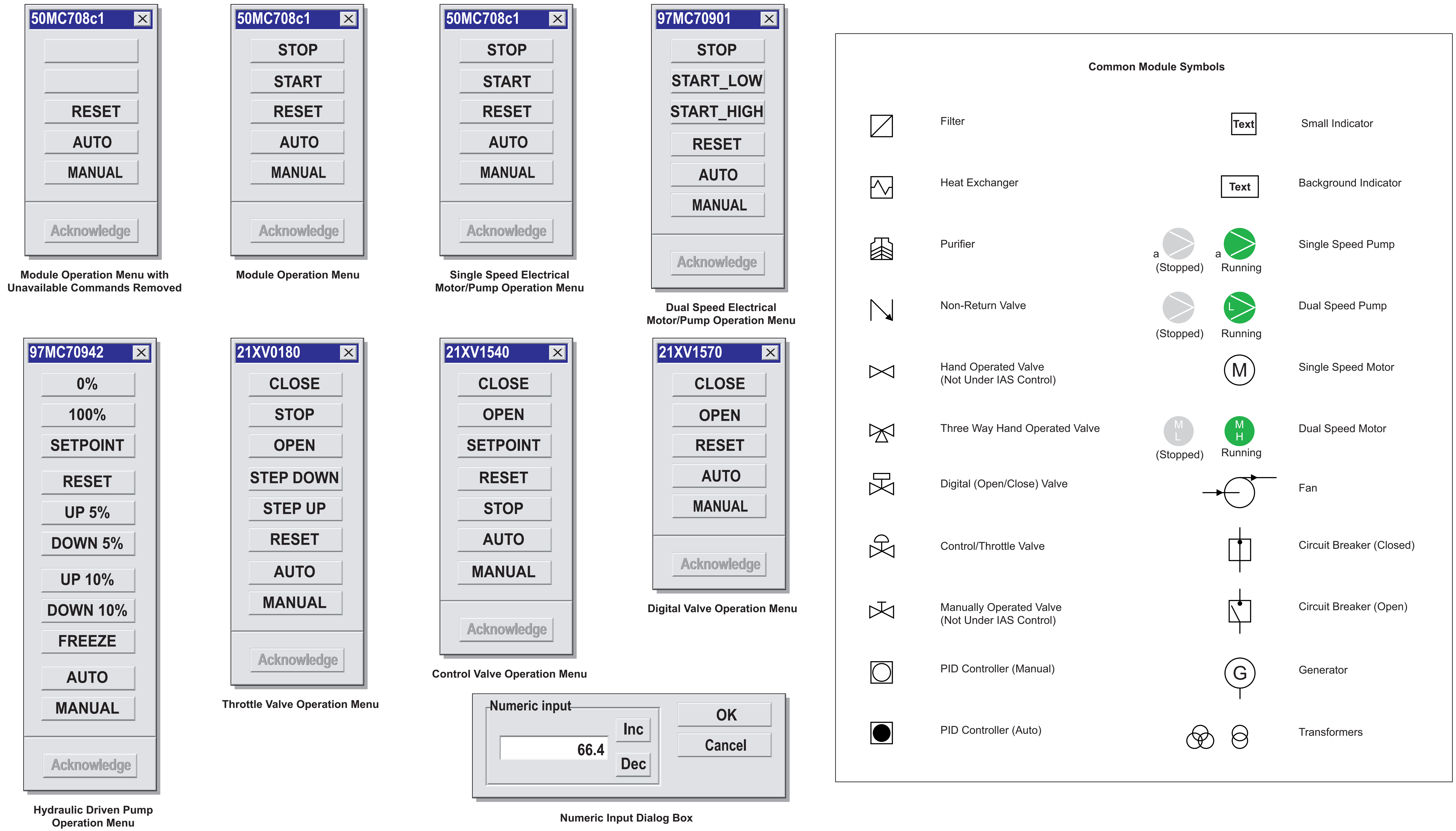
- Process: Showing the process equipment under system control
- Flow: Showing the process equipment under system control for software configuration
- Event: Showing process events and events generated by the system
- Trends: Showing historic trend curves for process variables
- Equipment: Showing the status of the process and operator control units

Both process and flow types of view can display the same information. Normally, process views are used by the system. The system can also present detailed information regarding a single component, eg, a motor, valve or pump.

This information is then displayed via the following dialog boxes:

- Single Point View: Shows the current operational status of the module together with a trend (if configured) and selected adjustable parameters
- Module Parameters: Shows all the adjustable parameters of the module
- Module Terminals: Shows the connection terminals of the module together with their signal values
- Show Connection: Shows the connections to and from the module terminals
- Alarm Configuration: Shows the alarm limits set for the module
- I/O Card: Shows the input/output configuration and connections of the module terminals
- Module Status: Shows the operational configuration of the module
- AIM Time Series Explorer: Allows the management of module terminal series and parameter time series

Illustration 3.2.2b Operation: Symbols and Views



Mode Indication

Process elements can be operated in various modes. To reflect the mode that a process element is in, a tag mark character is displayed next to its module symbol. The characters used and their colours are:

- Manual mode: 'Blank space' or a white 'm'
- Automatic mode: Green 'a'
- Disabled mode: Cyan 'd'
- External mode: Green 'e'
- Follow or freeze mode: Cyan 'f'
- Interlocked: Cyan 'i'
- Local mode: Cyan '1' or 'L'
- Overridden: Cyan 'o'
- Tripped: Magenta 't'

The dynamics of a process are shown by changes in the colour of the symbols in a view. For example, the colour of a motor symbol will be white when it is stopped, yellow when it is starting up or shutting down (transient state) and green when running and fully operational. The standard symbol and pipe colours used to indicate status and fluids carried is listed as follows:

Symbol	White	Yellow	Green	Blue	Red
Motor	Stopped	Transient	Running	Standby	Alarm
Pump	Stopped	Transient	Running	Standby	Alarm
Valve	Closed	Transient	Open	Standby	Alarm
Generator	Stopped	Transient	Running	Standby	Alarm
Circuit breaker	Open	Transient	Closed	Standby	Alarm

Pipe Colour	Fluid
Blue	Fresh water, condensate, LNG liquid
Light blue	Low pressure steam
Brown	Heavy fuel oil
Light brown	High pressure steam, diesel oil
Black	Bilge water
Green	Sea water, ballast water, nitrogen, glycol
Yellow	Lubricating oil, hydraulic oil, cold vapour
Purple	Compressed air

Basic Operation Procedure for Pumps

To operate a pump from the IAS screen, the local switch has to be turned to the NOR position and the main switchboard panel switch has to be turned to the IAS position.

a) Move the cursor over the module symbol to be operated.

b) Press the left trackball button to open the symbol operation menu.

The name of the item of equipment that the module controls is displayed in the title bar of the module operation menu. This menu is used to operate the module and the commands on the menu reflect the actions that can be performed.

The following operating buttons are available on the menu for a single speed electrical motor driven pump:

- STOP - This stops the motor and is only available in the MANUAL mode
- START - This starts the motor and is only available in the MANUAL mode
- RESET - This command resets the appropriate timeout counters and can be used to recover from a failed start or stop operation
- AUTO - This command selects the automatic mode and cancels the MANUAL mode. When in automatic mode the motor/pump is controlled by an output signal from another module and not via the operation menu. In this case the STOP and START buttons will become blank
- MANUAL - This command cancels the automatic mode and allows the motor/pump to be controlled via the operation menu. Selection of the manual mode is not possible if the Lock in Auto Mode parameter is set to 1 during the system configuration
- ACKNOWLEDGE - This will only become available (with black button text) when an unacknowledged alarm is active for the module concerned. All the alarms are acknowledged when this button is pressed

For a dual speed electrical motor, such as those fitted to the forced draught fans and the GS, bilge and fire pumps, the start buttons are repeated to allow starting on high or low speed as follows:

- START-LOW - This command causes the motor/pump to start and run at low speed and is only available in MANUAL mode. If this command is selected when the motor/pump is running at high speed the motor/pump will run at low speed. The command can be used to cancel a high speed start operation, but has no effect during low speed running. If the low speed start fails, use the RESET command to recover from the alarm situation
- START-HIGH - This causes the motor/pump to start and run at high speed and is only available in MANUAL mode. If this command is selected when the motor/pump is running at low speed the motor/pump will run at high speed. The command can be used to cancel a low speed start operation, but has no effect during high speed running. If the high speed start fails, use the RESET command to recover from the alarm situation

For a hydraulic driven pump the speed is controlled by adjusting the pressure of the hydraulic input supply to the pump. The following command buttons are available, in addition to the standard AUTO, MANUAL and ACKNOWLEDGE buttons described earlier:

- SET POINT - This command allows the operator to define the speed of the hydraulic driven pump. This is accomplished by specifying the value of the set point (control signal) for the valve regulating the pressure of the hydraulic input supply to the pump. When the command is selected, it displays the numerical input dialogue box see illustration 3.2.2b. The displayed numeric value is the current valve set point in % terms. A new value is entered either using the INC (increase) or DEC (decrease) buttons, or typing directly into the NUMERIC INPUT field using the operator panel keyboard and clicking the OK button. The size of the valve orifice (opening) changes to the new set point. The hydraulic pressure input supply to the pump changes, resulting in a change of speed. Then pump speed is increased or decreased as the set point is increased or decreased. This command is only available in MANUAL mode
- 0% - This command reduces the set point to zero, fully closing the valve and stopping the pump and is only available in the MANUAL mode
- 100% - This command increases the set point to 100%, fully opening the valve, running the pump at full speed and is only available in the MANUAL mode.
- RESET - This command resets the appropriate timeout counters and can be used to recover from a failed set point change operation

- UP 5% and UP 10% - This command increases the set point by either 5 or 10% (depending on the button pressed) opening up the valve, increasing the pump speed by either 5 or 10% and is only available in the MANUAL mode
- DOWN 5% and DOWN 10% - This command decreases the set point by either 5 or 10% (depending on the button pressed) closing in the valve, decreasing the pump speed by either 5 or 10% and is only available in the MANUAL mode
- FREEZE - This command locks the set point for the hydraulic supply valve to the pump. The valve opening is maintained at its current value and holds the pump at its current speed. This command is only available in MANUAL mode

Configuration Options

During system configuration one or more of the following functions may have been configured for the motor/pump control modules:

- LOCAL/REMOTE MODE - All the motor/pump control modes have a local/remote function which allows the motor to be started either from the local panel or from the IAS. Transfer between local and remote control is performed at the local panel
- CONTROL LOGIC INTERLOCKS - These functions prevent the motor/pump from being damaged. For the electrical motors the interlock functions inhibit the starting and stopping commands or execute the starting and stopping commands of the motors. For hydraulic pumps the interlock functions inhibit all commands
- POWER DEMAND - The motor/pump control modules for the heavy consumers have a power interlock function that prevents the motor/pump from being started if there is insufficient power available
- STANDBY START - The motor/pump control modules have a standby start function that allows a maximum of three electrical motors to be defined as part of a duty/standby sequence. They include:

  1. A motor continuing to run when put into the automatic mode, after initially starting in the manual mode

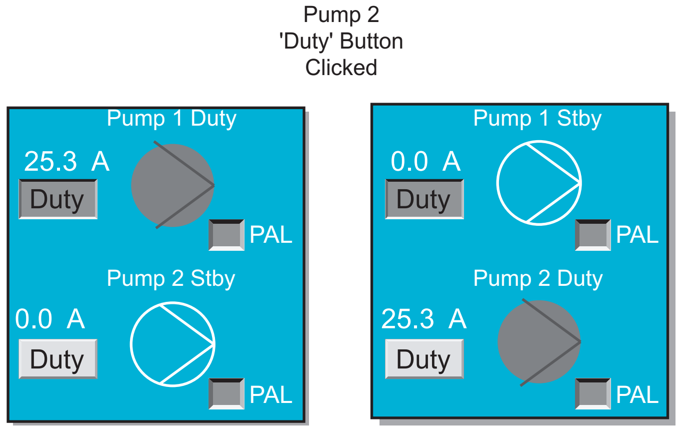
  2. A motor automatically starting if another in the sequence stops due to a failure

  3. A motor automatically starting if, for example, a pressure switch is used to start an additional LO pump if the LO pressure is too low in a generator

- BLACKOUT RESTART - This function causes a motor to restart automatically when power is re-established after a blackout, provided that the motor was running before the blackout occurred. A start delay is provided on each motor to prevent too many motors starting at the same time
- SHUTDOWN - The control modules have a shutdown function that overrides all other control inputs to the module and provides an emergency stop facility
- DUTY/STANDBY - The control modules may be connected in two different duty/standby configurations:

  1. The duty motor/pump is in manual mode and the standby motor/pump is in automatic mode. Under these cicumstances the standby motor/pump will start if, for example, the system pressure falls below a set limit.

  2. With both motor/pumps operating in the automatic mode the duty/standby selection is controlled by interlock toggle buttons. The presentation of the buttons changes to indicate the current selection for the associated motor/pump. Under normal circumstances only the motor/pump selected as duty will be running with the other motor/pump ready to start should conditions arise where additional capacity is required. See the illustration below showing two single speed electrical motor/pumps in a duty/standby configuration with duty selection buttons.



Two Single Speed Electrical Pumps in a Duty/Standby Configuration with Duty Selection Buttons

Basic Operation Procedure for Valves

There are three types of valves used:

- Throttle valve - Hydraulically operated, multi-position with feedback and stops at each position
- Control valve - Pneumatically operated, with a PID control connection and may or may not have a position feedback
- Digital valve - May be pneumatically or hydraulically operated, but only opens or closes as commanded

All the valves on the IAS screen mimics are supported by operation modules.

a) Move the cursor over the module symbol to be operated.

b) Press the left trackball button to open the symbol operation menu.

The menu is used to operate the module and the commands on the menu reflect the actions that can be performed. The basic module menu functions cover automatic/manual control, local/remote control, control logic interlocking and shutdown

Throttle Valve Menu

The commands on the operation menu of a throttle valve are as follows:

- CLOSE - This command causes the valve to close until it reaches a position that is below the predefined close limit. This command can be used to cancel an open position but has no effect on a closed valve. If a valve close operation fails, the RESET command recovers the alarm situation. The command is only available in manual mode
- STOP - The stop command causes a moving valve to stop operating and remain at the current position. This command can be used to cancel an open or close position but has no effect on a stationary valve. The command is only available in manual mode
- OPEN - The open command causes the valve to operate until it reaches the fully open position. This command can be used to cancel a close position but has no effect on an open valve. If a valve open operation fails, the RESET command recovers the alarm situation. The command is only available in manual mode
- STEP DOWN - This command closes the valve by a predefined amount, as defined by the configuration pulse length. This command has no effect on a fully closed valve and is only available in manual mode

- STEP UP - This command opens the valve by a predefined amount, as defined by the configuration pulse length. This command has no effect on a fully opened valve and is only available in manual mode
- RESET - This command resets the appropriate timeout counters and can be used to recover from a failed start or stop operation
- AUTO - This command selects the automatic mode and cancels the manual mode. In this mode the valve is controlled by an output signal from another module and not from the module operation menu
- MANUAL - This command selects the manual mod eand cancels the automatic mode. If the 'Lock in Auto Mode' parameter is set to 1 during system configuration, selection of the manual mode is not possible. The valve is controlled via the module operation menu when in the manual mode
- ACKNOWLEDGE - This will only become available (with black button text) when an unacknowledged alarm is active for the module concerned. All the alarms are acknowledged when this button is pressed

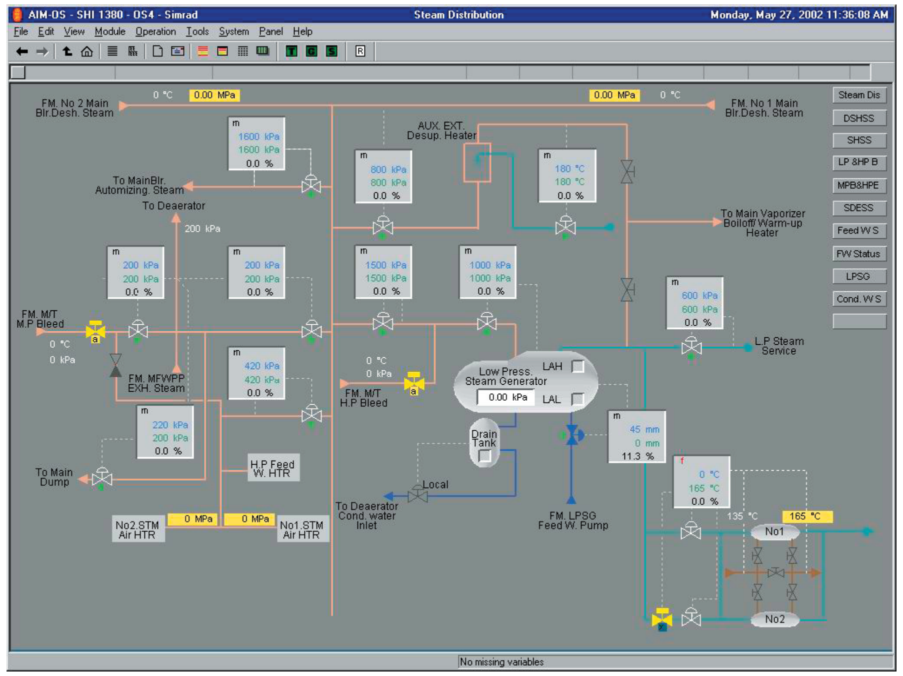
Control Valve Menu

The close, open, reset, automatic, manual and acknowledge commands on the operation menu of a control valve are similar to those on the throttle valve. The exception is the set point command which allows the operator to specify the position set point for the valve. When the command is selected, it displays the numerical input dialog box, see illustration 3.2.2b. The displayed numeric value is the current valve set point in % terms. A new value is entered either using the INC (increase) or DEC (decrease) buttons, or typing directly into the NUMERIC INPUT field using the operator panel keyboard and clicking the OK button. The position of the valve opening changes to the new set point. This command is only available in manual mode.

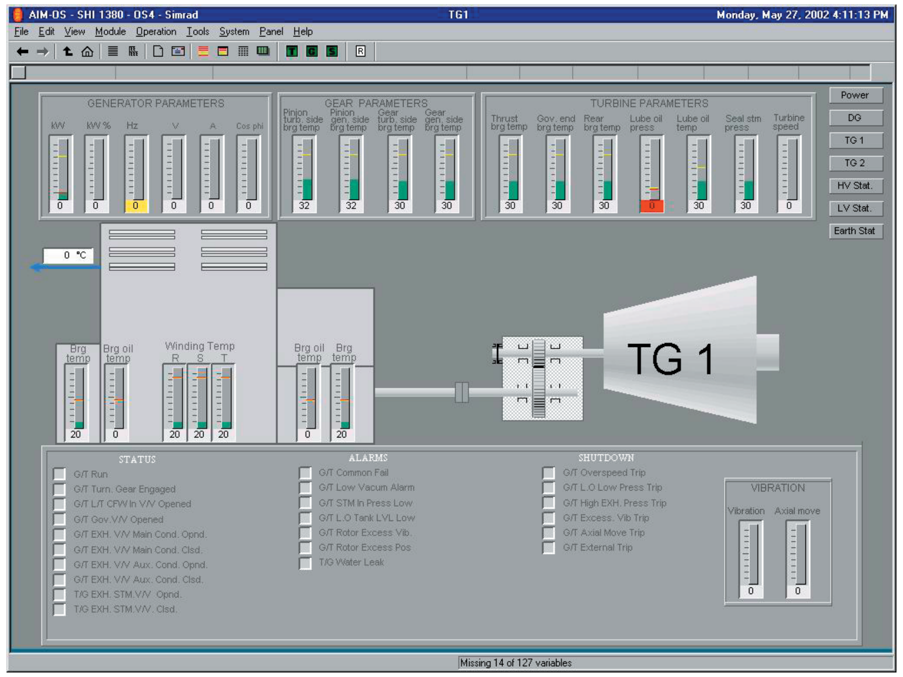
Digital Valve Menu

The close, open, reset, automatic, manual and acknowledge commands on the operation menu of a digital valve are similar to those on the throttle valve.

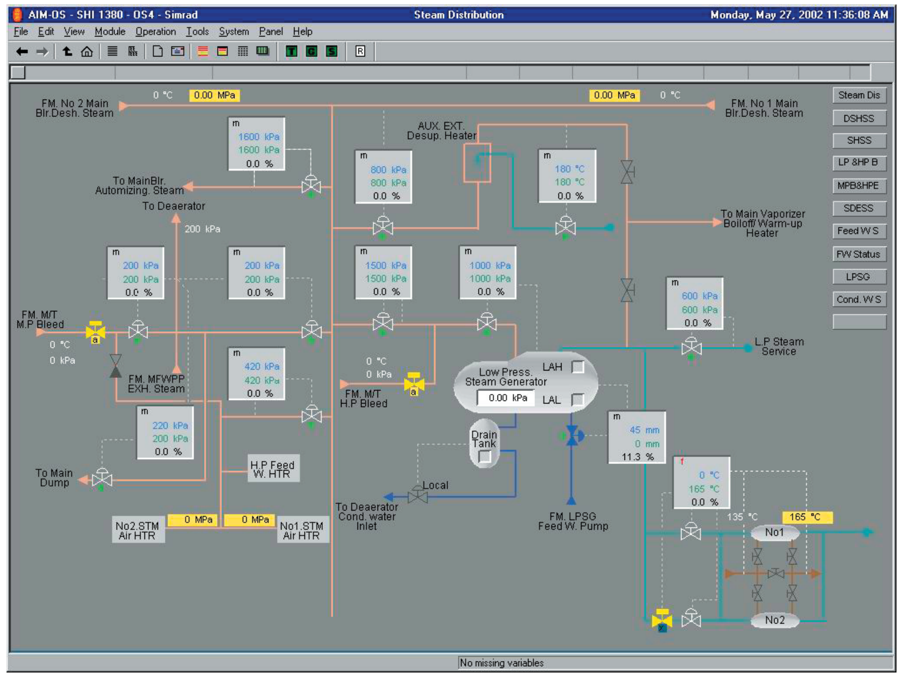
Illustration 3.2.3a Screen Displays



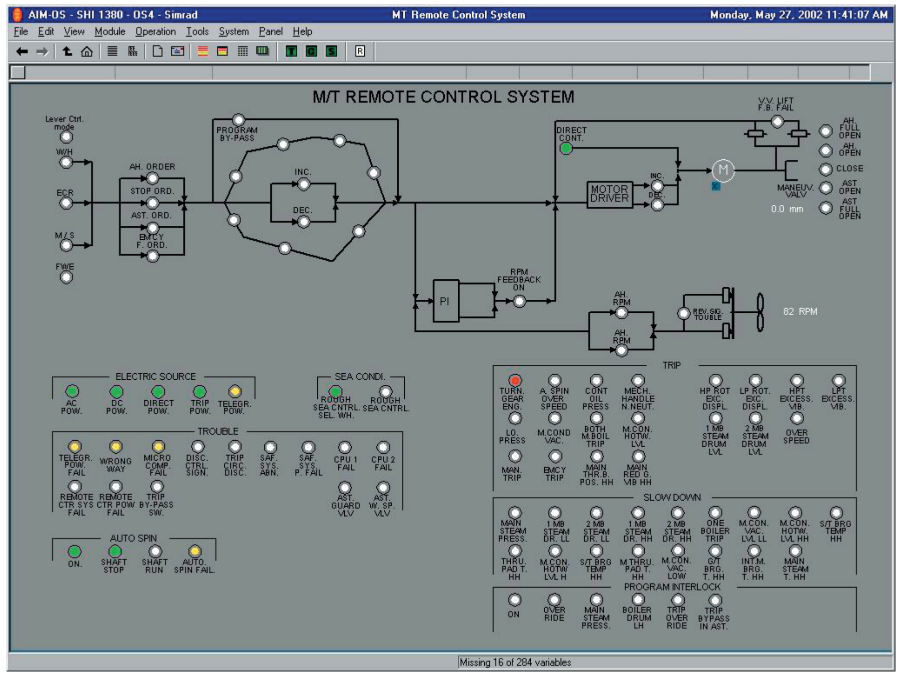
Central Fresh Water Cooling System



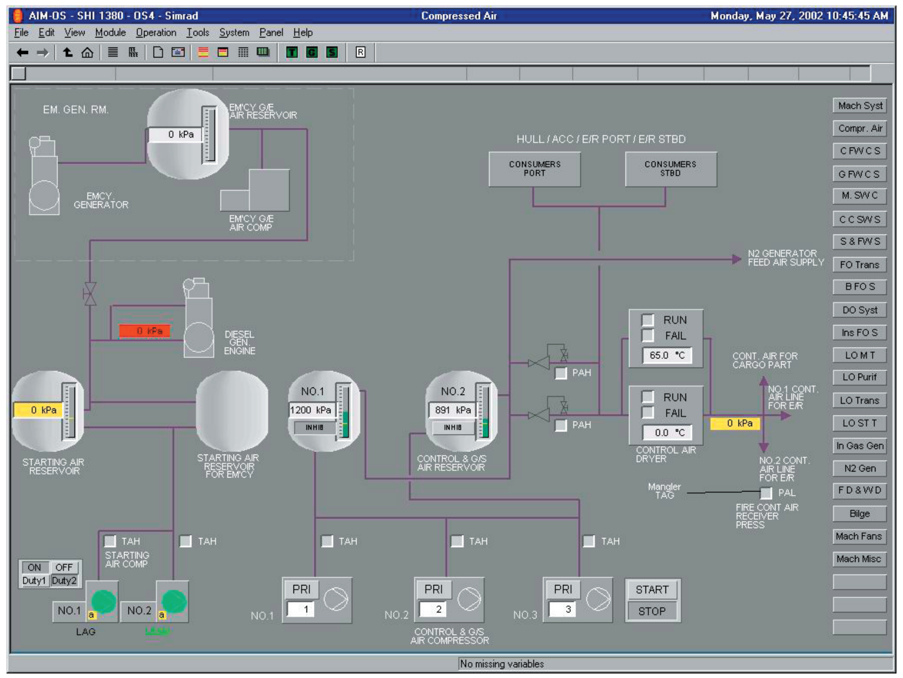
Turbine Generator



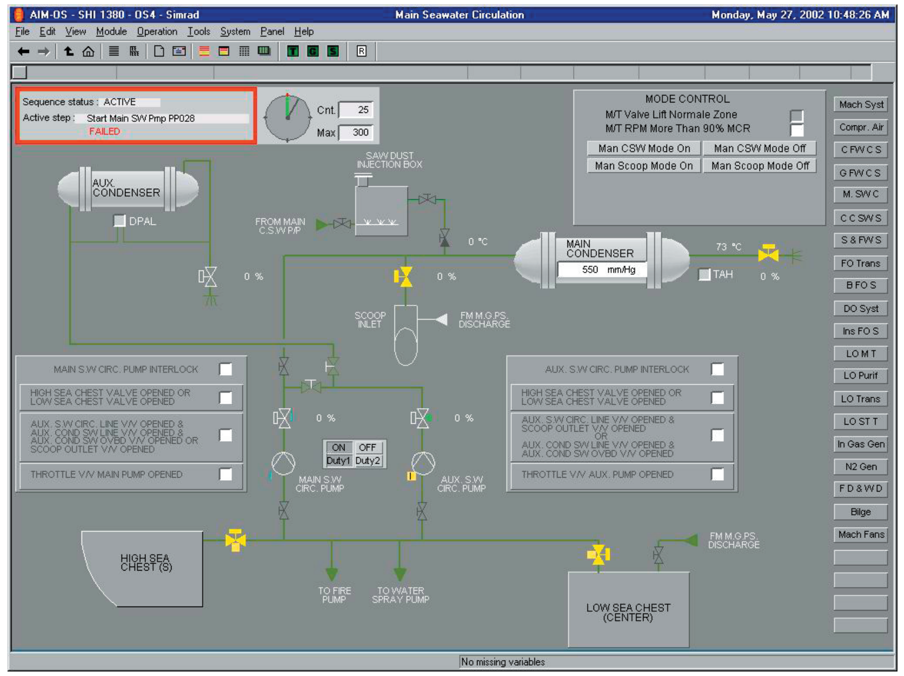
Steam Distribution



Main Turbine Remote Control System



Compressed Air System

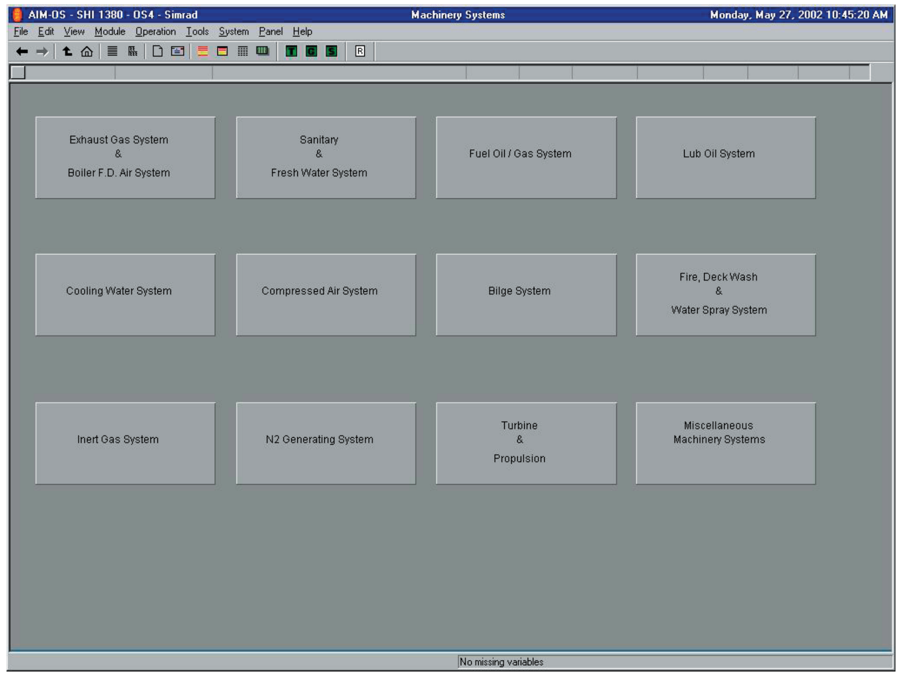


Main Sea Water Circulating System

3.2.3 SCREEN DISPLAYS

Menu Bar

The menu bar displays the names of nine menus, of which seven (file, edit, view, module, operation, tools and system) have context sensitive commands and two (panel and help) have fixed commands.



The commands available on the seven menus with context sensitive commands depend on:

- The type of system view being displayed
- Which user group the logged on user name is a member of
- The selected system mode, ie, monitoring, operation, OS/PCU configuration

Some of the menu commands are global, ie, available for all views, all users and all modes (eg, the log off command on the file menu), whilst others are specific. If the menu commands are 'blanked' it means that they are unavailable in the current context.

Process View Menus

The commands on these menus are as follows:

File Menu

The commands on this menu are:

New image	Save image	Save image as
Image properties	Print image	Event printer
Print screen	Exit	

Edit Menu

The commands on this menu are:

Undo	Redo	Cut
Copy	Paste	Add hot spot

With the exception of Add hot spot, these are standard Windows NT editing commands that are not used with process views.

View Menu

The commands on this menu are:

Navigator	History	Preferences
Redraw		

Module Menu

The commands on this menu are:

Find tag	Operate	Single point view
Parameter view	Terminal view	Alarm limits
I/O card	Module status	Time series

Operation Menu

The commands on this menu are:

Acknowledge	Command control	PCU operation
HS operation		

Tools Menu

The commands on this menu are:

Browse modules	Module status list	Module editor
Message monitor	Report system	Alarm groups

System Menu

The commands on this menu are:

Palette	Select time zone	Set system time
Set time zone	OS configuration	OS config. mode
PCU configuration mode		

Panel Menu

The commands on this menu are:

Lamp test

Help Menu

The commands on this menu are:

About AIM/OS

This option displays details about the AIM operating system installed at that operating station.

Flow View Menus

Flow Menu

The commands on this menu are:

File menu

This menu has the same commands as the process views file menu listed previously.

The commands on this menu are specifically for changing the appearance of the flow view image. These commands are only available when the operator is logged on as an authorised user in the OS or PCU configuration mode.

View Menu

The commands on this menu are:

Navigator	History	Zoom centre
Zoom point	Zoom percent	Zoom rectangle
Inc. display level	Dec. display level	Preferences
Redraw		

The following flow view menus have identical commands and contents as the process menus:

Module	Operation	Tools
System	Panel	Help

Tool Bar

The tool bar at the top of the display contains short cut buttons to many commonly used functions. The type and function of the buttons displayed will vary according to the display selected, blanked buttons are unavailable.

Last Alarm Line

This line is located just below the tool bar on the display and will always show the most recent alarm.

Image Area

The area of the display showing the selected process, event, trend, flow and equipment view images.

Message Line

This line displays system and operator event messages. There is a status box which appears at the right hand end when the left trackball button is pressed as long as the cursor is within the image area.

System Views

The system has the following types of views:

Process views	Flow views	Event views
Trend views	Equipment view	Input/Output view

Process Views

These views are graphic representations of an actual equipment/plant process area. They are designed to provide the operator with all the relevant information about that process. Dedicated views are provided for monitoring the major equipment such as generators and boilers, etc.

Flow Views

These views are similar to the process views, the main difference is the techniques used to create them. The flow views have zoom functions and information level displays not included in the process views.

(**Note:** Flow views are for software configuration only and should not be used as the user interface.)

Event Views

These views are defined for displaying system and process events and form no part of the view hierarchy.

Trend Views

Trend views can be displayed as independent views, associated with process areas. They either form part of the view hierarchy or part of other views, eg, single point views.

The trend system controls the displaying, creating and appearance of trends. It can create and present several trends in a view and allows splitting of these trend windows on several levels.

A trend is the presentation of single or multiple trend curves in a scaled axis system. There are two different types of trend presentation:

1. Trend view: Has a fixed size, filling the screen
2. Trend pop-up: Small, resizable, remains displayed irrespective of the view selected and can be positioned anywhereon the screen.

Both of these displays have a context menu for controlling their appearance.

All system process variables can be monitored as trend curves. A trend curve is a graphical presentation of the values for a single process variable with the progress of time or the correlation of the values for two process variables over a selected time span.

These two presentations are:

- Time trend curve: A plot of the values for a single process variable with the progress of time
- XY trend curve: A plot of time correlated values from two different process variables (X and Y) for a defined time span

There is a multiple curve facility, where it is possible to have several trend curves in the same trend, provided that they are all the same type. A mixture of time and XY trend curves is not possible. There is also a time trend facility which can contain a maximum of 10 curves. Separate scales are overlaid on the Y axis and a common time that shows the same time resolution for all curves on the X axis.

Equipment View

This view shows information on all the operator and process stations within the system. It is displayed by clicking the equipment view button on the tool bar.

Input/Output View

The input/output view shows information on the input/output cards in a selected process station. It can be displayed by clicking the input/output view button on the toolbar.

View Hierarchy

All the views in the system (except for the event and equipment views) are arranged in a configurable hierarchical system. The view hierarchy is shown in the navigator dialog box, accessible from the navigator button.

The view hierarchy comprises several levels, where the first (top) level represents a process system such as ballast or cargo. This top level view often provides an overview of the process, whereas process details or components will be found in the second (lower) level views. Trend views are located on the second (lower) level.

If all the available information for a process is included in a single process or flow view, there is no lower level view for that system other than trend views. The first (top) level views are connected to the views buttons on the operator panel.

Context Menus

All views have a pop-up context menu that is opened by pressing the right trackball button, as long as the cursor is on the background of a view. The commands on these menus depend upon the type of view currently being displayed and the operation or configuration mode selected. The commands available on this menu are:

- Find tag: Allows module search by tag names
- Browse module: Allows module search by attributes

Hot spots

In process views, hot spots are sometimes available providing hyperlinks or shortcuts to a related view. They provide links across the view hierarchy and they can also be used to display flow and trend views. A hot spot is represented by a button containing text. Hot spots can be located anywhere in a view, but are usually located at the right side of the view.

Logging On and Off

Before using the system, the operator must first log on with the correct IAS (AIM-2000) user name and log-on password combination. When the operator has completed operation of the system, they should log off.

IAS System Modes

The system has four operational modes:

1. Monitoring

This mode is for personnel who require access to the system but are not qualified to operate it. To enter this mode the user's name must be a member of the guest's user group.

2. Operational

This mode is for normal system operation. To enter this mode the user's name must be a member of the user's, power user's or administrator's user group.

3. OS Configuration

The user's name must be a member of the administrator's user group.

4. PCU Configuration

The user's name must be a member of the administrator's user group.

Command Control

The operation of the IAS system is divided into command groups which reflect the system operation. Each of these groups represent a specific process area, eg, ballast, cargo, etc. As all operator stations can view all process areas, operational control of these areas must be restricted. This is achieved by using the command groups to limit the control access of the operator stations. A command group has the following functions:

- Restricting the control of process areas to specific operator stations
- Restricting the acknowledgement of alarms
- Restricting the reporting of events to specific stations

It is possible to transfer control of process area related modules from one operator station group to another by command transfer, using buttons in the command group on the operator panel.

Each operator station group will have one of the following states for each command group:

- In control: The modules in the command group can be monitored and controlled, parameter adjustment and configuration operations executed
- Not in control: The modules in the command group may be monitored, but control, parameter adjustment and configuration operations cannot be executed

The status of command control can be monitored using the status or command status buttons. Command control can be transferred using the GIVE and TAKE buttons or via the respective commands from the command control menu.

Events

The event system handles reporting, presentation and storing of events within the IAS system. The system provides the following:

- Presentation of events
- Event view
- Last alarm line
- Alarm indications in process views
- Alarm and message printing
- Audible alarm
- Alarm acknowledgement
- Alarm suppression
- Event filtering

An event is designated as any change in the way a part of the process or the IAS system functions. Events can also provide information concerning the history of events over a specified period of time. All events are time stamped and logged when they occur and are divided into alarm or message categories. The alarms are then divided into system or process alarms. The messages are divided into system, message or process messages.

The information structure for an event is similar to a database record. These event records are stored and presented in chronological order as lists.

There are two different ways of presenting events, the event view or the event (alarms) window. Both presentations contain the same information. The difference is that the event view fills the whole screen whereas the event (alarms) window has a reduced size and overlays the currently displayed view.

Clicking on the event view button on the tool bar displays the event view.

Alarm Indication

All the alarms from the various systems are pooled via the redundant network to form a uniform alarm system for thr vessel. The alarms are indicated on the screens of the operator stations and will activate the buzzer in the IAS keyboard. Alarms and events are logged by the system and printed out.

Alarms can be displayed within a view in the following ways:

- A square indicator next to a symbol
- A background colour of a numeric or text field
- A square status indicator preceding a text field
- A bar graph indicator colour and the background colour of its numeric value field

Alarms can be suppressed individually or in groups (engines etc). The system also uses a system of alarm, event and horn filters to select which events are displayed and annunciated at operator stations. Filters can be modified or created from the 'select filter' dialog box.

The system uses colours to illustrate alarm priority levels as follows:

- Green: Normal
- Yellow: 1. Low priority
- Red: 2. High priority
- Magenta: 3. Critical priority
- Cyan: Alarm disabled
- Brown: Module not active or I/O disabled

Context Menu

If the operator presses the right trackball button when the cursor is over a module symbol, the pop-up context menu opens. This menu gives access to the settings for that module and any other views in which the module is configured. The context menu contains the following commands:

Single point view	Parameter view	Terminal view
Show connection	Alarm limits	I/O card
Module status	Time series	Flow view
Trend	Process view	

The menu always contains the same commands, but those that are available will depend upon the module symbol selected and the user group that the operator belongs to.

Displays and Views

The system is made up of the following types of views:

- Process: Showing the process equipment under system control
- Flow: Showing the process equipment under system control for software configuration

- Event: Showing process events and events generated by the system
- Trends: Showing historic trend curves for process variables
- Equipment: Showing the status of the process and operator control units

Both process and flow types of view can display the same information. Normally, process views are used by the system. The system can also present detailed information regarding a single component, eg, a motor, valve or pump. This information is then displayed via the following dialog boxes:

Single Point View

Shows the current operational status of the module together with a trend (if configured) and selected adjustable parameters.

Module Parameters

Shows all the adjustable parameters of the module.

Module Terminals

Shows the connection terminals of the module together with their signal values.

Show Connection

Shows the connections to and from the module terminals.

Alarm Configuration

Shows the alarm limits set for the module.

I/O Card

Shows the input/output configuration and connections of the module terminals.

Module Status

Shows the operational configuration of the module.

AIM Time Series Explorer
Allows the management of module terminal series and parameter time series.

Equipment Views Available

The following equipment status views are available:

Port and starboard boilers

- Burner control
- Alarms
- Purging
- Water level
- Forced draught fans
- Steam dump
- Control logic
- Boiler safety
- Sootblowers

Electrical power distribution
Electrical power management
Steam and feed water flow
Main turbine control
Main propulsion bearing temperatures
Stern tube system
Sea water system
Turbine generator
Diesel generator
Fuel oil tanks and system
Fire detectors
Compressed air
Inert gas generators
Main condenser
Low pressure steam generator
Lubricating oil transfer
Bilge system
Fresh water cooling system
Steering gear
Bow thruster
Engine room ventilation fans

Command Control Locations

The Bridge, Cargo Control Room and the Engine Control Room command locations control the following groups:

Bridge

- Ballast system
- Fire control system
- Navigation system
- IAS system alarms
- Common alarms

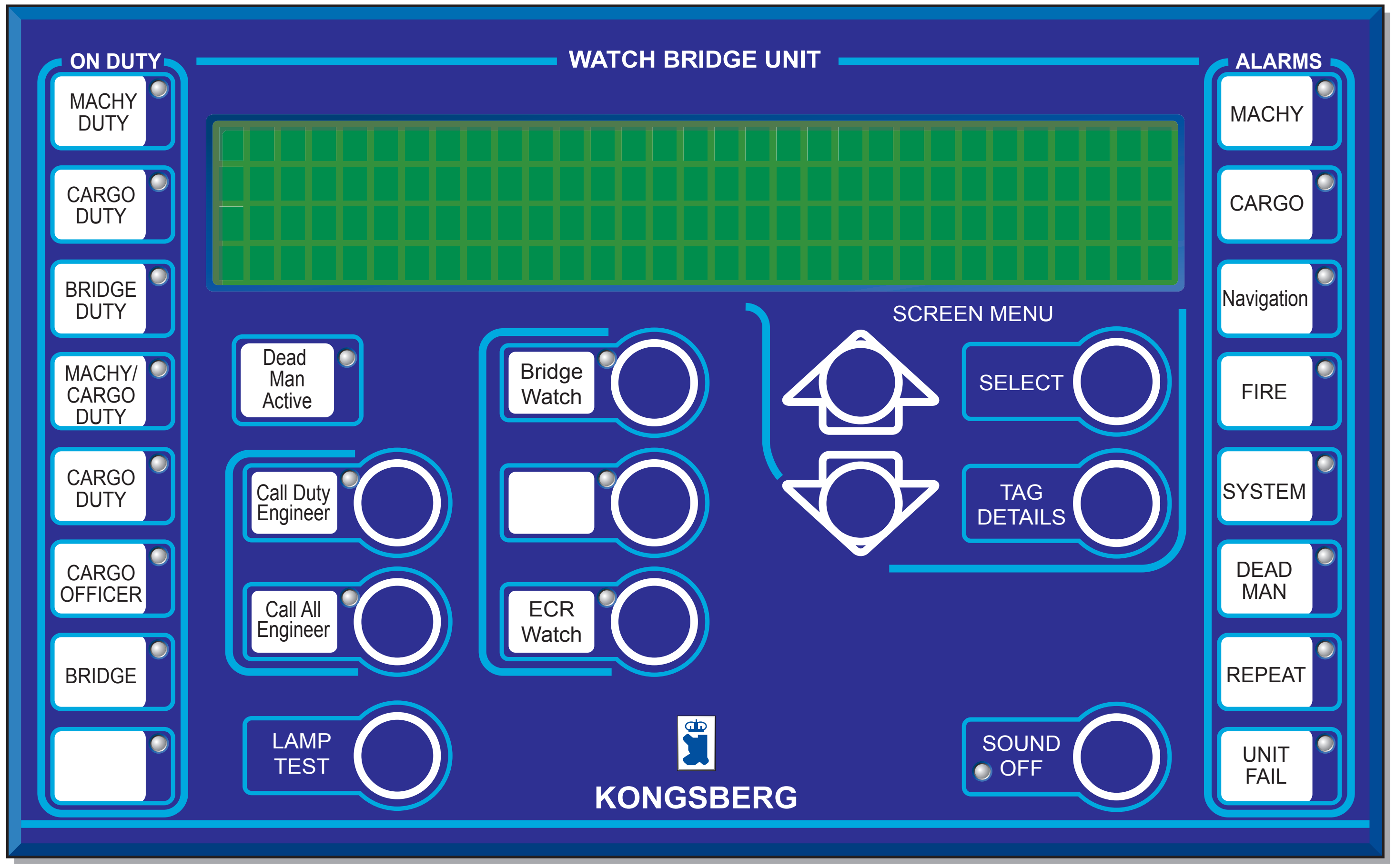
Cargo Control Room

- Ballast system
- Fire control system
- Cargo system
- Fuel oil transfer system
- Gas handling system
- Compressors and heaters
- Inert gas generator system
- N_2 generator system
- IAS system alarms
- Common alarms

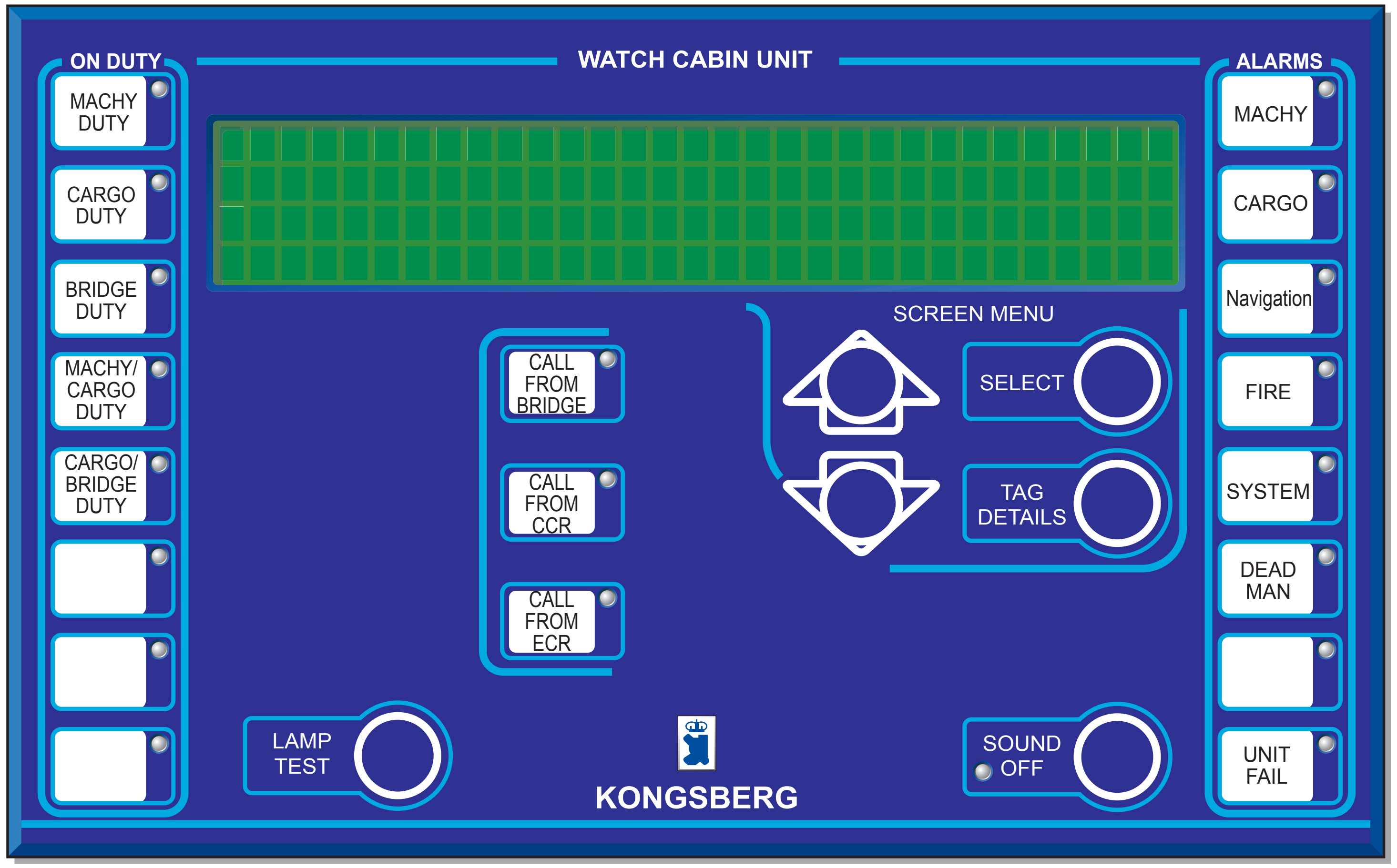
Engine Control Room

- Boiler control system
- Fire control system
- Fuel oil transfer system
- Gas handling system
- Compressores and heaters
- Inert gas generator system
- N_2 generator system
- Electrical power management
- IAS system alarms
- Common alarms

Illustration 3.2.4a Watch Call Panels



Bridge Watch Call Panel



Cabin Watch Call Panel

3.2.4 WATCH CALL SYSTEM

Introduction

The watch call system is an IAS application that monitors the cargo and engine room during Unmanned Machinery Space (UMS) operations. The system comprises a number of self-contained, wall mounted watch call panels that are installed at selected locations. The panels are controlled from operator stations and are used to warn the bridge and on-duty officers of alarm conditions. The system has two main functions:

1. Alarm extension. This is a group alarm status and on-duty officer indication facility with a built-in on-duty acceptance, fault indication and test facilities.
2. Officer call. This is an individual and general calling facility for officers that can be activated from selected vessel control locations.

Watch Call Panels

There are two types of watch call panels:

- Watch bridge unit (WBU) - for use on the bridge
- Watch cabin unit (WCU) - for use in cabins and public places

Operation control and configuration of the watch call system can be performed using the WATCH CALL command on the OPERATION menu on the operator station.

Clicking on this command displays the WATCH CALL dialogue box which has three pages, OPERATION, CONFIGURATION and CAN NETWORK.

The operation page mimic contains the following:

- ON DUTY indicators with buttons that show and select on-duty officers. When the green LED in the top right-hand corner is lit it indicates that the officer on the label is on duty When the LED flashes it indicates that a call has been made and when the call is accepted the flashing LED changes to a steady light. These also act as watch buttons that transfer watch responsibility between the bridge and the engine control room. They have a yellow LED located next to the top right corner of the button label that flashes to indicate a responsibility transfer request has been made. When the transfer request is accepted, by pressing the BRIDGE WATCH or ECR WATCH button, the transfer is made and the flashing LED changes to a steady light
- ALARM indicators that show in which process area there are active alarms
- A REPEATER ALARM indicator that shows if there is a repeat of a previous alarm
- An indicator that shows if the Dead Man System is active. It has a green LED in the top right corner that lights when the system is active
- An LCD screen with a 40 character by 4 line display, which is used to show the date and time or an alarm summary
- A LAMP TEST button which is used to check the serviceability of the indicator, button LEDs and the buzzer. It is also used, in conjunction with the up and down and SELECT buttons, to adjust the light intensity of the LCD screen, indicator and button LEDs and the background lighting
- When an alarm summary is displayed, the up and down buttons are used to scroll the list shown on lines two to four on the LCD screen
- The SELECT button is used to choose the type of information shown on the LCD screen. Pressing the button for the first time displays the Alarm Summary. Repeated pressing of the button cyclically displays the Alarm Summary and the date and time
- When the Alarm Summary is displayed on the LCD screen, the TAG DETAILS button is pressed to show (on lines three and four) the details of the alarm shown on line two
- The SOUND OFF button is pressed to stop the buzzer from sounding and acknowledging group alarms and officer calls

When an engine room alarm is activated, it is annunciated in the duty engineer's cabin, on the bridge and the public rooms. The buzzer can be acknowledged at any panel. The alarm lamp will stop flickering when acknowledged from the duty engineer's cabin and the lamps are extinguished when acknowledged at the IAS operator station. If the duty engineer fails to acknowledge the alarm from the ECR within 3 minutes, the alarm will be repeated on the bridge and public room panels.

Dead Man System

This system is part of the alarm system and consists of two types of panels:

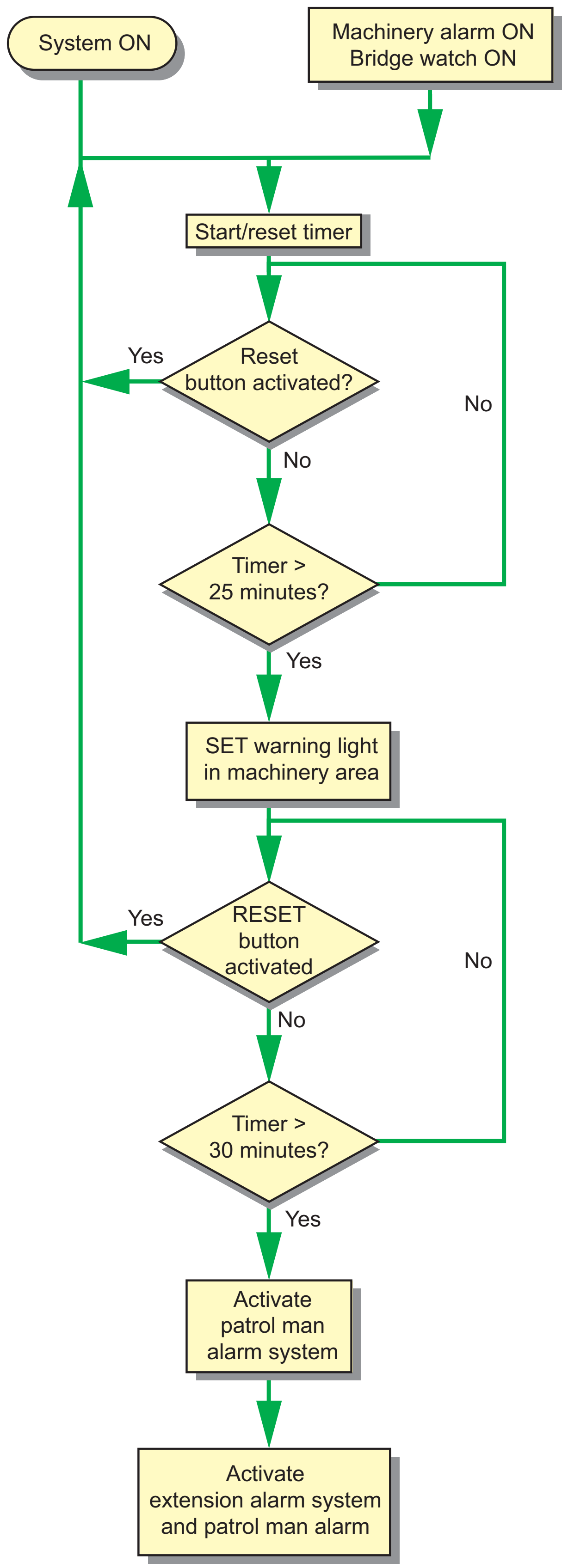
- One start panel - situated at the entrance to the engine room
- Two reset panels - situated in the engine room

The system can be manually activated from the start panel at the entrance to the engine room or automatically by the watch call system. The reset interval period is 30 minutes and a prewarning alarm will be activated 5 minutes before the dead man alarm sounds.

The count down timer is reset by pressing the RESET button on one of the reset panels in the engine room or on the Alarm Extension mimic.

The system is switched off by pressing the OFF button on the start panel.

Flow Chart for Dead Man System



There are three positions where the patrolman system can be started:

- Engine control console
- Upper deck lobby - entrance to engine room)
- Upper deck cross alleyway entrance

The Patrolman can be reset from any of following the light signal columns:

Engine casing (upper deck frame 32 centre) - entrance from upper deck

Funnel casing (B deck frame 31 port) - aft of FD fans

Emergency generator room - outboard bulkhead

Outboard of No.1 main switchboard

Outboard of No.2 main switchboard

2nd deck port (frame 39) - inboard of No.2 air conditioning compressor

3rd deck port (frame 50) - Inboard of inert gas generator freon cooler

Steering gearing room - port bulkhead

4th deck port (frame 35) - forward of No 1 Main Feed Water Pump

Floor level (frame 54) - forward bulkhead, adjacent to No 3 ballast pump

2nd deck starboard - outside engine store

3rd deck - in engine workshop

3rd deck starboard (frame 35) - aft of No.2 turbine alternator

4th deck starboard (frame 62) - inboard of No.2 cargo machinery CFW pump

Floor starboard (frame 35) - forward of the purifier feed pumps

3.2.5 SHIPBOARD MANAGEMENT SYSTEM

Introduction

The shipboard management system (SMS) is designed to assist ship personnel in managing the vessel in a safe and efficient manner. The system has the following main modules, each with a password protection:

1. Spare parts inventory management system.
2. Planned maintenance system.
3. Word processing and data filling system.
4. Compilation system of voyage abstract.
5. Vibration monitoring analysis system.
6. Guidance of cargo handling and trend data system.
7. Ship operation report system (SORS).
8. Ship performance management system.
9. Utilities and back-up of the SMS.
10. Data transmission system of the SMS.
11. Lubricating oil analysis record system.
12. Compilation of dry dock repair specifications.
13. Ship personnel management system.

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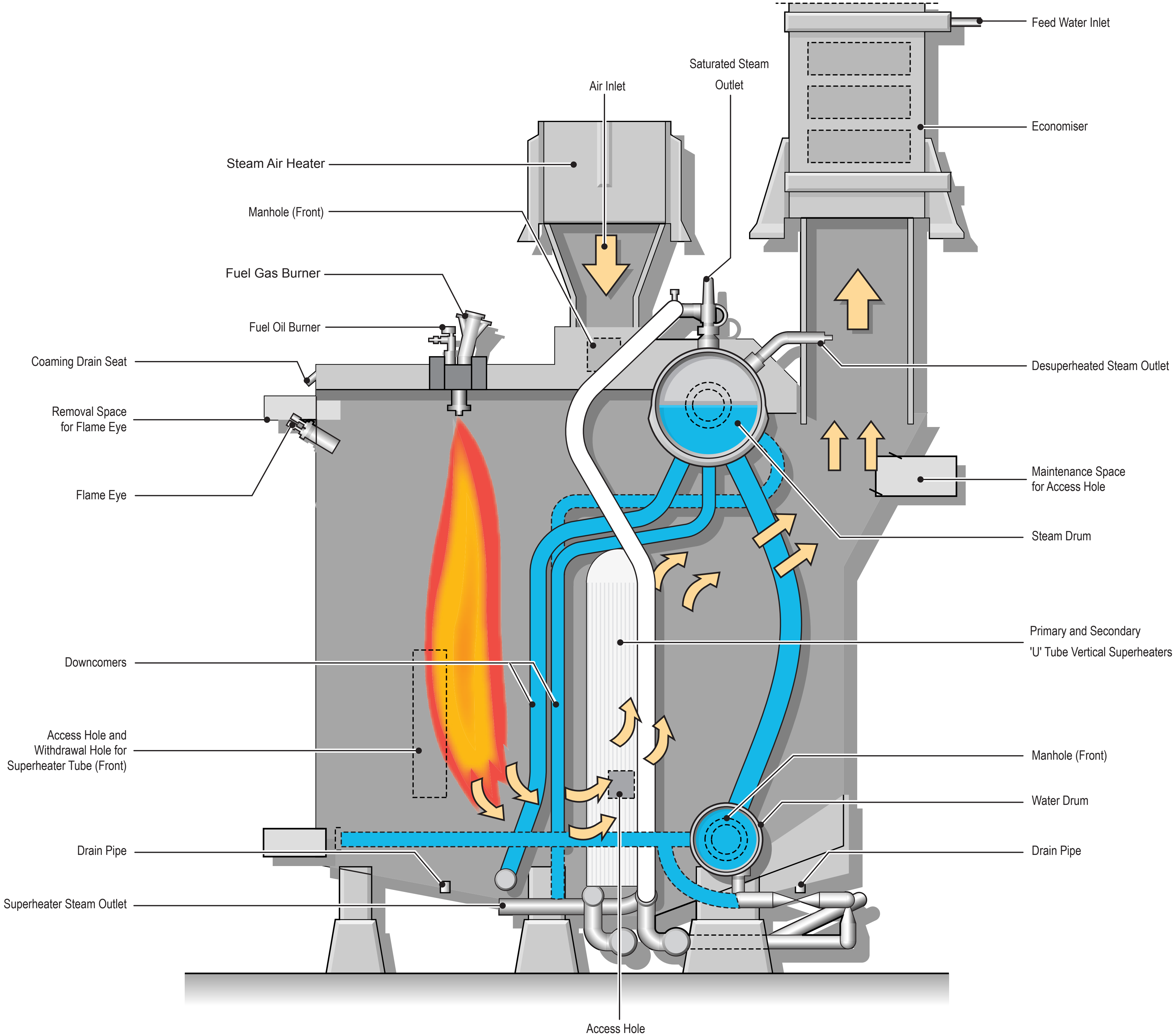
3.3 Main Boilers

Illustrations

Illustration 3.3.1a Main Boiler



3.3 MAIN BOILERS

3.3.1 MAIN BOILERS DESCRIPTION

Maker:	Kawasaki Heavy Industries
No. of sets:	2
Model:	UME 65/50
Type:	Two drum, water tube, roof fired, mono wall
Maximum evaporation:	65,000kg/h
Normal evaporation:	50,000kg/h
Steam condition:	5.88MPa superheated steam at 525°C
Feed water inlet:	145°C
Efficiency fuel oil:	88.5%
Efficiency boil-off gas;	84.0%
Fuel oil consumption:	3,600kg/h at normal evaporation
Fuel gas consumption:	3,056kg/h at normal evaporation
No. of burners:	3 combined oil/gas

Internal Auxiliary Desuperheater

Maximum steam flow:	35,000kg/h
Outlet pressure:	350°C
Outlet pressure:	5.44MPa

Safety Valve Settings

Drum high set:	7.546MPa
Drum low set:	7.448MPa
Superheater:	6.370MPa
Economiser:	9.433MPa

General Construction

Each boiler is of the two drum type construction, with one steam drum and one water drum and consists of the boiler proper, boiler casing, superheater, economiser, air heater, fuel and gas firing equipment, mountings, fittings and other accessories.

The unit is composed of a steam drum and a water drum connected by a bank of inclined generating tubes. Other water side components include:

- Screen tubes shielding the superheater elements from the direct radiant heat of the furnace
- Side and roof water wall tubes
- Front and rear water wall tubes
- Downcomers
- Bottom headers
- Roof and bottom front wall headers
- Roof and bottom rear wall headers
- Front and rear wall riser pipes

The tubes in the furnace floor, sides and roof, front and rear walls are of membrane wall construction. Each tube has two fins welded to it, opposite each other, and running the length of the tube. The fins of the adjacent tubes are welded together to form the membrane wall. The furnace is enveloped on three sides, together with the roof and the floor, by the membrane construction. This forms a gas tight envelope of the furnace and prevents gas leaking into the casing.

The remaining principal components of construction are a superheater, an internal desuperheater in the steam drum, a superheated temperature control desuperheater in the water drum, the economiser, steam air heater and the casing.

The combination burners are roof mounted and therefore the gas flow is evenly distributed across the screen bank, superheater and generating bank tubes before discharging through the economiser and into the flue.

Drum Internals

The steam drum internals consist of the desuperheater, surface blow line, internal feed pipe, chemical feed line, baffles and dry box.

Steam generated in the boiler tubes enters the steam drum where it is forced to enter a baffle located at the normal water level, before entering the upper part of the steam drum. The baffle is intended to reduce the surging of the water level due to hard steaming, sudden load changes and any vessel movement. Before leaving the boiler through the steam outlet nozzle, the steam must pass through the dry box located at the top of the steam drum. The dry box separates larger water particles from the steam and helps to prevent or reduce carry over of water with the steam.

A submerged tube desuperheater is located in the steam drum below the normal water level. Superheated steam is fed through the tubes, giving up most of its degree of superheat to the water within the drum and emerging as reduced heat auxiliary steam. Desuperheated steam is supplied in this way to ensure that there is always a flow of steam through the superheater even when the demand for superheated steam is low. This ensures that the superheated tubes are not damaged by overheating during low steam flow conditions.

The water drum located at the bottom of the boiler houses a submerged tube desuperheater, through which some of the superheated steam is diverted to control the final superheated outlet temperature. The drum has a blowdown pipe fitted to control the boiler water impurities.

Both steam and water drums are fitted with swinging manhole covers to allow entry and inspection.

Furnace

As previously described, the furnace walls are of the membrane construction. The tubes forming the furnace sides, floor and roof and front and rear walls are of 63.5mm diameter.

External downcomer tubes are placed outside the boiler casing and provide ample circulation of the water from the steam drum to the water drum, bottom header and the front and rear water wall headers. These tubes are welded into the drums.

The water cooled furnace floor tubes leave the bottom header and transverse the floor before bending upwards to form the furnace side and roof. They terminate in the steam drum.

The furnace front and rear tubes are arranged from the lower to upper water wall headers. The upper water wall headers are connected to the steam drum by riser pipes.

Where openings in the furnace walls are required for burners, access doors and sootblowers, the water wall tubes are formed around them and then back to their original plane.

The furnace water wall tubes are backed up with insulation and supporting buckstays that allow for expansion. The outer casing is corrugated steel plate coated with heat resistant paint.

The steam generating tubes are 45mm in diameter and are arranged in a staggered pitch and expanded into the drums.

Saddles

Saddles are provided under the water drum and the front and rear water wall headers to support the boiler. The rear saddle under the water drum is fixed and the front saddle has slotted bolt holes, grooves and grease fittings to allow for easy movement and lubrication. Grease fittings are provided on the front and rear saddles of the water wall header. The grooved saddles are free to move to allow for expansion of the boiler as it warms up.

(**Note:** The boiler sliding feet should be inspected and cleaned as frequently as possible and should be greased at least every 600 hours. Failure to do this could result in the sliding feet seizing and subsequent damage to the boiler as it expands.)

Superheater

The superheater consists of a primary and secondary superheater and is of the vertical, U tube, convection type and arranged for multipass steam flow. The superheater elements are arranged in line with the centre loop forming a 'walk-in' space for inspection and cleaning.

Each tube panel has alloy spacers and supports which are welded to the tubes to maintain a clearance between the tubes. Each header, arranged at the bottom of the boiler to allow easy access and maintenance, is separated internally by welded steel diaphragms to direct the steam flow through five passes between the headers. Drainage is through small openings in the lower edge of the diaphragms.

Economiser

A finned extended surface type economiser is placed above the boiler tube bank. The economiser is made up of closely spaced, continuous loop elements, welded to the terminal headers at each end. Each element tube is of 38.1mm diameter carbon steel with a spiral steel fin, connected by U-bends to form an integral loop. All the elements are arranged in a staggered pattern and welded to the inlet header (upper) and outlet header (lower). The outside of the terminal headers are provided with handholes to allow access. The economiser is insulated and surrounded by a steel casing with large removable access panels.

Feed water enters the inlet header at the top and flows through the elements to the bottom header and from there to the boiler steam drum. This is counter to the gas flow which passes upwards over the elements and so prevents a high temperature difference across the economiser tube.

Forced Draught Fans

Maker:	Osaka Blower Co.
Type:	TACS - 1140 - 2 speed
Motor:	270/115kW
Capacity:	1,280/960 m^3/minute at 1,190/895 rpm

Two fans are situated on B deck and are controlled by adjustable vanes, automatically positioned by the combustion control equipment. The fans are arranged to supply their respective boilers. Either fan can be put into service on both boilers by manually opening the crossover connections on the air supply trunking.

Control of the fans is from the Air Flow Control IAS faceplate. The FD fan high/low speed is determined by the inlet vane command signal. The speed command is sent via the network to the IAS and the order for change of speed is as follows:

Command	Condition
Low to high	Low speed ON and FD fan inlet vane command >60%

A timer allows 10 minutes at this condition, then fan goes onto high speed.

High to low	High speed ON and FD fan inlet vane command <35%

Timer allows 50 minutes at this condition, then fan goes onto low speed.

Steam Air Heater

The boiler has a steam air heater to heat the combustion air before entry to the windbox and the furnace. The steam is supplied from the main engine IP bleed system when the pressure is sufficient. At other times this system is supplied with make-up steam up from the desuperheated steam system. The drains are directed to the LP heater or the atmospheric drain tank.

Each air heater has inlet steam isolating valves, BV223 and outlet drain isolating valves SD005F and SD001F. The air temperatures can be monitored on the Air Flow Control faceplate.

Combined Oil and Gas Burners

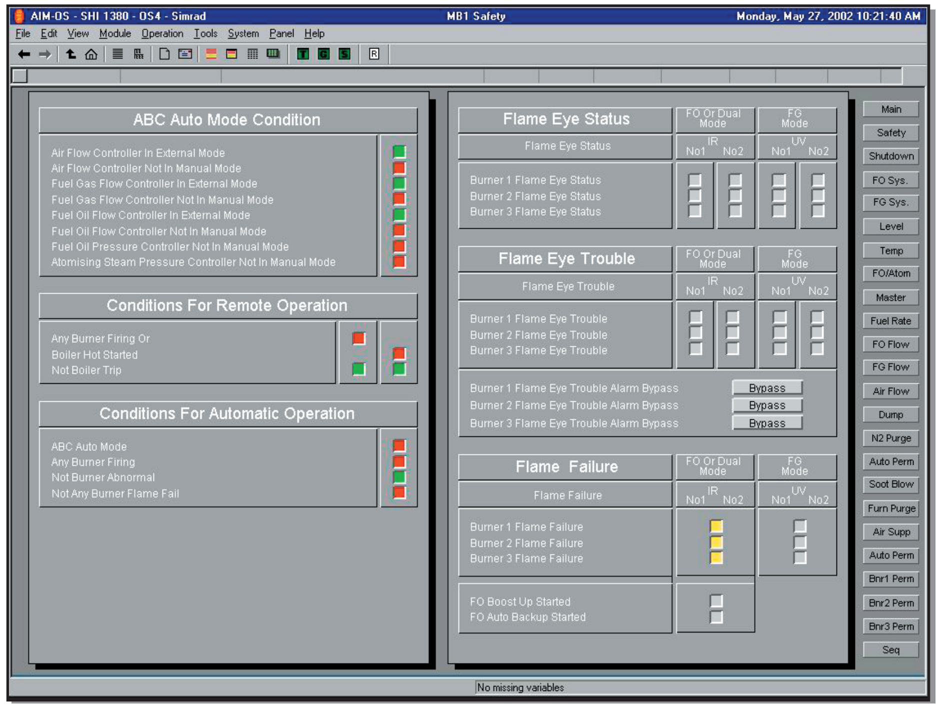
The boiler is fitted with three combination fuel oil and gas burners mounted in the furnace roof wall. The fuel burner is a steam assisted pressure jet type consisting of atomiser gun, forced draught air register and a fuel oil shut off valve. The fuel is distributed to the burners from a burner manifold and branch connection pipe. The operation of increasing or decreasing the number of burners is automatically operated by the automatic combustion control signal, and remotely operated by pushbutton when necessary.

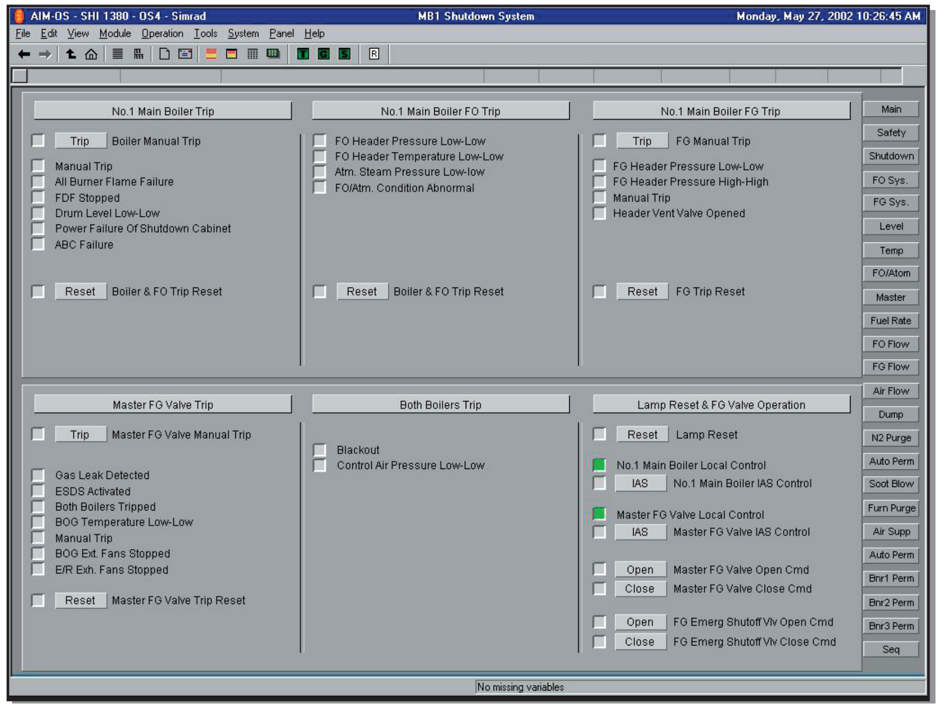
Seal Air Fans

Maker:	Taiyo Electric Co.
Type:	Horizontal centrifugal
Capacity:	7m^3/min at 600mmAq (6kPa) at 50°C
Motor;	2.2kW at 3,600 rpm

Two seal air fans are supplied, one for each boiler. The seal air fan provides cooling and sealing air to the burner flame eyes, sootblowers and glands.

The fans are started locally and the seal air pressure is monitored by the IAS, and an audible alarm operates when the pressure falls to below the set point of 3.5kPa.





3.3.2 AUTOMATIC BOILER CONTROL SYSTEM

Introduction

The system consists of the following process cabinets:

- PS-M7 - automatic control system common to both boilers
- PS-M8 - automatic control for the port boiler
- PS-M9 - automatic control for the starboard boiler
- PS-M5 (port boiler) and PS-M6 (starboard boiler) - for IAS alarm monitoring
- Shutdown control (2) - for the port and starboard boilers
- Sootblower control - for the port and starboard boilers
- Local control - for the port and starboard boilers

PS-M7 Process Cabinet

This contains the boiler's master control and includes the alarms from the boiler auxiliary systems. Also connected to this common control process cabinet are alarms from auxiliary machinery in the engine room and the turbine process cabinet, which form the propulsion management system.

PS-M8 and PS-M9 Process Cabinets

These control the burner start, stop and safety sequences with continuous monitoring of the boiler and burner safety interlocks via the emergency shutdown cabinets. The process cabinets communicate with each other.

PS-M5 and PS-M6 Process Cabinets

Each boiler also has an alarm cabinet PS-M5 (port boiler) and PS-M6 (starboard boiler) which communicate the alarms to the Intergrated Automation System (IAS).

Shutdown Control Cabinet

There is one shutdown cabinet for each boiler which operates independently of the automatic boiler control (ABC) system. The shutdown alarms are signalled to the IAS process stations.

Each shutdown cabinet will activate the following trips on the boiler under the following condition:

Trip Symbol:

F = Fuel Trip
G = Gas Trip
GM = Gas Master Valve Trip

Condition:

- F and G - All burner flames fail
- F and G - Steam drum water level low-low
- F and G - Forced draught fan stopped
- F and G - Control air pressure low
- F - Fuel oil pressure low-low
- F - Fuel oil temperature low-low
- F - Diesel oil/atomiser condition abnormal
- F - Atomising steam pressure low-low
- G - Fuel gas/furnace pressure differential pressure low-low
- G - Fuel gas/furnace pressure differential pressure high-high
- G - Fuel gas vent valve open
- GM - Gas leak detected
- GM - Boil-off gas temperature low-low
- GM - Boil-off gas extraction fans stopped
- GM - Engine room extraction fans stopped
- F and G - Boiler manual trip
- GM - Both boilers tripped
- Cabinet manual trip
- G - Boiler gas manual trip
- F and G - Shutdown cabinet failure
- F and G - Automatic boiler control computer failure
- GM - ESDS activated
- F and G - Blackout

Sootblower Cabinet

The sootblower cabinet controls the sootblowing sequences of both boilers and can be operated remotely from the IAS operator stations, via PS-M5 and PS-M6, to the sootblowing cabinet. The sootblowing sequences can also be operated locally from the sootblower control panel.

There is an output from the sootblower control panel to the ABC system to signal an air increase requirement during sootblowing.

Boiler Gauge Board (BGB)

A local operator cabinet is placed near the boiler firing platform and can be used for each boiler. This cabinet includes the following:

Burner Operation Panel (BNP)

The panel includes indicator lamps showing valve positions, interlocks and safety signals.

The pushbuttons activate the same sequences as those used when operating from the IAS operator stations. Command must be transferred from the engine control room in order to use the functions from the panel.

Manual Loader Panel (MLP)

The panel is used for manually operating the following system control valves via the increase/decrease pushbuttons:

- Atomising steam supply
- Superheated steam temperature
- Fuel gas supply
- Fuel oil supply
- Forced draught inlet vanes
- Boiler feed water level
- Excess steam dump
- Fuel oil pump pressure
- Fuel oil temperature

(**Note:** The control valves and FD fan vanes are equipped with an analogue back-up unit for control in the manual mode. The unit will normally copy the controller manual output signal to the control valve and allow the valve or vane to be adjusted by the increase/decrease pushbuttons when in LOCAL mode. When the system is returned to remote mode, a bumpless transfer is achieved, but the controller will remain in the manual mode until the controller at the ABC operator station is changed to the automatic mode.)

Emergency Operation Panel

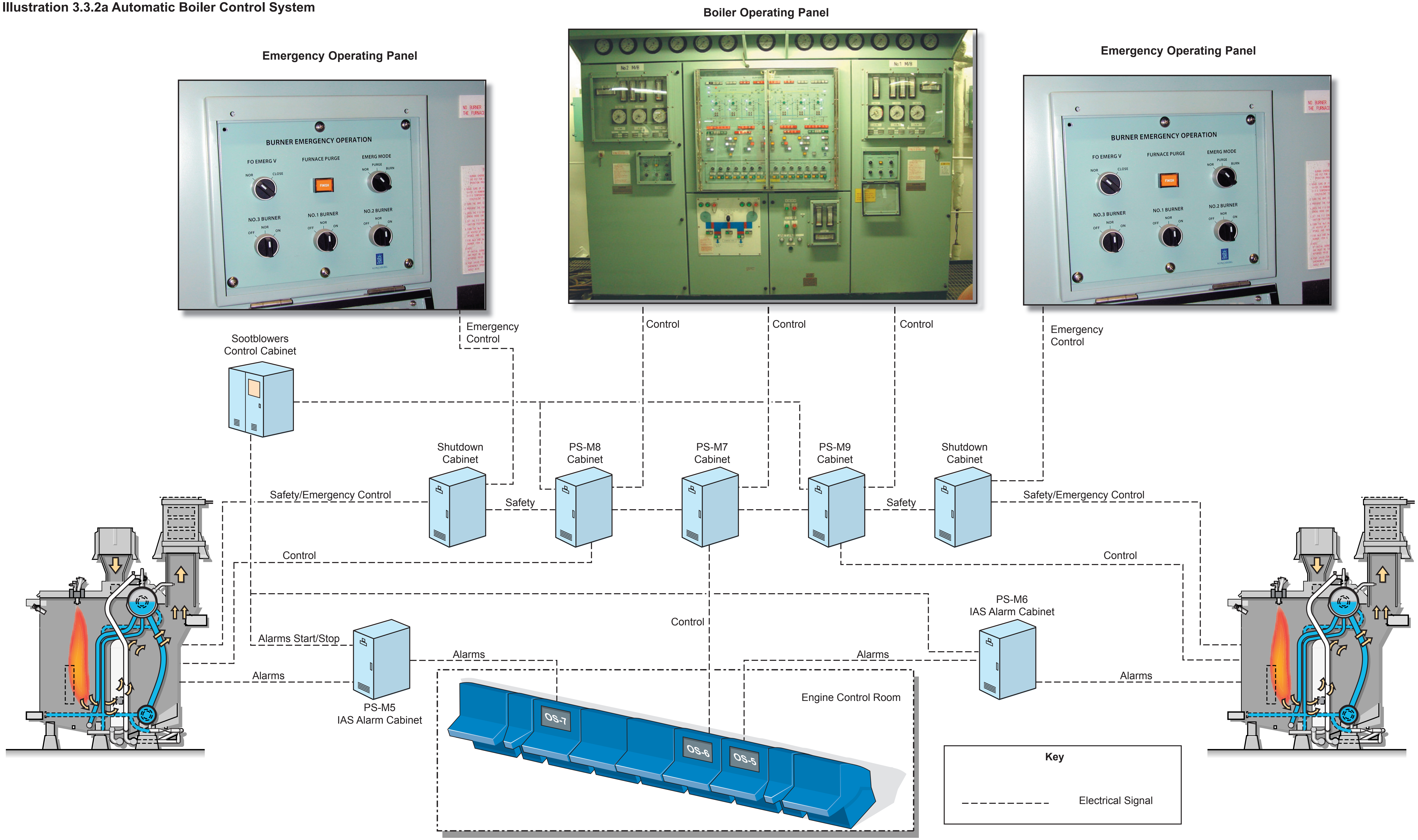
This panel can be used for firing the boilers in case of a boiler control process station failure. The furnace purging can be started and the fuel oil burners can be started and stopped.

Automatic Boiler Control (ABC) System Functions

The system can perform the following:

- Start and stop oil burners
- Start and stop gas burners
- N_2 purge of the gas lines
- Control the water level in each boiler

Illustration 3.3.2a Automatic Boiler Control System



- Control the superheated steam temperature in each boiler
- Operate the main steam dump valve to the main condenser
- Fuel mode changeover
- Control the superheated steam pressure in each boiler, including:
    - Boiler master control with load ratio control
    - Air flow control with O_2 control
    - Fuel oil control
    - Fuel gas control
- Burners FO automatic increase/decrease according to the boiler load
- Automatic fuel oil increase in case of a fuel gas supply failure
- Fuel oil pump pressure control
- Atomising steam pressure control
- Allow the local control panels to be used

The position of the BOG flow control valves to the boilers determine the LD compressor vane control and flow, thus the ABC has indirect control of the LD compressors.

In the case of a power failure, the system is supplied from the uninterruptible power supplies (UPS) and battery systems (see section 2.12.8).

The ABC system incorporates the following features.

Drum Water Level Control

This part of the system is designed to keep the water level in the drum constant. This is done by controlling the feed water flow to the drum in accordance with the steam flow from the boiler, with a correction from the drum level measurement and feed flow signal.

A high high water level in the boiler drum will result in the feed water valve closing immediately.

Superheated Steam Temperature Control

The purpose of this system is to maintain the superheated steam outlet temperature at a constant 525°C.

To achieve this, part of the superheated steam from the outlet of the primary superheater is cooled in an internal desuperheater in the steam drum. This cooler steam is then mixed with the rest of the steam from the primary superheater, before it enters the secondary superheater.

The controller measures the steam temperature as it leaves the secondary superheater, then operates the pneumatic control valve to divert the required amount of steam to the internal desuperheater. In addition the controller receives a signal from the air flow transmitter. The control valve closes if the superheated steam temperature falls to below 450°C.

Superheated Steam Pressure Control

This purpose of this system is to maintain the pressure at the outlet of the secondary superheater at 5.88MPa. This is done by controlling the total fuel oil and fuel gas flow and the combustion air flow to all the burners in use.

(**Note:** The air flow controller will lead during an increase in demand and the fuel oil/gas controller will set the minimum air flow during decreasing demand.)

Excess Steam Dump Control

This control system prevents any overpressure in the boilers and allows the boilers to burn the excess cargo boil-off gas, which would otherwise be vented to atmosphere. The primary function being to increase BOG burning capability without excess boiler pressure.

When the steam pressure reaches the set point, the steam dump valve BV234 will open allowing steam to dump via one of the two external desuperheaters which operate in a split range configuration.

Each of the external desuperheaters has a condensate water spray system controlled by the IAS, which receives its control signal from the boiler control system. The IAS will also control the dump steam inlet temperature to the main condenser by operating spray valve T56.

This system conserves the HFO on board and prevents the illegal venting of the gas to atmosphere.

Atomising Steam Control

This system controls the atomising steam pressure in accordance with the fuel oil pressure. The pressure controller set point signal is derived from the fuel oil pressure to the burners.

Fuel Oil Pump Discharge Pressure Control

This system controls the FO pressure to the burners at a constant pressure. The pressure controller set point signal is derived from the fuel oil outlet pressure from the FO heaters.

Flame Eye Control

There are four flame eyes fitted to each of the burners. Two infrared for oil flame detection and two ultraviolet for gas flame detection. A flame is detected if one of the flame eyes is activated and a failure alarm is activated if there is a difference between two corresponding flame eyes.

Sootblowing Control

The sootblowers can be started, stopped or retracted remotely at the IAS panel and locally at the sootblower panel. A signal for an increase in air flow is sent from the sootblowing panel to the port or starboard boiler control system process stations (PS-M8 or PS-M9), depending on which boiler is being sootblown.

Forced Draught Fan Changeover Low/High Speed Control

The FD fan speed, either low or high, is determined by the inlet vane command signal. The fan will change speed if the air flow required is more or less than the flow delivered when the inlet vane is at the limit of its control.

Fuel Oil Master Valve Shutoff Control

This valve is interfaced to the shutdown cabinet and is normally open, except during a shutdown condition and if the shutdown cause has not been reset. The reset can only be made from either the burner operating panel or the automatic boiler control system.

Fuel Gas Master Valve Control

This valve is interfaced to the shutdown cabinet and can be operated from either the burner operating panel or from the ABC system. The burner operating panel indicator lamps are activated from the shutdown cabinet while operations are interfaced via the automatic boiler control system.

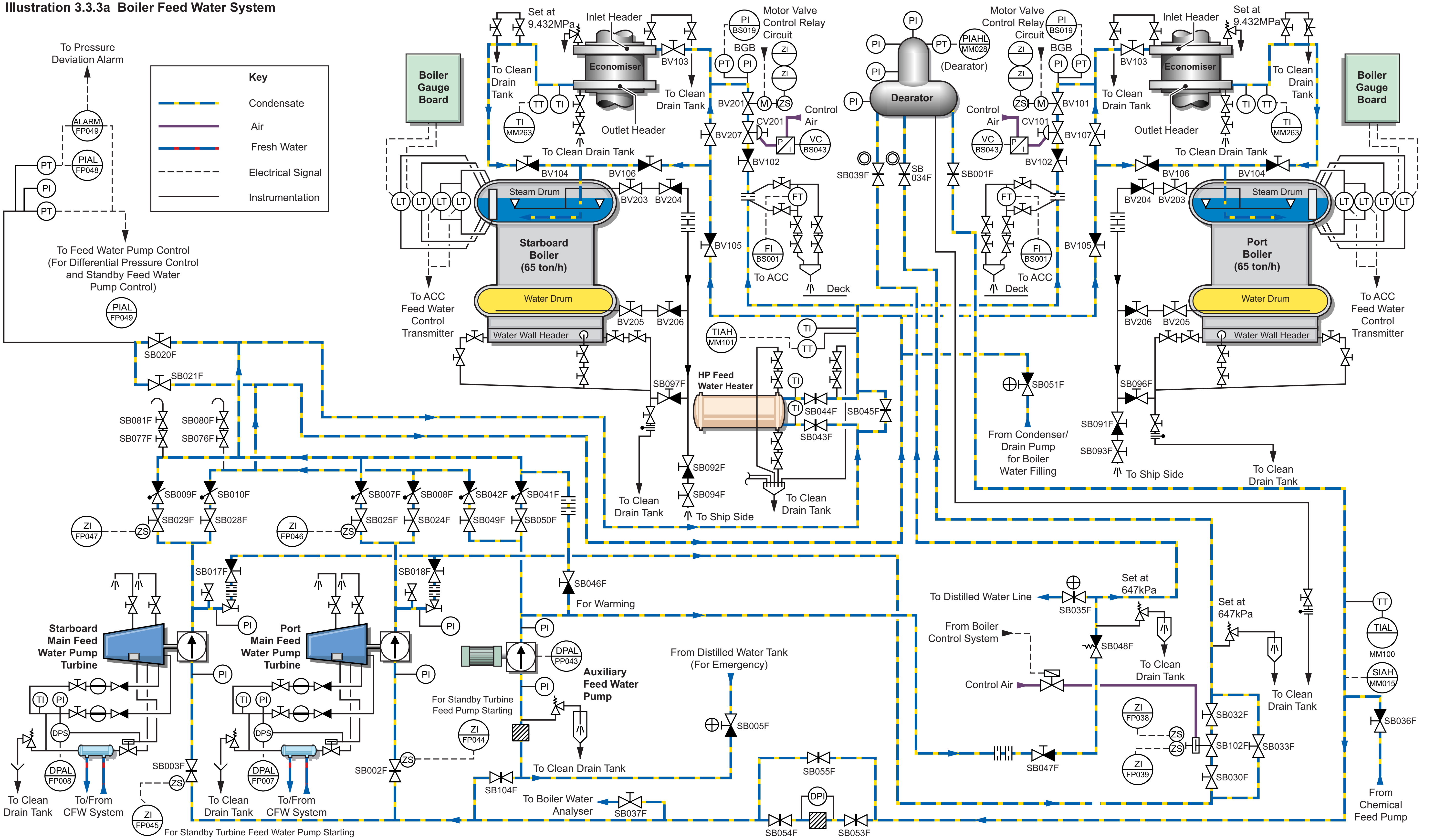
Emergency Fuel Gas Shut Off Valve Control

This valve is interfaced to the shutdown cabinet and operation and can be completed from either the burner operating panel or from the automatic boiler control system. The burner operating panel indicator lamps are activated from the shutdown cabinet while operations are interfaced via the automatic boiler control system.

Fuel Gas Analyser Control

The fuel gas analyser on/off solenoid valve is controlled by the PS-M7 (ABC) cabinet via the shutdown cabinet. The solenoid valve is normally open, but in the case of a FUEL GAS ABNORMAL signal or a FUEL GAS MAIN LINE PRESSURE HIGH signal the valve will close.

Illustration 3.3.3a Boiler Feed Water System



3.3.3 BOILER OPERATING PROCEDURES

Preparation of the Starboard Boiler for Firing from Cold

Preliminary Checks

a) All internal parts of the boiler and tubing should be free of debris, clean of oil and combustible materials and the refractory checked to be in good condition.

b) The furnace gas passages and air passages should be clear.

c) Check dampers for operation and indication.

d) Close the drain valves of the level gauges.

e) Check the operation of the safety valves easing gear, ensuring that the gags have been removed.

f) Check that the drum manholes and header hand holes are properly closed. All casings are to be secured in position.

g) Check that the boiler access doors, air duct and gas duct access doors and header casing doors are properly closed.

h) Open the superheat header drains.

i) Check that all water wall header drains and blow down valves are shut.

j) Open the superheater vent valve and the control desuperheater isolating valves.

k) Open the drum vent valves if not already open.

l) Check that all the level gauge and instrumentation root valves are open and that their drains are closed.

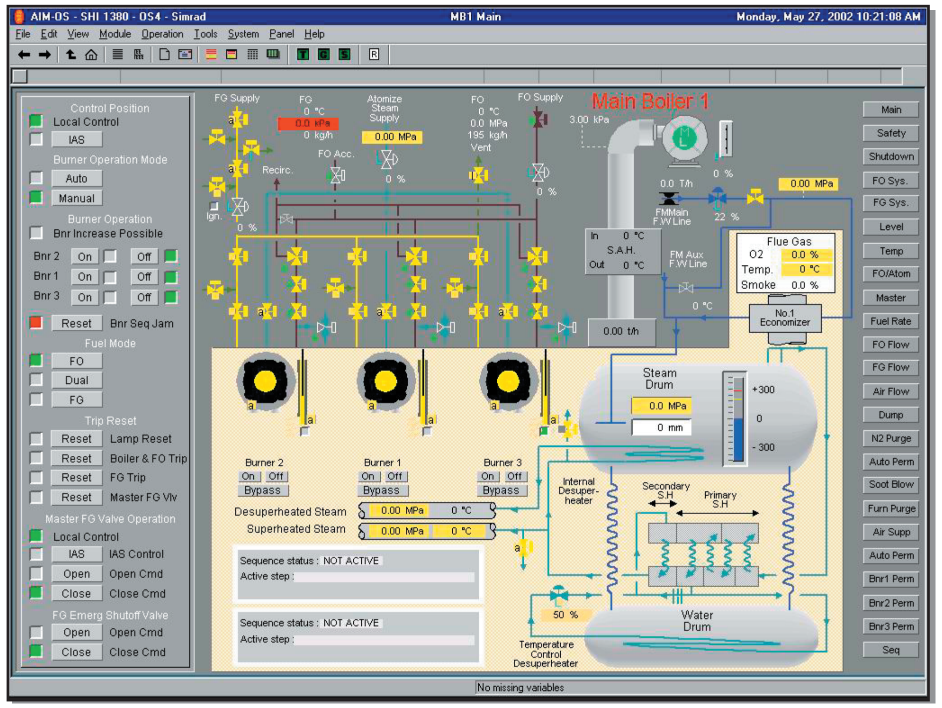
Ensure that all the control switches on the Manual Loader Panel are turned to the LOCAL position.

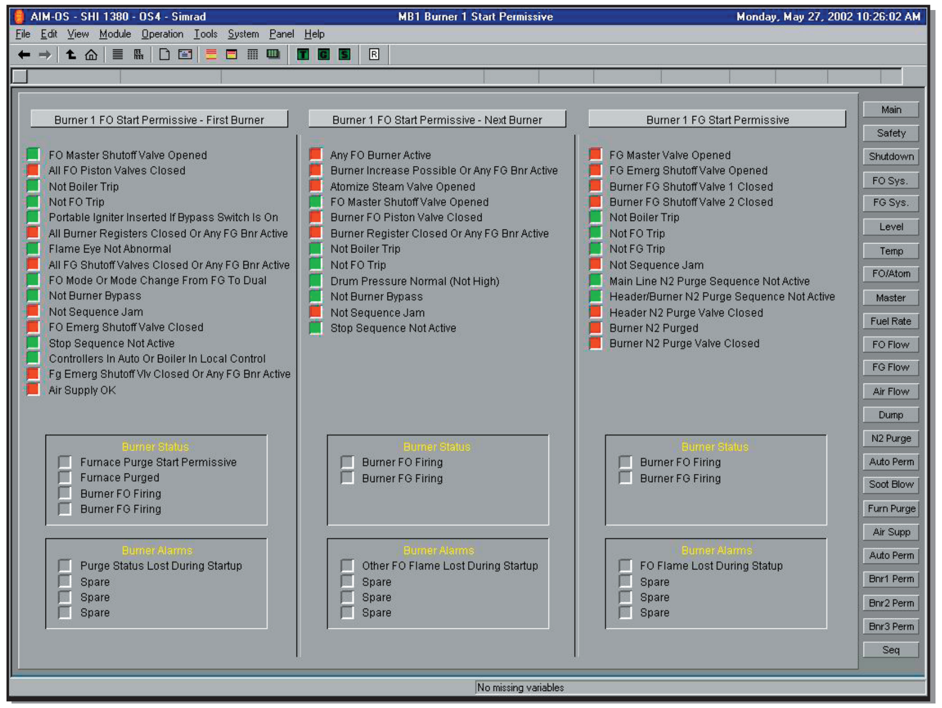
Procedure for Filling the Starboard Boiler and Establishing the Correct Water Level

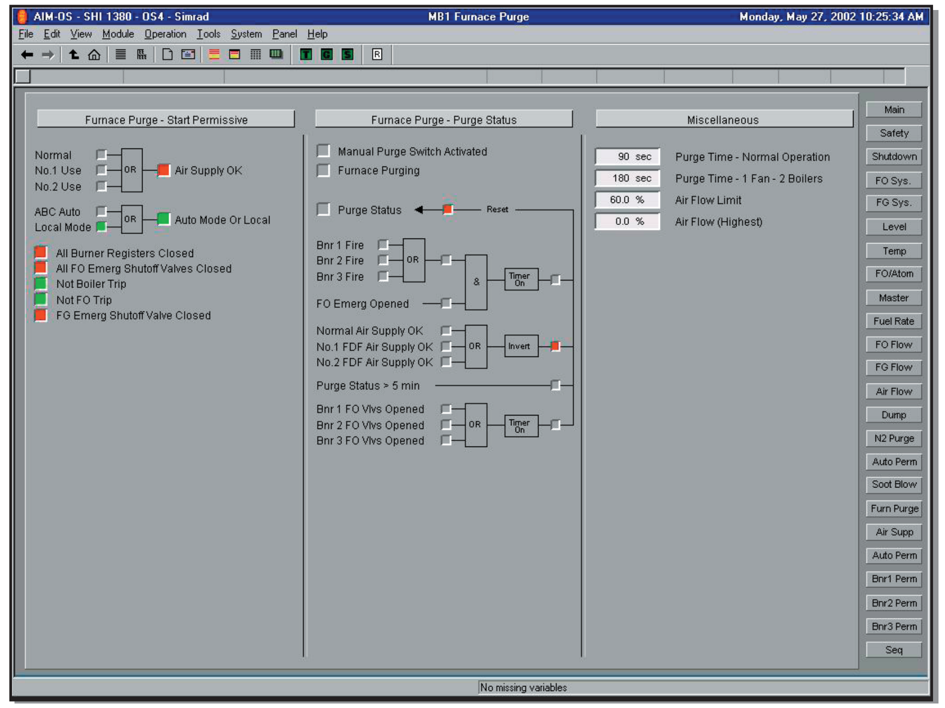
Initial filling the boiler is achieved by pumping distilled water from the distilled water storage tanks using the auxiliary feed water pump.

Prior to filling the boiler the feed treatment chemical manufacturer's recommended initial dose should be applied. This can be mixed into a solution and poured through the steam drum door prior to closing up, or pumped into the steam drum using the chemical injection equipment (see section 2.5 Boiler Water Sampling and Treatment Systems).

a) Set up the valves as follows with due consideration for the effects of water hammer and mechanical shocking. All feed valves are considered initially closed.







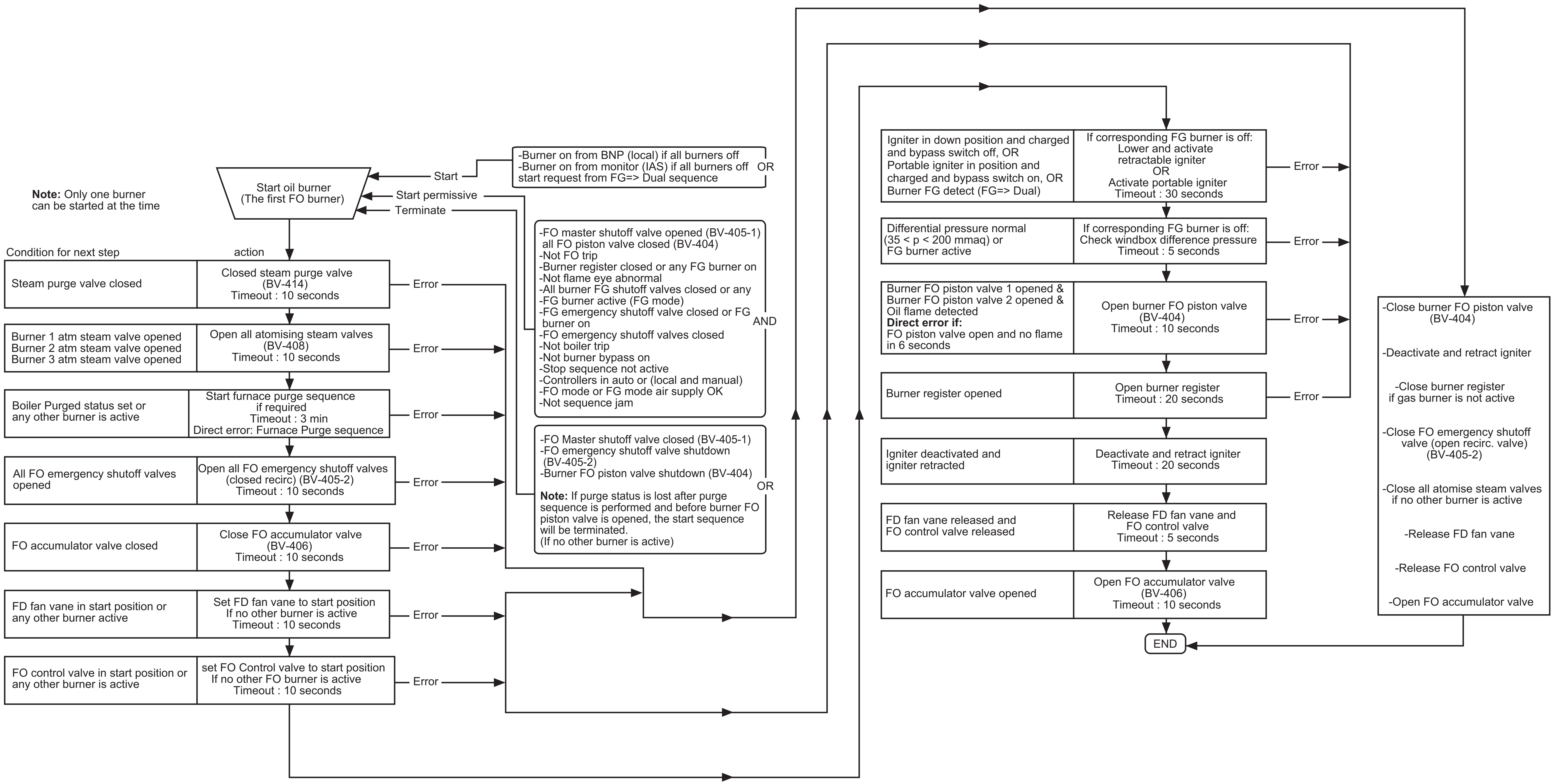
Position	Description	Valve
Open	Auxiliary feed pump suction from distilled tanks	SB005F
Open	Auxiliary feed pump discharge to auxiliary line	SB049F
Open	Auxiliary feed pump recirculating valves to distilled tanks	SB047F, SB035F
Open	Auxiliary feed to economiser	BV105, BV207
Open	Economiser inlet	BV103
Open	Economiser vents to clean drain tank	BV109, BV110
Open	Economiser outlet to steam drum	BV104

b) Start the auxiliary feed pump from the IAS and fill the boiler through this system and vent all air from the economiser and feed water lines Close the vents when all air has been expelled and water issues from them. During this operation, open for a short while and then close the auxiliary feed check valve BV106, to prime this section of the feed line.

c) Fill the boiler to about 100mm below the normal level in the gauge glass, Stop the pump and close in the discharge valve. This is to allow room for expansion during the first firing and steam raising phase.

(**Note:** It is unwise to rely upon the remote level gauging at this stage. It can take some time to stabilise after the boiler has been in use and the static heads are established.)

Illustration 3.3.3b Flowchart for Starting the First Fuel Oil Burner



d) Briefly open the water level gauge drain valves and ensure that they are clear and that the level in the gauge reacts. This is to initially prove that they are operating and not blocked.

Preparation of the Fuel Oil System and Initial Firing

The boilers are flashed from cold with DO and adjustment is made for increased air pressure during the purge sequence and minimum air pressure during burner ignition. The fuel oil pressure is 0.5MPa at ignition and reduced for steam pressure raising.

With reference to section 2.6 Fuel Oil and Gas Service Systems and the illustration 3.3.3a above, set up the boiler fuel system with diesel oil as the fuel supplied and recirculating at the burner header rail. Set up the valves to supply atomising air to the burner.

The following four methods can be used to flash the boiler:

1. Automatically via the IAS in the engine control room
2. Local/automatic mode at the Burner Operating Panel
3. Local/semi automatic mode at the Burner Operating Panel
4. Local/emergency mode at the Emergency Operating Panel

Procedure to Fire the Boiler Automatically, Via the IAS Screen in the Engine Control Room

a) Start the forced draught fan with the vanes closed from the local control panels.

b) At the IAS screen MB1 Main click on the Burner Operation Mode MANUAL button.

c) Ensure that the Burner Increase Possible indicator is green. If it is not green, reset by clicking on the Burner Seq Jam button.

d) Ensure that the FO Fuel Mode is indicator is green.

e) Reset the Boiler and FO trips by clicking on the Reset button.

f) The furnace purge sequence is automatically activated by pressing the clicking on the Burner Operation BNR 1 button.

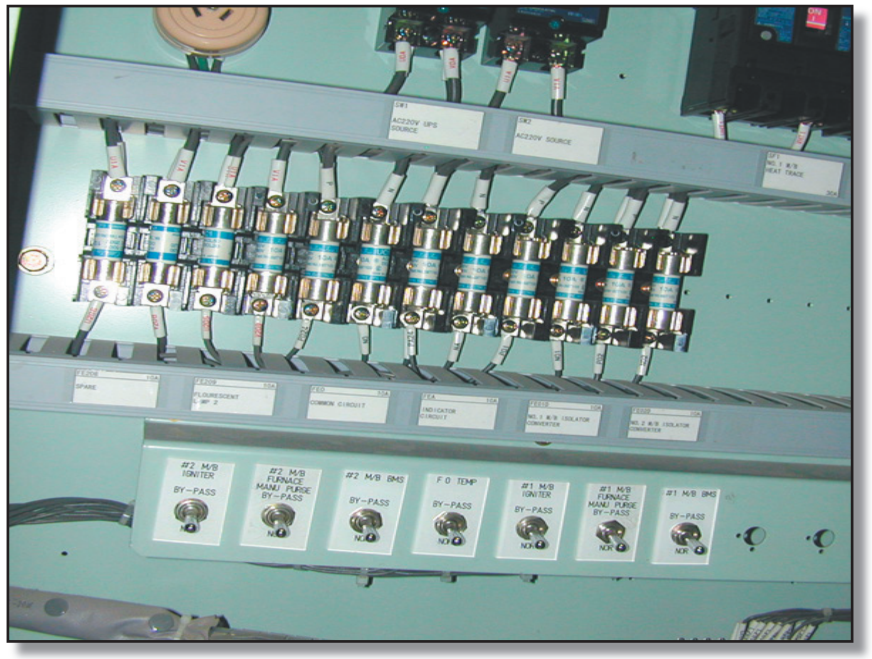
Procedure to Fire the Boiler using the Local/Automatic Mode at the Boiler Operating Panel

Assuming all the boiler trips are reset and the forced draught fan is running with the vanes closed.

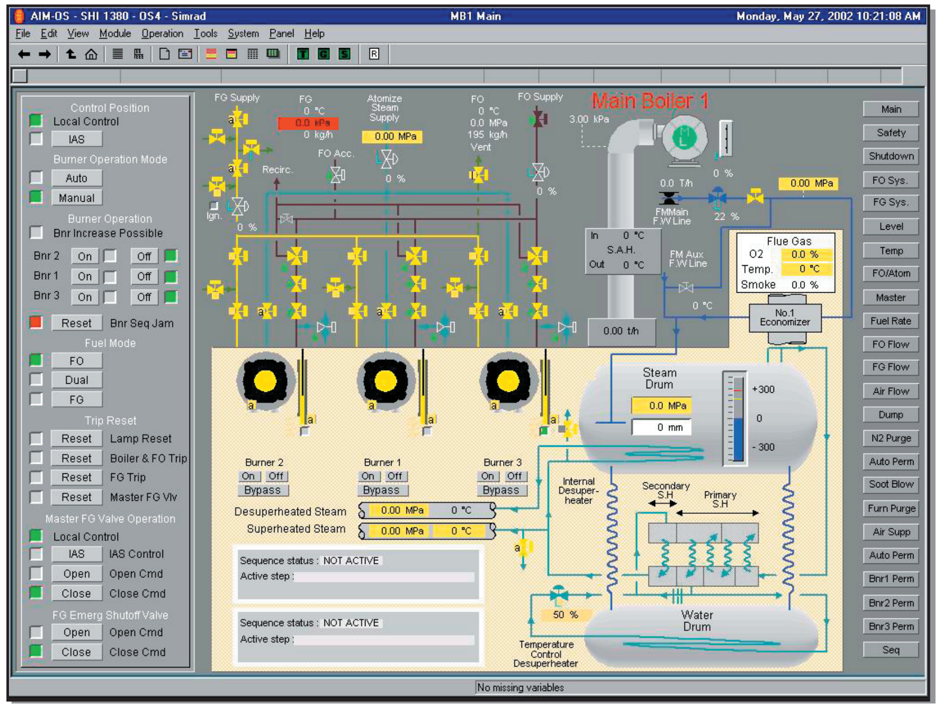
a) At the IAS screen MB1 Main click on the LOCAL CONTROL position button and the Burner Operation Mode MANUAL button.

b) At the Burner Operating Panel press the No.1 BURNER ON pushbutton to activate furnace purge sequence.

As in method 1, the furnace purge is activated.



Bypass Switches in the Burner Operating Panel



Procedure to Fire the Boiler using the Local/Semi Automatic Mode at the Boiler Operating Panel

Assuming all the boiler trips are reset and the forced draught fan is running with the vanes closed.

This involves using the portable igniter and bypassing the automatic igniter sequence.

a) At the IAS screen MB1 Main click on the LOCAL CONTROL position button and the Burner Operation Mode MANUAL button.

b) At the Burner Operating Panel, open the lower panel door and lift the igniter switch to the bypass position.

c) Connect the portable igniter with the power supply and lower the igniter into the burner register sight glass, until the limit switch contact is made.

d) At the Burner Operating Panel press the No.1 BURNER ON pushbutton to activate furnace purge sequence.

Procedure to Fire the Boiler using the Local/Emergency Mode at the Emergency Operating Panel

Assuming there is no automatic valve control and all the boiler trips are reset and the forced draught fan is running with the vanes closed.

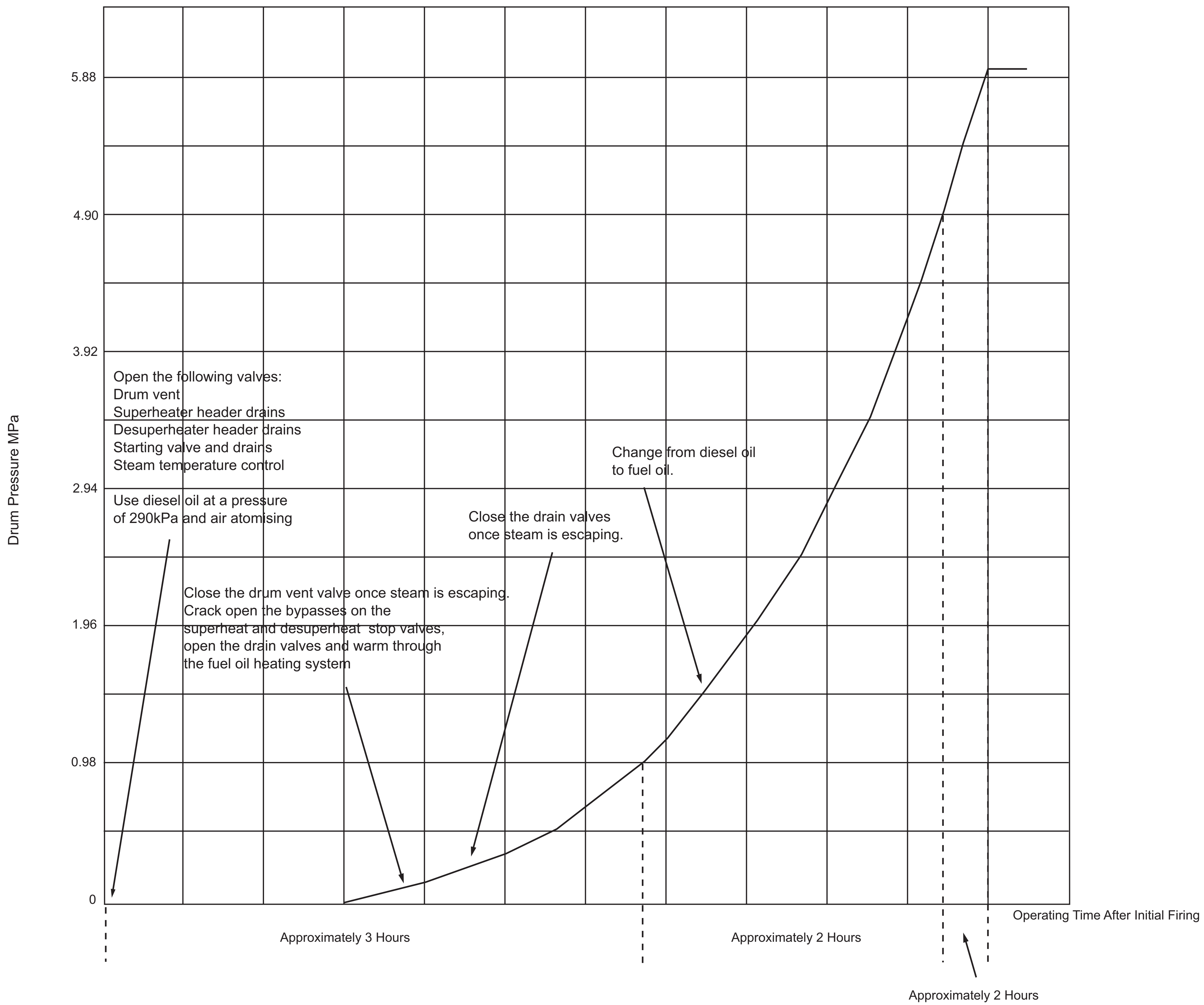
a) At the Burner Operating Panel, open the lower panel door and lift the following switches to the BYPASS position.

- Furnace manual purge
- Boiler management system
- FO temperature

b) At the Manual Loader Panel, turn the following IAS/Local switches to the LOCAL position.

- Drum level
- Air flow
- FO flow
- FG flow
- Steam temperature
- Atomising steam

Illustration 3.3.3c Boiler Pressure Raising Graph



The above systems are controlled using the arrowhead pushbuttons to increase of decrease the settings.

c) At the Emergency Operating Panel, turn the Emergency Mode switch to the PURGE position.

The furnace purge sequence will start and when complete, the FINISH PURGE light will be illuminated.

d) Turn the No.1 Burner switch to the ON position.

The burner will be supplied with fuel oil, the air registers will open to allow air into the furnace and the igniter will be activated to ignite the burner. Control of the systems is by pushbutton.

The No.1 burner operating signal starts the following sequence:

- The furnace purge will start
- The FO emergency shut-off valve opens
- The FO accumulator valve closes
- The FO piston valve opens
- Once the oil flame is detected the burner register opens
- The FO control valve and the FD fan vane control resets
- The FO accumulator valve opens
- The igniter de-energises and is retracted

Once the sequence is started, the FD fan inlet vane will open fully and all the burner registers will open. The system will check if there is sufficient air flow being supplied to the furnace. When the burner registers open the limit switches and sufficient air supply is detected, a 60 seconds furnace purge timer will start. If the air flow is below limits during the purge period the sequence will be cancelled.

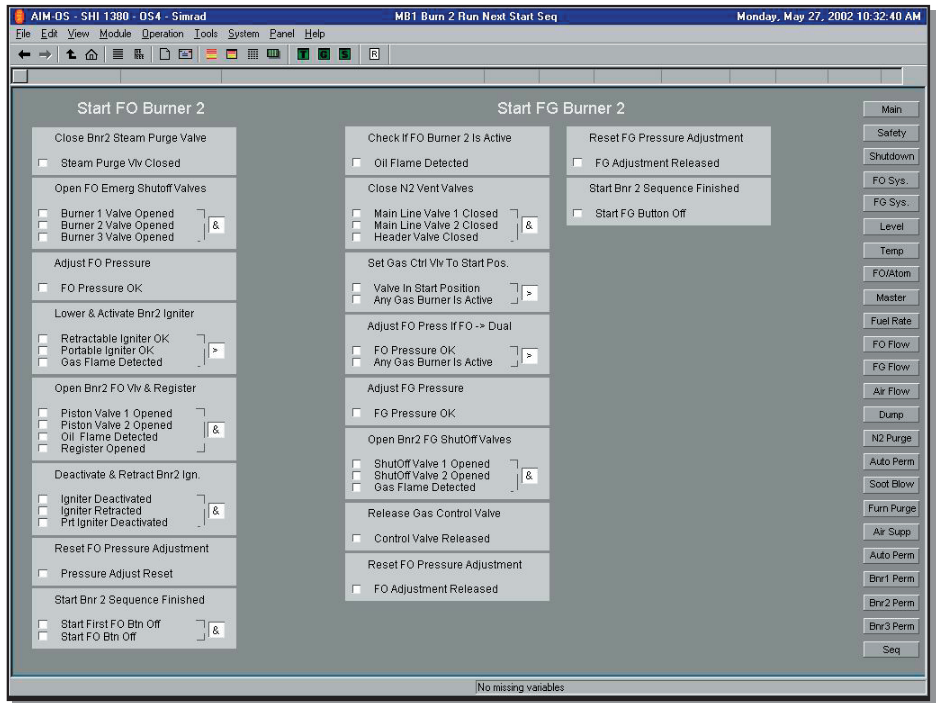
After the furnace purge time has elapsed, all the burner registers will close and the FD fan inlet vane will go to the burner ignition position. A burner start, without further furnace purge, will be permitted for 5 minutes as long as the air supply is still sufficient and no fuel gas or fuel oil piston valve closed position disappears.

The FO burners can only be started one at a time.

Observe the process from the furnace top and ensure that there are no leaks of fuel or air, that the fire is clean and sitting correctly in relation to the quall, and that the flame eyes are reading the flame.

If the oil flame is not established within 6 seconds, the FO piston valve and the FO emergency shut-off valve closes and the FO recirculating valve opens.

Normally when the boiler is firing, the FO master valve and the FO emergency shut-off valve will close if a ALL BURNER FLAME FAIL signal is detected by the shutdown cabinet after 3 seconds. To avoid this shutdown during start up, the time limit is automatically increased to 6 seconds.



The burners are equipped with a retractable igniter, but there is also a portable igniter that can be used in an emergency. When this igniter is used during the oil burner sequence, a bypass switch on the boiler gauge board must be activated to bypass the normal igniter.

(**Note:** It would be prudent, particularly where refractory repairs have taken place, to pull the fire out after about five minutes. This allows the heat generated to even out and prevent thermal shocking due to uneven expansion.)

Procedure to Fire the Boiler

a) Maintain the fuel pressure at 300 - 400kPa, adjusting the fuel air ratio as necessary to optimise combustion. When the steam pressure reaches 100 - 150kPa and steam is issuing from the drum vent, close the vent.

The superheater and desuperheater header drains should remain open during the steam raising process to remove any water. They can be throttled in on the secondary valves as the pressure increases.

CAUTION

When controlling steam flow through any of the boiler and steam line drains always use the secondary of the two valves, leaving the primary valve fully open. This is done to protect the primary valve from damage due to cutting and erosion by the steam.

b) With reference to the steam raising graph, continue to raise steam over the time period specified. When the drum pressure reaches 200 - 300kPa, start warming through the desuperheated steam system (see section 2.1.2 Desuperheated Steam System). Start to warm the heavy fuel oil in the settling tanks and prepare the fuel oil heaters for operation.

During this operation and whilst the steam drum pressure is still less than 500kPa, it will be possible to maintain the water level using the auxiliary feed pump. Expansion of the boiler contents will cause the level to rise initially and may preclude the need to add any water before a turbine driven feed pump can be brought into operation.

c) Start to warm through the main superheater lines to the feed pumps. Prepare the main and auxiliary feed systems for operation including the electric feed pump. Line up the valves as follows:

Position	Description	Valve
Open	Feed pump suction	SB003F, SB002F
Open	Feed pump recirculating valves	SB017F, SB018F SB047F
Open	Feed pump recirculating controller valves	SB030F, SB032F
Shut	Feed pump recirculating controller bypass	SB033F

(**Note:** If the auxiliary feed pump is used for topping up the boiler and the suction is from the distilled tank, the recirculating valve back to the distilled tank will need to be open.)

Position	Description	Valve
Open	Feed pump recirculating line to dearator	SB034F, SB039F
Open	Feed pump main feed discharge valves	SB029F,SB025F SB049F
Open	Feed pump auxiliary feed discharge valves	SB028F, SB024F, SB050F
Open	Differential pressure control	SB020F
Open	HP feed heater inlet and outlet valves	SB043F, SB044F
Open	Level controller inlet	BV102,

Steam will be available to heat the HFO heaters/tanks as the boiler pressure increases.

d) Change over to HFO once DO has been recirculated and the fuel oil temperature has reached a minimum of about 70°C at the burner rail. Relight the boiler using fuel oil at 500kPa and atomising air and continue to raise the steam pressure in accordance with the steam raising graph.

(**Note:** The boiler should not be flashed up using diesel oil once the steam pressure has exceeded 1.0MPa but preferably as soon as possible after achieving fuel heating and temperature.)

The water level can now be maintained using the electric feed pump. Shut the cross-connection valve SB051F from the auxiliary condensate line. Run the electric feed pump as necessary, feeding through the auxiliary feed line and the economiser.

e) When the steam pressure reaches about 1.5kPa, start one of the main feed water pumps. The feed pump can be left running, its output will be limited by the available steam pressure. It may now be necessary to throttle in the superheater vent in order to raise steam pressure at the rate shown on the graph.

f) With reference to the boiler water level control faceplate, open the motor driven valve BV201 at the local starter panel by turning the switch to the LOCAL position and pressing the OPEN pushbutton. Clicking on the feed regulating valve CV201 faceplate allows it to be opened and manual control to be taken. Until the automatic level control has stabilised, control the feed to the boiler with the valve set to MANUAL.

The motor driven valve BV201 is normally set to Auto to enable it to close in the event of a high high water level in the boiler. Carefully monitor the conditions as described above and adjust the vent and drains accordingly.

g) Warm through the atomising steam system (see section 2.6.3 Fuel Oil and Gas Oil Service Systems). When the system is drained and ready for use, change over from atomising air to atomising steam.

The boiler can be placed in automatic combustion control by turning the control switches on the Manual Loader Panel to the IAS position. The IAS applies a fixed fuel and air signal until the pressure has nearly reached the set point. The master steam set point must be reduced to the boiler pressure and gradually raised, otherwise the rate of firing may be excessive.

h) Warm through and drain the superheated steam lines to the turbine generators. Prepare one of the turbine generators for service as described in section 2.11.1 Turbine Generators. When the boiler pressure reaches about 4.0MPa start the turbine generator, synchronise and apply load. Leave the diesel generator on load until the boiler has stabilised on full automatic control.

The boiler safety valves should be carefully tested when the pressure is about 0.3 - 0.4MPa below full pressure, by using the easing gear to lift the disc well clear of the seat. A short strong blow of steam should be released before letting the valve disc re-seat sharply.

When the boiler has reached the operating pressure and combustion control is being regulated in automatic by the IAS, place the water level control to automatic, if not already established.

Ensure that all systems previously in manual control have been placed to AUTOMATIC, including the local control panel to the REMOTE position. All safety overrides must be restored to normal and tested.

Place the burner control to AUTOMATIC on the MB2 Fuel System screen. This allows the IAS to put the second burner into operation as required. This will be necessary with the plant operating on one boiler.

i) Close all the drain valves.

Procedure to Fire a Boiler with the other Boiler in Operation

With one boiler in use and the plant operating normally the second boiler can only be fired on fuel oil, not diesel oil.

Preliminary Checks

a) All internal parts of the boiler and tubing should be free of debris, clean of oil and combustible materials and refractory checked to be in good condition.

b) The furnace gas passages and air passages should be clear.

c) Check dampers for operation and indication.

d) Close the drain valves of the level gauges.

e) Check the operation of the safety valves easing gear ensuring that the gags have been removed.

f) Check that the drum manholes and header hand holes are properly closed. All casings to be secured in position.

g) Check that the boiler access doors, air duct and gas duct access doors and header casing doors are properly closed.

h) Open the superheater header drains.

i) Check that all water wall header drains and blowdown valves are shut.

j) Open the superheater vent and the superheat primary stop valves.

k) Open the drum vent valves if not already open.

l) Check that all the level gauge and instrumentation root valves are open and that their drains are closed.

Procedure to Fill the Second (Port) Boiler with Water

There are two options available:

1. Using the auxiliary feed pump with suction from the dearator.
2. Using the auxiliary feed pump with suction from and recirculation to the distilled water tank.

The best solution is to fill the second boiler whilst raising steam in the first boiler, using the condensate system. This is not possible if the boiler has been shut down and drained for repairs with the plant running on the other boiler, without shutting down the auxiliary feed system.

This still leaves the problem of maintaining the level during the early stages of raising pressure. This will be achieved by using the auxiliary feed system in the normal condition, fed from the auxiliary feed pump, with due consideration for the effect of throttling across the auxiliary feed regulating valve.

Procedure to Fill the Boiler from the Condensate System

Where one boiler is already in use and the plant operating normally, the auxiliary condensate system will be running and no further preparation of it is needed. It will be necessary to isolate the auxiliary feed line from the feed pumps. When the plant is being started from cold, the system will need to be prepared (see section 2.2.1 Main and Auxiliary Condensate System).

Prior to filling the boiler the feed treatment chemical manufacturer’s recommended initial dose should be applied.

This can be mixed into a solution and poured through the steam drum door prior to closing up or, pumped into the steam drum using the chemical injection equipment (see section 2.5 Boiler Water Sampling and Treatment System).

a) Set up the valves as follows with due consideration for the effects of water hammer and mechanical shocking. All feed valves are considered to be initially closed.

Position	Description	Valve
Open	Auxiliary feed valve	BV105
Regulate	Auxiliary feed valve	BV107
Open	Economiser inlet	BV103
Open	Economiser outlet	BV104
Open	Economiser header vent valves	BV109, BV110
Open	Crossover from condensate system	SB051F

b) Fill the boiler through this system and vent all air from the economiser and feed water lines. Close the vents when all air has been expelled and water issues from them. During this operation, open for a short while and then close, the auxiliary feed check valve BV106 to prime this section of the feed line.

c) Fill the boiler to about 100mm below the normal level in the gauge glass. This is to allow room for expansion during the first firing and steam raising phase.

(**Note:** It is unwise to rely upon the remote level gauging at this stage. It can take some time to stabilise after the boiler has been in use and the static heads are established.)

d) Briefly open the water level gauge drain valves and ensure that they are clear and that the level in the gauge reacts. This is to initially prove that they are operating and not blocked.

Preparation of the Fuel Oil System and Flashing Up Second Boiler

a) With reference to section 2.6 Fuel Oil and Gas Service Systems, recirculate fuel oil until the temperature has reached a minimum of about 90°C at the burner rail. Warm through the atomising steam system (see section 3.3.2 Boiler Control Systems). When the system is drained and ready for use, set up the valves to supply atomising steam to the burner using the Fuel Oil Pressure Atomising graphic screen.

b) Start the forced draught fan on low speed with the vanes closed from the local control panel and ensure that the FO and FG emergency shut-off valves are closed.

c) Set the fuel mode operation to FUEL OIL MODE.

d) The furnace purge sequence is automatically activated by pressing the START BURNER 1 pushbutton.

Once the sequence is started, the FD fan inlet vane will open fully and all the burner registers will open. The system will check if there is sufficient air flow being supplied to the furnace. When the burner registers open the limit switches and sufficient air supply is detected, a 60 seconds furnace purge timer will start. If the air flow is below limits during the purge period the sequence will be cancelled.

After the furnace purge time has elapsed, all the burner registers will close and the FD fan inlet vane will go to the burner ignition position.

A burner start, without further furnace purge, will be permitted for 5 minutes as long as the air supply is still sufficient and no fuel gas or fuel oil piston valve closed position disappears.

The FO burners can only be started one at a time from either the Burner Operating Panel or from the IAS operator station.

Proceed as follows:

e) Turn the No.1 burner switch from the NOR to the ON position. This commences the flashing up sequence as described in the previous section. Observe the process from the furnace top and ensure that there are no leaks of fuel or air, that the fire is clean and sitting correctly in relation to the quall, and that the flame eyes are reading the flame.

(**Note:** It would be prudent, particularly where refractory repairs have taken place, to pull the fire out after about five minutes. This allows the heat generated to even out and prevent thermal shocking due to uneven expansion.)

f) Maintain the fuel pressure at 300 - 400kPa, adjusting the fuel/air ratio as necessary to optimise combustion. When the steam pressure reaches 100 - 150kPa and steam is issuing from the drum vent, close the vent.

The superheater and desuperheater header drains should remain open during the steam raising process to remove any water. They can be throttled in on the secondary valves as the pressure increases.

CAUTION

When controlling steam flow through any of the boiler and steam line drains always use the secondary of the two valves, leaving the primary valve fully open. This is done to protect the primary valve from damage due to cutting and erosion by the steam.

g) With reference to the steam raising graph, continue to raise steam over the time period specified.

Expansion of the boiler contents will cause the level to rise initially.

h) The water level can now be maintained using the main feed system.

(**Note:** The boilers should not be coupled until the superheat temperature of the incoming boiler is within 50°C of the boiler in use.)

i) With reference to the boiler water level control graphic screen MB2 Level Control, line up the main feed to the boiler by opening the motor driven valve BV101 at the local starter panel. Clicking on the feed regulating valve CV101 faceplate allows it to be opened and manual control to be taken.

j) Close the auxiliary feed valves BV105 and BV107. Until the automatic level control has stabilised, control the feed to the boiler with the valve CV101 set to MANUAL.

The boiler can be placed in automatic combustion control by turning the control switches on the Manual Loader Panel to the IAS position. The IAS applies a fixed fuel and air signal until the pressure has nearly reached the set point.

k) Continue to raise steam pressure and temperature in accordance with the graphs. Commence warming through the superheat and desuperheat lines and draining as necessary. The superheat and desuperheat main stops have warming through valves fitted around them with drains located between the main and primary stops.

l) When the boiler pressure reaches about 5.0MPa, the desuperheat primary and main stops can be opened, assuming that warming through and draining has been satisfactory. Close the warming through valve but continue to drain the line.

The boiler safety valves should be carefully tested, when the pressure is about 0.3 - 0.4MPa below full pressure, by using the easing gear to lift the disc well clear of the seat. A short strong blow of steam should be released before letting the valve disc re-seat sharply.

m) As the boiler desuperheated steam pressure reaches the same pressure as the output from the on line boiler, it will begin to overcome the check valve and feed into the desuperheat steam system. The superheat main stop is left closed and the superheat vent left open at this time. This method is known as ‘floating the boiler on line’.

When the boiler has reached the operating pressure and combustion control is being regulated in automatic by the IAS, place the water level control to automatic, if not already established. All safety overrides must be restored to normal.

n) Stabilise the boiler and the automatic controls. Observe the superheat temperature as it increases due to the load now on the boiler. Prepare to bring the superheater steam on line by opening drains on the superheater pipe lines, the feed pumps, the turbine generators and the main engine steam chest. This is a precaution should any water still remain in the superheater or pipelines and is carried into the system during coupling.

o) Slowly open the superheat main stop valve and bring the superheat steam onto line.

CAUTION

During the coupling operations of the desuperheated and superheated steam systems, observe the combustion conditions on the other boiler. The effect of the coupling is to reduce the load of the on-line boiler and, its reaction should be checked as satisfactory.

p) Close all the drain and the superheat vent valves.

Automatic Burner Increase / Decrease

When the burner mode is selected, the number of burners are controlled automatically according to the boiler demand. This mode is not applicable in gas only firing of one or two gas burners. The system will monitor the boiler demand via the output from the master pressure controller and the FO pressure.

The priority for starting is predefined as:

- No.1 burner => No.2 burner => No.3 burner

If No.2 or No.3 burner is selected as the first ignition burner

- No.2 burner => No.1 burner => No.3 burner
- No.3 burner => No.1 burner => No.2 burner

The priority for stopping is predefined as:

- No.3 burner => No.2 burner => No.1 burner

Taking the Boiler Out of Service

The individual burners can be stopped either from the IAS operator station or from the local operator panel.

a) Operate the sootblowers (see section 3.3.4).

b) Reduce the boiler load gradually.

c) Change from heavy fuel oil to diesel oil before stopping the boiler if both boilers and the steam plant are to be shut down.

d) Open the superheat vent valve and stop the boiler using the manual trip. Stop the FD fan.

e) The furnace post purge should be carried out twice by using the furnace pre-purge sequence. Purge the furnace by pressing REQUEST in the Furnace Purge section of the panel. Allow the furnace purge to complete as indicated when the COMPLETE lamp lights.

f) Close the main steam stop valve.

g) Open the superheater drain valves a quarter of a turn.

h) Change the automatic combustion control system to LOCAL operation.

i) Close the fuel oil valves and atomising steam valves.

j) Remove the burner.

k) Maintain the normal water level, which will drop as the boiler cools down.

l) When the boiler pressure drops to about 1.0MPa fully open the superheater drain valves and desuperheater drain valves.

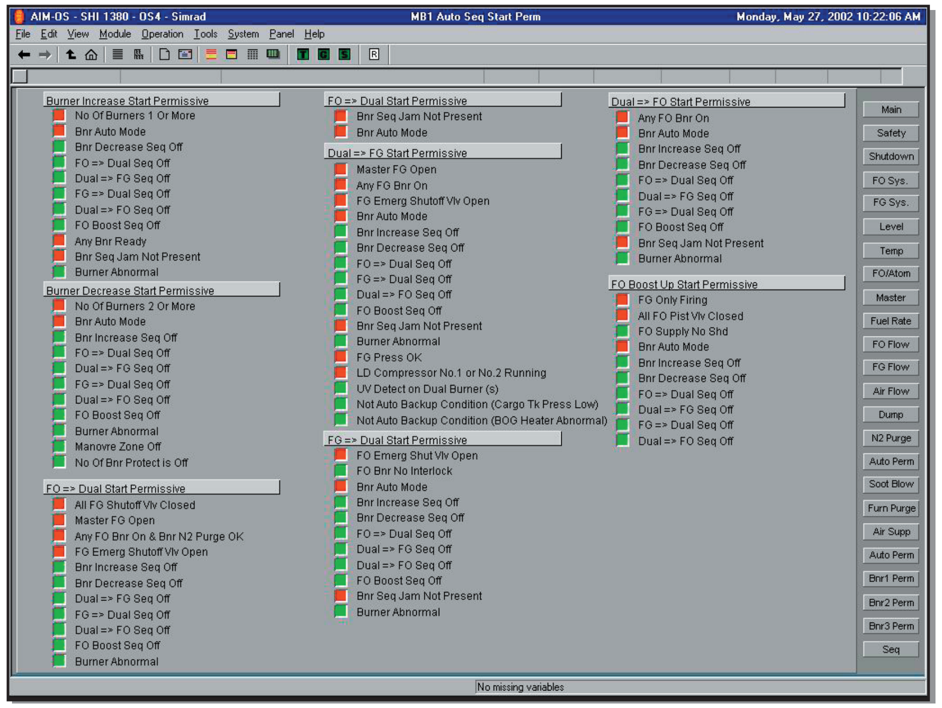
m) Open the drum vent at 100 - 150kPa.

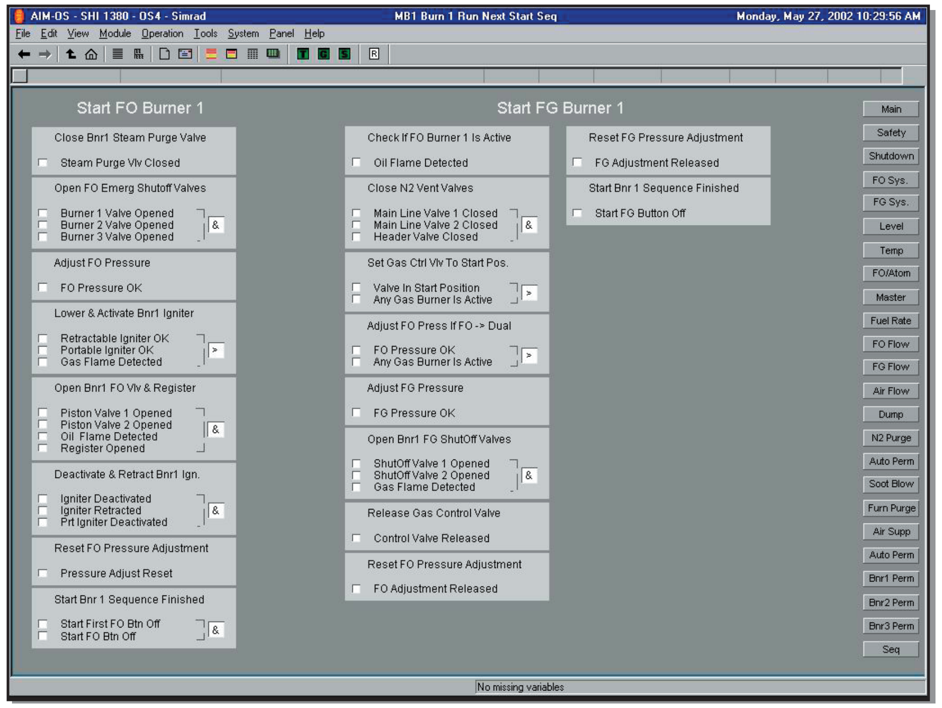
CAUTION

To avoid uneven expansion and damage to the pressure parts and refractory, do not open the furnace access door until the furnace cools. Do not cool the boiler by blowing down and filling with cold feed water.

n) Allow a minimum of four hours to cool down a boiler. Regular checks of the casing and flues should be made to ensure that no fires have developed within the boiler. Check the furnace using the peepholes provided. Observe the funnel from outside to ensure that no smoke, indicating fire, is being emitted. Monitor the uptake temperatures and the O_2 content. Observe the superheater outlet temperature. This should be dropping rapidly down to saturation temperature. Failure to drop to saturation temperature could indicate a fire somewhere, giving the steam a degree of superheat.

o) Close all the main and auxiliary feed valves.





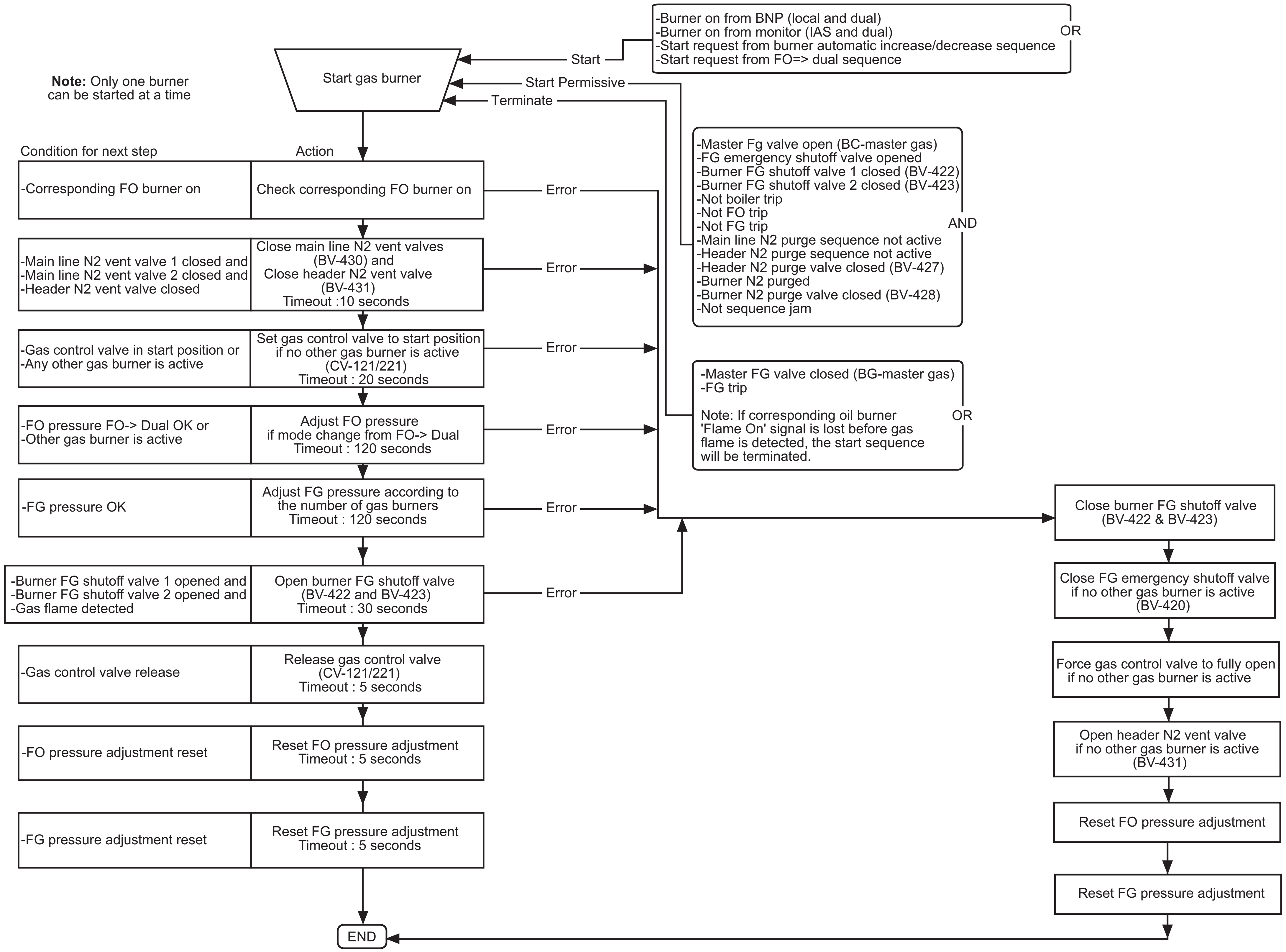
Gas Burning

During gas burning the FO burners are cooled by the steam purge system.

The following start sequences can be performed when the fuel oil mode operation is set to either FO MODE or DUAL MODE.

- Start dual burner No.1
- Start dual burner No.2
- Start dual burner No.3

Illustration 3.3.3d Flowchart for Starting Fuel Gas Burners



The following stop sequences can be carried out when the fuel mode is set to either DUAL FUEL MODE or to FUEL GAS MODE.

- Start FO mode (Dual => FO only)
- Stop dual burner 1 (by activating the STOP BURNER 1 pushbutton)
- Stop dual burner 2 (by activating the STOP BURNER 2 pushbutton)
- Stop dual burner 3 (by activating the STOP BURNER 3 pushbutton)
- Stop one gas burner in case of three burners firing at FG mode

The stopping of burners is always available and will terminate any start attempt. The following commands are executed:

- If fuel mode operation is to be changed from dual fuel to FO, the fuel gas pressure is adjusted to a correct changeover pressure
- Closing individual fuel gas shut-off valves
- Start FO mode (Dual => FO only)
- If no other gas burner is active in the corresponding boiler, the fuel gas emergency shut-off valve is closed
- If no other gas burner is active in the corresponding boiler, the fuel gas control valve is fully opened for N_2 purging
- Closing burner register if corresponding oil burner is not active
- If no other gas burner is active in the corresponding boiler, the header N_2 vent valve is opened
- If no other gas burner is active in any boiler, the master gas valve is closed and after the timer main line N_2 purge is started (all gas firing is stopped)
- Boiler header N_2 purge sequence is started if no other gas burner is active in the corresponding boiler
- Burner N_2 purge sequence is started

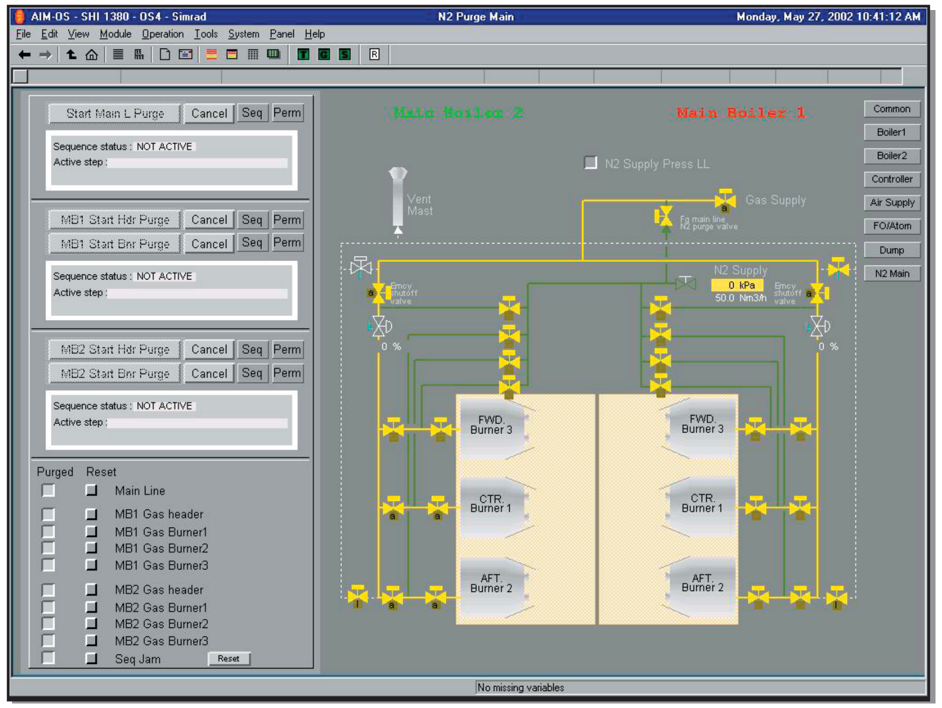
Fuel Mode Changeover

There are three different modes of fuel selection.

- Fuel oil - only oil burners ON
- Dual fuel - both gas and oil burners ON
- Fuel gas - only gas burners ON

The available sequence for changeover is:

Fuel oil => <=Dual fuel => <= Fuel gas



Fuel Oil => Dual Fuel

If activated the system will start up the gas burners where an oil burner is already on. The sequence used is similar to the manual start sequence.

Dual => Fuel Gas

When the mode switch is changed from dual to fuel gas, the system will stop the oil firing.

Fuel Gas => Dual Fuel

When the mode switch is changed from FG to dual, the system will start up oil burners where gas burners are firing.

FG => dual will automatically activate one of the following conditions:

- FO auto back-up
- FG increase order
- Only 1 FG burner in FG mode

FO Auto Back-up

FO auto back-up will be activated if one of the following conditions should occur in FG mode:

- Vessel commences manoeuvring
- Main turbine trips
- Cargo tank pressure low
- BOG heater abnormal
- Both LD compressors stopped

Dual => FO

The system will stop gas firing when the mode switch is changed from dual to FO.

Fuel Oil Boost Up

Should the FG master valve trip when firing on gas only, the FO burners will be started without using the igniters.

Nitrogen Purging of Gas Supply Lines

The gas supply lines can be purged from either the IAS operator stations or locally at the burner operation panel. The following sequences are available:

- Purge main line
- Purge No.1 boiler gas header
- Purge No.2 boiler gas header
- Purge No.1 boiler gas burners (No.1, 2 and 3)
- Purge No.2 boiler gas burners (No.1, 2 and 3)

Purging of Main Gas Line

This process involves purging the line from the master fuel gas valve outlet to each of the fuel gas emergency shut-off valve inlets with N_2.

Main line N_2 purging can be started when the following conditions apply:

- No gas burners firing in any boiler
- The master fuel gas supply valve is closed
- Both fuel gas emergency shut-off valves are closed
- Boiler header N_2 purge valves are closed
- Burner N_2 purge valves are closed

The system will open the main line vent valves and then open the main line N_2 purge valve.

(**Note:** As the boiler header N_2 vent valves are not closed, if backpressure becomes a problem the closing of these valves can be included in the purge sequence.)

After the purging time has elapsed the N_2 purge valves will close again, while the header vent valves will be opened. The main line vent valve will remain open.

A status indication MAIN LINE PURGED will be set after the successful sequence is completed. This status will be reset when the Master Valve Closed indication disappears.

This sequence will be performed automatically when the master FG valve is closed, but can also be manually started from a pushbutton on the IAS operator station or from the local panel, by activating the MAIN LINE N_2 PURGE pushbutton (when in command).

Purging the Gas header

This process involves purging the line from each boiler fuel gas emergency shut-off valve outlet to each burner fuel gas shut-off valve inlet with N_2.

The gas header N_2 purging can be started when the following conditions apply:

- No gas burners firing in that boiler
- The boiler fuel gas emergency shut-off valve is closed
- The main line N_2 purge valves are closed
- Burner N_2 purge valves are closed

The system will fully open the following valves:

- Gas control valve
- Boiler header N_2 vent valve
- Boiler header N_2 purge valve

After the purging time has elapsed the N_2 purge valve will close again and reset the gas control valve. The boiler header N_2 vent valve will remain open.

A status indication HEADER PURGED will be set after the successful sequence is completed. This status will be reset when the boiler fuel gas emergency shut-off valve closed indication disappears.

This sequence will be performed automatically when the fuel gas emergency shut-off valve is closed, but can also be manually started from a pushbutton on the IAS operator station or from the local panel, by activating the HEADER/ BURNER N_2 PURGE pushbutton (when in command).

Purging the Gas Burner

This process involves purging the line from each burner fuel gas shut-off valve outlet to each gas burner with N_2.

The gas burner N_2 purging can be started when the following conditions apply:

- At least one burner firing in that boiler
- The main line N_2 purge valve is closed
- The header N_2 purge valve is closed

This sequence will be performed automatically as part of the gas burner stop sequence. The burner N_2 purge valve will open when:

- The fuel gas shut-off valve is closed
- There is at least one flame in the furnace
- There is sufficient air flow during furnace after purge

The burner fuel gas shut-off valve at the burner side will then open if the purge valve is successfully opened.

A status indication BURNER <x> PURGED will be set. This status will reset when the burner fuel gas shut-off valves closed indication disappears.

This sequence will be performed automatically when the fuel gas shut-off valves are closed and also after the header N_2 purge sequence is finished.

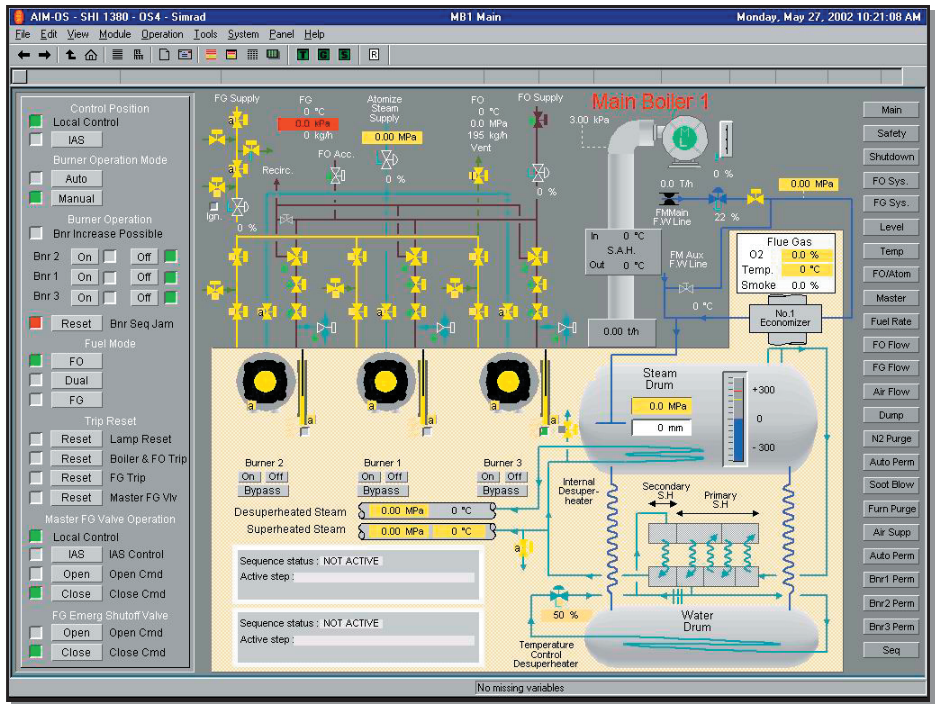
(**Note:** If an open contact is detected for the master fuel gas valve, the main line N_2 valves are automatically closed.)

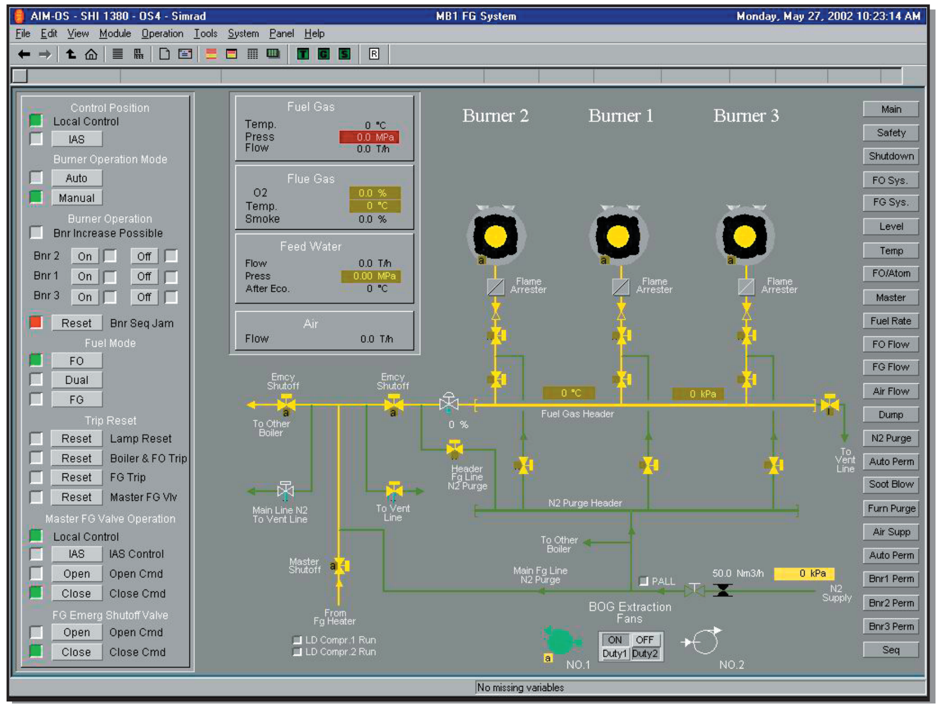
Automatic Procedure for Starting the Fuel Gas Burners

Assuming no other gas burner is in operation and that the boil-off gas has been set on deck for free flow to the engine room.

The gas burners can be started once the following apply:

- The vessel is outside the manoeuvring range
- The corresponding FO burner is in operation





- The dual fuel mode is ready
- The burner fuel gas shut-off valves are closed
- The gas trips are reset
- The N_2 purging sequences are complete
- There is a request to burn boil off gas

Initially the main N_2 vent valve and the boiler header N_2 vent valve will be closed. These valves are automatically opened as part of the gas burner stop sequence.

Referring to the IAS screen FG System

a) Click on the FUEL GAS MASTER valve icon and open it.

b) Click on the FUEL GAS EMERGENCY SHUT-OFF valve icon and open it.

c) Click on the DUAL FUEL mode icon.

The IAS will automatically start the gas burners and a gas flame will be detected in the furnace.

If any part of the start sequence fails, or a gas flame is not established within the preset time, the fuel gas shut-off valves are closed. The fuel gas emergency shut-off valve is only closed if no other fuel gas burner is active in the boiler.

(**Note :** If no other fuel gas burner is active in the corresponding boiler, the fuel gas control valve is moved to the full open position and the boiler header N_2 vent valve is opened for N_2 purging. If no other fuel gas burner is active in any boiler, the main line N_2 vent valves are opened for N_2 purging.)

To start the fuel gas burners in the other boiler, follow the procedure above from b) as the fuel gas master valve will be in the open position to supply the first boiler.

As the gas header pressure increases, the control system increases in the steam dump to the main condenser. This has the effect of increasing the demand on the boiler and so increasing the consumption of boil off gas.

If necessary, the LD compressor can be started to increase the flow of boil-off gas, to match the increased demand in the boilers and so reduce the gas header pressure.

Procedure to Manually Increase the Steam Dumped to the Main Condenser

a) Click on the MANUAL button on the MBC Dump Control screen which will display a menu.

b) Click on the MAN OUTPUT button to display an increase/decrease icon.

c) Click the INC button to increase the % open setting on the dump valve.

Observe the header gas pressure on the Cargo Vapour and Main Header IAS screen and click on the TREND GRAPH pop up screen. Increase or decrease the dump valve accordingly.

Automatic Procedure for Stopping the Fuel Gas Burners

The fuel gas burners are stopped from the IAS operator station by clicking on the DUAL FUEL mode icon.

The gas burners will now be shut-off and the N_2 purge sequence will commence.

Control and Alarm Settings

Setting	Description
+140mm	Boiler water level high alarm
+180mm	Boiler water level high (motorised inlet valve closed)
+160mm	Boiler water level high (MT auto slowdown)
+150mm	Boiler water level high (MT interlock)
+200mm	Boiler water level high (MT trip)
-150mm	Boiler water level low alarm
-170mm	Boiler water level low (MT auto slowdown)
-200mm	Boiler water level low low (boiler trip)

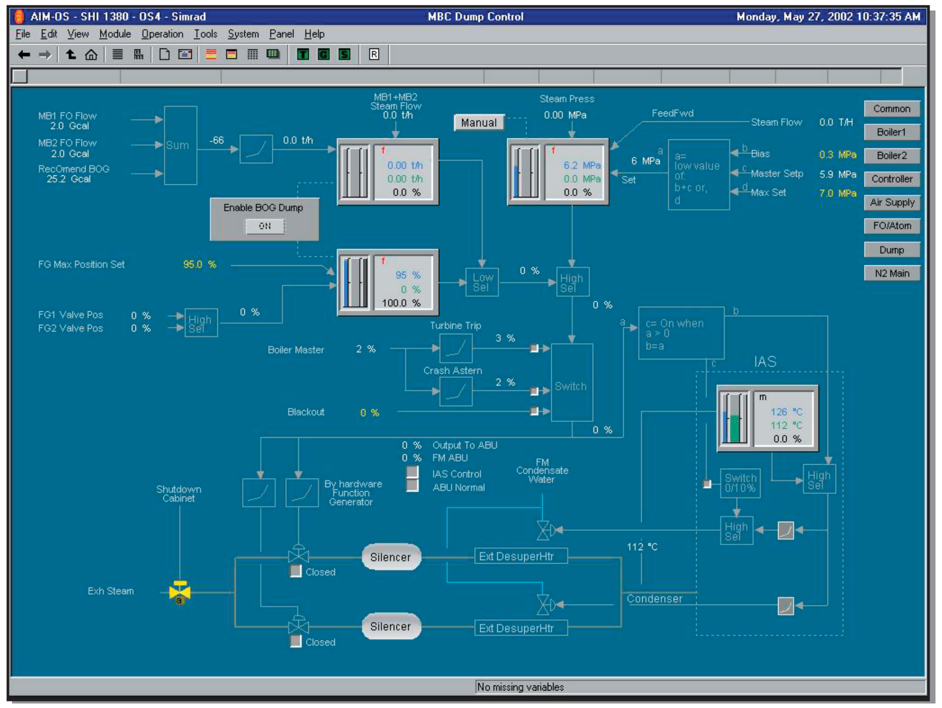
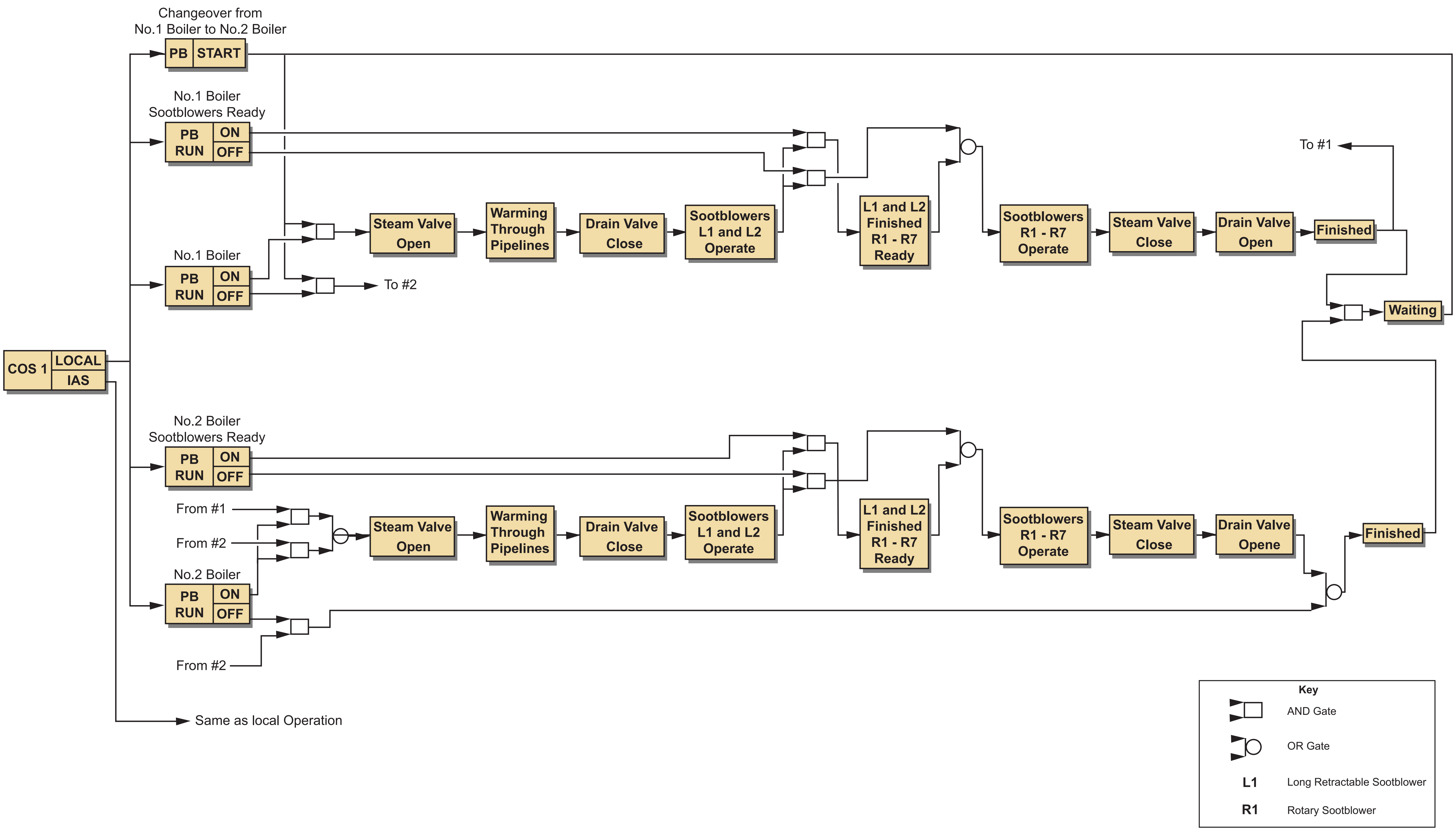


Illustration 3.3.4a Sootblowers Operating Sequence Flowchart



3.3.4 SOOTBLOWERS

Description

Each of the boilers is fitted with nine sootblowers comprising two long stroke retractable units and seven stationary rotary units. The sootblowers are of the steam nozzle and tube type, positioned as follows:

Position	No.	Type
Superheater	Two	Long retractable
Boiler bank tubes	Two	Stationary rotary
Economiser	Five	Stationary rotary

All the sootblowers are driven by electric motors and use desuperheated steam at 1.568MPa. The steam pressure is controlled by the IAS using valve DS010F which ensures a constant 1.568MPa supply. The response is designed to be sufficient to prevent the safety valve lifting during sudden load change such as when the blowers change over as they progress through the sequence, hence the system safety valve setting at 2.056MPa.

Each boiler is fitted with an automated drain valve for warming through and also a constantly open steam drain trap to ensure that the steam line remains clear of water.

Control of the boiler sootblowers is carried out and the sequence observed using the IAS from the graphic screen MBC Sootblow or at the main sootblower panel.

All the sootblowers are fitted with a local start button for use in the local mode of operation. In addition, the long stroke blowers are fitted with an emergency retract button for use in any operating mode. All the blowers have a stop position switch and the long blowers have a reversing switch. These are fitted for control purposes within the IAS. Motor running, direction and overload conditions are fed back to the IAS for indication, control and alarm purposes.

Operating Modes

Each boiler can have its sootblowers operated automatically in two modes:

- Economiser sequence only
- Boiler full sequence

The boilers can be sootblown simultaneously or one following the other.

Economiser Sequence

The blowers operate in the order R3, R4, R5, R6 and then R7.

Full Sequence

The full sequence comprises automatic operation of the blowers in the order R1, R2, L1, L2, R3, R4, R5, R6, and then R7.

The sootblowers can also be operated in the local mode, at the boiler, in any desired order.

Failure or an abnormal condition on a sootblower during an automated sequence will result in that sootblower being bypassed. The sequence will continue with the next programmed sootblower. An alarm is sounded for each sootblower that is bypassed.

Alarms and Interlocks

The following interlocks are fitted within the system:

- Overload - relay fitted in the local panel
- Steam pressure low
- No retract
- PLC abnormal
- Overtime

Either of the above conditions will cause all of the long stroke sootblowers to retract and the system to shut down. The steam valve will not close until all the long stroke sootblowers are in the retracted position. Any rotary sootblowers will continue to turn until they reach their stop position.

The following alarms are also fitted:

- Long stroke sootblower time exceeded, due to:
  - Forward motor not running
  - Reverse position switch time-out
  - Retract motor not running
  - Stop position time out
- Long stroke sootblower motor overload
- Long stroke stop position abnormal
- Emergency retract pushbutton operated on the IAS
- Emergency retract pushbutton operated locally
- Rotary sootblower time exceeded/stop position time-out
- Rotary sootblower motor overload

Any of the alarms will cause the sootblower concerned to register 'Abnormal' and, if in the automatic sequence, will be bypassed and the sequence will continue with the remaining sootblowers.

Warming through Sequence

When operating the blowers, either in automatic or in manual/local mode, the steam pipelines must be warmed through before starting the sootblowing sequence. This comprises of the automated steam supply valve being opened fully and then the automated drain valves being opened for the programmed time. On completion of this sequence, the drain valves will shut and the automated sootblowing sequence will begin or, if in local mode, the operator can commence manual operation.

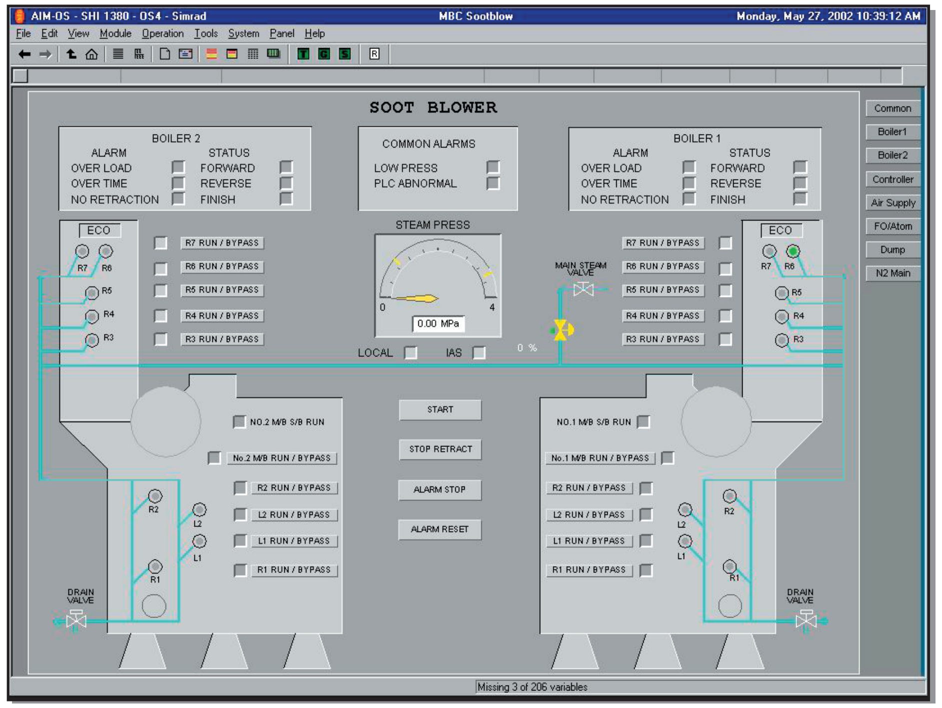
Upon completion of the sequence, the master steam valve closes and the port and starboard drain valves open.

Operation of the Sootblowers

It is recommended to operate the sootblowers daily during fuel oil firing, once a day during dual fuel firing and leaving port when full away on passage, during gas only firing.

Operation of any Automatic Sequence

The sootblowing can be started, stopped or retracted locally at the soot blower control panel or from the IAS operator panel. The commands are sent to the KHI soot blower control panel, where the sootblowing sequences are carried out and the feedback is fed to the IAS.



A signal for an increase in air flow is sent to the ABC process stations and the O_2 controller is inhibited.

Sootblowers' Operating Procedure using the IAS Mimic Screen

a) Open the manual sootblower steam supply valves DS009F and DS011F (illustration 2.1.2a Desuperheated Steam).

b) At the sootblower control panel, turn the COS1 switch to the IAS position.

c) Ensure that there is electrical power on the sootblower control panel.

d) At the IAS mimic screen, used the curser to press the START button.

The sootblowing sequence will now start by warming and draining the steam pipelines, followed by a sequence sootblowing operation of both boilers.

Sootblowers Operating Procedure using the Local Sootblower Control Panel

a) Open the manual sootblower steam supply valves DS009F and DS011F (illustration 2.1.2a Desuperheated Steam).

b) At the sootblower control panel, turn the COS1 switch to the IAS position.

c) Ensure that there is electrical power on the sootblower control panel.

d) Press the PB11 START button.

The sootblowing sequence will now start by warming and draining the steam pipelines, followed by a sequence sootblowing operation of both boilers

(**Note:** If the the COS1 switch is turned from the Local/IAS operation that is in use at the time, the sootblowing operation will stop immediately.)

To Bypass a Boiler or a Sootblower

Before operating the start button on the IAS or local control panel, press the RUN pushbutton on the local control panel for the boiler or sootblower to be bypassed.

To Retract or Stop a Sootblower

Either press the STOP/RETRACT pushbutton on the local control panel or on the IAS screen mimic.

The L1 and L2 sootblowers will retract and the R1 - R7 sootblowers will stop after one cycle run. The sequence will then continue to operate the other sootblowers.

The retractable sootblowers L1 and L2 can also be retracted manually by using a handle. The motor overload relay will require resetting after a Motor Overload alarm.

3.3.5 STEAM DUMP CONTROL SYSTEM

This system allows the boilers to burn the cargo gas, which would otherwise be vented to atmosphere and the control system prevents any overpressure in the boilers.

When the steam pressure reaches the set point, the steam dump valve BV234 will open allowing steam to dump via one of the two external desuperheaters which operate in a split range configuration.

Each of the external desuperheaters has a condensate water spray system controlled by the IAS, which receives its control signal from the boiler control system. The IAS will also prevent the dump steam inlet temperature to the main condenser rising above 112°C by operating spray valve T56.

This system conserves the HFO on board and prevents the illegal venting of the gas to atmosphere.

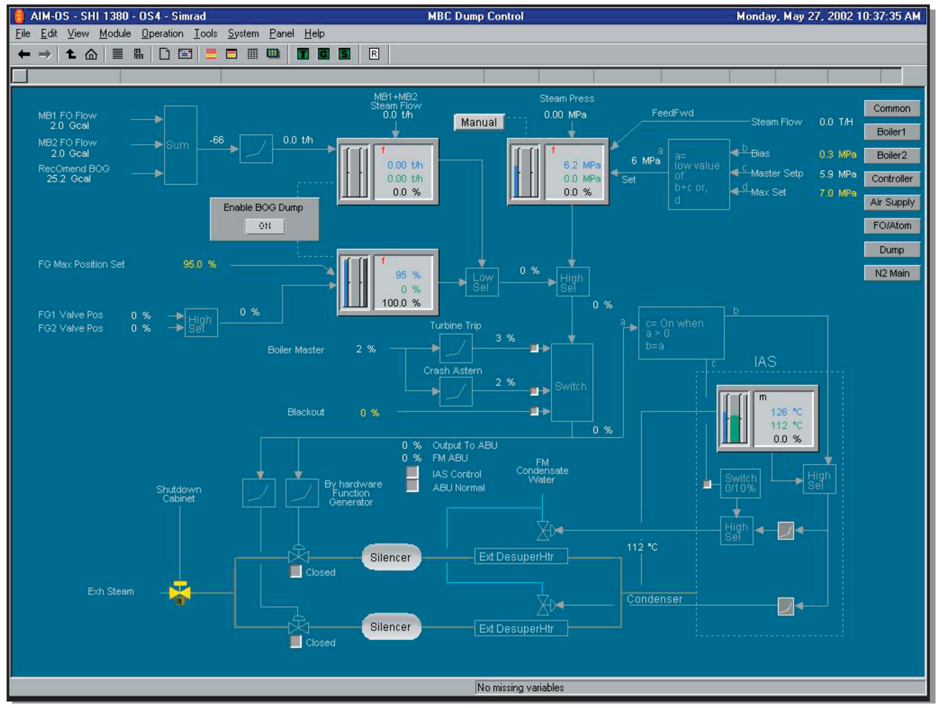
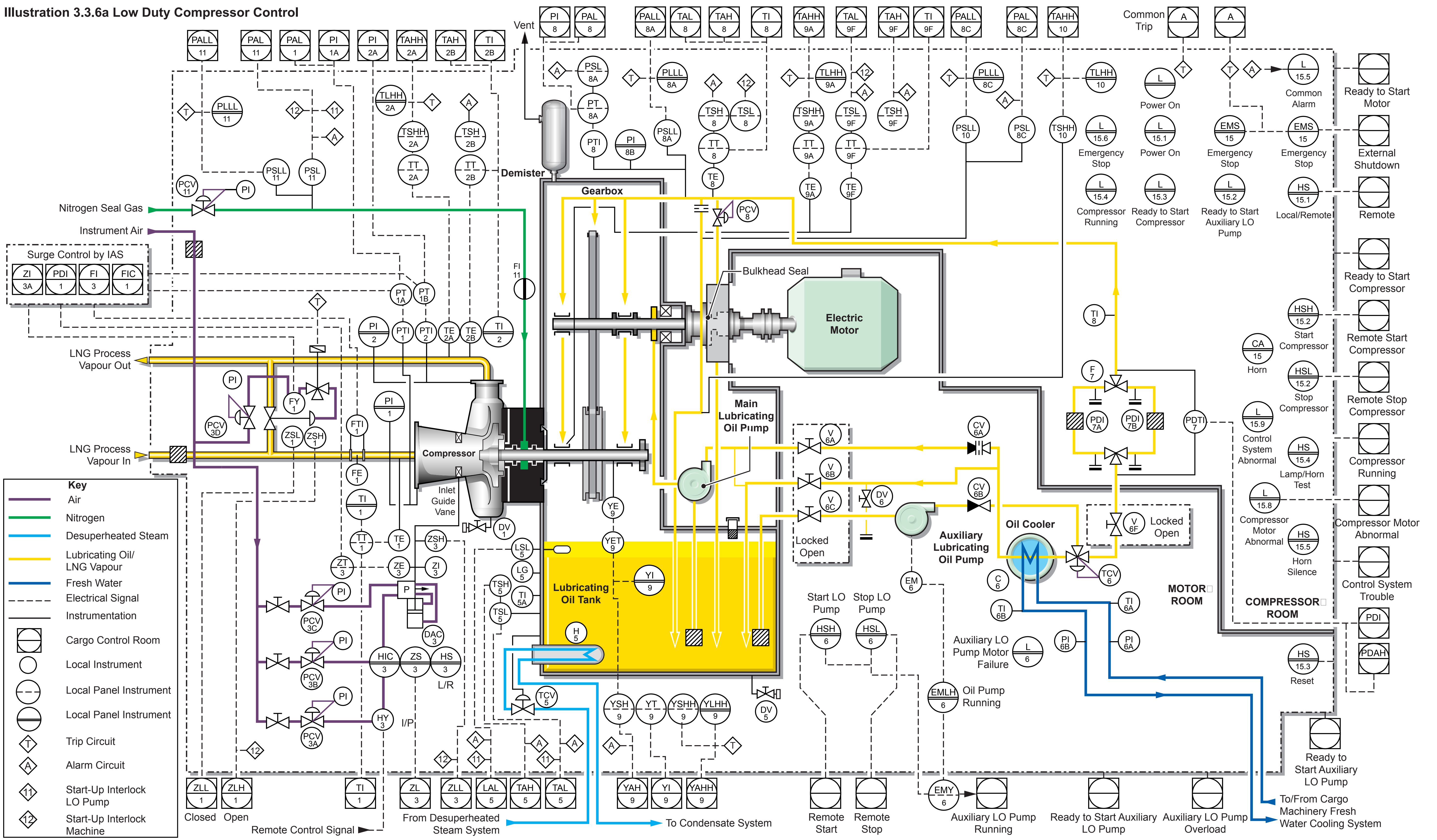


Illustration 3.3.6a Low Duty Compressor Control



3.3.6 LOW DUTY COMPRESSOR CONTROL

Two low duty (LD) compressors, which are installed in the cargo machinery room, are provided to compress the LNG vapour, produced by natural boil-off and forced vaporisation, to a sufficient pressure to be used in the boilers as fuel.

The LD compressors are driven by electric motors, installed in an electric motor room segregated from the compressor room by a gas tight bulkhead. The shaft penetrates the bulkhead through a gas tight shaft seal.

Low Duty Compressors

Manufacturer:	Cryostar
Model:	CM 300/55
Type:	Centrifugal, single stage, fixed speed with adjustable guide vanes
Volume flow:	8,000m³/h
Inlet pressure:	106.0kPa absolute
Outlet pressure:	200.0kPa absolute
Inlet temperature:	-140°C
Discharge temperature:	-101.5°C
Shaft speed:	24,000/12,000 rpm
Motor speed:	3,580/1,790 rpm
Rated motor power:	6,600V, 770kW

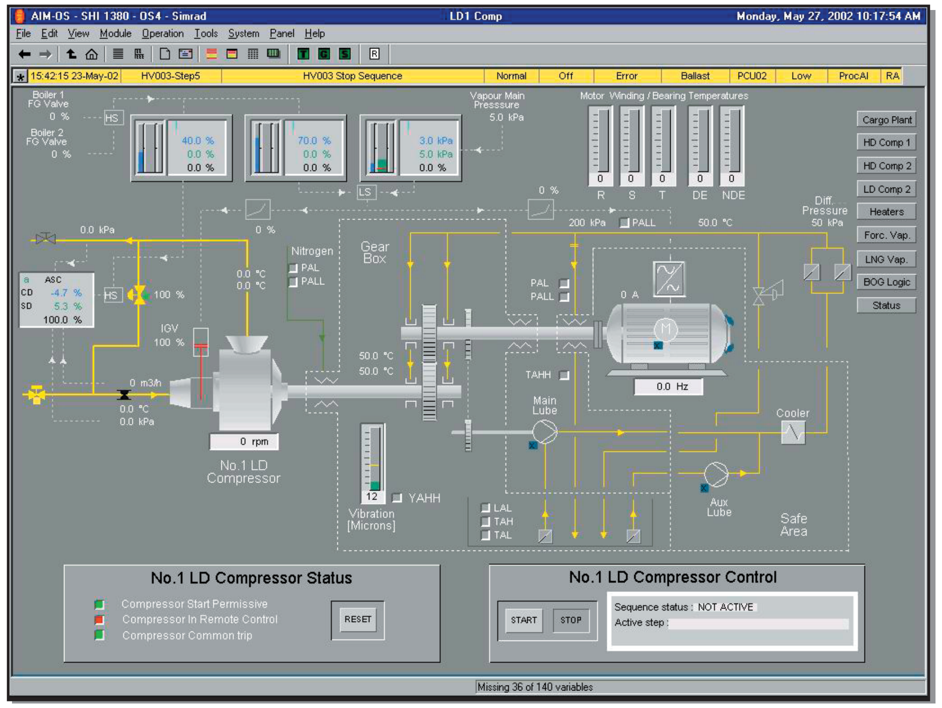
The following conditions trip the LD compressors:

- The ESD system
- High high gas discharge temperature
- Low gas suction pressure
- Electrical power failure
- Excessive rotor vibration
- Excessive shaft displacement
- High high LO temperature
- Low LO pressure
- High high inner bearing temperature
- Low low gas seal pressure
- Low low bulkhead gas seal pressure
- High high bulkhead gas seal temperature
- Fuel gas valve closing
- Low temperature fuel gas to boilers
- Low pressure fuel gas to boilers
- High pressure fuel gas to boilers
- Mist separator high level

Non-trip alarms are indicated on the IAS are as follows:

- Compressor discharge gas temperature
- Compressor LO filter differential pressure
- Compressor LO pressure
- Seal gas pressure
- Motor aft bearing temperature
- Motor forward bearing temperature
- Motor winding temperatures

The compressors are operated locally or from the cargo control room.



Compressor Systems

Seal Gas System

The seal gas system is provided to seal the compressor shaft opening from the release of explosive LNG vapour. The seal consists of two chambers, with the first chamber on the impeller side allowing any leak-off gas to be drawn back to the suction side of the compressor, while the second chamber is fed with dry nitrogen. Seal gas is nitrogen produced by the nitrogen generator on board.

The system is maintained by a pressure control valve where seal gas pressure is always higher than the suction pressure (usually adjusted at 30kPa). To avoid LNG vapour leaking to the atmosphere during standstill, a vent line valve is fitted which leads to No.4 vent mast. This vent line valve must be closed prior to starting the compressor.

Lubricating Oil System

Lubricating oil in the system is stored in a vented 320 litres sump. An integrated steam immersion heater with thermostatic switch is fitted in the sump to maintain a constant positive temperature of at least 25°C and avoid condensation when the compressors are stopped.

Lubricating oil is supplied from the sump through separate suction strainer screens and one of the two LO pumps. The discharge from the pumps is through check valves to a common LO supply line feeding the gearbox and bearings. The main operational pump is driven by the high speed shaft gear. Upon failure of the driven pump, the standby electric motor driven auxiliary pump is energised immediately and a remote alarm is initiated to indicate abnormal conditions. The standby electric motor driven auxiliary pump is also used to start the compressors.

The LO passes through a fresh water cooled oil cooler and a thermal bypass temperature control valve, to maintain the LO inlet temperature at approximately 48°C. The oil supply to the bearings is fed via a 25 micron duplex filter with an automatic continuous flow switch changeover valve.

A pressure control valve regulates the oil flow to the bearings. Excess oil is bypassed and discharged to the sump. Pump relief valves act as back up and are set at 4 bar.

The LO system feeds the following:

- Journal bearing on both sides of the high speed shaft
- Journal bearing on the driven end of the low speed shaft
- Integral thrust and journal bearing on the non-driven end of low speed shaft
- Sprayers for the gear wheels

Anti-Surge Control System

An automatic surge control system is provided to ensure that the compressor flow rate does not fall below the designed minimum. Below this rate, the gas flow will not be stable and the compressor will be liable to surge, causing shaft vibration which may result in damage to the compressor.

All the gas compressors are equipped with an automatic surge control system which consists of:

- A flow transmitter
- A compressor differential pressure transmitter
- A ratio station
- An anti-surge controller
- A bypass valve on the gas stream

On the basis of a preset ratio between the gas flow and compressor differential pressure signals, the anti-surge controller produces a signal which modulates the compressor bypass valve.

Inlet Guide Vanes

To achieve the required gas flow, the compressors have inlet guide vanes fitted at the suction end.

The vanes are operated by pneumatic actuators which receive control signals from the flow controller.

Rotation of the vanes is possible through an angle of 100°. The position is indicated both locally and at the cargo control room.

Bulkhead Shaft Seals

Each compressor shaft is equipped with a forced nitrogen bulkhead shaft seal, preventing any combustible gas from entering the electric motors room.

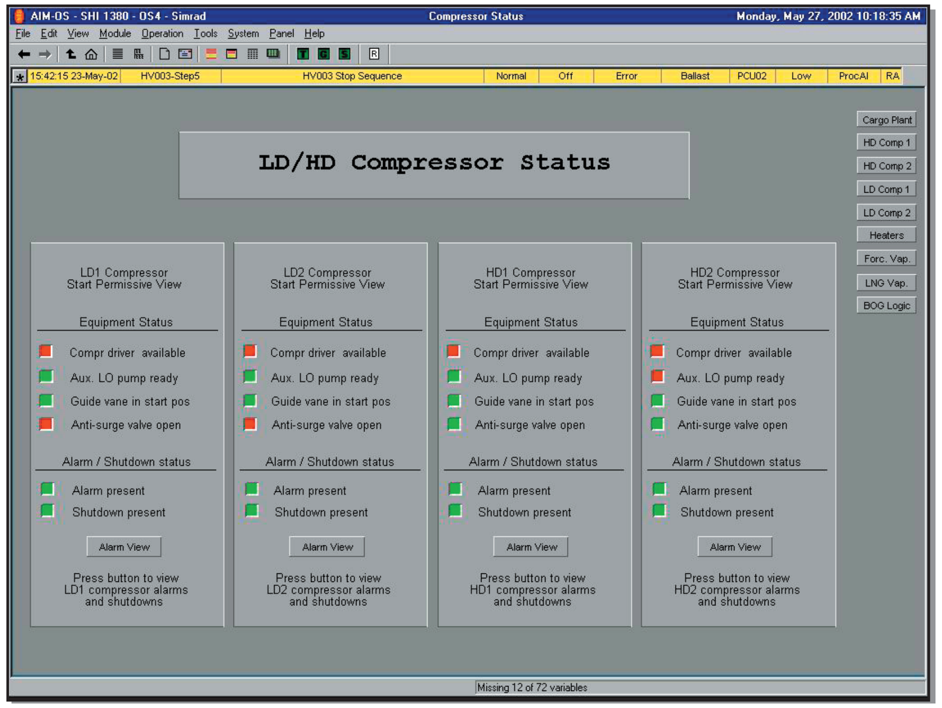
The seals are of the flexibox type. They are fixed on the bulkhead and float on the shafts, supported by two ball bearings.

Capacity Control

The boiler gas flow demand control valve position dictates the capacity of the compressor. The compressor output capacity is controlled by changing the position of the guide vanes and the electrical input to the variable speed motor. At the lowest capacity demand the guide vanes will be fully closed and the electrical input at a minimum.

As the demand signal increases, the guide vanes will be fully opened while the motor speed will be kept at the minimum setting. Further gas flow demand will increase the motor speed accordingly. The output from the controllers are limited to prevent rapid changes and surging in the compressor gas discharge.

(**Note:** The electrical input to the variable speed motor will be interlocked to a minimum if the guide vane control is switched to LOCAL. The compressor control will be set to the manual mode if any of the fuel gas control valves are operated manually.)



Operating Procedures

To prepare the LD compressors for running.

a) Check the LO level in the sump tank.

b) Start the LO heater about 30 minutes (depending on ambient temperature) prior to the expected compressor start up.

c) Close the seal chamber vent line valve.

d) Open the nitrogen seal gas supply manual valve.

e) Open the compressor suction and discharge valves.

f) Open the cooling water inlet and outlet for the LO cooler.

g) Open the instrument air supply to the control panel.

h) Switch on power to the control cabinet. Reset any alarms.

In the cargo control room.

i) Select the mimic LD1 (LD compressor) for the appropriate operation.

j) The anti-surge controller is to be set at minimum i.e. the bypass valve is fully open.

k) Adjust the vapour header pressure controller set point to above the process value to fully open the Anti-Surge valve and allow the LD compressor to start on a light load

l) Before starting the gas compressor click on and place the following in AUTO mode

- The auxiliary LO pump control
- The compressor motor control
- The compressor vane control
- The anti surge (bypass) valve control

m) Start the LD compressor by pressing the start sequence icon.

The following sequence will occur

- The auxiliary LO pump starts
- After a period of 30 seconds, the motor starts
- The anti-surge valve will fully open, over a period of 2 minutes

n) Start the compressor. The shaft vibration monitoring system is released after approximately 14 seconds.

o) Adjust the vapour header pressure controller set point to just below the process value.

The resulting vapour header pressure controller signal will cause the fuel gas valve controller to open the fuel gas valve.

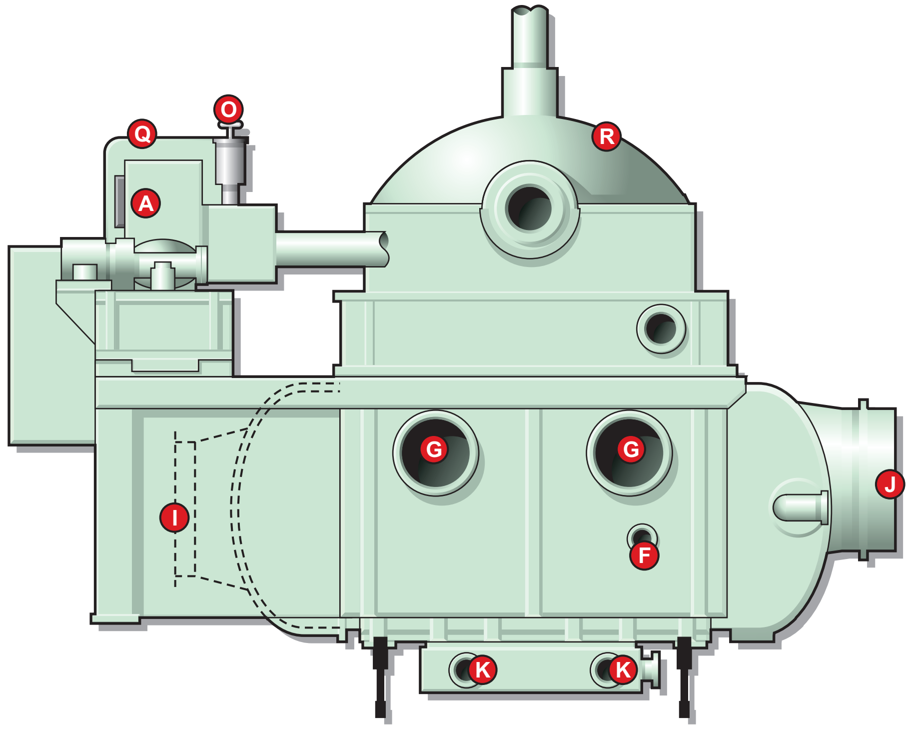
The system will now by controlled by the boiler load and the fuel gas valve controller will go to Manual mode.

p) Click on the fuel gas controller and change it to AUTO mode to allow the engine room system to control the boil-off gas pressure.

3.4 Main Turbines

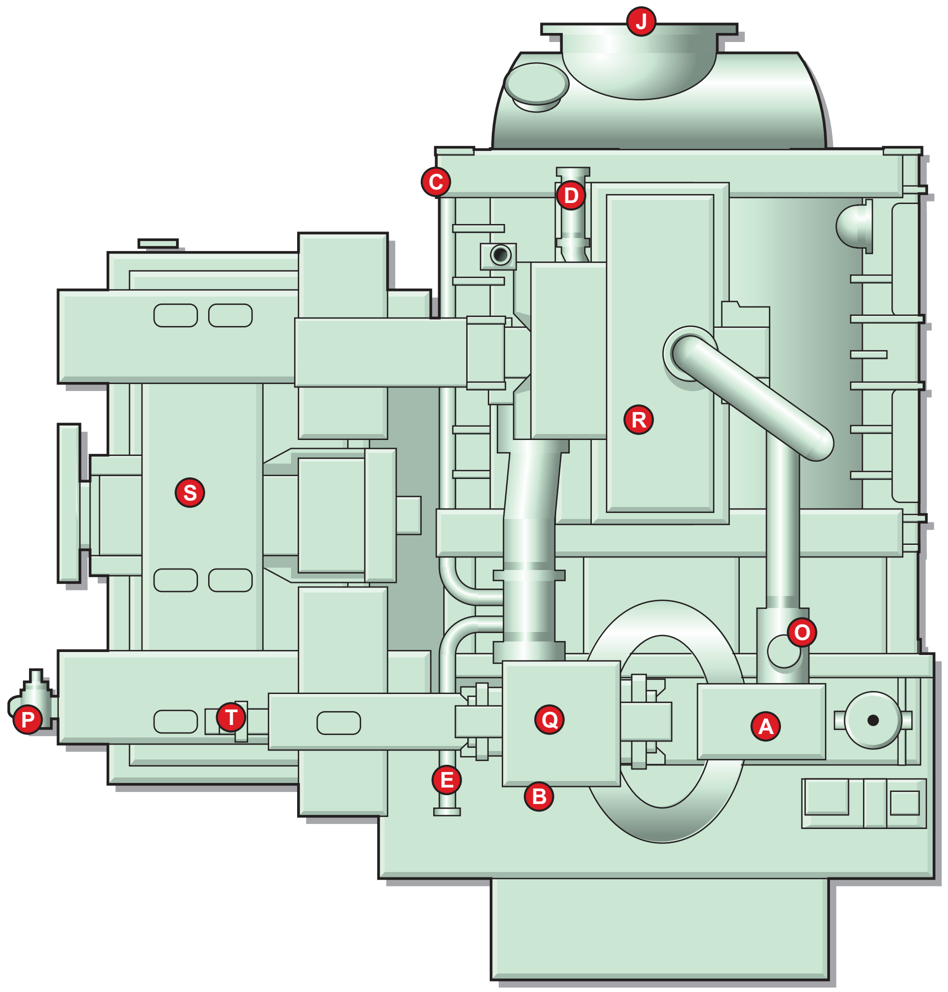
Illustrations

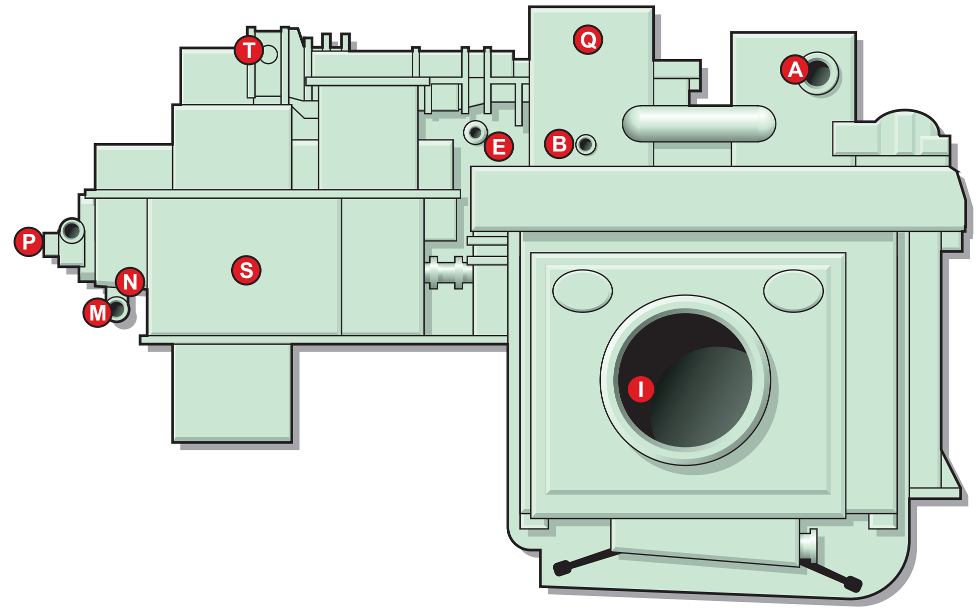
Illustration 3.4.1a Main Turbine



LOOKING FROM FORWARD

PLAN VIEW





LOOKING FROM STARBOARD

Key

A: Ahead and Astern Manoeuvring Valve
B: High Pressure Bleed Steam Outlet
C: Intermediate Pressure Bleed Steam Outlet
D: Low Pressure Bleed Steam Outlet
E: Emergency Steam Inlet
F: High Pressure Exhaust Steam
G: Turbine Generator Exhaust
H: Dump Steam Inlet
I: Main Condenser Cooling Water Inlet
J: Main Condenser Cooling Water Outlet
K: Condensate Water Outlet
L: Lubricating Oil Outlet
M: Main Lubricating Oil Inlet
N: Gear Oil Spray Inlet
O: Astern Guard Valve
P: Main Lubricating Oil Pump
Q: High Pressure Turbine
R: Low Pressure Turbine
S: Reduction Gearing
T: Turning Gearing

3.4 MAIN TURBINES

3.4.1 MAIN TURBINES AND ANCILLARIES

Specification

Maker:	Kawasaki H.I.
Type:	UA-400 cross-compound, impulse-reaction
	HP turbine: one two-row Curtis and eight Rateau stages
	LP turbine: Four Rateau and four reaction stages
	Astern turbine: two two-row Curtis stages
Output:	Maximum - 39,500PS (33 nozzles)
	Normal - 33,580PS (23 nozzles)
HP turbine speed:	5,075 rpm at MCR
LP turbine speed:	3,350 rpm at MCR
Propeller speed:	90 rpm at MCR
Critical speed:	72 rpm
Overspeed trip:	103.5 rpm
Steam condition:	5.733MPa and superheated at 520°C
Direction of rotation:	Clockwise, looking from aft
Astern maximum continuous speed:	63 rpm for a maximum of 2 hours
Steam bleed off:	HP: HP turbine 5th stage
	IP: Crossover pipe
	LP: LP turbine 3rd stage
Main gearing:	Double helical, tandem articulated, double reduction gear
Main LO pump:	Main turbine driven, gear type
Capacity:	210m^3/h at 390kPa
Main condenser:	Single pass surface cooling with dump steam chamber
Cooling surface:	3,700m^2
Tube size:	Diameter 19mm, thickness 0.7mm
Condenser vacuum:	-93.1kPa at a sea temperature of 27°C
Main turbine trips at:	-39kPa
Vacuum pumps:	Horizontal water ring type
No. of sets:	2
Capacity:	12.7m^3/h
Gland condenser:	Cooling area of 25m^2
Exhaust fan capacity:	7m^3/minute
Gear case dehumidifier:	Desiccant type
Capacity:	50m^3/h at electrical load of 1.3kW

Descriptions

Turbines

The turbines are the cross-compound, impulse reaction type, consisting of high and low pressure turbines.

Steam is supplied from the main boilers at 5.733MPa at 520°C at full away. The steam enters the turbine through the main steam piping, main steam strainer and main stop valve or astern guardian and manoeuvring valve.

For ahead operation the steam is supplied to the high pressure (HP) turbine through the ahead nozzle valves and nozzle chambers. The extra nozzle valves are operated every 3 days to ensure freedom of movement.

The HP turbine first stage nozzles are arranged as follows:

Valve	Number of Nozzles
Main throttle valve	23
1st extra nozzle valve	6
2nd extra nozzle valve	4

The HP turbine is of the impulse single-flow type, in which steam enters the turbine through the ahead stop valve connected to the HP turbine directly. The steam flows across the two-row Curtis stages and eight Rateau stages and then to the exhaust chamber at the aft side of the HP turbine. Two extra nozzle valves are fitted which are opened at full away at sea to generate the maximum output if required.

From the HP turbine the steam flows through the cross-under pipe to the low pressure (LP) turbine.

The LP turbine is of the impulse reaction single-flow type in which steam flows towards the forward side through the steam chest, transfers its energy to four Rateau stages and four reaction stages and exhausts into the main condenser.

The astern turbine is of the impulse type, arranged at the forward end of the LP turbine. Steam enters through the astern manoeuvring valve, astern guardian valve, and transfers its energy to two, two-row Curtis stages, towards the aft side, and exhausts into the main condenser.

For emergency independent operation of the LP or HP turbine, the flexible coupling can be removed and the cross-under piping changed for the emergency piping (see section 4.3).

Gland Steam

Labyrinth type seals are used at the end of the turbine rotors to prevent the steam in these regions from leaking to atmosphere and more importantly, to prevent air from entering the turbine where the internal pressure is less than atmospheric.

The seals are formed by radially slotting sections of labyrinths into the packing rings, which themselves are likewise slotted into the turbine upper and lower casings. The peak and trough edges of these labyrinths are located adjacent to corresponding square radial grooves machined into the rotor shaft. The clearances between the labyrinth edges and the rotor are minimised to reduce steam leakage between the inner (high gland steam pressure) areas and the outer (low gland steam pressure) areas. Adequate axial clearance between the rotor and labyrinths allow for the designed axial movement and expansion between the rotor and the casing.

Steam is supplied to the glands at a pressure of 24kPa from a gland steam receiver mounted underneath the turbine. Where the internal steam pressure is higher than the pressure in the gland housing, steam will enter the series of diaphragms from the turbine, and is effectively throttled across each stage causing its pressure to drop. The final very low pressure steam is led away to the gland steam condenser.

Where the pressure in the gland housing is greater than the internal turbine pressure at the shaft exit point, the steam available from the gland steam receiver will be drawn through the gland, effectively sealing it and preventing the ingress of air. The gland steam receiver releases excess steam through a control valve to the flash chamber or receives steam from a make-up controller supplied from the HP exhaust steam range. The need for the steam to make-up or spill changes with the turbine load, ie at high load the steam will generally be spilt out of the system and at low loads the packing steam will need to be made up.

Gland Condenser

The gland condenser is a horizontal, straight tube type with the gland exhaust fan mounted on top. It has cooling tubes through which the main condensate is passed to act as the cooling medium. Turbine gland leakage steam and air is collected in the gland condenser. Air and non-condensible gases are drawn out and exhausted by the fan. Condensate passes through a loop seal and drains to the atmospheric drains tank.

Main Condenser

The main condenser is a surface cooled, radial-flow type with a dump steam chamber. It is mounted directly below the LP turbine at right angles to the axis of the turbine and the condenser neck is bolted directly onto the turbine exhaust flange. Thermal expansion of the upper part of the condenser in the longitudinal direction is accommodated by the deflection plate, fitted at the forward side of the condenser. The condenser shell, hotwell, water chambers and dump steam chamber are all fabricated from steel plate and welded together. The internal surfaces of the water chambers are lined with neoprene with sacrificial anodes fitted to help prevent corrosion. The condenser tubes are arranged for radial flow of the steam across them. The air extraction box is positioned at the centre of the tube nest.

Steam entering the condenser is guided around the boundary between the tube nest and the shell, and then towards the centre of the tube nest.

Condensate flows down into the hotwell at the bottom of the condenser, from where it is pumped out by the main condensate pump. The water level in the hotwell is maintained by recirculating the condensate back into the hotwell.

The condenser is of the regenerative type, whereby the steam entering the condenser gives up some of its heat to the condensate. This is achieved by guiding the steam flow as described above. This also has the added advantage of deaerating the condensate. The air and non-condensable gases enter the air extraction box at the centre of the tube nest from where they are removed by the vacuum pump. The dump steam pipe is led into the condenser, the steam being water sprayed on entry in order to cool it, preventing thermal damage to the tubing due to local overheating.

Cooling sea water is supplied by a main circulating pump and when at sea and conditions are normal, by a scoop system set into the hull of the ship (see section 2.3.1 Main and Auxiliary Sea Water Circulating Systems).

Gearing

The reduction gearing between the turbine and propeller is a double reduction, tandem articulated type. The reduction gear consists of two first pinions, two first gear wheels, two second pinions and one second gear wheel

Both the HP and LP turbines are connected to the first pinions of the reduction gear by flexible couplings. The pinions drive the first reduction gear wheels. The first reduction gear wheels are connected through flexible shafts fitted with flexible couplings to the second reduction pinions, which drive the second-reduction gear wheel or main gear wheel. The main thrust bearing is located in a separate casing forward of the main reduction gear. An 11kW reversible motor driven turning gear is provided and mounted at the aft end of the driving shaft, which is connected to the HP first reduction pinion.

Lubrication

The lubricating oil system (see section 2.3.1 Main Turbine Lubricating Oil System) consists of one main turbine driven lubricating oil pump, two motor driven auxiliary lubricating oil pumps, a main lubricating oil strainer and bypass filter, a pressure control valve, a temperature regulator, one lubricating oil cooler, an emergency gravity tank and one lubricating oil pan and sump tank built into the hull. The main turbine driven LO pump supplies the turbine and gearing with oil when the turbine revolutions are 81 rpm.

The motor driven LO pump will start when the revolutions are 76 rpm, the oil pressure is low or an abnormality occurs in the operation of the turbine driven pump. This is controlled by the IAS graphic screen LO Main Turbine. Oil is drawn from the main engine sump tank and discharged to each bearing and to the gear oil sprayers after passing through the main turbine LO filter, the oil cooler and recirculating pressure regulator.

The oil returns to the hull sump tank from the oil pan under the main reduction gear casing. If loss of electrical power occurs the bearings are supplied from the turbine driven pump and the emergency gravity tank. Control oil is used to actuate the manoeuvring valves and is supplied from the main LO pumps.

Safety Device

The control oil mechanism will trip the main turbines manouevring valve under the following conditions:

- Overspeed
- Main condenser vacuum low low
- Main condenser hotwell level exceptionally high
- Lubricating oil pressure low
- Control oil pressure low
- HP turbine rotor excessive vibration
- LP turbine rotor excessive vibration
- Main reduction gearing vibration
- HP turbine rotor position excessive displacement
- LP turbine rotor position excessive displacement
- Main thrust bearing axial movement
- Boiler steam drum water level very high
- Both boilers tripped
- Manual hand and emergency trips operated
- Auto spinning overspeed
- Emergency manouevring handle not in neutral position
- Turning gear engaged

These safety devices will not reset automatically when the cause of the trip is corrected. The trips are reset by pressing the RESET pushbutton on the main turbine control panel for a few seconds and then the yellow CAUSE RESET pushbutton on the main turbine manoeuvring control cabinet.

When the turning gear is engaged, or the emergency manual manoeuvring handle is not in the neutral position, interlock it will prevent the main turbine's steam throttle valve opening.

The control oil mechanism will automatically slow down the main turbines under the following conditions:

- Main condenser hotwell high
- Main condenser vacuum high high
- Main steam pressure low low
- One boiler tripped
- Boiler steam drum water level high high or low low
- Main thrust pad temperature high high
- Stern tube temperature high high
- Main turbine automatic slowdown
- Main turbine automatic slowdown override
- Main gearing and turbine bearing temperature high high
- Intermediate gearing bearing temperature high high
- Main steam temperature high high

Tag	Description	Low	High
MT026	Main steam temperature		530°C
MT029	Astern turbine steam chest temperature		350°C
MT032	Low pressure exhaust steam temperature		150°C
MT033/185	Main condenser hotwell temperature		45°C
MT035	Main steam pressure	5kPa	50kPa
MT042	Gland steam pressure	5.4MPa	6.0MPa
MT049	HP turbine vibration	100mm/sec	130mm/sec
MT050	LP turbine vibration	150mm/sec	180mm/sec
MT051	HP turbine axial movement	0.5mm	1.0mm
MT052	LP turbine axial movement	0.5mm	1.0mm

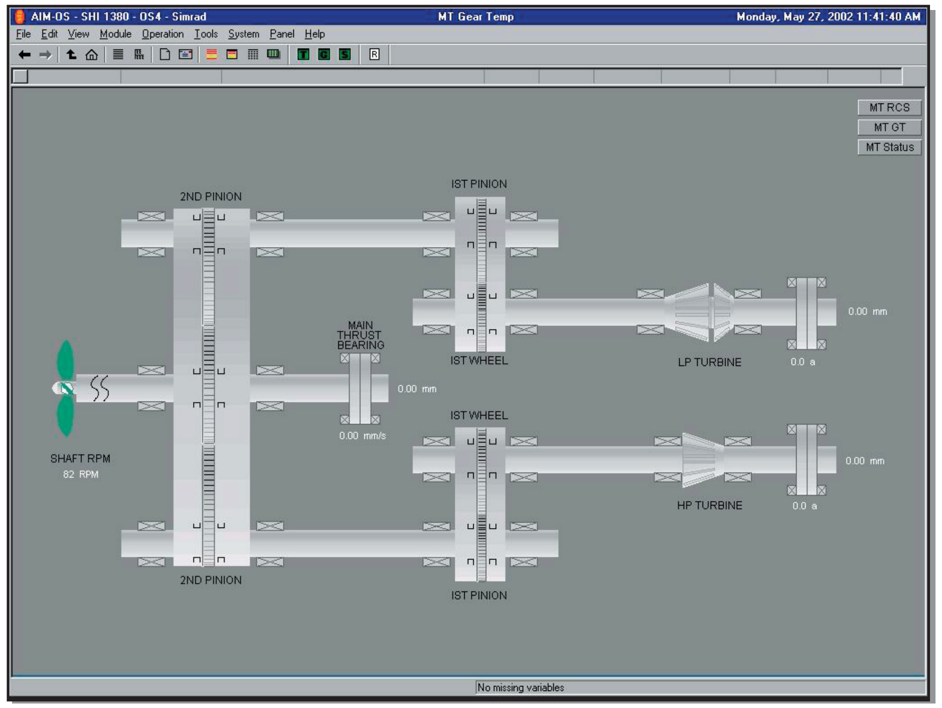
Tag	Description	Low	Low low	High high
MT043	Main condenser vacuum	600mmHg	500mmHg	
MT048	Main condenser hotwell level	300mm	-110mm	
MT055	Main steam pressure		53.5MPa	
MT056/57	Boiler steam drum level			160mm
MT058/59	Boiler steam drum leve		-170mm	
MT061	Main condenser vacuum		500mmHg	
MT062	Main condenser level			300mm
MT076	Main condenser vacuum trip		300mmHg	
MT077	HP rotor vibration			130mm/sec
MT078	HP rotor vibration			180mm/sec
MT079	HP turbine axial movement			1.0mm
MT080	LP turbine axial movement			1.0mm
MT081/160	Thrust bearing axial movement	1.1	1.6	1.6mm
MT082/159	Reduction gearing vibration	1.8	7	18mm/sec
MT083/4	Boiler steam drum level very high level			200mm
MT087	Main condenser hotwell level extremely high			500mm

The Main Turbine and the Intergrated Automation System

Equipment Involved

- Main engine and gearbox bearing probes
- Interface with the main telegraph system for indication and alarm purposes
- Interface with the main engine protection system for indication and alarm purposes
- Interface with the main engine control system for indication and alarm purposes
- Transmitters, control valves and pump starters associated with the LO systems
- Main turbine turning gear

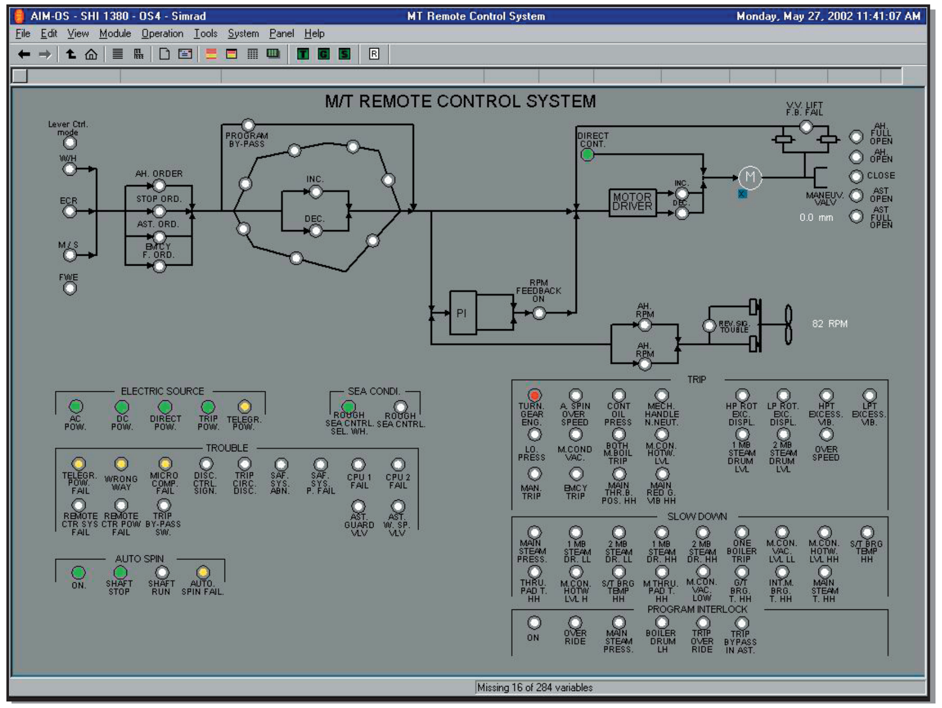
The primary function of the IAS with regard to the main turbine is purely alarm and monitoring, either directly from the bearing temperature probes, or as remote monitoring of the package vendor units. This includes monitoring of the turning gear. Monitoring and alarm functions are provided for the pressure and temperature sections of the control oil system. Control of the lubricating oil pressure and temperature is carried out together with the control of the lubricating oil and control oil pump's starting and stopping function.

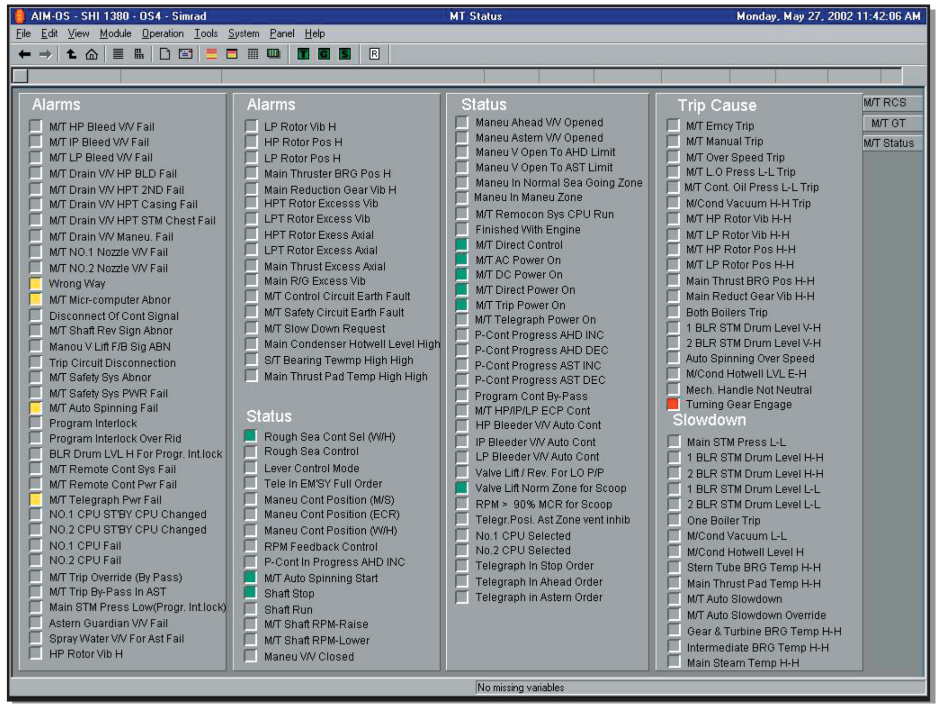


Gland steam make-up and spill is also controlled by the IAS.

The following graphic screens are used to monitor and control the main turbine functions carried out by the IAS:

Graphic Screen	Description
MT Gear Temp	Main gearing bearing temperatures
LO Main Turbine	Main turbine lubricating oil system
MT Remote Control System	Main turbine mimic board
MT Status	Main turbine protection





Procedure for Start-Up

Successful operation of the turbine depends on the manner of the warming through, loading, stopping and cooling down of the turbines. Steam turbines are built and operate with very close tolerances in their structure, and the very nature of the driving medium can lead to problems associated with thermal expansion unless due care is taken. Correct warming through and proper drainage is essential together with careful handling of load changes.

The preparation of the turbine for use is the responsibility of the operator. Correct loading up times are programmed into the turbine control system, as are the opening of the drain valves and bleeds. Should any of these functions need to be carried out manually, they should be done in the same manner as the automated function.

Initial Checks and Preparation

a) Start the main sea water circulating system (see section 2.3.1 Main and Auxiliary Sea Water Circulating Systems).

b) Check the water level in the main condenser hotwell. It should be higher than normal to allow for filling of the recirculating pipework. Top up as necessary from the distilled water tanks through valves SD276F and SD277F.

c) Prepare the main condensate system for operation (see 2.2.1 Main Condensate System). Ensure that both pump suction valves are open and that the recirculation system is ready for use. Start one of the condensate pumps with the discharge valve closed, then slowly open the valve.

The condensate will be recirculated back into the condenser through the recirculation valve until the condenser receives water from other drains or exhaust. The level control ensures that the level in the hotwell remains constant, and that condensate is pumped up to the deaerator whilst still retaining the correct level.

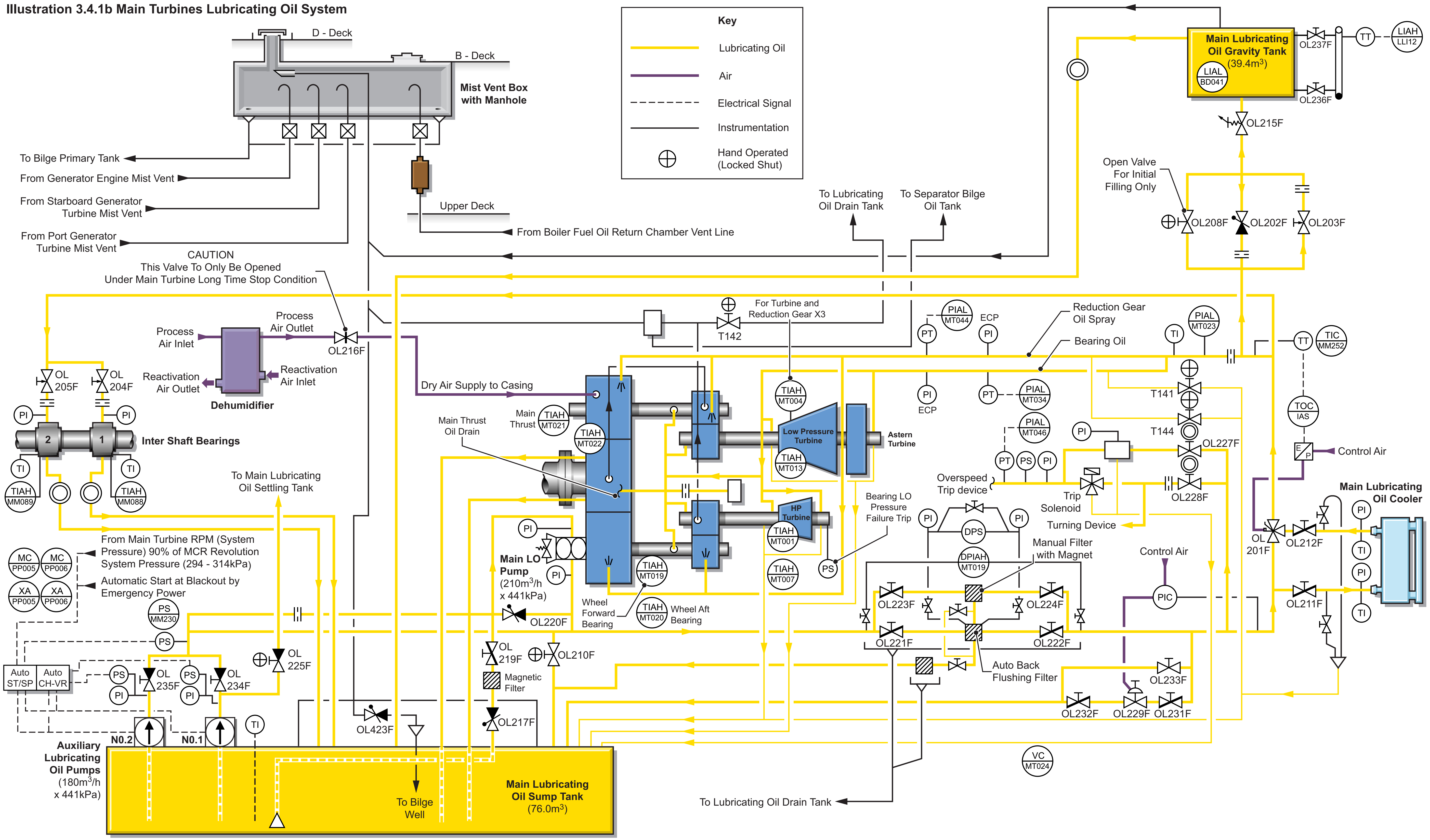
During this initial period of little drainage into the condenser, it is possible for the level to drop due to leakage up to the deaerator. The level in the hotwell will require monitoring and further topping up as necessary.

d) Open the gland leak-off valve between the main turbine and the gland steam condenser.

e) Check and record the axial position of the rotors at the cold condition.

f) Check the oil level in the main sump tank and top up as necessary, taking the amount of oil to be placed into circulation into consideration.

Illustration 3.4.1b Main Turbines Lubricating Oil System



g) Set up the main turbine lubricating oil system, placing the valves as follows:

Position	Description	Valve
Open	Auxiliary LO pump discharge valves	OL235F, OL234F
Closed	LO system drain to the sump tank	OL210F
Open	Gear driven LO pump suction valve	OL219F
Close	Magnetic filter inlet and outlet valves	OL223F, OL224F
Close	Automatic backflushing filter inlet and outlet valves	OL221F, OL222F
Open	LO cooler inlet valve	OL211F
Open	LO cooler outlet valve	OL212F
Open	LO coolers fresh water inlet valves	WF008F
Open	LO cooler fresh water outlet valves	WF009F
Close	LO cooler fresh water drain valves	

h) Start the central fresh water cooling system (see section 2.4.1 Central Fresh Water Cooling System).

i) Vent any air from the LO coolers, then close the vent valves.

j) Set the LO temperature controller to 44°C from the IAS graphic screen MT GEAR TEMP. Start one of the LO pumps from the same faceplate.

k) Set valves for gravity tank supply and operation.

Position	Description	Valve
Open	Gravity tank quickclosing inlet/outlet valve	OL215F
Throttled	Gravity tank overflow control valve	OL203F

Check around the LO system for leaks. The level in the LO sump tank will drop as the system charges and may require topping up. A flow of oil should be observed returning from the LO gravity tank and the control oil tank sight glasses. It is good practice to observe gear sprayers and any other oil returns that can be accessed and viewed without loss of oil.

The system oil pressures should be as follows:

Main LO system: 0.1 - 0.15MPa
Control oil system: 0.29 - 0.39MPa

l) Engage and start the turning gear. Observe the amps being drawn by the turning gear motor. If these are higher than normal investigate the turbine, gearing and shafting to determine why they are not turning freely.

CAUTION
Before proceeding to the next stage ensure that the main stop valve, the astern guardian valve and the ahead and astern manoeuvring valves are all closed.

m) Warm through and drain the main superheated line from the boilers to the main turbine manouevring valve by opening the bypasses on the intermediate stop valves and raise the main turbine steam line to approximately 490kPa. Ensure that the turbine, main steam strainer and high pressure steam chest drains are all open. Open the warming through valves ST011F and ST012F from the desuperheated steam system, ensuring the drains to the atmospheric drain tank are open. Warm the line slowly by opening valves SS096F and SS097F, whilst continuing to turn the turbine using the turning gear.

n) Drain and warm through the supply steam line to the gland steam make-up system by opening the drain valves to the atmospheric drain tank. Open the make-up controller inlet valve T24 and outlet valve T25 and the spill controller inlet valve T27 and outlet valve T28. Put the make-up and dump controllers on automatic. Start the gland exhaust fan. Adjust the gland packing steam pressure so that it is about 20kPa.

CAUTION
The gland packing steam will start to heat the turbine. It is therefore essential to keep the turbine turning on gears and the LO system running to avoid localised heating.

o) Ensure that the vacuum pumps are supplied with sealing and cooling water and start one pump. Observe the vacuum forming in the condenser, checking for leaks should this not take place at the normal rate or fail to achieve the rated vacuum of 720mm Hg at a sea temperature of 27°C.

p) Open the spray water valve for astern operation.

Maintain the warming through of the turbine and steam piping for at least one hour, raising the main turbine steam line pressure to full pressure on the bypass valves on the boiler turbine stop valves SS001F and SS002F.

q) Open the intermediate valve slowly and fully close its bypass valve.

r) Close the warming through valves from the desuperheated steam system.

(**Note:** If the engine has been turning on gears for less than 24 hours with the gland steam supplied, there is no need to use the warming through steam and the engine can be used immediately.)

CAUTION
If the ship is to be moved using tugs or any other means of external propulsion, disengage the turning gear. Failure to do so may damage the turning gear due to the propeller idling whilst under way. Ensure that the LO system is running. If the turning gear is disengaged, the Auto Spin system must be in use.

Testing the Engine

Request permission from the bridge before turning the turbine on steam.

s) Ensure that all the turbine systems are normal. Disengage the turning gear. The red light on the console changes to green indicating that the turning gear is fully disengaged.

t) Confirm that the ahead and astern manoeuvring valve is closed.

u) Using the emergency manouevring handwheel, 'kick' the main turbine ahead and astern, confirming all satisfactory. Reset the emergency manoeuvring valve and test the ahead and astern operation switch in the ECR.

v) Trip the turbine from each location to confirm the normal operation of the trip. Reset the trip.

w) With the engine in ENGINE CONTROL ROOM mode, select AHEAD on the manoeuvring console toggle switch and slowly open the ahead manoeuvring valve enough to allow a small quantity of steam through. Increase the steam until the shaft just begins to turn as indicated on the tachometer. Close the ahead manoeuvring valve. Repeat this operation in the astern direction.

This should be carried out over about 20 minutes to promote warming through of the turbine and to give the opportunity to inspect the turbine for any defects or signs of trouble.

While the control of this plant is highly automated and of modern design, there can be no substitute for good steam engineering practise. Ensure that the plant is physically checked, listened to and all senses used to detect early signs of problems.

x) Upon completion of the tests, place the turbine in AUTOSPIN mode which will automatically turn the engine ahead and astern on steam until it is required.

CAUTION
Do not allow the rotors to remain stationary for more than three minutes once the gland packing steam has been admitted. Failure to follow this advice could result in the rotors deflecting.

Run up to Full Speed after Manoeuvring

Following manoeuvring at full ahead at 53 rpm, the turbine control system is set to full away on passage. The speed will increase to 65 rpm immediately before the speed increase program takes control. The program controlling the turbine will slowly increase the speed through a preprogrammed ramp lasting 45 minutes until the required full away speed is achieved. The automatic drain valves will be closed at the beginning of the run up period.

The bleed steam valves will open automatically at preprogrammed stages in the ramp allowing bleed steam into the systems they serve.

Careful monitoring of the plant is required during this period of instability. The turbine must be observed and, should any vibration be detected, the turbine must be slowed down until they cease and then be investigated. This can be caused by rotor deflection due to poor warming up procedures. A period of running at revolutions below those at which the vibration started can lead to the deflection lessening.

After a period of time the revolutions can be increased and the vibration monitored. Should this fail to rectify the situation, then the turbine will need to be stopped and further investigations instigated.

Procedure for Shutting Down the Main Turbines in Port

Terminal regulations normally require the main stop valves to be shut and locked, but they also require the main engines to be ready for immediate use in the event of an emergency. To facilitate these requirements the procedure for shutting down and warming through the main turbine is to be carried out as follows.

a) At Finished With Engines, change main turbine control from Wheelhouse to ECR.

c) Change the mode switch to DIRECT control.

d) Shut the main stop valves SS001F and SS002F.

e) Reduce the main steam line pressure to 1.0MPa by turning the main turbine ahead and astern using the ECR direct control switch

CAUTION
The shaft revolutions must not exceed 5 rpm during this process.

f) Once the main steam line pressure has been reduced to 1.0MPa ensure that the Manoeuvring Valve Closed light is illuminated and that the Manoeuvring Valve Indicator is at the ZERO position.

g) Operate the main turbine EMERGENCY TRIP switch at the main turbine emergency gauge board so as to leave the turbine in a tripped condition.

h) Ensure that the turbine has stopped before engaging the turning gear. Once the turbine has stopped, engage and start the turning gear and observe the ammeter reading.

If the turning gear lever fails to engage, use the handle provided to turn the motor to line up the clutch teeth.

i) Open No.1 and No.2 main turbine extra nozzle valves.

j) Open fully the master warming through valve ST012F and slowly open both the double shut off warming through valves SS096F and SS097F.

k) Check the turning gear ammeter to ensure that the motor load is unchanged. If there is any increase close the warming through valves immediately.

l) Adjust the bypass valves at SS01F and SS02F in order to maintain a main steam line pressure of approximately 0.1MPa.

m) Maintain a full vacuum on the main condenser as for normal operations.

n) Start the gear casing dehumidifier.

An entry is to be made in the Engine Room Movement Book for the following items, indicating the event and the time they were completed:

- Main turbine on ECR
- Main turbine on ECR direct control
- Main turbine stop valves closed
- Main turbine emergency trip tested and turbine remains in a tripped condition
- Turning gear engaged and running

Procedure for Warming Through the Main Turbines Prior to Standby Leaving Port

Once confirmation is received that the loading arms have been disconnected and are clear of the vessel proceed as follows.

(**Note:** It is desirable that the following procedure should take 75 minutes.)

a) Commence raising the main steam line pressure to 6.0MPa, utilising the bypass valves on the main stop valves SS01F and SS02F, over a minimum period of 20 minutes.

b) Once the main steam line is at operating pressure, open fully the main stop valves SS01F and SS02F and close the bypass valves.

c) Close the main turbine warming through valves ST011F, ST012F, SS906F and SS907F and the main turbine extra nozzle valves, unless the Chief Engineer indicates an MCR requirement.

d) Stop the gear casing dehumidifier.

e) Stop and disengage the turning gear.

f) Reset the main turbine emergency trip at the turbine side emergency gauge board.

g) Reset yellow CAUSE RESET pushbutton on the Manoeuvring Control Cabinet.

h) Engage the green Warming Through Overspeed protection pushbutton on the main turbine panel on the main console.

i) Ensure an engineer is positioned at the main turbine side and place the main turbine on ECR and Direct Control. Turn the main turbine ahead and astern at a maximum 8rpm using the DIRECT CONTROL switch.

j) Once confirmation is received from the main turbine side that all is in good order, continue turning the main turbine ahead and astern.

(**Note:** Ideally the main steam line temperature (tag No.MT026) should reach at least 290°C and the HP turbine steam chest (tag No.MT031) 180°C before standby.

k) During this period ensure that the engine telegraph is tested from the bridge.

l) When permission is received from the bridge/terminal that the gangway is removed, change over the main turbine control to the ECR LEVER CONTROL position and switch on the AUTOSPIN. Confirm that the autospin engages after 3 minutes and that the turbine turns ahead and astern sequentially.

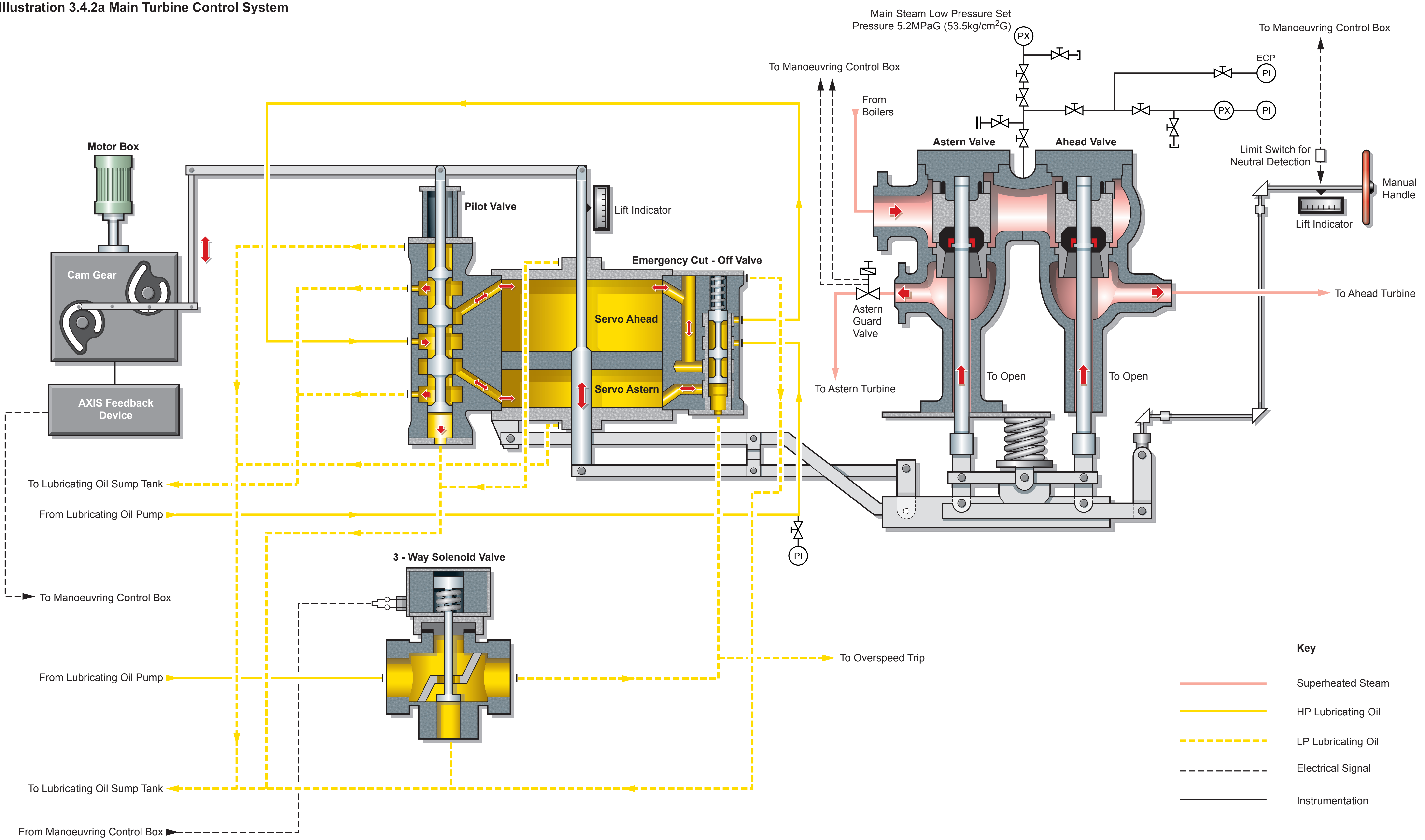
(**Note:** An engineer must be present in the ECR at all times while the vessel is alongside a jetty with the main turbine on autospin.)

m) At Standby Engines, transfer the main turbine control mode from the ECR to Wheelhouse.

An entry is to be made in the Engine Room Movement Book for the following items, indicating the event and the time they were completed:

- Loading arms all disconnected and permission granted to commence warming through the main turbine
- Main turbine stop valves open
- Turning gear stopped and disengaged
- Main turbine trip tested
- Main turbine warming through in ECR Direct Control
- Main turbine on ECR Lever Control and Autospin active
- Main turbine on WH Lever Control

Illustration 3.4.2a Main Turbine Control System



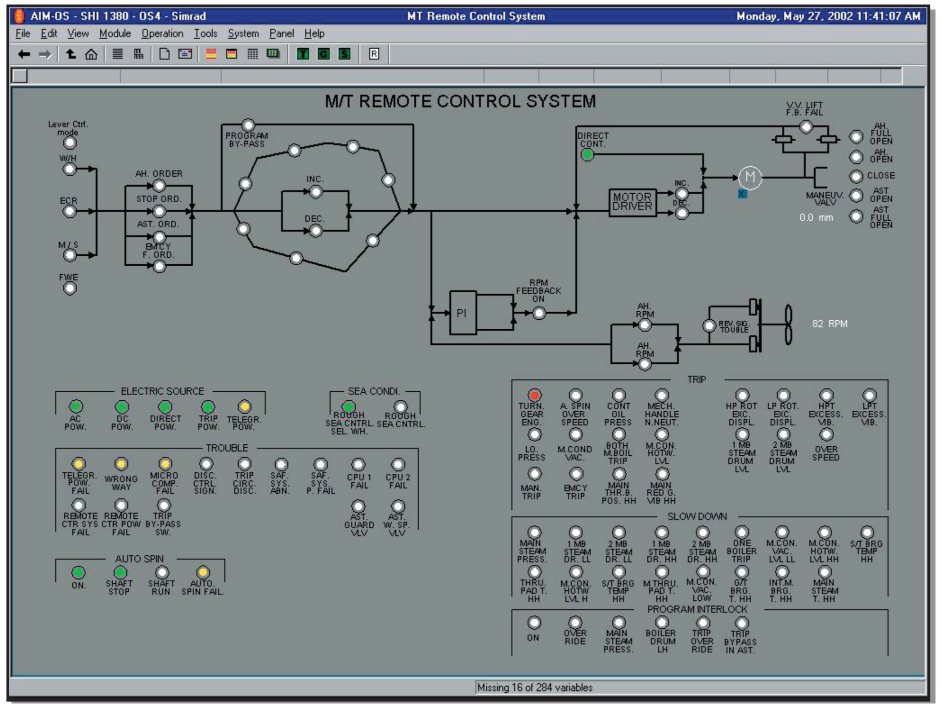
3.4.2 MAIN TURBINE CONTROL SYSTEM

Maker: Nabco Ltd

Introduction

The turbine remote control equipment provides the interface between the operator and the main turbine, carrying out the commands in a preprogrammed sequence from consoles on the bridge and the engine control room. The system is of the electro-hydraulic type which consists of the dual control main computer, electric and electronic circuits, process signal interface units, and the hydraulic servo mechanism of the actuator of the ahead and astern manoeuvring valves.

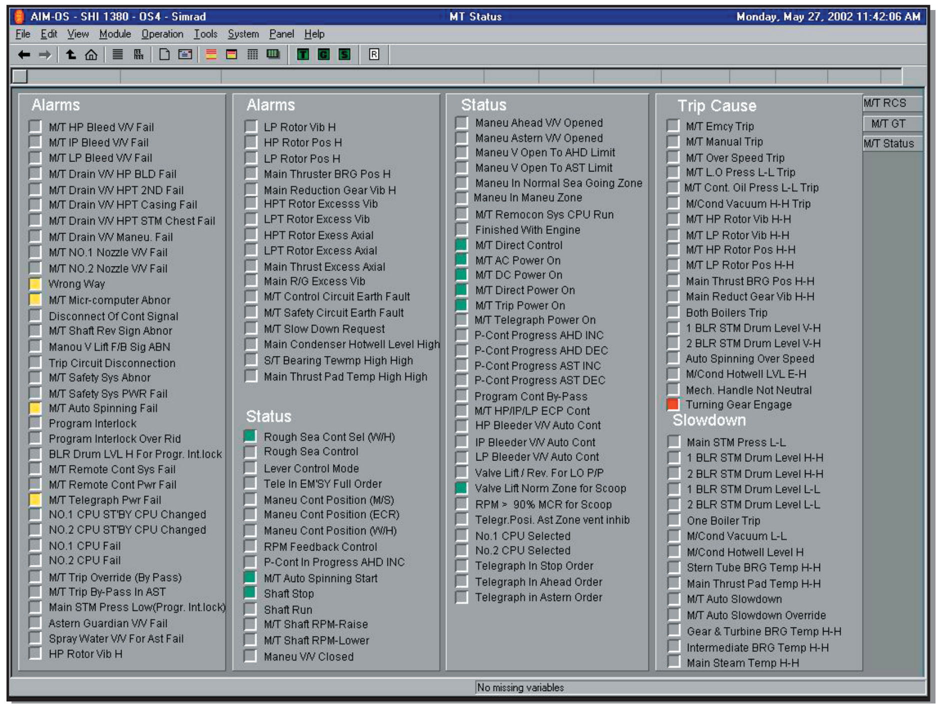
The IAS graphic screens used to monitor the main turbine functions are the Main Turbine Remote Control System and the Main Turbine Status:



Control Oil System

A control oil system is provided at the turbine and is dependent on the main LO system. It is supplied by the same pumps as the LO supply, but at a primary (higher) pressure than the LO supply as a result of the orifice fitted in the LO supply to the bearings and gearing.

Control of the governor motor and solenoids which utilise the control oil to operate the manoeuvring valves, is carried out by the separate turbine management system operated through the bridge or engine room control consoles. The turbine management system signal is converted to movement of an electric positioning motor or governor.



This motor moves a pilot valve assembly which, by covering and uncovering ports, allows a flow of oil to the manoeuvring valve's servo piston. The oil acting on the servo piston moves it in the desired direction and consequently moves the manoeuvring valve. The manoeuvring valves admit steam to the turbine at a rate dependant upon their position ahead or astern. Movement of the piston is fed back to the pilot valve assembly and when the piston has travelled the desired amount, the ports in the pilot valve assembly are covered and no further movement takes place.

Main Turbine Remote Control MTRC Equipment

The control levers are combined with the engine telegraph and signal the desired turbine command to the computer. The computer carries out the command for a change in turbine speed or direction through consistent, stepped procedures. The logic is designed to carry out the most suitable turbine and boiler operating procedures considering best practice and their limitations.

System Composition

The turbine remote control system consists of the following:

Main Turbine Manoeuvring Control Panel

The Main Turbine Manoeuvring Control Panel (MTMCP) is housed in the engine control room. The panel receives the commands signalled from the telegraphs and houses the components required to control the main turbine in accordance with the telegraph command. It consists of the control computer, mimic panel and miscellaneous electric and electronic signal circuits.

Wheelhouse Main Turbine Manoeuvring Control Console

The main turbine manoeuvring control console consists of the following:

- Telegraph transmitter with manoeuvring lever, which is moved to the desired turbine speed setting, ahead or astern, the command being processed and acted upon by the MTMCP.
- Telegraph lever position indicator
- Telegraph logger
- RPM indicator
- Sub panel containing manoeuvring duty changeover switch, manoeuvring pushbuttons, indicator lamps and telegraph repeater
- Main turbine emergency trip
- Main turbine slowdown override
- Main turbine trip override

Engine Control Room (ECR) Main Turbine Manoeuvring Control Console

The main turbine manoeuvring control console consists of the following:

- Telegraph receiver with manoeuvring lever
- Manoeuvring valve lift indicator
- Sub panel containing switches for manoeuvring and bleed valves, program control, emergency systems and drain valves, manoeuvring valve operating switches (spring loaded) and indicator lamps
- Lever position indicator
- Control mode changeover panel
- RPM indicator
- Revolution counter
- Main turbine emergency trip
- Main turbine slowdown bypass
- Main turbine trip bypass

Local/Emergency Control Panel at the Main Turbine Side

The local/emergency control panel consists of the following:

- Turbine trip reset switch
- Control position transfer switch
- Manoeuvring valve lift indicator
- RPM indicator

- Local/remote control switch for HP, IP and LP bleed steam valves
- Open and close switches for HP, IP and LP bleed steam valves
- Dial gauges showing steam and LO pressures and main condenser vacuum
- Emergency trip and trip override switches for main turbine
- Emergency manoeuvring valves handwheel
- Indicator lights showing turbine trip and manoeuvring position status

(**Note:** When changing from neutral position to either Ahead or Astern, the governor oil pressure is dumped.)

System Functions

The turbine remote control system can perform the following functions:

Auto Spinning

It is intended to prevent any sagging of the hot turbine rotors whilst they are stationary by turning the engine frequently in both directions. This also has the effect of keeping the temperature of the turbines high enough to prevent thermal damage when the engine is used again.

When the engine is stopped between movements during manoeuvring and the following conditions apply, the auto spin function will operate:

- The CONTROL MODE switch on the ECR console is turned to the LEVER position
- The telegraph lever is set at the STOP position
- The AUTO SPINNING switch on the ECR console is turned to the ON position
- The main turbine trips are reset
- The propeller shaft revolutions are less than 3rpm

If the propeller shaft revolutions are less than 3 rpm for 2.5 minutes, the auto spinning system opens the ahead steam manoeuvring valve to a preset limit to turn the propeller shaft at 3 rpm and then close. Once the propeller shaft has stopped for 3 minutes auto spinning system opens the astern steam manoeuvring valve to a preset limit to turn the propeller shaft at 3 rpm and then close.

This sequence is repeated every 3 minutes.

The auto spinning mode is activated automatically and the SPIN ZONE lamp on the Wheelhouse and ECR consoles are lit.

To stop the auto spin function from taking place change the Auto Spinning from ON to OFF.

The turbine will trip if the auto spinning rpm reaches 15 rpm.

Automatic Slowdown

The main turbine is automatically slowed down when one of the following conditions occur:

Description/Tag No.	Set Point
Main steam pressure low low ESLD-121	5.2MPa
Main boiler steam drum level high high	+200mm
Main condenser hotwell level high high ESLD-161	N+300mm
Stern tube bearing temperature high high	
One boiler trip	
Main condenser vacuum low low ESLD-129	55kPa (530mmHg)
Main thrust pad temperature high high ESLD-160~2	110°C
Main steam temperature high high ESLD-141	530°C
Gearing and turbine bearing temperature high high ESLD-151~159	G:57°C, T:77°C
Intermediate bearing temperature high high.	

(**Note:** The Auto Slowdown function can be cancelled by turning the Auto Slowdown switch to Override on the Wheelhouse or ECR consoles.)

Transfer of Manoeuvring Control between Wheelhouse and Engine Control Room

The following conditions need to apply:

- Telegraph lever position matches, otherwise the HANDLE MATCHING indicator light will flicker until the positions match
- The telegraph lever or the direct manoeuvring methods match, otherwise the LEVER or DIRECT indicator light will flicker until the positions match.

Operation of the Main Turbine Control System

Preparation for Lever Control

Prepare the main turbine for use as described in section 3.4.1 Main Turbine.

a) Set the control location toECR. The location is displayed by an indicator lamp on all the consoles.

b) The control lever in all locations should be at the STOP position.

c) Select the control mode as LEVER. Engine control positions may be selected as Wheelhouse or ECR.

The turbine can now be controlled from the telegraph lever which initiates the control ramps and carries out all functions automatically. Use of the toggle switches on the engine control room console, to raise or lower turbine speed, bypasses the computer control system and actuates the governor servo motor directly when direct control is selected.

Transfer of Control from the Engine to the Bridge

In bridge control the wheelhouse telegraph lever signals the MTRP directly. The telegraph levers in the engine control room does not need to be moved. The indicator built into the telegraph lever will show the position in which the bridge telegraph lever has been placed.

a) Telephone contact between the bridge and engine room establishes the need to transfer control.

b) The telegraph levers in all locations must be in the same positions. This can be checked by observing the pointers indicating the current telegraph position and the remote telegraph position. When the levers are all correctly positioned the HANDLE MATCHING lamp is lit.

c) The engine control room control location switch is moved from ECR to Wheelhouse.

The WHEELHOUSE CONTROL indicator lamp begins to flicker and the buzzer sounds. Until this is acknowledged the wheelhouse telegraph lever is inoperative.

d) The bridge operator acknowledges the change of control location by moving the wheelhouse console location switch from ECR to Wheelhouse and pressing the ACKNOWLEDGE button.

The WHEELHOUSE CONTROL indicator lamp stops flickering and becomes steady. The main turbine can now be controlled from the bridge.

Transfer of Control from the Bridge to the Engine Control Room

a) Telephone contact between the bridge and engine control room establishes the need to transfer control.

b) The telegraph levers in all locations must be in the same positions. This can be checked by observing the pointers indicating the current telegraph position and the remote telegraph position. When the levers are all correctly positioned the MATCHING lamp is lit.

c) The engine control room control location switch is moved from Wheelhouse to ECR.

The WHEELHOUSE CONTROL indicator lamp begins to flicker and the buzzer sounds. The main turbine can now be controlled from the engine control room.

d) The bridge operator acknowledges the change of control location by moving the wheelhouse console location switch from to Wheelhouse to ECR and pressing the ACKNOWLEDGE pushbutton.

The WHEELHOUSE CONTROL indicator lamp stops flickering and becomes extinguished. The ECR indicating lamp is lit.

To Change from Remote to Local Turbine Control

In the event of the turbine remote control system failing, control can be taken from the machinery side (MS).

a) At the main turbine emergency panel, turn the CONTROL POSITION switch to the M/S position.

b) The engine control room will answer the machine side control signal by pressing the M/S pushbutton on the main turbine control console.

c) Pull out the lock pin on the manoeuvring valve and turn the valve carefully in the direction required, ahead steam or astern steam.

d) Answer the telegraph by pressing the REPLY pushbutton on the telegraph panel.

Direct Control

This is achieved by first changing the main turbine control mode from LEVER control (telegraph control) to DIRECT control, using the switches on the ECC5-2 console. The manoeuvring valve servo motor can now be controlled to move the pilot piston to direct oil to the power piston and either open the ahead or astern steam valve.

Main Turbine Emergency Control Panel

Normal and Manoeuvring Mode

The main turbine remote operating system has two modes of operation, NORMAL and MANOEUVRING. The position of the telegraph lever and a change over switch determines the mode to be used.

Alarms and Trips

The main turbine is protected by alarms and trips which can be viewed through the IAS system. These are listed as follows.

Alarms

Description/Tag No.	Set Point
Low LO pressure PS-69/PAL-131	69kPa
Control oil low pressure PS-70/PAL-134	245kPa
Main condenser low vacuum PS-71/VAL-129	-77kPa (600mmHg)
Gland steam high pressure PAH-128	49kPa
Gland steam low pressure PAL-128	4.9kPa
Description/Tag No.	**Set Point**
HP turbine thrust bearing axial displacement XAH-173A	0.5mm
LP turbine thrust bearing axial displacement XAH-174A	0.5mm
Main thrust bearing axial displacement XAH-175A	1.1mm
HP turbine vibration XAH-173V	100 microns
LP turbine vibration XAH-174V	150 microns
Main reduction gearing vibration XAH-175V	7mm/S
Bearing LO high temperature TAH-147	50°C
Gearing LO low pressure PAL-132	69kPa
Main condenser high level alarm FS-161A LAH-161	+250mm
Main condenser low level alarm LAL-161	-110mm
HP/LP turbine and thrust bearing temperature TAH-151~158	75°C
Main gear bearing TAH159	55°C
Main thrust bearing TAH160~1	55°C
Inlet steam temperature TAH141	530°C
LP turbine exhaust chamber temperature high TAH145	150°C
Astern steam temperature high TAH127	350°C
Inlet steam pressure low PAL-121	5.5MPa
Inlet steam pressure high PAH-121	6.0MPa

Trips

Description	Set Point
1. Manual emergency trip (ahead and astern)	
2. Overspeed trip	103.5rpm
3. LO pressure low low PS-69/PAL-131	49kPa
4. Control oil pressure low low PS-70/PAL-134	196kPa
5. Main condenser vacuum low low PS-71/VAL-129	380kPa (500mmHg)
6. Main condenser hotwell level very high FS-161A LAH-161	N +500mm

Description	Set Point
7. HP turbine rotor excessive axial displacement XAH-173A	1.0mm
8. LP turbine rotor excessive axial displacement XAH-174A	1.0mm
9. Main thrust bearing excessive axial displacement XAH-175A	1.6mm
10. HP turbine rotor excessive vibration XAH-173V	130 microns
11. LP turbine rotor excessive vibration XAH-174V	180 microns
12. Main reduction gearing excessive vibration XAH-175V	18mm/S
13. Turning gear engaged	
14. Both boilers tripped	
15. Boiler drum level high high	
16. Power failure	
17. Emergency manoeuvring handle not in neutral position	
18. Safety system power failure	

(**Note:** A trip bypass switch is fitted to No.s 5, 7, 8, 9, 10, 11, 12, and 15. In the event of the turbine operating in the astern direction, trip No.s 4, 6, 7, 8, 9, 10, 11 and 12 are not automatically activated.)

Bleed Valves Control

The HP, IP and LP bled steam valves are set to open at pressures that will supplement auxiliary steam systems in the engine room.

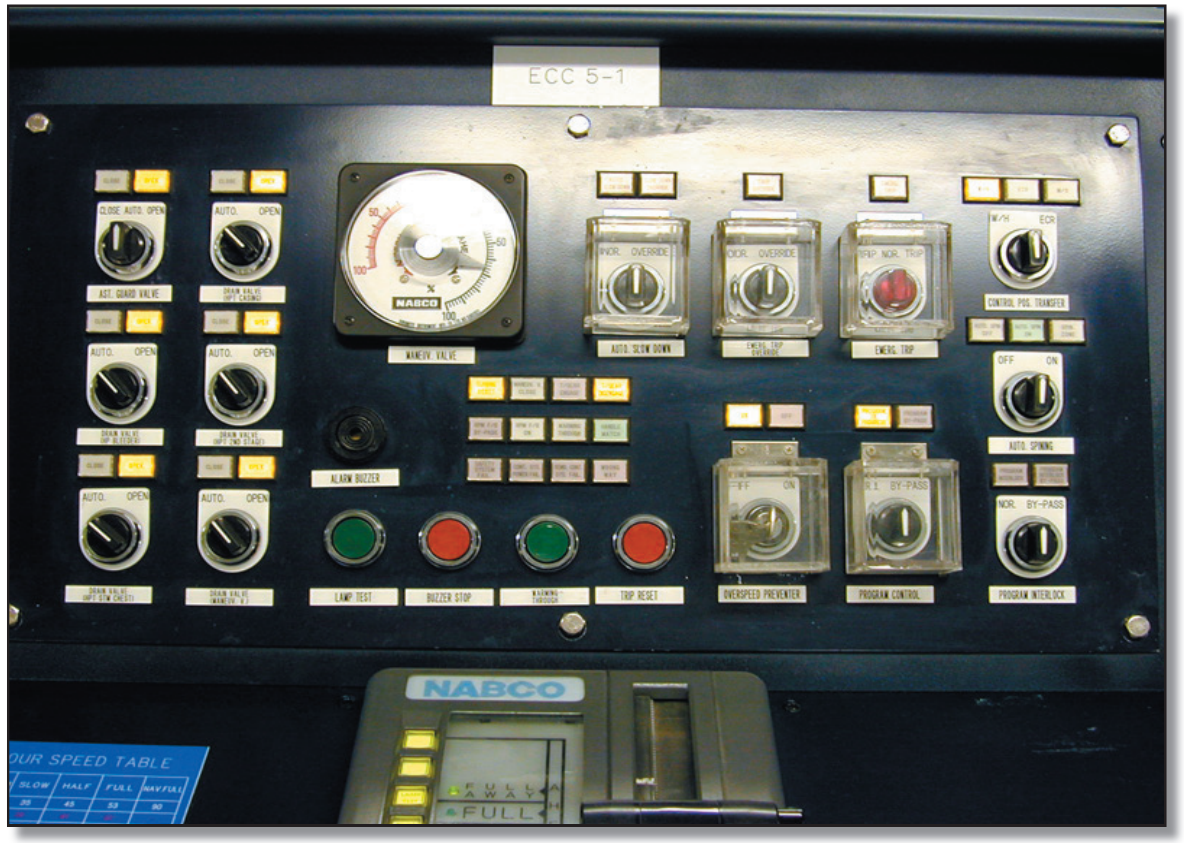
Bypass Switches

These are fitted to the following controls

- Overspeed preventor - never used, except in an extreme emergency
- Program control - used when a quicker response is required during the initial full away period when the turbine's speed is being increased gradually
- Program interlock - used should the increase in speed program become locked. Direct control of the manoeuvring valve can be taken to continue with the speed increase
- Automatic slowdown override - used when it is determined that a slow down in the vessel's speed would endanger the vessel
- Emergency trip override - used when it is determined that a slowdown in the vessel's speed would endanger the vessel

Rpm Feedback Control.

The speed of the propellor shaft is monitored and fed back to the main turbine control system, to ensure that the turbine speeds are maintained within the recommended safe parameters.

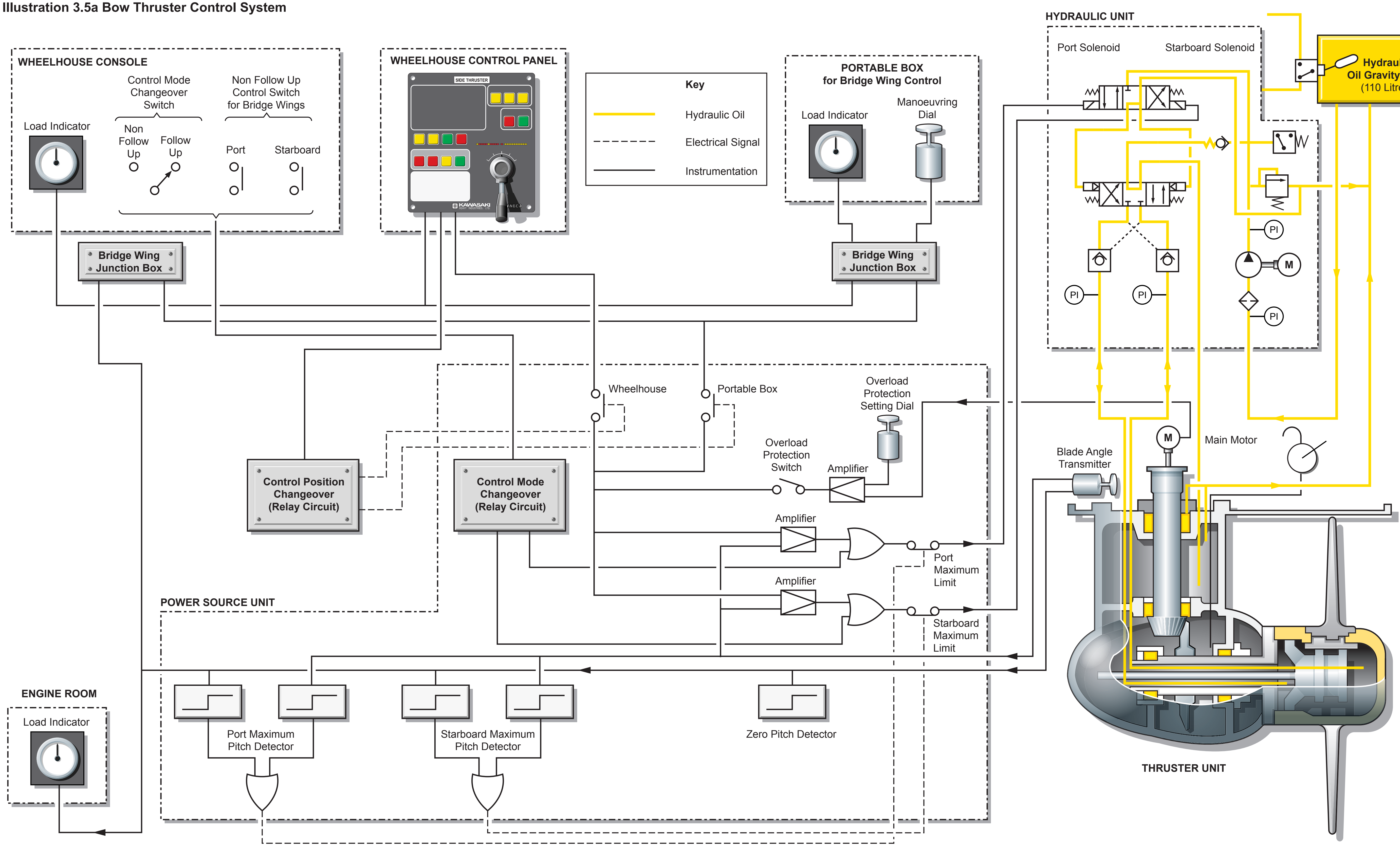


ECR Main Turbine Control Console showing Bypass Switches

3.5 Bow Thruster

Illustration

Illustration 3.5a Bow Thruster Control System



3.5 BOW THRUSTER

Maker:	Kawasaki Heavy Industries
No. of sets:	1

Thruster

Type:	Kawasaki KT-255B3
Motor:	2,500kW
Propellor diameter:	2.85m
Propellor speed:	245 rpm
Input shaft speed:	880 rpm
Nominal thrust:	36.5 tonnes
Maximum blade angle:	±25°
Remote control type:	Electrical - hydraulic
Solenoid valve type:	DEH16P - 20 - 220 - 2WD24AL (24V DC)

Oil Service Pump

Type:	QT52-40H - gear type
Discharge pressure:	50kg/cm^2 at 64 litres/minute
Relief valve set pressure:	55kg/cm^2
Motor:	11kW

INTRODUCTION

The purpose of the bow thruster is to turn the ship when operating at slow speeds or when not under way, to keep the ship in position in a cross wind and to move the ship towards or away from a mooring position as required. The thrust is produced by rotation of a propeller unit which is housed in a transverse cylindrical ducting; the propeller unit being rotated by means of a vertical electric motor via bevel gears. The propeller blade pitch is controllable in order to obtain the desired magnitude and direction of thrust.

The thruster comprises of a number of separate sections:

- The electric motor unit with drive shaft and bevel gearing driving the propeller unit hub
- The propeller unit with blades mounted in the hub
- The hydraulic unit which changes the pitch of the propeller blades
- The control system which regulates the blade pitch in accordance with demand from the bridge.

At speeds greater than 5 knots there is a risk of drawing air into the thruster, particularly when operating at shallow draught, and that will degrade the performance and can cause cavitation damage. The drawing in of air can be detected by the fluctuation (hunting) of the main motor ammeter reading and should be avoided.

Side Thruster Unit

Power is transmitted from the electric motor through the flexible coupling, input shaft and bevel gears to the propeller shaft, rotating the propeller in a constant direction.

The propeller part consists of four propeller blades, a propeller hub with a hydraulic servomotor and the sliding block mechanism. The propeller blades are connected to blade carriers by blade bolts and this assures easy exchange of blades in the thruster tunnel. The gear case, which carries the propeller parts, is connected to the thruster tube by bolts and this assures easy overhauling of all parts inside the tube.

Pressurised oil from the solenoid valve is fed to the hydraulic servomotor through the tubes and annular space in the propeller shaft, resulting in the reciprocating movement of the servomotor piston. This movement of the piston is converted into rotary movement of the blades by the sliding block mechanism. The vent side of the servomotor piston drains, via the solenoid valve, to the gear case. From this pressurised gear case, oil returns to the header tank. The main actuator power pack pump takes oil from the header tank and supplies it to the thruster unit via the solenoid control valves. The hydraulic power pack unit provides oil under pressure and this is used to change the pitch of the thruster unit blades.

A shaft sealing mechanism is attached to the gear case in order to prevent leakage of oil out of the system.

The thruster proper takes 350 litres of oil and the gravity tank 110 litres.

A hand pump is provided for draining the thruster unit and testing for water ingress.

Lubricating Device

The bevel gear and all the bearings inside the gear case are lubricated by the bath lubricating method.

The lubricating oil in the gear case is slightly pressurised by the connection with the gravity tank which is provided above the load waterline to prevent sea water from leaking into the oil system.

Operating Limits

The thruster units must operate within specific limits of draught and speed. The draught of the ship at the thruster must exceed 4.0m and the ship must not be operating above 5 knots. If the limit in either case is exceded there is a risk of air being drawn into the thuster unit and this can result in blade cavitation or vibration. The drawing in of air is marked by a change in load on the thruster and by hunting of the main motor ammeter.

Before changing over the control position from the wheelhouse to the bridge wings, or vice versa, ensure that the control lever position and the load indicator read out correspond to each other.

The main motor must only be started when the blades are in the neutral zone (zero pitch) or in the allowable zone (blade pitch of ±3°). The system is interlocked to prevent the main motor from starting if the blade pitch is outside the set limits. Interlock switches also prevent the main motor from starting if the cooling fan has stopped, if the power pack gravity tank level is low or if the control oil pressure is low.

Procedure for Operating the Thruster Units

Manipulation of the switches and thruster components is normally only undertaken from the bridge at the wheelhouse control stand or the control points on the bridge wings. The main switch at the motor control panel should be set at REMOTE in order to allow for this.

Starting

a) Ensure that the engine room has the port and starboard turbine generators and the diesel generator connected to the main switchboard.

b) Start the bosun's store fan by pressing the FAN ON pushbutton. An alarm will sound in the cargo control room which has to be acknowledged in the cargo control room.

c) Start the main power source by pressing the STOP pushbutton, which also acts as a Power On button and confirm this by means of the main source lamp.

d) Press the RUN pushbutton and confirm that the hydraulic and motor available text is illuminated.

e) Check that the pitch of the blades is zero and if it is not, zero the blade angle by means of the control lever.

f) Test the thruster by operating the handle to port and starboard.

(**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.)

Stopping

a) Zero the blade handle by means of the control lever.

b) Press the operation mode STANDBY button.

c) Press the operation mode OFF button.

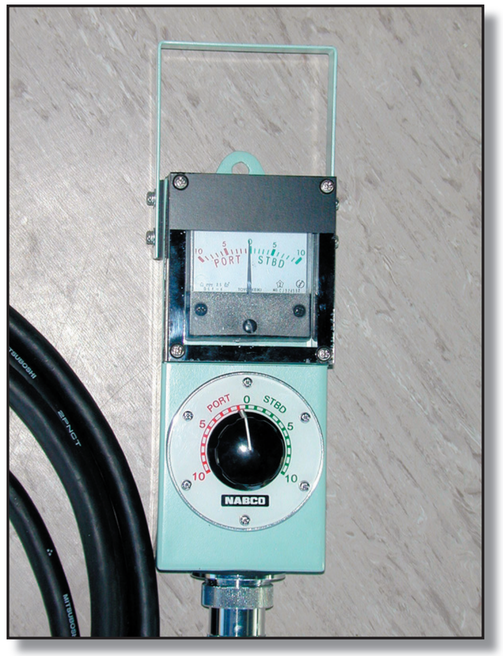
d) Press the operation mode STOP button.

e) The thruster is now out of operation but the main power panel is still active and this needs to be shut down if any work is to be undertaken on the thruster unit.

The bow thruster drive motor, hydraulic servo pump and gravity tank are located in the bow thruster compartment forward.

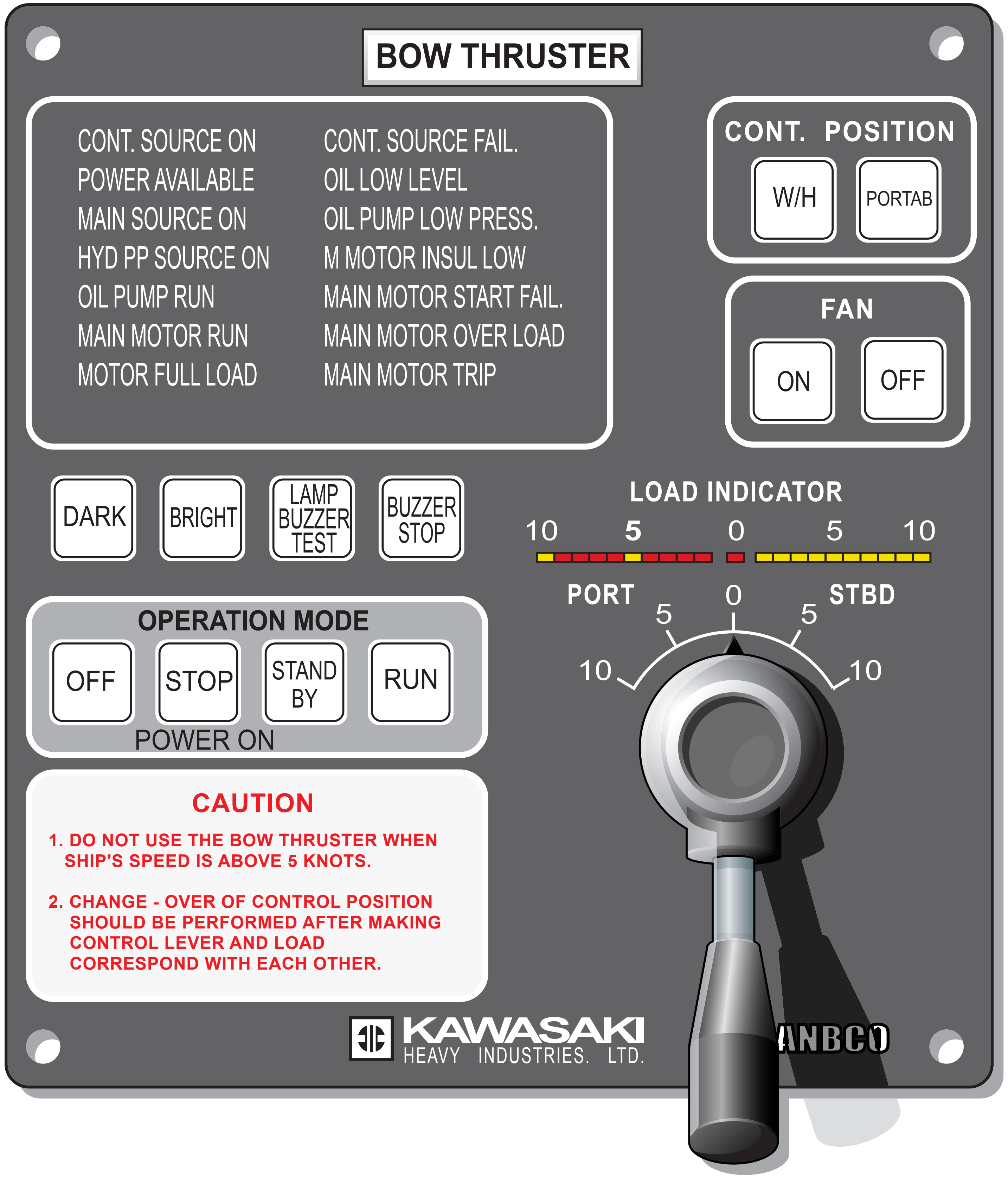
There is a portable remote operating box for use from the bridge wings. It is plugged in to the bridge wing panel and contains an operating knob with a load indicating dial.

The bridge wing panel contains an emergency stop pushbutton for stopping the bow thruster motor.



Bow Thruster Bridge Wing Control Unit

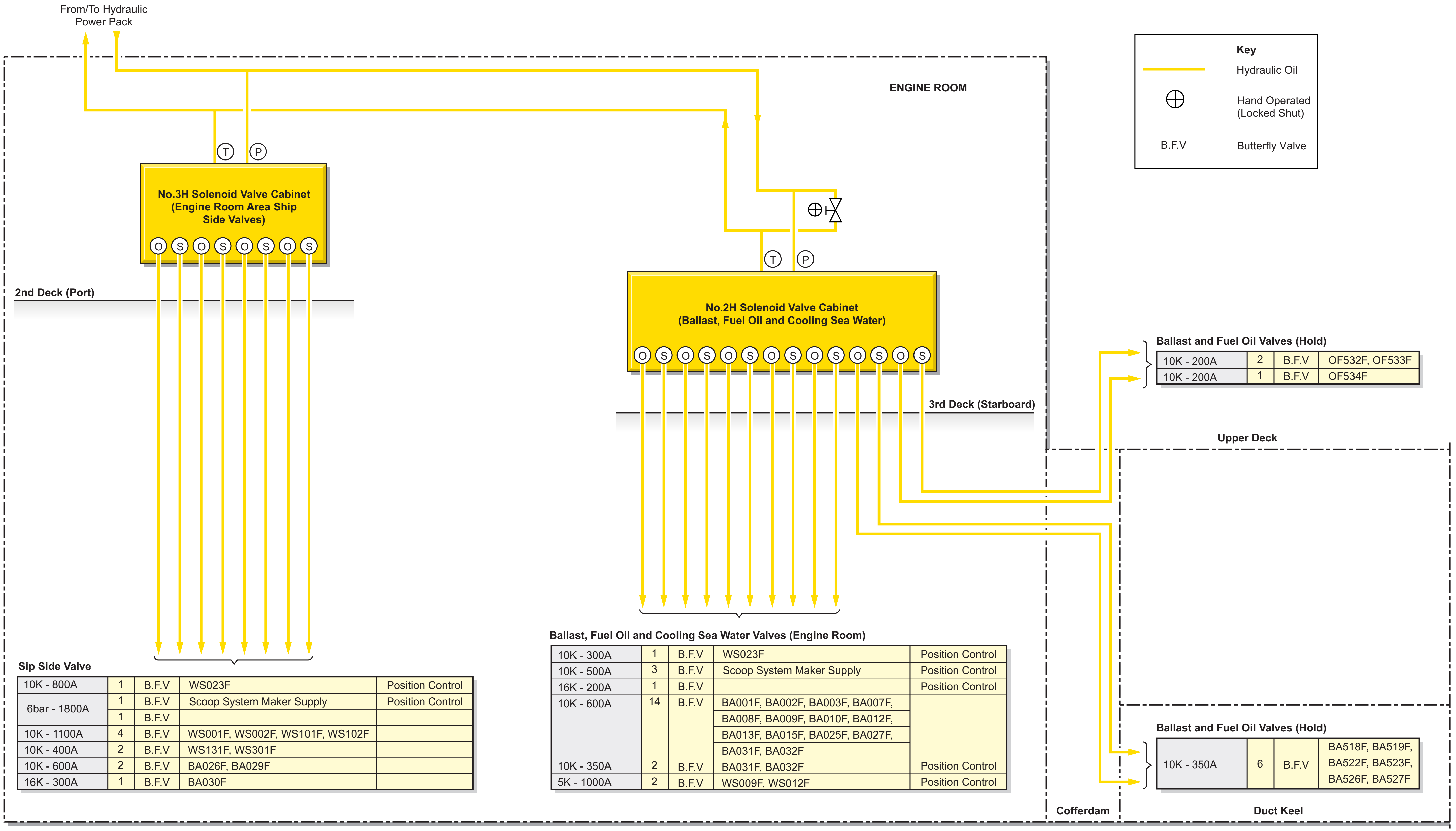
Illustration 3.5b Bow Thruster Control Panel



3.6 HYDRAULIC REMOTE VALVE OPERATING SYSTEM

Illustration

Illustration 3.6a Hydraulic Remote Valve Operating System



Ballast and Fuel Oil Valves (Hold)

10K - 200A	2	B.F.V	OF532F, OF533F
10K - 200A	1	B.F.V	OF534F

Ballast, Fuel Oil and Cooling Sea Water Valves (Engine Room)

10K - 300A	1	B.F.V	WS023F	Position Control
10K - 500A	3	B.F.V	Scoop System Maker Supply	Position Control
16K - 200A	1	B.F.V		Position Control
10K - 600A	14	B.F.V	BA001F, BA002F, BA003F, BA007F, BA008F, BA009F, BA010F, BA012F, BA013F, BA015F, BA025F, BA027F, BA031F, BA032F	
10K - 350A	2	B.F.V	BA031F, BA032F	Position Control
5K - 1000A	2	B.F.V	WS009F, WS012F	Position Control

Sip Side Valve

10K - 800A	1	B.F.V	WS023F	Position Control
6bar - 1800A	1	B.F.V	Scoop System Maker Supply	Position Control
	1	B.F.V		
10K - 1100A	4	B.F.V	WS001F, WS002F, WS101F, WS102F	
10K - 400A	2	B.F.V	WS131F, WS301F	
10K - 600A	2	B.F.V	BA026F, BA029F	
16K - 300A	1	B.F.V	BA030F	

Ballast and Fuel Oil Valves (Hold)

10K - 350A	6	B.F.V	BA518F, BA519F, BA522F, BA523F, BA526F, BA527F

3.6 HYDRAULIC REMOTE VALVE OPERATING SYSTEM

Maker: Yuken Kogyo Co. Ltd
Operating pressure: 12.7MPa
Relief valve pressure: 13.7MPa

Introduction

A number of valves throughout the machinery spaces and ship are remotely operated by hydraulic means from the ship's control centre and engine control room. Valves are fitted with hydraulic actuator units allowing the valves to be opened and closed from the control centre via a mimic panel. The valves have valve positioners fitted so that the position of the valve, open or closed, can be seen locally and indicated on the mimic panel. The system also has pressure and temperature compensating blocks so that variations in pressure and temperature which are not produced by the controller are not allowed to activate the system. On the mimic panel are open (green) and close (red) illuminated buttons which allow for movement of the valve and also indicate its current position.

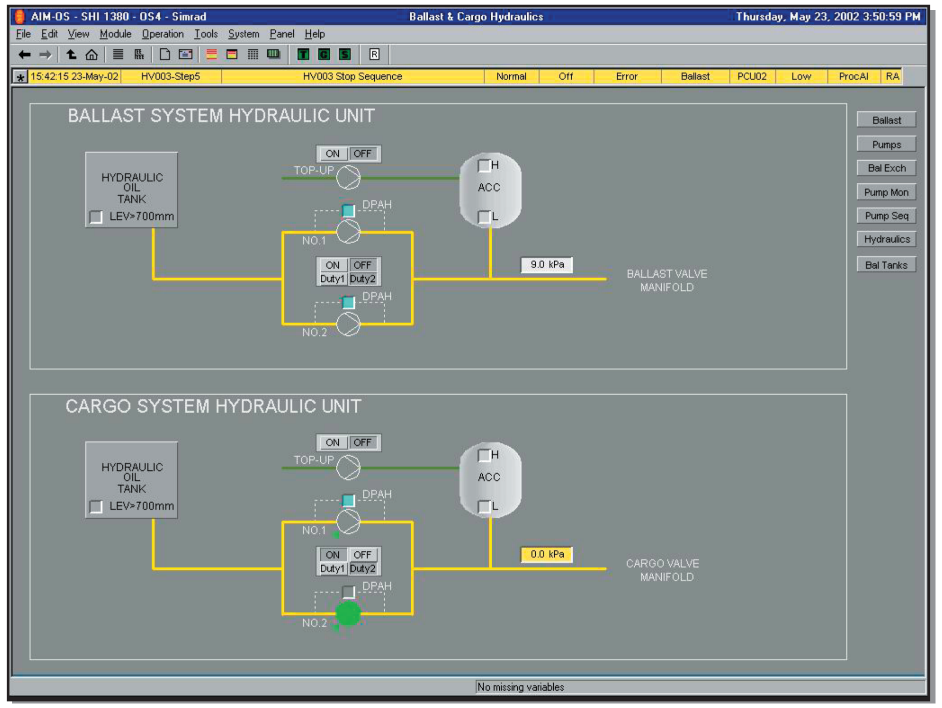
There are two separate systems for ballast, fuel oil and cooling sea water valves and ship side valves, each having its own control panel. The hydraulic power packs, located on the port side of the upper deck, provide hydraulic power for operating the valves.

The opening or closing of a valve is activated by pressing the open or close button on the mimic panel. This operates a solenoid valve which directs oil from the power pack to the valve actuator and returns vent oil from the actuator in order to move the valve in the desired direction. A portable unit connects to the emergency connections on the valve hydraulic actuator and the valve may be closed or opened locally by operation of the hand pump.

The power pack unit has an oil reservoir, charged with nitrogen, and two electric motor driven gear pumps which maintain the oil pressure. The oil reservoir has sufficient capacity to allow compensation for leakage from the system for about five minutes. The pumps are operated by means of pressure switches. One pump is set as the operating pump and the other as the standby pump. If the pressure falls to a predetermined value the operating pump cuts in to restore hydraulic pressure; it cuts out when the pressure has been restored. If the duty pump cannot maintain pressure, the standby pump cuts in and will cut out when the duty pump cut-in pressure has been achieved. Switches at the power pack control panel allow the pumps to be selected as No.1 duty and No.2 standby or vice versa.

The pumps should be changed over each week in order to ensure that both power pack pumps achieve approximately equal running hours.

The hydraulic power unit has start and stop buttons for the two pump units together with lights showing if the pump is running or in service. The system can be cross-connected to the cargo valve hydraulic system in an emergency.

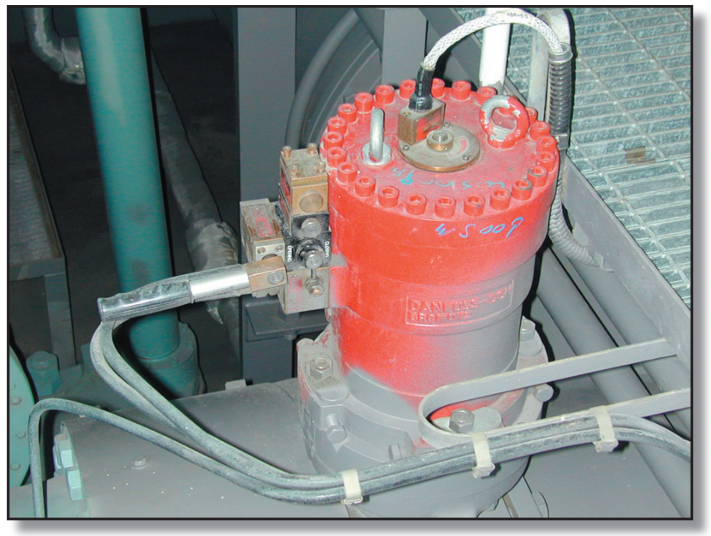


Mimic panels are provided for the ballast system, the fuel oil system and for the cargo hold bilge system. The mimic panels also show the manually operated valves in the system with an indicator showing if the valve is open.

In the event of the failure of the hydraulic system, the ship side valves may be operated using the portable hydraulic pumps. The hoses are connected to the snap-on type connectors on the actuater cylinders and the portable pumps are used to pressurise the cylinder necessary to move the valve in the required direction.

The discharge valves on the main sea water circulating pump and the auxiliary sea water circulating pump can be operated locally. The lever on the actuator is turned to either the CLOSE or OPEN position and the hand pump lever is operated to pressurise the cylinder and operate the valve.

Emergency Hydraulic Pumps Situated in the Workshop



Main Sea Water Pump Discharge Valve WS009F

Procedure for Operating the Remote Valve Operating System

a) Ensure that the oil system is fully charged and that there are no leaks evident.

b) Turn the power switch to the ON position and ensure that the power light illuminates.

c) Press the start button on the selected operating pump and ensure that the IN SERVICE light illuminates and the RUNNING light illuminates when the pump is running.

d) Check the pressure rise on the pressure gauge and check that the pump cuts out at the pressure of 12.7MPa.

e) Check that the second pump unit is operational.

f) The system is now ready for operation.

g) Press the OPEN or CLOSE buttons for the selected valves on the mimic panels in order to open or close the selected valves when setting the pipeline system.

h) When the pipeline is set, start the selected pump and check that the system is pumping as intended.

i) Each day press the LAMP TEST button in order to check that the lamps are illuminating.

The ship side valves supplied from No.3 solenoid cabinet may be operated from the following positions:

- Local position
- Fire control station
- IAS
- Cargo control room

No.3H Solenoid Valve Cabinet (Ship's Side Valves)

Description	Valve No.
Low sea suction centre	WS00F1
High sea water suction starboard	WS002F
Low sea water suction starboard	WS101F
High sea water suction port	WS102F
Auxiliary condenser overboard	WS023F
IG generator overboard	WS301F
Port ballast overboard	BA026F
Starboard ballast overboard	BA029F
Central SW coolers overboard	WS13F
Ballast eductor overboard	BA030F
Scoop inlet valve	WS420F
Main condenser overboard	WS421F

No.2H Solenoid Valve Cabinet (Ballast, SW Cooling and FO Valves)

Ballast System (Engine Room)

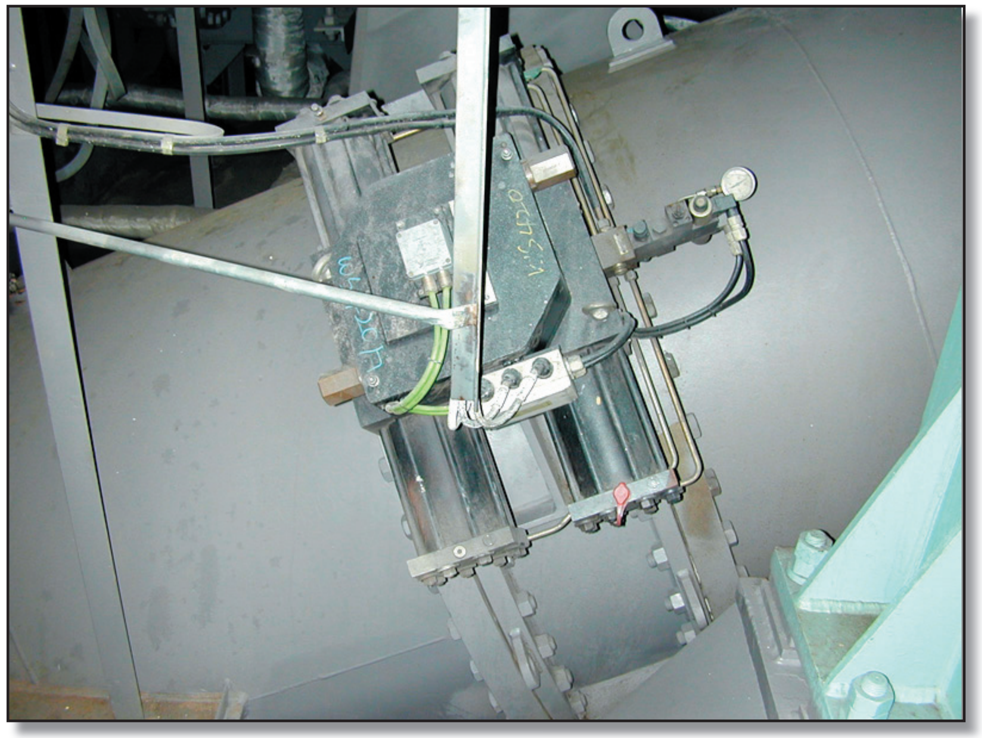
BA006F, 011F, 014F, 028F, 017F, 001F, 002F, 003F, 007F, 008F, 009F, 010F, 012F, 013F, 015F, 025F, 027F, 031F, 032F

Ballast System (Hold)

BA516F, 519F, 522F, 523F, 526F, 527F

Fuel System (Hold)

OF532F, 533F, 534F



Hydraulically Operated Sea Water Scoop Inlet Valve WS420F

Part 4: Emergency Procedures

Illustrations

4.1 FLOODING IN THE ENGINE ROOM

Flooding in the engine room may occur due to a defect in the hull structure, possibly due to grounding, berthing or collision damage, or, more likely, due to a defect in the sea water pipeline system.

Measures to Prevent or Alleviate Flooding

Maintain pipelines externally, tighten slack supports and replace broken U bolts on pipe brackets to minimise fretting in way of supports.

Operate all ship's side valves regularly, so that they can be operated easily when required. Valves such as fire pump suction valves, which are normally open, should be closed and reopened regularly to prevent a build up of marine growth.

Before opening sea water filters for cleaning, make sure the shut off valves are tight by opening the vent in the cover. In any case, break the cover joint before removing all cover bolts. The same applies when opening coolers and pipelines anywhere in the system. Care must always be taken when removing covers or opening any part of the sea water pipe system as valves which are indicated as being closed my not be fully closed. Where gate valves or through cocks are used for draining and venting, prove them clear by rodding before removing covers.

If source of ingress is rapid and cannot be identified, shut all remote operated sea and shipside valves. This action assumes that the levels have reached above the floor plates.

Personnel should be familiar with the position of bilge suctions and the pumps that can be utilised for bilge pumping duties. They should also be familiar with the position of main sea suction and overboard valves and know which main suction is currently in use.

The emergency bilge suction valve should be operated on a regular basis. Double bottom sounding pipe cocks and caps should be secured after use.

Pumps Available for Bilge Pumping Duties

Engine Room Bilge Pump

Can take suction from the bilge main.

No.1 (Port Outboard) Bilge, Fire and General Service Pump

Can take direct suction from the port forward bilge well and the bilge main via cross connecting valve FD006F.

No.2 (Port Inboard) Bilge, Fire and General Service Pump

Can take direct suction from the bilge main and also the port forward bilge well via cross connecting valve FD006F.

No.3 (Starboard) Ballast Pump

Takes suction from its own emergency bilge suction valve BA004F, which is operated by an extended spindle above the floor plate level.

The main sea suction valves WS002F and WS001F, high and low suction, are hydraulically operated valves. They can be operated from the engine control room (IAS) or locally by hand. The main overboard valves from the sea water circulation system are hydraulically operated from the engine control room (IAS).

Bilge Suction Strainers

Bilge suction strainers should be checked and cleaned whenever the opportunity arises. Frequent checking and cleaning will reduce the risk of a strainer becoming blocked and difficult to clear due to subsequent flooding.

4.2 STEAMING ON ONE BOILER

GENERAL DESCRIPTION

If a boiler is shut down due to a failure in any of its systems, then the main turbines can still be operated but at a much reduced power. It may not be possible to use all the cargo normal boil off gas (BOG) in the remaining boiler, and facilities for incineration will be limited by the maximum steaming rate of the online boiler. After a period of time under these conditions it might be necessary to vent the excess BOG gas to maintain tank pressures within the designated limits. (See cargo manual section 4.13 for the pressure relief system).

Normal evaporation for each boiler is approximately 50,000kg/h for 100% MCR. Individual circumstances will dictate where the steam produced is used, and selected non-essential services should be shut down as required, depending upon prevailing circumstances.

It may be possible to shut down the turbine generator and use the diesel generator, but in this case the forced draught fan must be on reduced load and it will not be possible to achieve the maximum steaming rate from the boiler.

Shut down non-essential heating and evaporators if conditions permit and reduce the electrical loading where possible.

The main turbines use approximately 82,800kg/h at normal MCR. However, this includes bleed steam, which may well have to be isolated due to reduced steaming conditions. Basically, the circumstances encountered in each particular case will dictate the steam usage, with priority being given to essential services such as gland steam, feed pump, turbine generator and boil-off/warm-up heaters.

In the event of a boiler shut down, planned or otherwise, the bridge must be informed immediately.

The main turbine must be slowed down sufficiently to enable the remaining boiler to be maintained within its operating parameters. Control of the boiler coming out of service will be generally under manual operation and particular care must be taken to ensure the remaining boiler controls and associated systems function to compensate accordingly. The steaming rate of the remaining boiler must be maintained below the design maximum.

During transition periods vigilance is necessary to ensure safe operation of the plant, particularly with reference to water level control and firing rate.

When conditions have settled down, the faulty boiler can be shut down and isolated. Depending on the type of fault and when the correct temperature is reached, the boiler should then be either filled with water or emptied and dried.

As conditions stabilise, if required, a progressive increase of steam supply to the main turbine may be possible until the maximum steaming rate is achieved.

Operating Procedures

Boiler Trips

a) Inform the bridge of the problem and reduce the engine speed to a rate which maintains steerage way but does not overload the remaining boiler.

b) Isolate the faulty boiler completely including the air heater.

c) Keep a check on the gas boil-off situation as well as the condition of the remaining boiler.

d) Shut down as much steam using equipment or systems as possible. Reduce the electrical loading.

e) Reduce the cargo compressor load and open the mast vents if necessary.

(**Note:** This will not be possible in port due to local restrictions.)

f) Keep the forced draught fan running on the faulty boiler to cool it down, or allow it to cool down naturally. Either fill the boiler to the top of the gauge glass or empty it out when cool.

g) When conditions have stabilised, increase the engine speed as required up to the maximum firing rate on the remaining boiler.

When a Boiler has to be Shut Down

a) Inform the bridge of the problem and reduce the engine speed to a rate which maintains steerage way but does not overload the remaining boiler.

b) Change over the control system to manual on the boiler to be shut down and decrease its steaming rate, ensuring that the remaining boiler is on automatic and takes up the load.

c) When the conditions have stabilised and the faulty boiler is on its minimum firing rate, shut it down and isolate it completely, including the air heater.

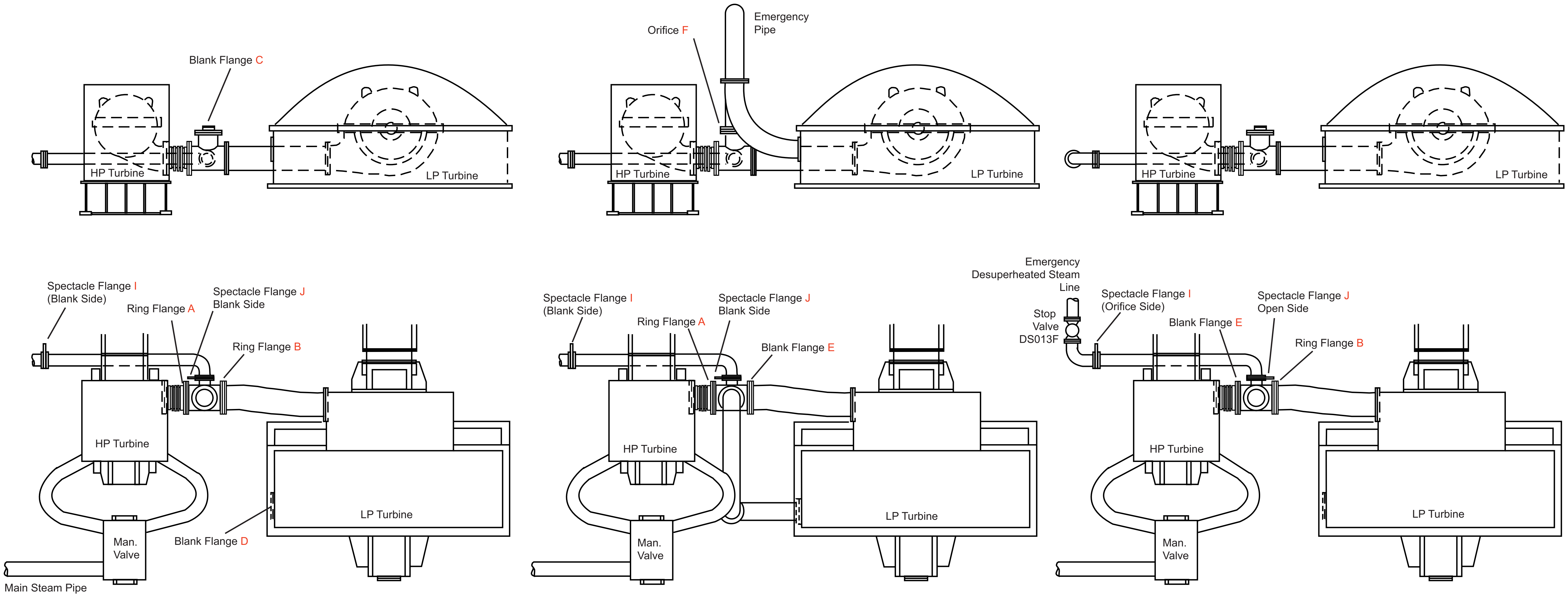
d) Closely monitor the supply of the boil off gas, and the condition of the remaining boiler.

e) Shut down as much steam using equipment or systems as operationally possible. Reduce the electrical loading.

f) Keep the forced draught fan running on the faulty boiler to cool it down or allow it to cool down naturally. Either fill the boiler to the top of the gauge glass or empty it out when cool.

g) When conditions have stabilised increase the main turbine steam supply as required, loading the boiler up to but not exceeding the maximum firing rate.

Illustration 4.3a Emergency Operation of Main Turbines



Normal Operation **Operation With HP Turbine Only** **Operation With LP Turbine Only**

4.3 EMERGENCY OPERATION OF THE MAIN TURBINES (SOLE RUNNING OF HIGH PRESSURE OR LOW PRESSURE TURBINE)

If failure occurs in the HP or LP turbines or associated gearing, the pipelines can be altered to allow either turbine to be operated singly at reduced power.

Some additional piping will have to be added in and some will have to be blanked off. When the damage has been to the LP turbine and the ship is to be operated on the HP turbine only, then no astern power will be available.

Failure of Bridge/Remote Control

If a failure occurs with the bridge control, engine control room control or the hydraulic servomotor system for the manoeuvring valves, then these can be put into manual operation and controlled locally.

Operating with the High Pressure Turbine Only

See illustration 4.3a

a) To avoid turning the LP turbine, disconnect the coupling between the LP turbine and the first pinion by removing the reamer bolts from the flange of the claw coupling.

b) Remove the ring flange B from the crossover pipe and insert a blank flange.

c) Remove the blank flange C from the crossover pipe and the blank flange D from the lower exhaust casing.

d) Connect the HP turbine exhaust directly to the LP turbine exhaust casing using the emergency piping G.

e) Insert an orifice F between the crossover pipe and the emergency piping.

f) Manually close the astern guard valve.

CAUTION

The LP astern turbine cannot be used so an astern movement is not possible.

g) Manually open the ahead manoeuvring valve to operate the turbine.

(**Note:** Turn the LP turbine rotor 180° once every 6 hours to prevent any deflection. Use the water spray in the LP turbine exhaust chamber to prevent any overheating of the exhaust casing.)

Operating with the Low Pressure Turbine Only

a) To avoid turning the HP turbine, disconnect the coupling between the HP turbine and the first pinion by removing the reamer bolts from the flange of the claw coupling.

b) Remove the ring flange A from the crossover pipe and insert a blank flange E.

c) Rotate the spectacle flanges I and J in the emergency piping from the blank area to the orifice area in the pipe.

d) Close the superheated steam stop valves SS001F and SS002F and only use desuperheated steam under emergency conditions.

e) Ahead running can be carried out by opening the desuperheated steam stop valve, DS077F on the 2nd deck level and controlling the ahead steam by opening valve DS013F on the main turbine level and astern running will be carried out by opening the astern manoeuvring valve at the engine side.

CAUTION

The steam chest pressure of the LP turbine must not exceed 0.32MPa.

Maximum output is limited due to the following:

- To protect the reduction gearing teeth from overload
- Boiler capacity
- Heat balance flow

The follow conditions will apply during emergency running

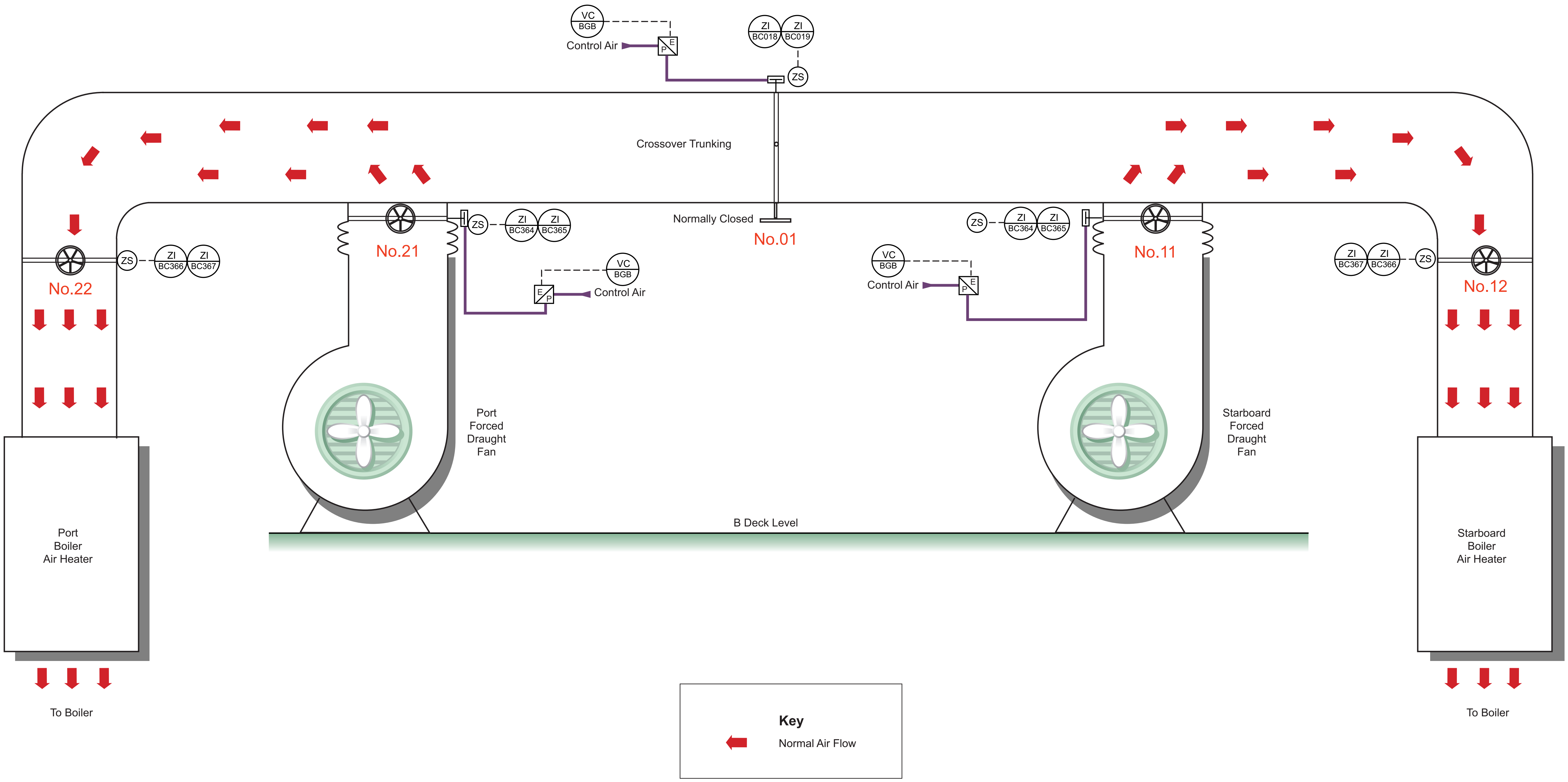
	HP Turbine in use	LP Turbine in use
Steam condition:	3.8MPa at 510°C	0.34MPa at 191°C
Output:	11,730PS	12,350PS
Rpm:	60	61

Should a failure occur, it would be most likely that the ship would be at sea. The turbines will therefore be hot and will need to be cooled for some time before any work can be carried out. Unless internal mechanical damage prevents it, the main turbine should be cooled down with the turning gear in use prior to opening up for internal inspection work.

If it is impossible to cool the engine using the turning gear, care must be taken when starting the usable turbine. It should be run at low revolutions for several hours in order to straighten out any bowing of the rotor which may have occurred during cool down whilst stationary. If vibrations occur when increasing speed, decrease the speed until the vibrations stop and allow the temperature of the rotor to stabilise. Speed can then be increased slowly to the maximum permitted value.

HP Turbine Emergency Piping G

Illustration 4.4a To Operate Both Boilers on One Forced Draught Fan



4.4 TO OPERATE BOTH BOILERS ON ONE FORCED DRAUGHT FAN (PORT AND STARBOARD)

Forced Draught Fans

Maker:	Osaka Blower Co.
Type:	TACS - 1140 - 2 speed
Motor:	270/115kW
Capacity:	1,280/960m^3/minute at 1,190/895 rpm

Two fans are situated on B deck and are controlled by adjustable vanes, automatically positioned by the combustion control equipment. The fans are arranged to supply their respective boilers. Either fan can be put into service on both boilers by manually opening the crossover connections on the air supply trunking.

Control of the fans is from the Air Flow Control IAS faceplate. The FD fan high/low speed is determined by the inlet vane command signal. The speed command is sent via the network to the IAS and the order for change of speed is as follows:

Command	Condition
Low to high	Low speed ON and FD fan inlet vane command >60%

A timer allows 10 minutes at this condition, then the fan goes onto high speed.

High to low	High speed ON and FD fan inlet vane command <35%

A timer allows 50 minutes at this condition, then the fan goes onto low speed.

Procedure for the Operation of Connecting one Forced Draught Fan to both Boilers

Assuming the failure of the (port) No.1 FD fan.

a) Turn the local boiler panel selector switch to No.2 FDF.

b) Close the discharge damper from No.1 FDF by pressing the No.11 CLOSE pushbutton.

c) At the IAS screen MB1 Main, click on the MANUAL button for the Boiler Operation Mode.

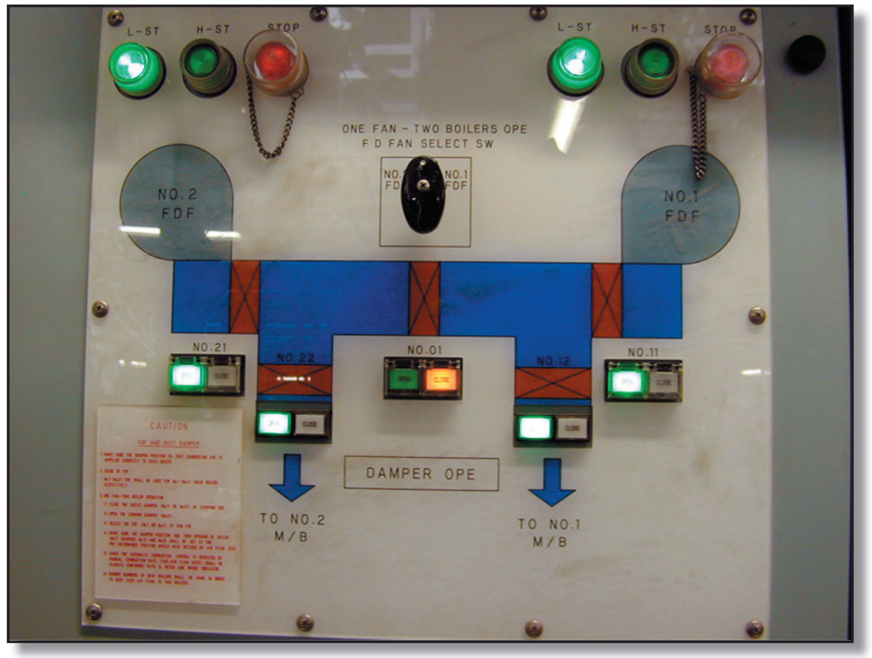
d) Reset the boiler trip by clicking on the RESET button on the Trip Reset area of the screen.

e) Relight the boiler by clicking on BNR 1 on the Burner Operation area of the screen.

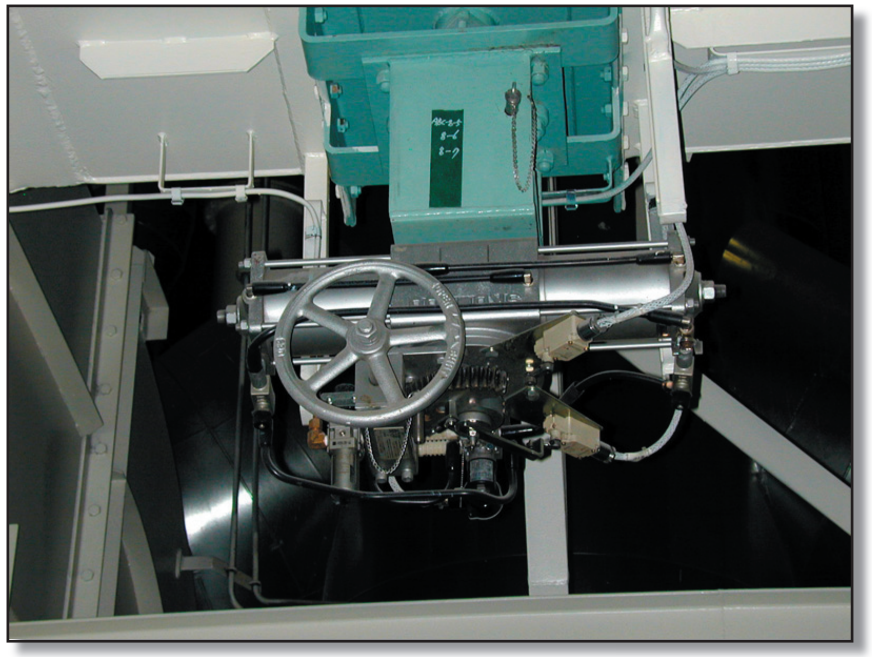
The IAS will operate the boiler sequence which will purge the furnace and light the No.1 burner.

f) Once the boiler is operating in a steady condition, return the control to the IAS by clicking on the IAS button on the Control Position area of the screen.

The FD fan will automatically operate on high or low speed, depending on the inlet vane command signal.



Forced Draught Fan Emergency Panel



Forced Draught Fan Crossover Flap

4.5 EMERGENCY STEERING

If failure occurs in the remote operating system from the wheelhouse, the steering can be operated from the steering gear room.

Description

The steering gear consists of a tiller, turned by a four cylinder hydraulic system, that in turn is driven by three electric motors. In accordance with IMO regulations the pumps, hydraulic power circuits and rams can operate as two isolated systems.

The steering gear is fitted with an automatic isolation system. This system is used to divide the hydraulic power circuits in the event of a hydraulic oil loss from the oil tanks.

In accordance with IMO regulations the hydraulic pumps used in the steering gear are supplied with power from two independent sources. In the event of power failure from the main switchboard, one pump can be supplied from the emergency switchboard.

Procedure for Operation of the Steering Gear on Loss of Remote Bridge Control

a) On loss of steering gear control from the bridge, establish communication with the bridge via the telephone system. A telephone is located on the steering gear compartment platform.

Indication of the rudder angle and a compass repeater are provided for manual control of the steering gear.

When operating the steering gear from the local position

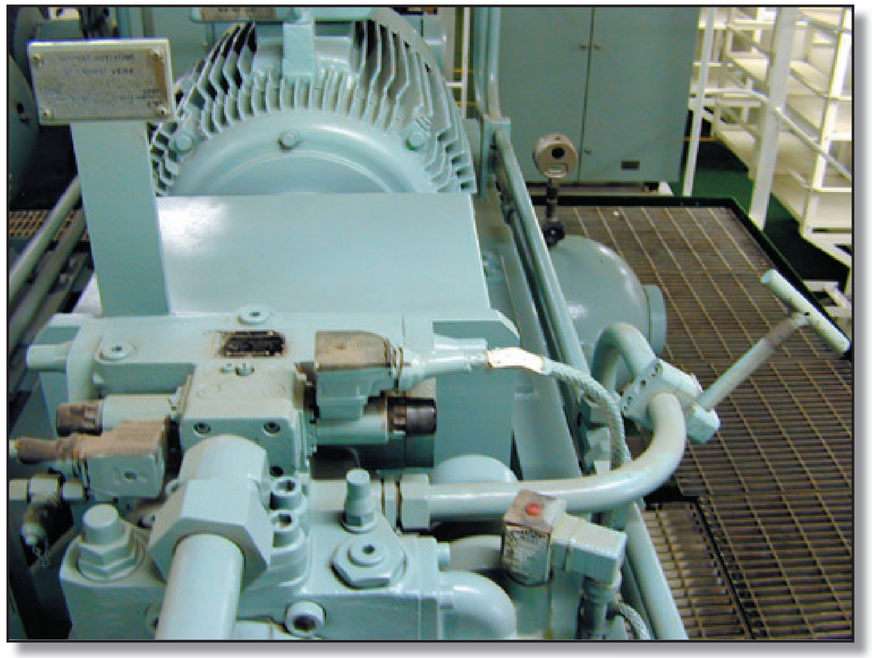
b) Follow the instructions from the bridge.

c) At the control panel for each steering gear turn off the PROPORTIONAL AMPLIFIER switch which stops the remote control of each pump.

d) Operate the steering gear in response to requests from the bridge by operating the solenoid valves of the running pump using the 'T' bar on the port/starboard pushbuttons.

Illustration 4.5a Steering Gear - Emergency Operation Valve Positioning Plan

Mode of Operation	Positioning of Valves												Actuating system
Description	Pump units in operation			Automatic pump isolating valves			'Safematic' Automatic system isolation valves		Hand operation of system isolation valves (V) and bypass valves (B)				Actuating system
	No.1	No.2	No.3	P1	P2	P3	Y1	Y2	V1	V2	B1	B2	Actuator
Normal operation	●	○	○	●	○	○	○	○	○	○	●	●	Actuator 1 & 2
	○	●	○	○	●	○	○	○	○	○	●	●	
	○	○	●	○	○	●	○	○	○	○	●	●	
	●	●	○	●	●	○	○	○	○	○	●	●	
	●	○	●	●	○	●	○	○	○	○	●	●	
	○	●	●	○	●	●	○	○	○	○	●	●	
	●	●	●	●	●	●	○	○	○	○	●	●	
Emergency auto isolation	●	○	○	●	○	○	●	○	○	○	●	●	Actuator 1
	○	●	○	○	●	○	○	●	○	○	●	●	Actuator 2
Emergency manual isolation	●	○	○	●	○	○	○	○	●	●	●	○	Actuator 1
	○	●	○	○	●	○	○	○	●	●	○	●	Actuator 2
	○	○	●	○	○	●	○	○	●	●	○	●	Actuator 2
Legend;	● on			energised					closed				
	○ off			not energised					open				



'T' Bar and Solenoid Valves

Control Panel and Proportional Amplifier Switch

Part 5: Fire Fighting Systems

Illustrations

Illustration 5.1a Emergency Stop List

Location of Pushbuttons: Fire Control Station and Engine Control Room

Stop Group	Load Group	Circuit	Description
ES1A	Engine Room Fuel Oil and LO Pumps	1P-008	MGO Supply Pump for Inert Gas Generator
		1GP-001	No.1 Stern Tube Lubricating Oil Pump
		1GP-004	No.1 Auxiliary LO Pump for Main Turbine
		1GP-017	No.1 Lubricating Oil Purifier
		1GP-018	No.1 Lubricating Oil Purifier Supply Pump
		1GP-020	Lubricating Oil TransferPump
		1GP-027	No.1 Boiler HFO Supply Pump
		1GP-029	Sludge Pump
		1GP-030	Diesel Oil Transfer Pump
		EP-009	Diesel Generator Pre-lubrication Oil Pump
		EP-010	No.1 Turbine Generator Auxiliary LO Pump
		EP-014	No.1 Main FW Pump Auxiliary LO Pump
		3PD-004	Marine Diesel Oil CJC Filter
		3PD-006	Oily Water Separator

Stop Group	Load Group	Circuit	Description
ES1B	Engine Room Fuel Oil and LO Pumps	2GP-001	No.2 Stern Tube Lubricating Oil Pump
		2GP-010	Aft Seal Tank Lubricating Oil Supplement Pump
		2GP-017	No.2 Lubricating Oil Purifier
		2GP-018	No.2 Lubricating Oil Purifier Supply Pump
		2GP-027	No.2 Boiler HFO Supply Pump
		1GP-020	Lubricating Oil TransferPump
		2GP-029	MGO Transfer Pump
		2GP-030	Engine Room HFO Transfer Pump
		EP-011	No.2 Turbine Generator Auxiliary LO Pump
		EP-009	Diesel Generator Pre-lubrication Oil Pump
		EP-015	No.2 Main FW Pump Auxiliary LO Pump
		EGP-007	No.2 Auxiliary LO Pump for Main Turbine
		15LD-004	Lubricating Oil Filter

Stop Group	Load Group	Circuit	Description
ES2B	Engine Room Vent Fans	2P-006	No.2 Blower for Inert Gas Generator
		2P-013	Starboard Main Switchboard Packaged AC Unit
		2P-018	No.2 Packaged AC Unit for Engine Control Room
		2GP-011	No.2 Engine Room Supply Fan
		2GP-012	No.2 Engine Room Exhaust Fan
		2GP-014	No.2 BOG Extraction Fan
		2GP-015	No.2 Boiler Forced Draught Fan
		2GP-016	No.2 Boiler Seal Air Fan
		EGP-002	No.1 Engine Room Supply Fan
		2GP-019	Welding Space Exhaust Fan
		2GP-020	Boiler Test Space Exhaust Fan
		2GP-025	Purifier Room Exhaust Fan
		2P-009	Sootblower Control Panel

Stop Group	Load Group	Circuit	Description
ES2A	Engine Room Vent Fans	1P-006	No.1 Blower for Inert Gas Generator
		1P-013	Port Main Switchboard Packaged AC Unit
		1P-018	No.1 Packaged AC Unit for Engine Control Room
		1P-020	Incinerator
		1P-010	Dryer Unit for Inert Gas Generator
		1GP-011	No.1 Engine Room Supply Fan
		1GP-014	No.1 BOG Extraction Fan
		1GP-015	No.1 Boiler Forced Draught Fan
		1GP-016	No.1 Boiler Seal Air Fan
		1GP-019	Toilet Extraction Fan
		1GP-025	Gland Steam Condenser Extraction Fan
		EGP-003	No.4 Engine Room Supply Fan
		EGP-004	No.1 Engine Room Supply Fan
		2PD-001	No.1 Engine Room Workshop Packaged AC Unit
		2PD-002	No.2 Engine Room Workshop Packaged AC Unit

5.1 INTRODUCTION

The vessel's fire fighting capacity is enhanced by the inclusion of systems that can detect and fight the types of fires which might occur due to the ignition of fuel oil, lubricating oil and cargo. The choice of fire fighting system to use will depend on the location and nature of the fire. Initially any fire is attacked using portable extinguishers and if that method fails the following systems are considered. The use of fire fighting equipment and fire fighting techniques are discussed fully in the SOLAS FIRE TRAINING MANUAL which is available in the ship's general office.

Portable Fire Extinguishers

There are three types on board:

1. Carbon Dioxide - CO_2

- Suitable for class A and B fires and for class C fires when in a liquid state, such as liquid gas leak.
- Safe for use in fighting electrical fires.
- May not be effective when used outside, especially in a breeze.

Identification Colour Code

The extinguisher is red with a black horizontal band and has CO_2 written in white bold lettering.

Dangers in Use

- Hold only the insulated parts of the discharge hose and horn. With the expansion and evaporation of the CO_2 there are cooling processes and a danger of frost burn if the discharge horn comes into contact with the skin.
- When using a CO_2 extinguisher in an explosive atmosphere, stand on the ground to ensure that any electrostatic charge is dissipated.
- Do not use without a discharge horn as the discharge will then entrain air and cause an increase in the intensity of the fire.
- Do not remain in the area after the discharge as CO_2 is asphyxiating.

Operating Procedure

a) Remove the safety pin.

b) Direct the horn at the base of the fire.

c) Press the lever down fully.

d) Direct the CO_2 at the base of the fire.

2. Foam

- Suitable for use on liquid spills and contained liquid fire of oils, paints, cleaning fluids and fires involving liquified solids such as fats and waxes (Class B fires).

Identification Colour Code

The extinguisher is red with a yellow horizontal band and has FOAM written in white bold lettering.

Dangers in Use

- Do not use on fires where there is live electricity in the vicinity.

Operating Procedure

a) Remove the safety pin.

b) Press the operating handle.

c) Squeeze the trigger.

d) Point the spray at the base of the fire.

3. Dry Powder

- Suitable for use on fires involving liquids and liquified solids.
- Suitable for use, with the correct techique, on extinuishing a high pressure gas flame (Class C Fires).
- Suitable for use against carbonaceous fires (Class A fires).
- Dry powder gives a fast flame knock-down and may be used on fires involving live electrical equipment.

Identification Colour Code

The extinguisher is red with a blue horizontal band and has POWDER written in white bold lettering.

Dangers in Use

- May not be effective against a deep seated fire.
- Avoid inhalation of the powder.

Operating Procedure

a) Remove the safety pin.

b) Press the operating handle.

c) Squeeze the trigger.

b) Point the spray at the base of the fire.

Fire Main System (see section 5.2 and 5.3)

This system is continually pressurised by a sea water hydrophore tank and fire jockey pump (7.5kW). The jockey pump only supplies a limited number of 20mm accommodation hoses so the fire pump is started at the earliest opportunity to ensure that a sufficient amount of sea water is available. The automatic start facility, due to a low fire main pressure, is not used because the pump will run without a fire hydrant outlet available and may damage the pump seals. The system can also be supplied by the bilge, fire and GS pumps, the water spray pump and the emergency fire pump.

The suction and discharge valves of the fire pump and one bilge, fire and GS pump are locked in the open position and the pumps can be started locally, at the fire control station, cargo control room, at No.2 group starter panel or at the bridge emergency console.

The pipelines and fittings are painted red and fire hoses and hydrants are startegically positioned in the engine room, accommodation and on deck.

A self-contained emergency fire pump (see section 5.8) is fitted in the bosun's store. The drive unit consists of a diesel engine, which drives the main pump, and the hydraulic pump which powers the hydraulic motor driving the feeding pump. The diesel engine, main fire pump, hydraulic pump and oil tank are located in the bosun's store.

The feeding pump and its hydraulic drive motor are located at the bottom of the forward pump room below the waterline. The feeding pump is driven by the hydraulic motor operated by the oil from the hydraulic pump.

The feeding pump ensures that the main fire pump is supplied with water no matter what the draught of the ship.

The emergency fire pump may be started locally or remotely from the fire control station and the bridge emergency console.

Illustration 5.1a Emergency Stop List

Location of Pushbuttons: Fire Control Station and Wheelhouse Emergency Panel

Stop Group	Load Group	Circuit	Description
ES3	Accomm Vent Fans	3GP-001	No.1 Main AC Plant (AHU)
		3GP-002	Refrigeration Provision Plant (Unit Cooler Panel)
		3GP-011	No.1 Sanitary Exhaust Fan
		3GP-012	Galley Supply Fan
		3GP-015	Paint Store Exhaust Fan
		3GP-021	No.2 Main AC Plant (AHU)
		3GP-027	H/H Defogging System
		3GP-031	No.2 Sanitary Exhaust Fan
		3GP-032	Galley Exhaust Fan
		3GP-033	Wheelhouse Fan Coil Unit
		3GP-036	Battery Room Exhaust Fan
		3GP-037	24V DC Battery Store Exhaust Fan
		1L-007	Accomm 220V Distribution Board (14LD)

Stop Group	Load Group	Circuit	Description
ES4A	Other Deck FO/LO Pumps and Vent Fans	1GP-024	No.1 Forward HFO Transfer Pump
		1CGP-003	No.1 HD Compressor Auxiliary LO Pump
		1CGP-004	No.1 LD Compressor Auxiliary LO Pump
		1CGP-006	No.1 Air Lock Supply fan
		1CGP-007	No.1 Cargo Machinery Room Exhaust Fan
		1CGP-008	No.1 Electric Motor Room Supply Fan
		1CGP-009	No.1 Passageway Exhaust Fan
		1CGP-010	Mid Deck Store Exhaust Fan
		1CGP-022	No.1 Hydraulic Pump Starter for Cargo Valves
		2CGP-022	No.1 Hydraulic Pump Starter for Ballast Valves
		EGP-005	CO_2 Room Exhaust Fan
		EGP-006	Emergency Generator Room Supply Fan
		EGP-008	Steering Gear Room Exhaust Fan
		1PD-002	Bow Thruster Room Supply Fan
		EP-016	Forward Pump Room Exhaust Fan
		1PD-006	Bosun's Store Exhaust Fan
		1PD-007	Hydraulic Oil Pump for Bow Thruster
		3GP-034	Hydraulic Power Pack Room Exhaust Fan
		3GP-013	Oil and Grease Store Exhaust Fan
		3GP-014	Chemical Store Exhaust Fan
		1CGP-023	Hydraulic Power Pack Brake

Stop Group	Load Group	Circuit	Description
ES4B	Other Deck FO/LO Pumps and Vent Fans	2GP-024	No.2 Forward HFO Transfer Pump
		2CGP-003	No.2 HD Compressor Auxiliary LO Pump
		2CGP-004	No.2 LD Compressor Auxiliary LO Pump
		2CGP-006	No.2 Air Lock Supply fan
		2CGP-007	No.2 Cargo Machinery Room Exhaust Fan
		2CGP-008	No.2 Electric Motor Room Supply Fan
		2CGP-009	No.1 Passageway Exhaust Fan
		2CGP-010	Duct Keel Exhaust Fan
		EP-005	No.2 Hydraulic Pump Starter for Cargo Valves
		EP-006	No.1 Hydraulic Pump Starter for Ballast Valves

CO_2 Flooding System for the Engine Room (see section 5.4)

A central bank of 576 cylinders each containing 45kg of CO_2 located in the CO_2 room, is situated on the starboard side of the engine casing on A deck. The system protects the engine room, No.1 and No.2 main switchboard rooms, purifier room, diesel generator room and the inert gas generator room.

Outlets for CO_2 are located in the protected spaces so as to give an even spread of CO_2 quickly throughout the compartment when the gas is released.
The system can be operated from the following positions:

- Engine room - fire control station or the CO_2 room
- No.1 and No.2 main switchbaord rooms - fire control station or at the entrance to the rooms
- Purifier room - fire control station or at the entrance to the room
- Diesel generator room - fire control station or at the entrance to the room
- Inert gas generator room - fire control station or at the entrance to the room

CO_2 Flooding System for the Cargo Area (see section 5.4)

A central bank of 22 cylinders each containing 45kg of CO_2 located in the CO_2 room, is situated on the starboard side of the engine casing on A deck. The system protects the port and starboard cargo switchboard, cargo machinery room, electric motor room, emergency generator room and the emergency switchboard room.

CO_2 Flooding System for the Deck Stores (see section 5.14)

Each store has a cylinder containing 45kg of CO_2 located outside the store room. The system protects the paint store, chemical store and the oil/grease store.

Oil Mist Detection System (see section 5.5)

This system continuously samples the atmosphere at a number of points in the machinery spaces. It gives warning of any explosive oil mist or vapours which may be present in quantities which might present a fire hazard in the engine room. The oil mist detector is able to detect levels of oil mist concentration far below the lower explosion limit of the oil mist, thus giving warning before the oil mist reaches the point where an explosion could occur.

Water Mist System (see section 5.6)

This system consists of fresh water at high pressure injected into the protected machinery space through special spray heads which break down the water stream into very fine mist-like particles.

The basic principle of the water mist system is that the very fine droplets of water tend to exclude oxygen from the area of the fire, thereby starving the burning material of oxygen. When the fine water droplets come into contact with the flames they are rapidly evaporated because of their large surface area for a small mass and this has a rapid cooling effect on the fire. The steam produced by the evaporation acts to further reduce the space available for oxygen. Because the water is in mist form the system is effective for oil fires. The system protects the incinerator room, hydraulic power pack room, port and starboard boiler burner platforms, inert gas generator room, the steering gear room, diesel generator room and the purifier room.

The system is self-contained and consists of a pump driven by an air motor, supplied by the control air system, which takes suction from the fresh water tanks and maintains the system pressure at 2.45MPa up to the control valves. From the control valves a set of piston type pumps driven by pressurised N_2 cylinders, supply the fresh water at a rate of 11 litres/minute through each of the spray heads.

The system control valves can be activated locally or by pressing the operating pushbutton at each location.

The N_2 cylinders are sent ashore for recharging.

Quick-Closing Valves and Fire Dampers System (see section 5.7)

This system is used, in the event of a major fire in the machinery spaces, to close the ventilation dampers and the outlet valves on the tanks containing fuel oil and lubricating oil. The system is operated from the fire control station where valves are positioned to direct the air, contained in a pressurised tank, to the quick-closing valves and to vent the damper cylinders. The pressurised tank is maintained at 9kg/cm^2 by the control air system.

The emergency generator room fuel oil tank outlet valve is operated by wire rope and handle from outside the rooms.

A similar arrangement for the incinerator room DO tank and waste oil tank outlet valves is installed as a local back-up to the pneumatic system.

Fire Detection System (see section 5.9)

This system will raise an alarm to alert the ship’s staff and has a direct input into the IAS for recording any alarms, faults and disconnections. The operating panel, control unit and power supply are contained in a central cabinet in the fire control station on the port side of the accommodation on the upper deck. The system uses 8 detector loops, connected to a 7.2Ah battery system back-up in the event of a power failure and detects any source of smoke, heat or flames in the protected spaces. The digital outputs of the system are used to stop the ventilation fans, release the fire doors and operate the water mist system. The system is looped to the gas sampling and alarm system and to the IAS cabinet in the electrical equipment room on A deck.

Emergency Life Saving Apparatus (ELSA)

The ELSA breathing devices are provided so that, in the event of a fire or other emergency, they are readily available, near the escape routes, to aid escape.

ELSA Stuated in Engine Room

They consist of a compressed air breathing set with a limited time of approximately 5 or 10 minutes. The breathing apparatus is in a carrying bag that can be slung over the shoulder and includes a high visibilty hood which incorporates an nasal mask and neck seal.

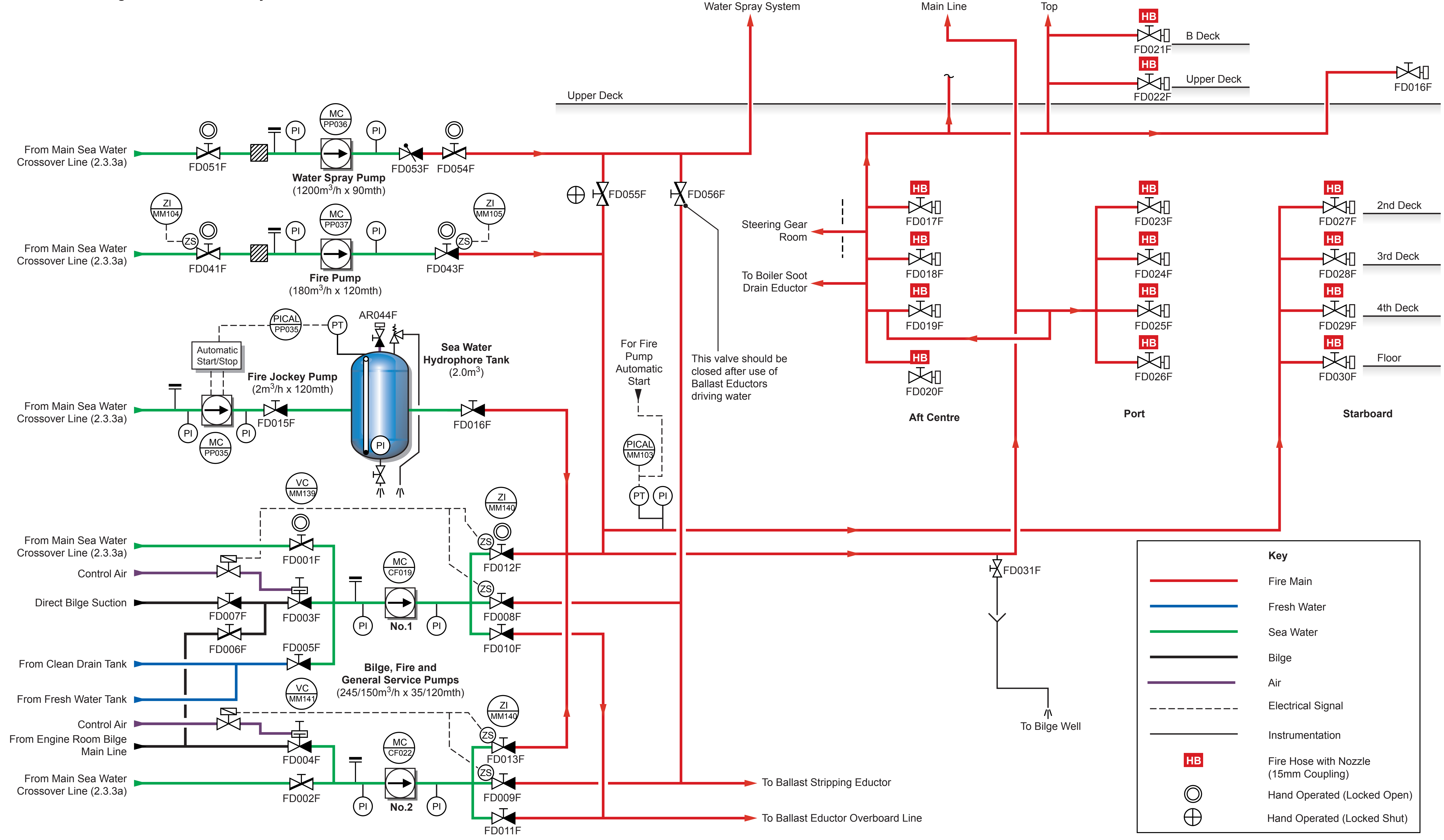
There are sixteen sets on board:

- Two sets in the engine room workshop on the 3rd deck
- One set near the port turbine generator on the 3rd deck
- One set near the starboard generator on the 3rd deck
- One set on the port side, at the base of the stairs on the engine room 4th deck
- One set on the starboard side, at the base of the stairs on the engine room 4th deck
- One set on the port forward side, at the base of the stairs on the engine room floor deck
- One set on the starboard side, near the scoop main condenser pipe on the engine room floor deck
- Four spare sets in the stores on the port side of the accommodation upper deck and four sets in the cargo control room

Emergency Light Sticks

There are emergency light sticks positioned in all the accommodation and work areas. These are activated by bending the stick, which snaps the glass phial and allows the two liquids to react and create a light source, which will last long enough to allow an escape from the lowest regions of the vessel.

Illustration 5.2a Engine Room Fire Main System



5.2 ENGINE ROOM FIRE MAIN SYSTEM

Fire Pump

Maker:	Shinko Industries Ltd
No. of sets:	1
Type:	Centrifugal self-priming
Model:	RVS200-2MS
Capacity:	180m^3/h at 120mth

Water Spray Pump

Maker:	Shinko Industries Ltd
No. of sets:	1
Type:	Centrifugal self-priming
Model:	KV350K
Capacity:	1,200m^3/h at 90mth

Bilge, Fire and General Service Pump

Maker:	Shinko Industries Ltd
No. of sets:	2
Type:	Centrifugal self-priming
Model:	RVS200-2MS
Capacity:	245/150m^3/h at 35/120mth

Fire Jockey Pump

Maker:	Shinko Industries Ltd
No. of sets:	1
Type:	Centrifugal
Model:	SQH50MM
Capacity:	2m^3/h at 120mth

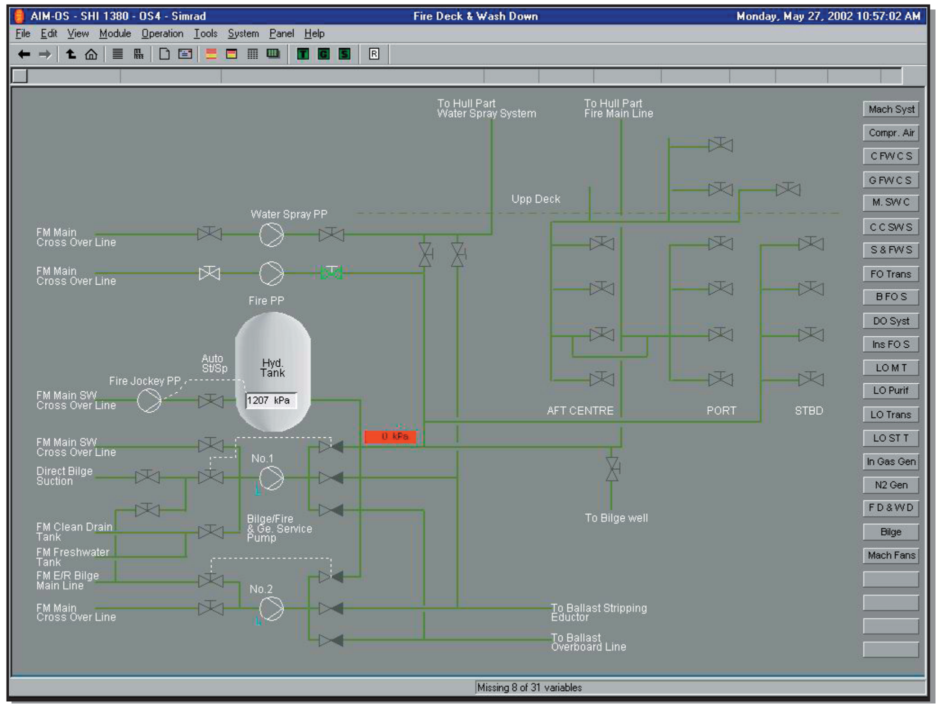
Emergency Fire Pump (Main Punp)

Maker:	Iron Pump A/S
Type:	CN100-100/315
Capacity:	72m^3/h at 97mth

Introduction

The engine room fire main system can supply sea water to:

- The fire hydrants in the engine room
- The fire hydrants on deck
- The fire hydrants in the accommodation block
- Hawse pipes
- Forward bilge eductors
- Passageway bilge eductors
- Hold bilge eductors
- The accommodation and cargo manifold water curtain spray system
- Boiler soot drain eductor



The fire pump, water spray pump and the bilge, fire and general service pumps are located in the engine room and are all driven by electric motors.

The emergency fire pump is located in the bosun's store. The pump is driven by a diesel engine and there is also a feeder pump for the main pump. The feeder pump is situated at the bottom of the forward pump room and has its own sea suction. The feeding pump is driven by an hydraulic motor, the hydraulic pump unit being driven by the diesel engine which powers the main pump (see section 5.8).

The fire pump, emergency fire pump and the fire, bilge and general service pump supply water to the fire and wash deck main.

The water spray pump can also supply the fire and wash deck main, but is normally used to supply water to either the ballast water eductor or, in an emergency, the water spray system.

The fire main is automatically pressurised at all times by means of a sea water hydrophore unit which is maintained under pressure by the fire jockey pump. The sea water hydrophore unit has a pump cut-in pressure of 0.8MPa and a cut out pressure of 1.18MPa. The sea water hydrophore unit operates in the same way as the fresh water hydrophore units with air pressure providing the loading in the hydrophore tanks. The connection from the sea water hydrophore unit to the fire main is at the outlet manifold from the fire pump and the fire, bilge and GS pumps.

Tag	Description	Low
PP035	Fire jockey pump pressure control	1100kPa

The fire pump may be started and stopped locally or from the following locations, provided that the local selector switch is set to remote:

- Engine control room
- Fire control station
- Wheelhouse
- Cargo control room
- IAS operator stations

The fire pump, the fire jockey pump, water spray pumps and the fire, bilge and GS pumps all take suction from the sea water main. Either the high or low sea chest must be open to this suction main at all times.

Preparation for the Operation of the Fire Hydrant System

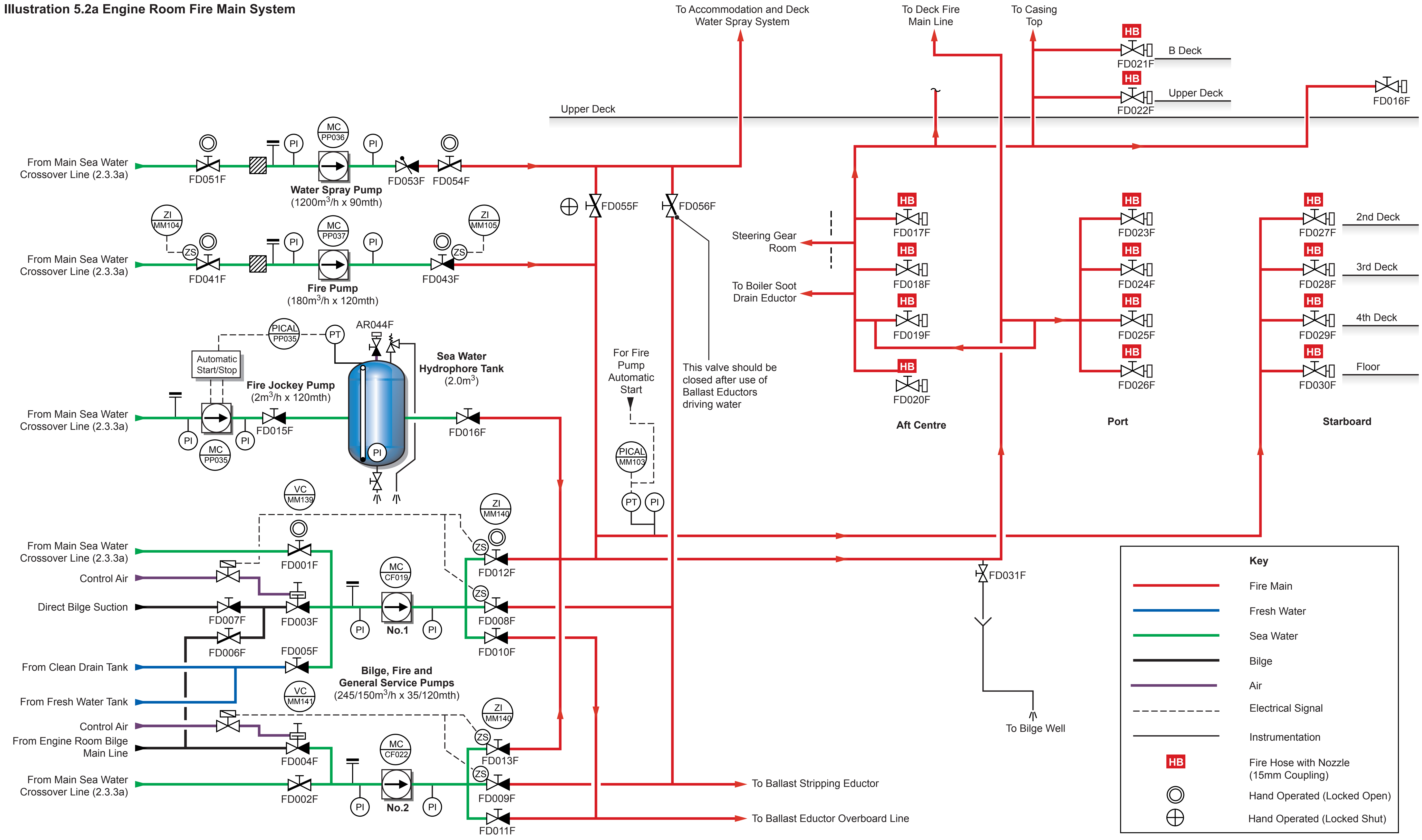
The fire main must be kept under pressure at all times by the sea water hydrophore unit. It is assumed that the fire main is already flooded before starting the sea water hydrophore unit.

Procedure to Operate the Sea Water Hydrophore Unit

a) Ensure that the sea water suction main is flooded with either the high or low sea suction valve open.

b) Vent the fresh water hydrophore tank and, using the fire jockey pump, fill it until the water level gauge glass is ¾ full, then stop the pump. Open the suction valve FD014F from the sea water main and the pump discharge valve FD015F.

Illustration 5.2a Engine Room Fire Main System



c) Connect a GS air flexible hose to the air inlet valve AR044F and pressurise the hydrophore tank to the general service air supply pressure of approximately 880kPa. Ensure that the hydrophore tank gauge valves are open.

d) Close the air inlet valve when the hydrophore tank is pressurised and disconnect the flexible hose.

e) The sea water hydrophore tank is now operational and sea water can be supplied to the fire main by opening valve FD016F.

f) Select the AUTOMATIC operation for the fire jockey pump.

The fire jockey pump should maintain the pressure in the fire hydrant system.

Procedure for Supplying Sea Water to the Fire and Wash Deck System

The fire and wash deck system may be supplied with water by the fire pump, located in the engine room, and by either of the two fire, bilge and GS pumps, also located in the engine room. These pumps take suction from the sea water main and so this must be open and operating (see section 2.3).

a) All intermediate isolating valves along the fire main on the main deck must be open.

b) All hydrant outlet valves must be closed.

c) Set up the valves as shown in the table below:

It is assumed that the SW main suction valves at the SW valve chest(s) are open to provide SW suction.

Position	Description	Valve
Fire Pump		
Open(locked)	SW main suction valve	FD041F
Open(locked)	Fire pump discharge valve	FD043F
Closed(locked)	Cross-connection valve to water spray system	FD055F
No.1 Fire and Bilge Pump		
Open(locked)	SW main suction valve	FD001F
Open(locked)	No.1 fire and bilge pump discharge to fire main	FD012F
No.2 Fire, Bilge and GS Pump		
Open	SW main suction valve	FD002F
Open	No.2 fire and GS pump discharge to fire main	FD013F

d) Start the main fire pump or the selected fire, bilge and GS pump. These pumps must be selected as REMOTE at their local selector switches in order to allow them to be started from the remote locations.

e) Open the desired hydrant valves on the fire main after connecting the fire hose.

(**Note:** In order to avoid cavitation and overheating of the pump at least one outlet on the system should be opened to allow some flow through the pump. This would usually be an anchor washer.)

Fire mains run along the port and starboard sides of the ship in the under deck passage. Hydrant connectors are provided at strategic positions so that all parts of the deck may be reached by water spray from the appropriate hoses. The cargo manifold side shell water curtain is supplied with water from the fire and wash deck main.

Water from the fire and wash deck main is used for driving the forward bilge and under passageway bilge eductors as described in section 2.8.2.

Emergency Fire Pump

The emergency fire pump unit is powered by a diesel engine acting through a hydraulic pump and motor for the feeding pump. It is essential that the diesel engine fuel tank is maintained in a full condition and that the engine lubricating oil system and the hydraulic oil system are checked frequently and replenished as necessary.

If the emergency fire pump is to be used this can be started remotely from the following locations:

- Fire control station
- Wheelhouse
- Cargo control room

The emergency fire pump may also be started locally from the top of the bosun's store, but if it is to be started remotely the local selector switch must be put to the REMOTE position.

The emergency fire pump feeding pump suction valve FD515F and the main pump discharge valve FD513F are always kept locked open so that the pump can be started and can supply water to the fire main pump immediately. The main pump discharge valve is a non-return valve. Although these valves are normally kept open they should, however, be operated periodically in order to ensure that they are free to be closed should the need arise.

See section 5.8 for the operation of the emergency fire pump.

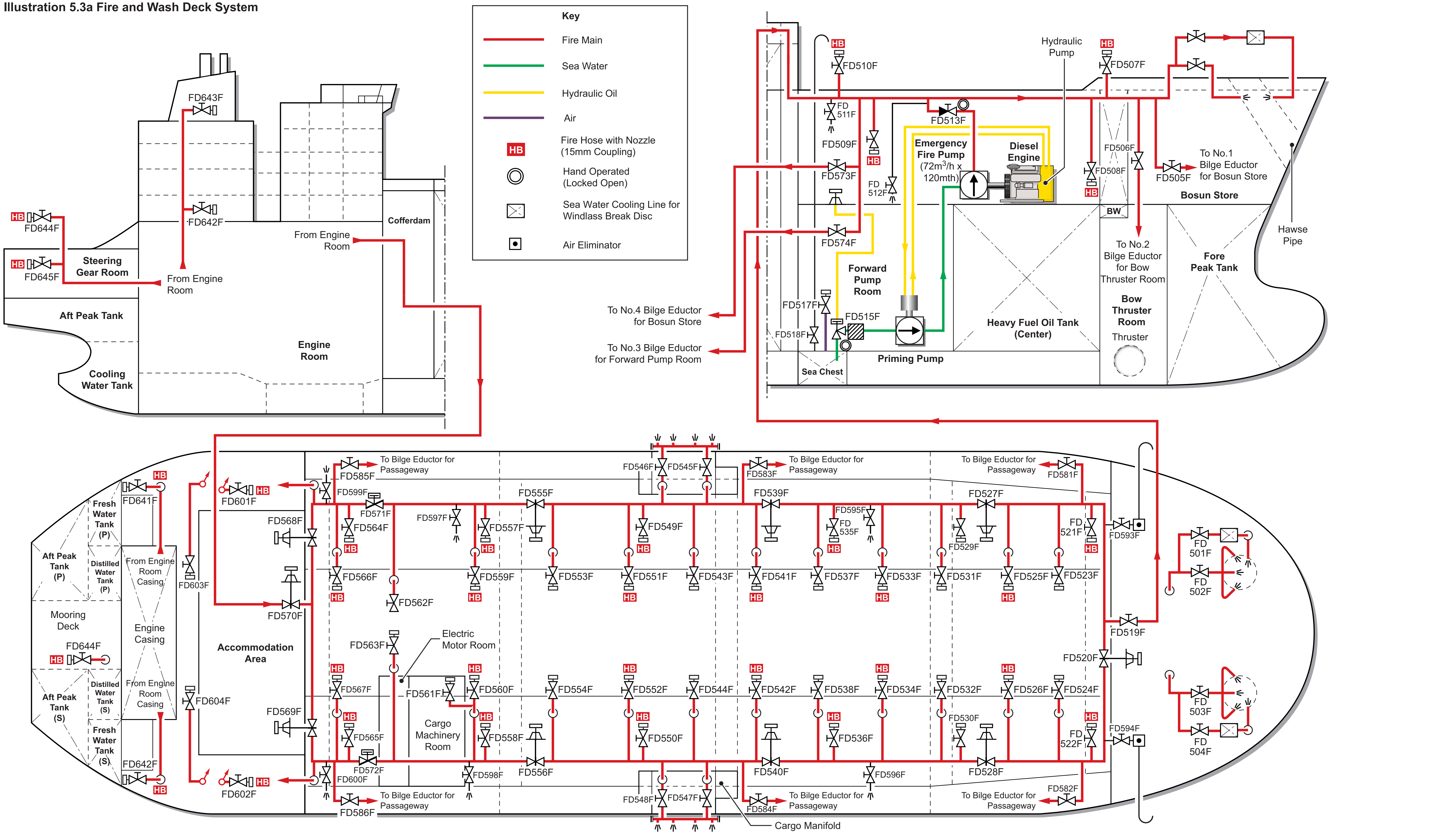
Water Spray System

The water spray pump supplies the water spray system, however the pump may also be used for operating the ballast stripping eductor. This will require the normally locked closed cross-connection valve FD055F to be opened and with this valve open the fire pump and bilge, fire and GS pumps may also serve the water spray system.

The water spray pump may be controlled locally by setting its selector switch to LOCAL but it is normally operated from the central control room mimic panel and to allow for this the selector switch must be turned to the REMOTE position.

Fire Jockey Pump and Hydrophore Tank

Illustration 5.3a Fire and Wash Deck System



5.3 DECK AND ACCOMMODATION FIRE MAIN SYSTEM

Introduction

The fire main system is maintained under pressure by the hydrophore tank system with its associated jockey pump as described in section 5.2. The fire main supplies hydrants in the engine room and on deck. If one of the fire hydrant valves is opened the pressure in the fire main falls because the fire jockey pump has insufficient capacity to maintain the pressure. The fire pump is set to automatic operation and will start automatically when the fire main pressure switch detects the fall in fire main pressure. By this means the fire main is automatically maintained under pressure in order to supply water to any of the hydrants.

The deck fire main system comprises the fire hydrants at the accommodation block and the fire hydrants on the ring fire main which runs around the main deck. Fire hydrants in the after deck areas and the funnel uptake block are supplied directly from the fire main system in the engine room via branch pipes.

Hydrant valves are normally kept closed but isolating valves on sections of the deck fire ring main are kept in the open position at all times except when there is a need to isolate a section of the fire main for any reason. As the deck fire main is a ring main all hydrants can be supplied with water except those located between any pair of closed isolating valves.

Procedure for Operating the Deck Fire Main

a) Ensure that the fire main is pressurised using the hydrophore tank and fire jockey pump as in section 5.2. Ensure that the fire pump is set for automatic operation as in section 5.2 and that the emergency fire pump is set for operation as in section 5.8, once fully pressurised.

b) Open the fire main isolating valves as in the following table.

Description	Valve
Isolating valve from engine room	FD570F
Port main line isolating valve	FD568F
Starboard main line isolating valve	FD569F
Port remotely operated fire safe isolating valve	FD571F
Port isolating valve aft of cargo manifold	FD555F
Port isolating valve forward of cargo manifold	FD539F
Port isolating valve at forward cargo tank	FD527F
Starboard remotely operated fire safe isolating valve	FD572F
Starboard isolating valve aft of cargo manifold	FD556F
Starboard isolating valve forward of cargo manifold	FD540F
Starboard isolating valve at forward cargo tank	FD528F
Forward ring main isolating valve	FD520F
Bow fire main isolating valve	FD519F

c) Start the main fire pump with the discharge valve throttled and pressurise the system. Open and close the air eliminator valves which are fitted at the ends of the port and starboard sections of the fire main.

d) The deck fire main is now pressurised and the fire main pump can now be stopped. Confirm that the jockey pump is holding the pressure in the fire main and then place the fire main pump in AUTOMATIC mode.

(**Note:** During routine deck washing procedures one of the two bilge, fire and general service pumps may be used for supplying water to the fire main in order to prevent constant use of the fire pump for such duties. Normally No.1 bilge, fire and general service pump is set to supply the fire main with its sea suction and fire main discharge valves open. If a bilge, fire and general service pump is used to supply sea water to the fire main for deck washing duties the fire pump must be set to MANUAL operation so that it will not operate automatically when the fire main pressure falls. After deck washing is finished it is essential that the fire pump is restored to automatic operation, see section 5.2.)

The Bow Fire Main System

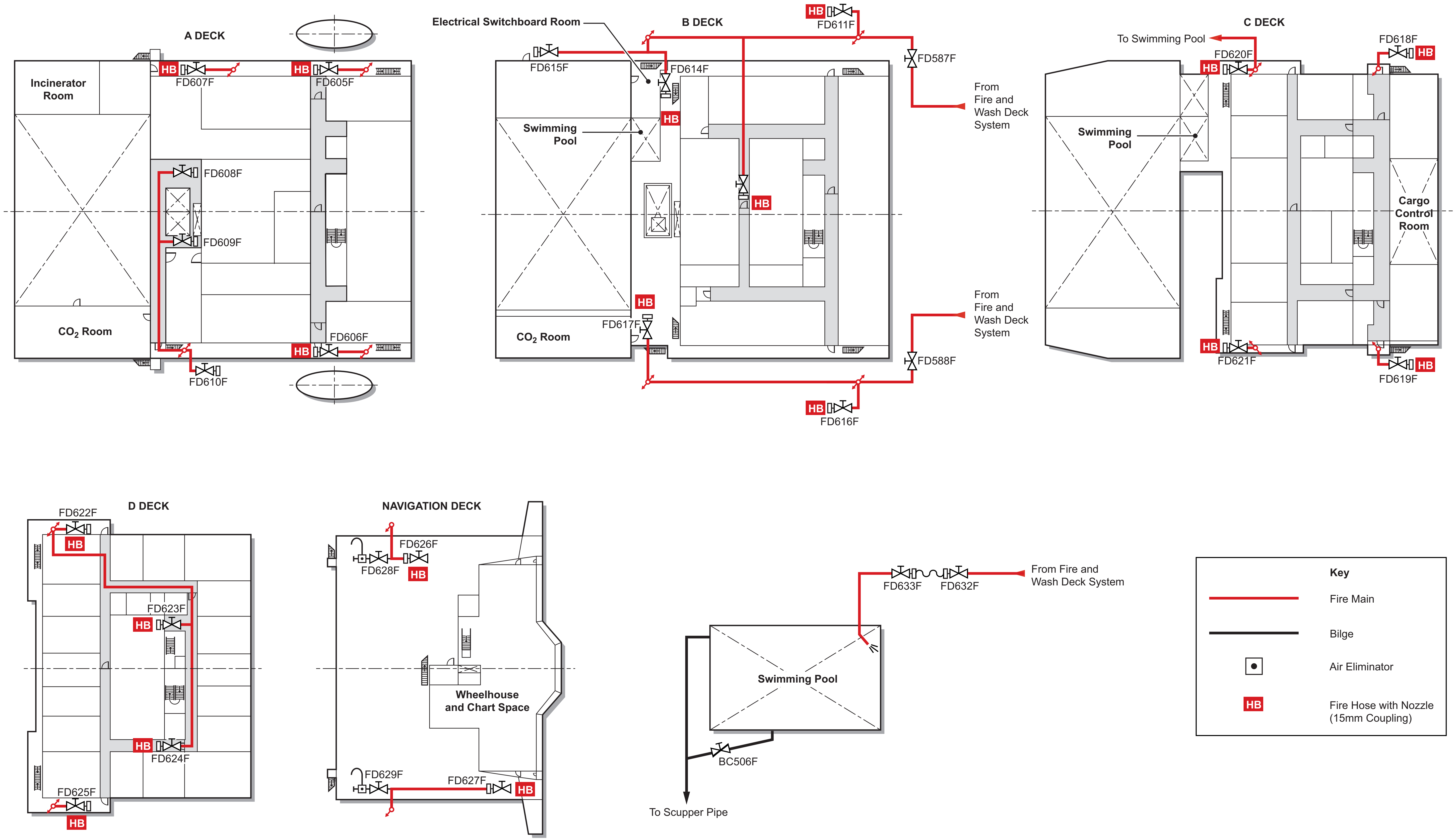
Water supplied by the fire main is also used as flushing water at the hawse pipes and as cooling water for the windlass disc brakes. Supply valves to the windlass disc brake cooling system, FD501F for the port windlass and FD504F for the starboard windlass, are opened as required, as are the port hawse pipe valve FD502F and starboard hawse pipe valve FD503F.

Valves FD505F and FD573F supply operating water for the bosun's store bilge eductors, valve FD506F supplies operating water for the bow thruster bilge eductor and valve FD574F supplies operating water for the forward pump room bilges.

The After Deck System

Fire hydrants in the steering gear room and on the aft mooring deck are supplied from the fire main in the engine room.

Illustration 5.3b Accommodation Fire Main System



The Accommodation Block

Fire hydrants on the port and starboard sides of the accommodation block are supplied with water from the fire main and are used as required. The swimming pool is filled from the fire main. Air eliminator valves are fitted at the uppermost parts of the fire main at the accommodation block.

(**Note:** All hydrant valves should be opened at frequent intervals in order to ensure that they will be free should they be required in an emergency. Use of all deck valves should take place at least once every two months and this can be achieved during fire drills and normal deck washing procedures.)

Within the accommodation 20mm diameter hose reels with attached spray/jet nozzles are strategically placed and can be served by the jockey pump hydrophore system in the first instance of an accommodation fire.

Cargo Manifold Water Curtains

The port and starboard cargo manifold side shell water curtains are supplied with water from the fire main. Each water curtain is supplied by means of two valves, one at each end of each water curtain. The valves are manually operated and the water curtains may also be supplied with fresh water.

Port Water Curtain Valves
FD546F and FD545F

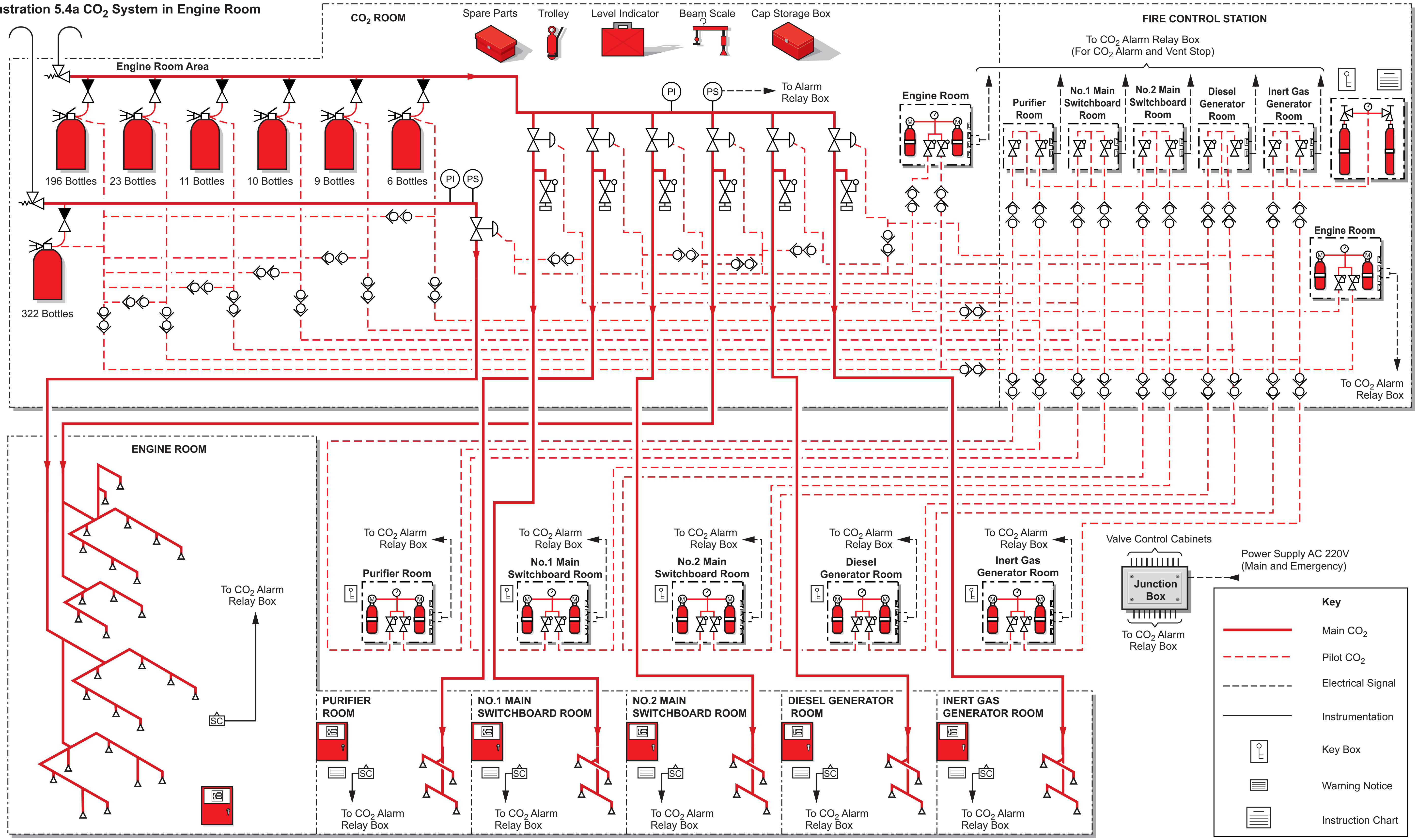
Starboard Water Curtain Valves
FD548F and FD547F

The water curtain valves from the fire main are operated as required but the fire main must be pressurised as described above.

Hose Boxes

Hose boxes are located close to each fire hydrant. The hose box contains a fire hose with nozzle and standard fixture to the fire hydrant. Hoses and nozzles must be stored correctly after use.

Illustration 5.4a CO_2 System in Engine Room



5.4 CO_2 SYSTEM

Engine Room System

Maker: NK Co. Ltd
Type: High pressure
Capacity: 576 cylinders each containing 45kg

Introduction

Dependent upon the application, CO_2 is normally employed at levels of between 35% and 50% by volume to produce an oxygen deficiency and thus extinguish a fire. This level of oxygen reduction is also capable of causing asphyxiation. Fixed systems are therefore designed to include safeguards which prevent the automatic release of the CO_2 whilst the protected area is occupied. The users of portable extinguishers should ensure that there is sufficient air to breathe normally. CO_2 is not generally regarded as having a high intrinsic toxicity and is not normally considered to produce decomposite products in a fire situation.

The CO_2 cylinders are fitted with safety devices to relieve excess pressure caused by high temperatures. To avoid these operating, it is recommended that cylinders are located in areas where the ambient temperature will not exceed 46°C. Cylinders must not be stored in direct sunlight.

Certain gaseous extinguishing agents may cause low temperature burns when in contact with the skin. In such cases the affected area should be thoroughly irrigated with clean water and afterwards dressed by a trained person.

WARNING
DANGER OF ASPHYXIATION
Re-entry to a CO_2 flooded area should not be made until the area has been thoroughly ventilated.

SYSTEM DESCRIPTION

Areas Protected

The central bank CO_2 system installed in the ship protects the engine room, No.1 and No.2 main switchboard rooms, purifier room, diesel generator room and the inert gas generator room. Outlets for CO_2 are located in the protected spaces so as to give an even spread of CO_2 quickly throughout the compartment when the gas is released.

Also within the CO_2 room is a central bank CO_2 system which is installed to protect the cargo area, which includes the cargo machinery room, cargo motor room, No.1 and No.2 cargo switchboard rooms, emergency generator room and emrgency switchboard room. Single cylinder individual systems are provided to protect the paint store, chemical store and the oil/grease store.

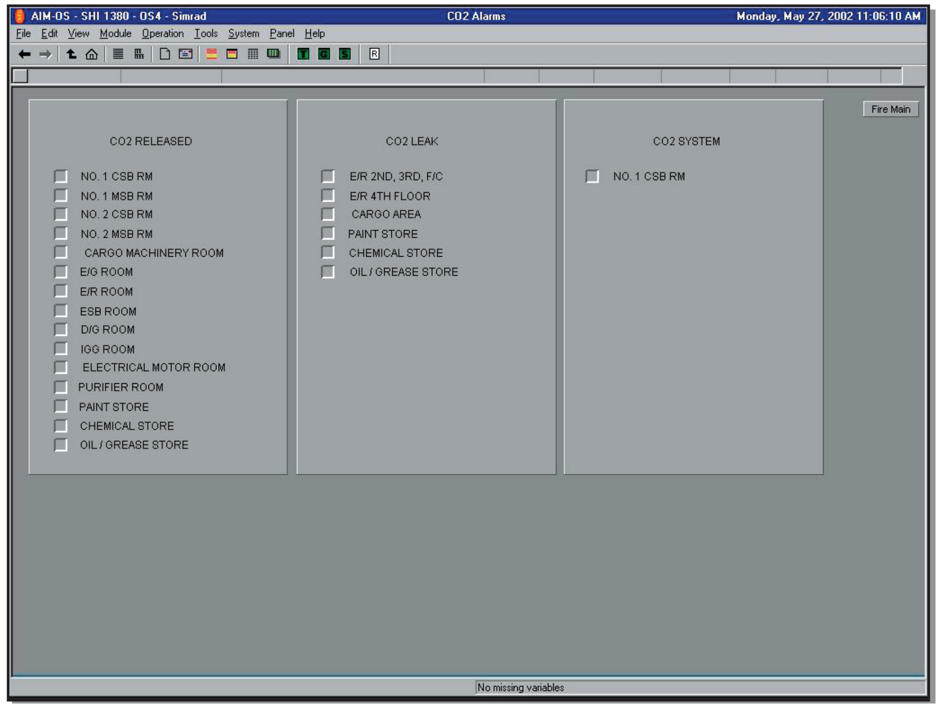
Central Bank CO_2 System for the Engine Room

The central bank CO_2 system consists of 576 cylinders each containing 45kg of CO_2 located in the CO_2 room, which is situated on the starboard side of the engine casing on A deck.

These cylinders are connected to discharge nozzles within the protected space via cylinder manifolds, distribution pipework and isolating valves.

A pressure gauge and pressure switch are fitted to the main CO_2 manifold.

The system is designed to discharge the required number of cylinders into the protected space at the same time. Each protected space requires a certain number of cylinders to give a 40% concentration of CO_2. The total number of cylinders is determined by the largest protected compartment.



When the release system is activated for a particular protected space, only the required number of cylinders for that space are released.

Protected Space	Number of Cylinders Required
Main engine room, including casing:	576
Diesel generator room:	11
Inert gas generator room:	23
Purifier room:	6
No. 1 main switchboard room:	9
No. 2 main switchboard room:	10

It has to be appreciated that if any of the cylinders are released to protect a space then there is no longer sufficient capacity to provide total protection for the engine room and the efforts must be made to have the CO_2 cylinders replenished at the next port.

The alarm is raised via the IAS when CO_2 is released into the protected spaces.

Control Cabinet

Discharge of the CO_2 is manually accomplished from a control cabinet located in the fire control station. The engine room system can also be activated from a panel in the CO_2 room. Operation of the release system opens the cylinder release valves and the main line discharge valve(s) to the protected spaces.

Alarms and Trips

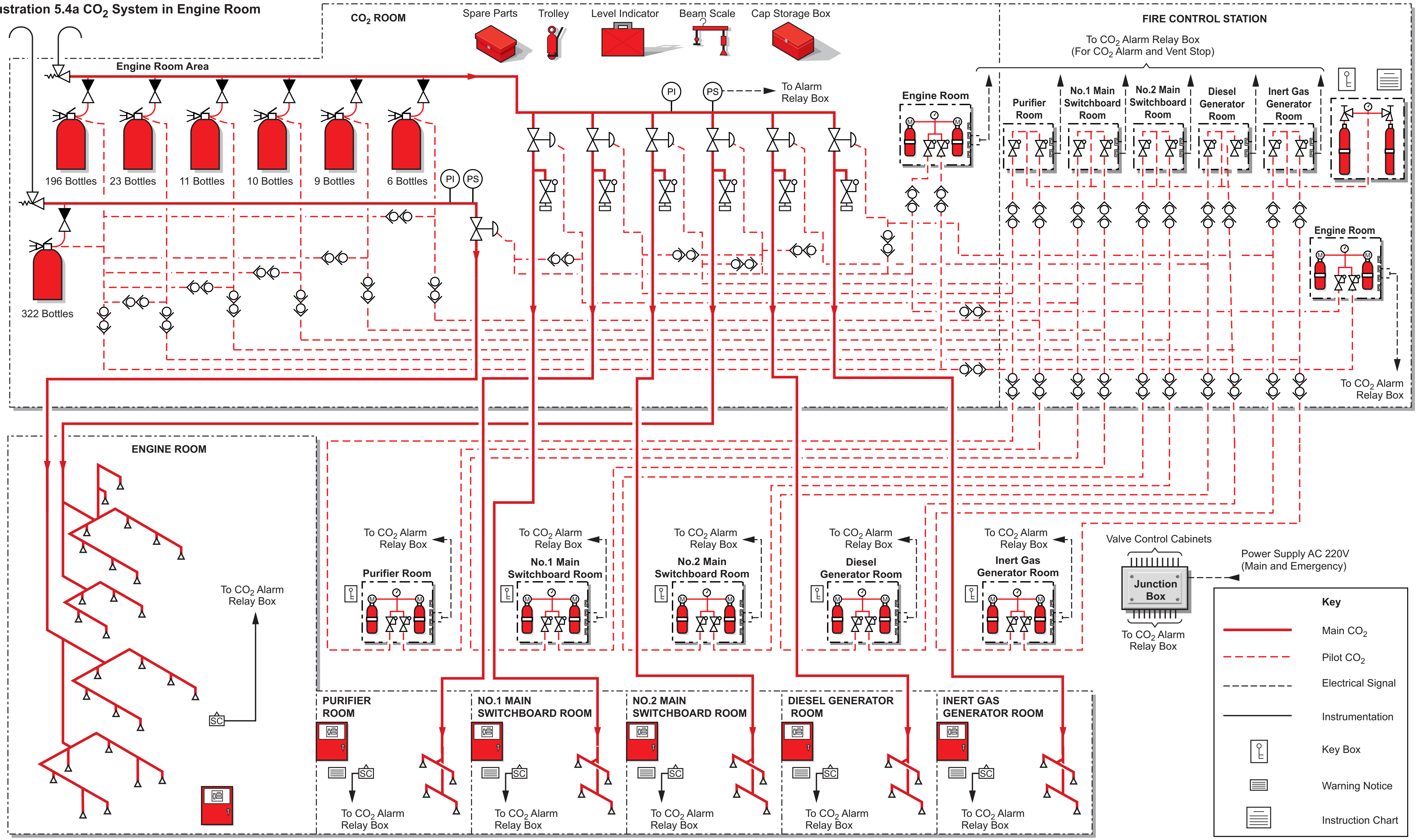
The valve cabinet door situated near the control cabinet door is fitted with electrical contacts which activate an alarm.

The alarms are fitted to the protected spaces and consist of visual and audible signals.

Opening the cabinet door in either the CO_2 room or the fire control station will trip the following:

Circuit	Description
1P-018	No.1 packaged air conditioning unit for the ECR
2P-018	No.2 packaged air conditioning unit for the ECR
2P-009	Sootblower control panel
1GP-011	No.1 engine room supply fan
2GP-011	No.2 engine room supply fan
EGP-002	No.3 engine room supply fan
EGP-003	No.4 engine room supply fan
1GP-014	No.1 boil-off gas extraction fan
2GP-014	No.2 boil-off gas extraction fan
EGP-004	No.1 engine room exhaust fan
2GP-012	No.2 engine room exhaust fan
1GP-015	No.1 boiler forced draught fan
2GP-015	No.2 boiler forced draught fan
1GP-016	No.1 boiler seal air fan
2GP-016	No.2 boiler seal air fan

Illustration 5.4a CO_2 System in Engine Room



Circuit	Description
1GP-019	Toilet exhaust fan
2GP-019	Welding space exhaust fan
1GP-025	Gland steam condenser exhaust fan
1P-010	Dryer unit for inert gas generator
2GP-020	Boiler water test space (workshop) exhaust fan

Opening the cabinet door in either the CO_2 room, their local CO_2 cabinet or the fire control station will trip the following:

Circuit	Description
2GP-025	Purifier room exhaust fan
1P-006	No.1 blower for the inert gas generator
2P-006	No.2 blower for the inert gas generator
1P-013	Port main switchboard packaged air conditioning unit
2P-013	Starboard main switchboard packaged air conditioning unit

Control Cylinder Cabinet

The system is operated by a supply of CO_2 separate from the main fire extinguishing CO_2. It is stored in small pilot cylinders installed within the control cylinder cabinet. The pilot cylinders are connected to the main pilot system pipework via two isolation valves installed within the control cabinet.

One isolation valve is connected via small bore pilot gas pipework to the cylinder bank to open the cylinders, the other is connected via a separate pilot gas line to open the line valve to the protected spaces. The isolation valves are positioned so that the control cabinet door cannot be closed with the valves in the open position. It is also arranged that the control cabinet door will operate the switches when in the open position, to initiate audible and visual alarms.

A time delay unit is located in the pilot CO_2 pipeline to the main storage bottles. This unit allows for a time delay of about 30 seconds between actuation of the main cylinder release isolating valve and the actual operation of the cylinder release valves. This delay offers time for personnel in the protected spaces to evacuate them after the CO_2 release alarm has sounded.

A pressure gauge is fitted to the pilot CO_2 pipeline to indicate pilot CO_2 pressure.

Operating Procedure

a) On discovering a fire in a protected space, shut down the machinery in that space together with fuel supplies, if any, and ventilating systems. Close all doors, ventilators and other openings having first ensured that all personnel have been evacuated.

b) Conduct a muster of all personnel ensuring that everyone is accounted for. The gas must not be released until any missing persons are accounted for and are known not to be in the protected space where CO_2 is to be released.

c) Go to the CO_2 system control cabinet in the fire control station and break the glass key cabinet and obtain the key.

d) Use the key to open the control cylinder cabinet door.

e) Open one of the cylinder valves in the control cylinder cabinet.

f) Go to the control valve cabinet for the protected space where the fire has occurred and open the cabinet door which activates an alarm.

g) Open the No.1 and No.2 ball valves to release the pilot CO_2 to the cylinder isolating valves (for cylinder banks) and protected space isolating valve for releasing of the main CO_2 supply. The gas is released to the protected space after the time delay period.

(**Note:** Local control cabinets are provided close to the protected spaces of the purifier room, No.1 and 2 switchboard rooms, diesel generator room and the inert gas generator room. The CO_2 may be released into a particular space by undertaking steps f) and g) above at the local control cabinet, after opening the selected pilot cylinder valve.)

h) After 10 minutes, close the pilot cylinder hand wheel valve.

i) When the pilot pressure gauge within the control box is zero, close both pilot isolation valves.

(**Note:** Allow time for structural cooling before opening the protected space and ventilating the CO_2 gas.)

WARNING

Do not enter the space for at least 24 hours. Ensure all reasonable precautions have been taken, such as maintaining boundary inspections, noting cooling down rates and/or any hot spots which may have been found. After this period an assessment party, wearing breathing apparatus, can enter the space quickly through a door which they shut behind them. Check that the fire is extinguished and that all surfaces have cooled prior to ventilating the space. Premature opening can cause re-ignition if oxygen contacts hot combustible material.

Procedure to Release CO_2 Manually

In the unlikely event of pilot gas initiation failure, the CO_2 system may be operated from the CO_2 room.

a) Open the control box door so that the alarms will still be activated.

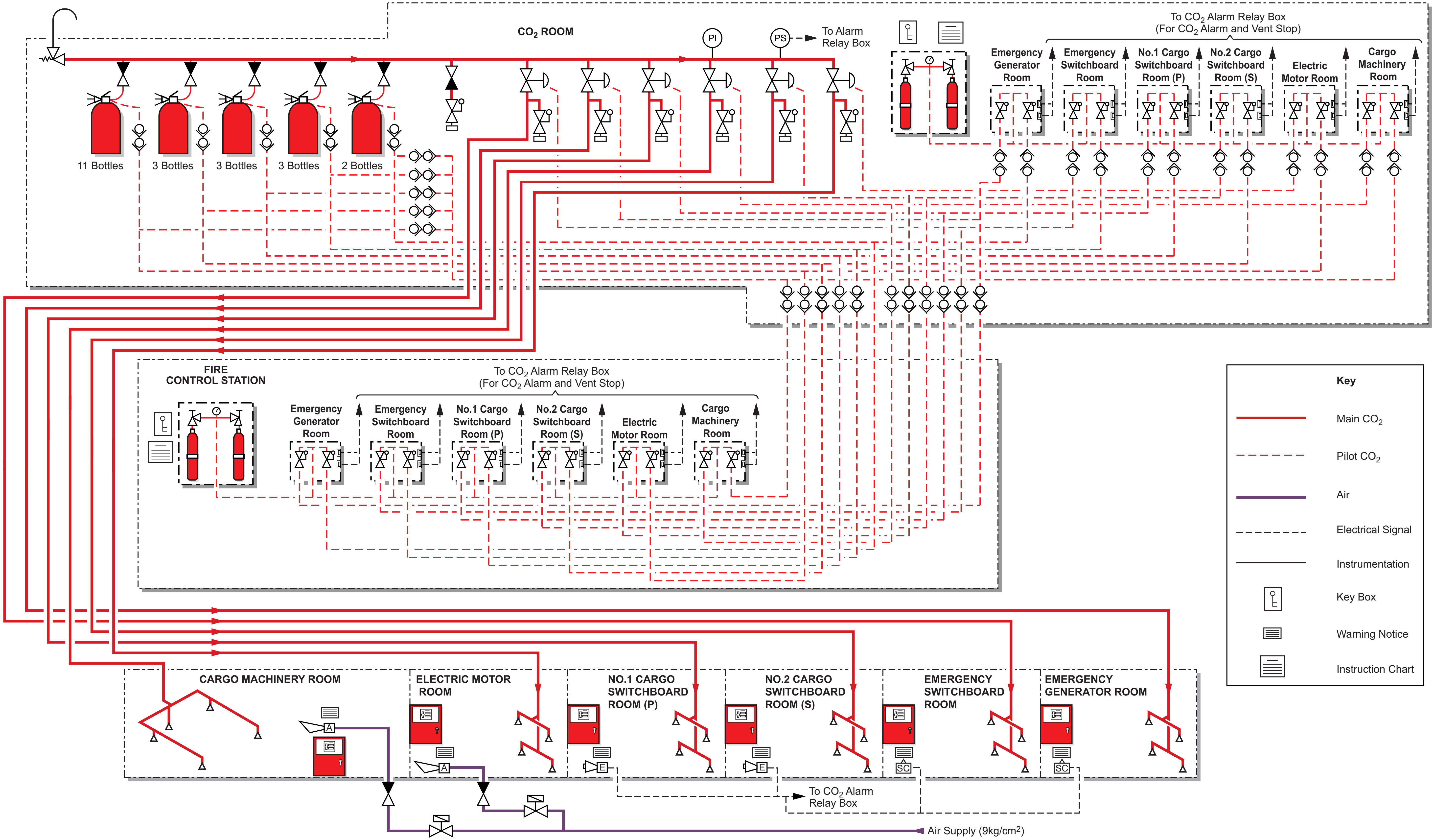
b) Ensure that all personnel have left the space and ensure that all vents and doors are closed.

c) In the CO_2 room manually open the relevant main valve for the protected space into which CO_2 is to be released, by turning the cylinder valve handle anticlockwise and pulling down the lever on the valve.

d) Remove the safety pins on the valve actuator mounted on the CO_2 cylinders to be released. A check must be made to determine how many cylinders are needed for the space in which the fire has occurred.

e) Pull down the operating lever on the valve actuator of the cylinders to be released. CO_2 will now be discharged.

Illustration 5.4b CO_2 System on Deck



CARGO AND DECK AREA CO_2 SYSTEM

Maker: NK Co. Ltd.
Type: High Pressure
Capacity: 22 cylinders each containing 45kg

Introduction

Dependent upon the application, CO_2 is normally employed at levels of between 35% and 50% by volume to produce an oxygen deficiency and thus extinguish a fire. This level of oxygen reduction is also capable of causing asphyxiation. Fixed systems are therefore designed to include safeguards which prevent the automatic release of the CO_2 whilst the protected area is occupied. The users of portable extinguishers should ensure that there is sufficient air to breathe normally. CO_2 is not generally regarded as having a high intrinsic toxicity and is not normally considered to produce decomposite products in a fire situation.

The CO_2 cylinders are fitted with safety devices to relieve excess pressure caused by high temperatures. To avoid these operating, it is recommended that cylinders are located in areas where the ambient temperature will not exceed 46°C. Cylinders must not be stored in direct sunlight.

Certain gaseous extinguishing agents may cause low temperature burns when in contact with the skin. In such cases the affected area should be thoroughly irrigated with clean water and afterwards dressed by a trained person.

WARNING
DANGER OF ASPHYXIATION
Re-entry to a CO_2 flooded area should not be made until the area has been thoroughly ventilated.

SYSTEM DESCRIPTION

Areas Protected

The central bank CO_2 system installed in the ship protects the port and starboard cargo switchboard rooms, cargo machinery room, electric motor room, emergency switchboard room, emergency generator room, paint store, chemical store and the oil/grease store. Outlets for CO_2 are located in the protected spaces so as to give an even spread of CO_2 quickly throughout the compartment when the gas is released.

Additionally the following spaces are protected under the engine room protection system - main engine room, diesel generator room, inert gas generator room, purifier room and No.s 1 and 2 main switchboard rooms.

Central Bank CO_2 System for Cargo Machinery

The central bank CO_2 system consists of 22 cylinders each containing 45kg of CO_2 located in the CO_2 room, which is situated on the starboard side of the engine casing on A deck.

These cylinders are connected to discharge nozzles within the protected space via cylinder manifolds and distribution pipe work.

A pressure gauge and pressure switch are fitted to the main CO_2 manifold.

The system is designed to discharge the required number of cylinders into the protected space at the same time. Each protected space requires a certain number of cylinders to give a 40% concentration of CO_2. The total number of cylinders is determined by the largest protected compartment.

When the release system is activated for a particular protected space, only the required number of cylinders for that space are released.

Protected Space	Number of Cylinders Required
Cargo switchboard room (port)	3
Cargo switchboard room (starboard)	3
Cargo machinery room	22
Electric motor room	11
Emergency generator room	2
Emergency switchboard room	3

The alarm is raised via the IAS when CO_2 is released into the protected spaces. Air horns also operate in the following spaces - cargo machinery room, engine control room and No.s 1 and 2 cargo switchboard rooms.

It has to be appreciated that if any of the cylinders are released to protect a space then there is no longer sufficient capacity to provide total protection for the cargo compressor room and the efforts must be made to have the CO_2 cylinders replenished at the next port.

Control Cabinet

Discharge of the CO_2 is manually accomplished from a control cabinet located in the fire control station and CO_2 room. Operation of the release system opens the cylinder release valves and the main line discharge valve(s) to the protected spaces.

Alarms and Trips

The valve cabinet door situated near the control cabinet door is fitted with electrical contacts which activate an alarm.

The alarms are fitted to the protected spaces and consist of visual and audible signals.

Opening the cabinet door in either the CO_2 room or the fire control station will trip the following:

Circuit	Description
EGP-006	Emergency generator room supply fan
1CGP-007	No.1 cargo machinery room exhaust fan
2CGP-007	No.2 cargo machinery room exhaust fan
1CGP-008	No.1 electric motor room exhaust fan
2CGP-008	No.2 electric motor room exhaust fan

Control Cylinder Cabinet

The system is operated by a supply of CO_2 separate from the main fire extinguishing CO_2. It is stored in small pilot cylinders installed within the control cylinder cabinet. The pilot cylinders are connected to the main pilot system pipework via two isolation valves installed within the control cabinet.

One isolation valve is connected via small bore pilot gas pipework to the cylinder bank to open the cylinders, the other is connected via a separate pilot gas line to open the line valve to the protected spaces. The isolation valves are positioned so that the control cabinet door cannot be closed with the valves in the open position. It is also arranged that the control cabinet door will operate the switches when in the open position, to initiate audible and visual alarms.

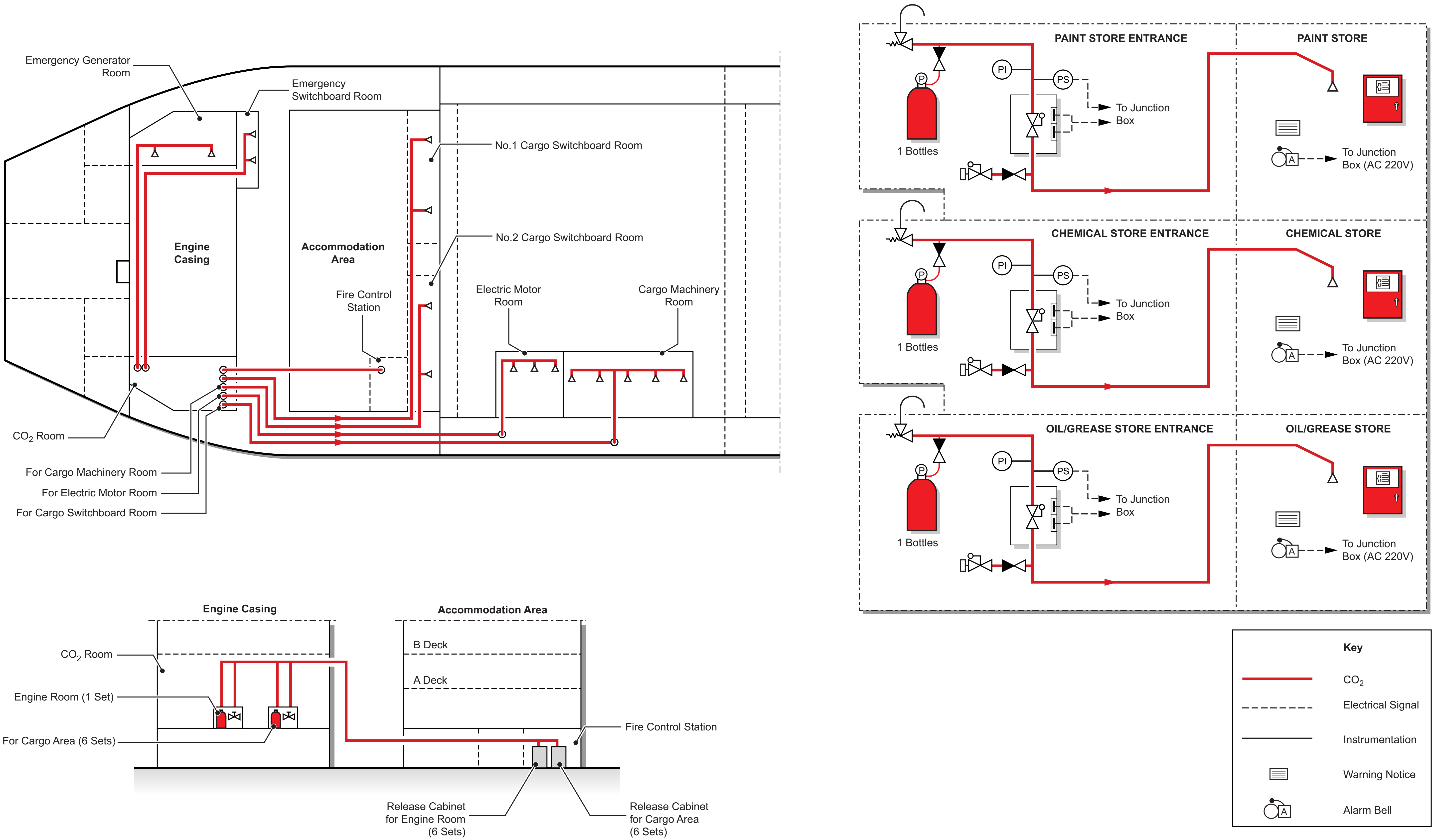
A time delay unit is located in the pilot CO_2 pipeline to the main storage bottles. This unit allows for a time delay of about 30 seconds between actuation of the main cylinder release isolating valve and the actual operation of the cylinder release valves. This delay offers time for personnel in the protected spaces to evacuate them after the CO_2 release alarm has sounded.

A pressure gauge is fitted to the pilot CO_2 pipeline to indicate pilot CO_2 pressure.

Operating Procedure

a) On discovering a fire in a protected space, shut down the machinery in that space together with fuel supplies, if any, and ventilating systems. Close all doors, ventilators and other openings having first ensured that all personnel have been evacuated.

Illustration 5.4c Cargo Area CO_2 System



b) Conduct a muster of all personnel ensuring that everyone is accounted for. The gas must not be released until any missing persons are accounted for and are known not to be in the protected space where CO_2 is to be released.

c) Go to the CO_2 system control cabinet in the fire control station and break the glass key cabinet and obtain the key.

d) Use the key to open the control cylinder cabinet door.

e) Open one of the cylinder valves in the control cylinder cabinet.

f) Go to the control valve cabinet for the protected space where the fire has occurred and open the cabinet door which activates an alarm.

g) Open the No.1 and No.2 ball valves to release the pilot CO_2 to the cylinders isolating valves (for cylinder banks) and protected space isolating valve for release of main CO cylinders. The gas is released to the protected space after the time delay period.

h) After 10 minutes, close the pilot cylinder hand wheel valve.

i) When the pilot pressure gauge within the control box is zero, close both pilot isolation valves.

This procedure can also be performed from the CO_2 room.

(**Note:** Allow time for structural cooling before opening the protected space and ventilating the CO_2 gas.)

WARNING

Do not enter the space for at least 24 hours. Ensure all reasonable precautions have been taken, such as maintaining boundary inspections, noting cooling down rates and/or any hot spots which may have been found. After this period an assessment party, wearing breathing apparatus, can enter the space quickly through a door which they shut behind them. Check that the fire is extinguished and that all surfaces have cooled prior to ventilating the space. Premature opening can cause re-ignition if oxygen contacts hot combustible material.

Procedure to Release CO_2 Manually

In the unlikely event of pilot gas initiation failure, the CO_2 system may be operated from the CO_2 room.

a) Open the control box door so that the alarms will still be activated.

b) In the CO_2 room manually open the relevant main valve for the protected space into which CO_2 is to be released by pulling up the lever on the valve.

c) Ensure that all personnel have left the space and ensure that all vents and doors are closed.

d) Remove the safety pins on the valve actuator mounted on the CO_2 cylinders to be released. A check must be made to determine how many cylinders are needed for the space in which the fire has occurred.

e) Pull down the operating lever on the valve actuator of the cylinders to be released. CO_2 will now be discharged.

In the Event of a Fire in the Deck Store Rooms and Galley

The local area CO_2 system for the store rooms and galley consist of 1 cylinder each containing 45kg of CO_2. The cylinders are located outside the store rooms.

The local area CO_2 system protects the following spaces:

Protected Space	Number of Cylinders Required
Paint store	1
Chemical store	1
Oil and grease store	1
Galley	1

The alarm is raised via the IAS when CO_2 is released into the protected spaces:

Opening the cabinet door will trip the following:

Circuit	Description
3GP-015	Paint store exhaust fan
3GP-014	Chemical store exhaust fan
3GP-013	Oil and grease store exhaust fan
3GP-032	Galley exhaust fan
3GP-012	Galley supply fan

Operating Procedure

a) Go to the local cabinet outside the protected space containing the fire.

b) Open the ball valve cabinet.

c) The CO_2 alarm bell will sound in the space.

d) The ventilation fan will stop.

e) Ensure all personnel have evacuated the space and that all personnel are accounted for.

f) Close and check that all appropriate doors, hatches and fire flaps are shut.

g) Isolate electrical power supplies to the space.

h) Remove the safety pin on the valve actuator on the CO_2 cylinder and pull down the operating lever.

i) Open the ball valve in the ball valve cabinet.

j) The cylinder will now discharge into the space.

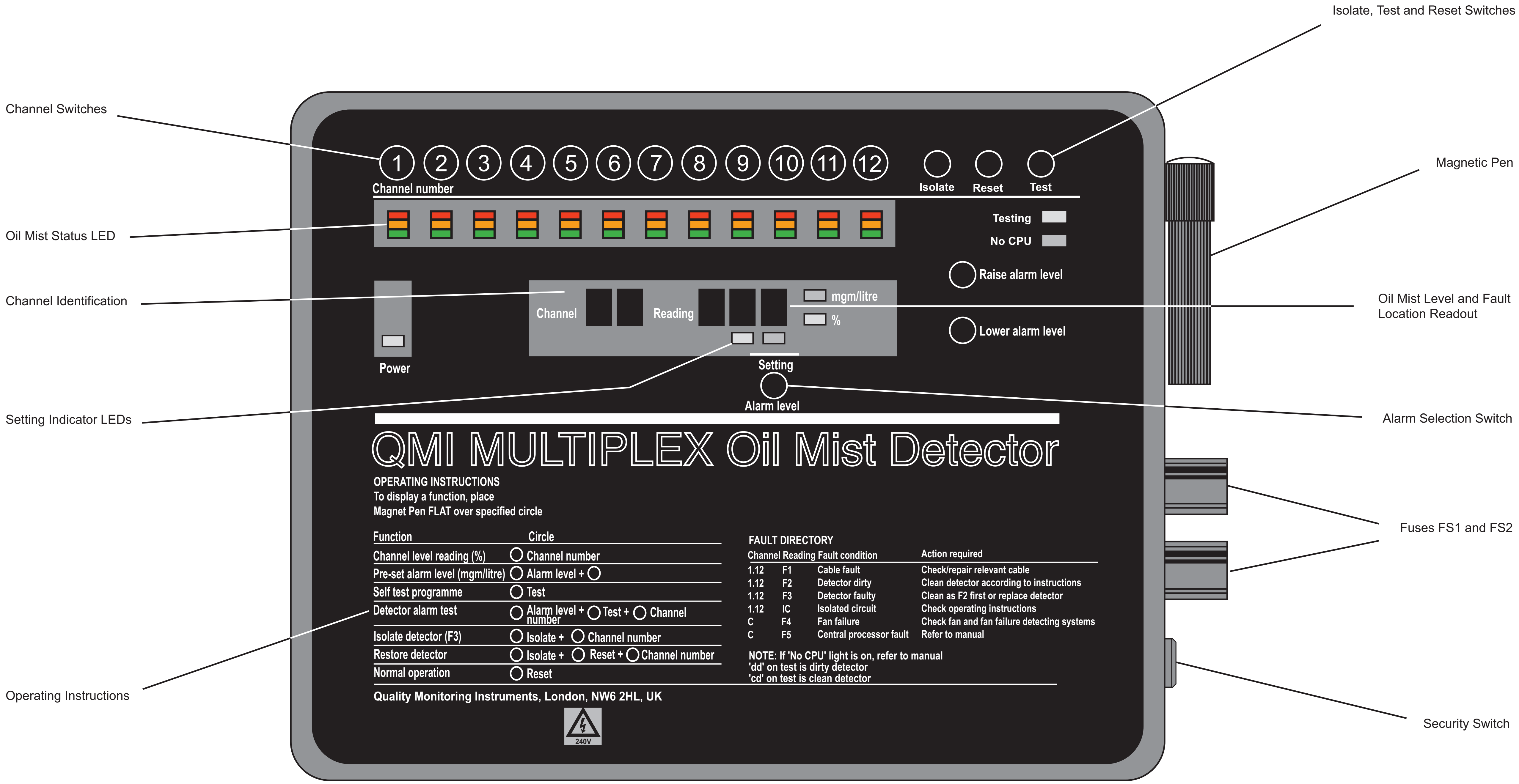
WARNING

Do not enter the space for at least 24 hours. Ensure all reasonable precautions have been taken, such as maintaining boundary inspections, noting cooling down rates and/or any hot spots which may have been found. After this period an assessment party, wearing breathing apparatus, can enter the space quickly through a door which they shut behind them. Check that the fire is extinguished and that all surfaces have cooled prior to ventilating the space. Premature opening can cause re-ignition if oxygen contacts hot combustible material.

Should the cylinder discharge accidentally, it will pressurise the line up to the ball valve. This line is monitored by a pressure switch which will activate CO_2 leakage alarms in the protected space.

Overpressure of the CO_2 line is prevented by a safety valve, which will vent the gas to atmosphere.

Illustration 5.5a Oil Mist Detector



5.5 OIL MIST DETECTION SYSTEM

Oil Mist Detector

Maker:	Il-Jin Maritas Co. Ltd
No. of sets:	1
Model:	QMI Multiplex

Introduction

Detection of explosive oil mist or vapours in the engine room is essential in order to minimise the risk of fire or explosion. The oil mist detector head continuously samples the atmosphere at a number of points in the machinery spaces and gives warning of oil mist or vapour which is present in quantities which might present a hazard. The oil mist detector is able to detect levels of oil mist concentration far below the lower explosion limit of the oil mist, thus giving warning before the oil mist reaches the point where an explosion could occur.

The mist detector head samples the atmosphere by means of six detectors located at the following places.

- Above the diesel generator in the diesel generator room
- Above the turbine generators
- Above the main fuel oil pumps in the purifier room
- Between the port and starboard boilers firing platforms
- Above the main turbines
- Above the steering gear pumps

The air sensors for the mist detector have air intake louvres at the front through which the air sample is drawn. The sensor contains a fan which draws the air into the unit and a green LED at the front of the unit indicates that the fan is running. Inside the unit is a sensing head which detects the presence of an oil mist.

The sensors monitor the level of mist and the detector heads report to the QMI Multiplex unit by means of a dedicated cable. The multiplex unit activates an alarm should the level of mist detected be above an acceptable level. Signals from the detector heads are scanned by the multiplex unit at 500 millisecond intervals and the data is presented on the multiplex unit display in percentage values.

Oil mist samples are measures in milligrams/litre and the output information relates to a setting of 1.3milligrams/litre as being 100%. This is recognised as a safe level but acts as a trigger point for activation of the alarm. When a level of 80% of this 1.3milligram/litre is reached the early warning alarm is triggered. A second alarm is triggered at 100%.

The multiplex unit displays the alarm information on its digital display, indicating the location of the sensor head which has detected the oil mist.

The multiplex unit is preset and should not require any resetting except in extreme circumstances. If adjustment needs to be made this should be undertaken by a competent engineer in consultation with the equipment manufacturer. The oil mist detector is an item of safety equipment and it is essential that it is maintained in optimum operating condition and is not tampered with in any way which could harm its sensitivity.

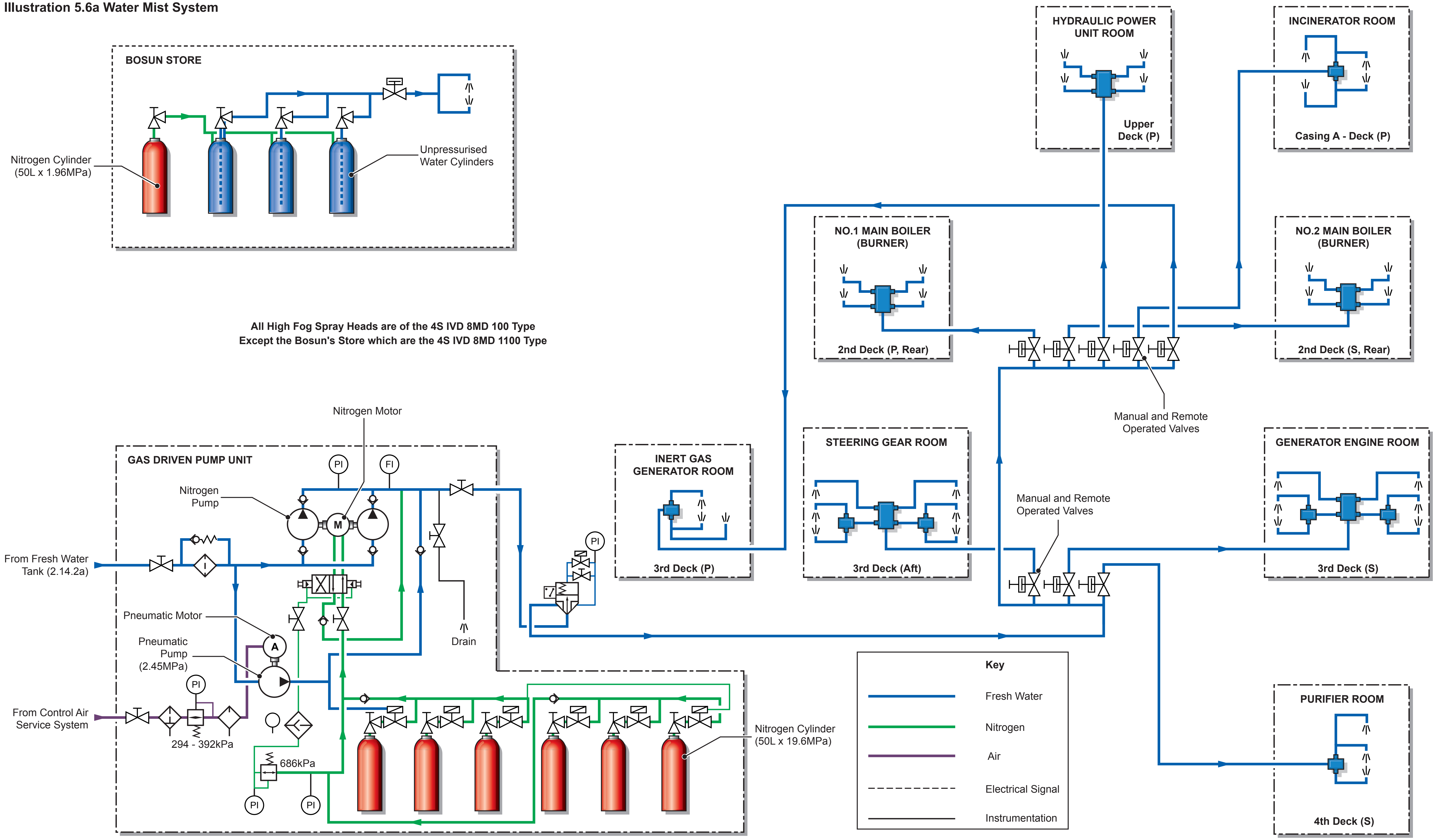
The multiplex unit must be tested at weekly intervals in order to ensure that it is operating correctly. This must be done in accordance with the instructions provided by the manufacturer in the operating manual.

Oil Mist Detector Head above Main Turbine

Alarms

Tag	Description	High	High high
MM224	Generator engine oil mist concentration	0.4mg/l	0.5mg/l
MM225	Purifier room oil mist concentration	0.4mg/l	0.5mg/l
MM226	Above main turbine oil mist concentration	0.4mg/l	0.5mg/l
MM227	Above TG oil mist concentration	0.4mg/l	0.5mg/l
MM228	Steering gear room oil mist concentration	0.4mg/l	0.5mg/l
MM229	Boiler firing platform oil mist concentration	0.4mg/l	0.5mg/l

Illustration 5.6a Water Mist System



5.6 WATER MIST SYSTEM

Maker: Marioff Hi-fog
Type: GPU pump unit
No. of sets: 1

Introduction

The water mist system provides fire protection in a number of machinery space areas. The basic principle of the water mist system is that the very fine droplets of water tend to exclude oxygen from the area of the fire thereby starving the burning material of oxygen. When the fine water droplets come into contact with the flames they are rapidly evaporated because of their large surface area for a small mass and this has a rapid cooling effect on the fire. The steam produced by the evaporation acts to further reduce the space available for oxygen. Because the water is in mist form the system is effective for oil fires.

Water at high pressure is injected into the protected space through special spray heads which break down the water stream into very fine mist like particles. The positioning of the spray heads is such that the desired area is protected by the spray.

Engine Room System

Water mist protection is provided for the following engine room areas:

Deck	Area	No. of Spray Heads
A	Incinerator room	4
Upper	Hydraulic power pack room	4
2nd	Port boiler burner platform	4
2nd	Starboard boiler burner platform	4
3rd	Inert gas generator burner	3
3rd	Steering gear room	6
3rd	Diesel generator room	6
4th	Purifier room	3

Each area is covered by a control valve which connects the spray heads to the pressurised water spray main.

The water mist pump unit, situated on the engine room 4th deck starboard, near the fresh water hydrophore system, contains the following:

- Fresh water pump driven by an air motor, supplied by the control air system, which takes suction from the fresh water tanks and maintains the system pressure at 2.45MPa up to the control valves.
- A set of piston type pumps driven by pressurised N_2 cylinders, which supply fresh water at a rate of 11 litres/minute through each of the spray heads.
- Two sets of N_2 cylinders pressurised to 200kg/cm^2, 19.6MPa each set containing three cylinders.

No electric power is required to operate the discharge pumps and the control valves can be activated locally. The control valve can be closed by operating the pushbutton a second time.

When a remote release pushbutton is pressed, a lamp under the pushbutton will illuminate to indicate a fresh water flow through the control valve.

The remote panel also contains LAMP TEST and audible alarm RESET pushbuttons.

Procedure for Operating the Water Mist System

a) When a fire is detected in a protected area the control valve for that area is activated and pressurised water is allowed to flow to the spray heads covered by that control valve.

b) Fresh water is delivered to the spray head by the air motor driven pump at an initial pressure of 2.45MPa.

c) When a drop in the system pressure is detected because of the water flow, the N_2 cylinder primary valve opens and releases the gas from 3 cylinders which drives the piston type pumps to raise the fresh water discharge rate to 11 litres/minute per spray head, ie. steering gear total is 66 litres/minute.

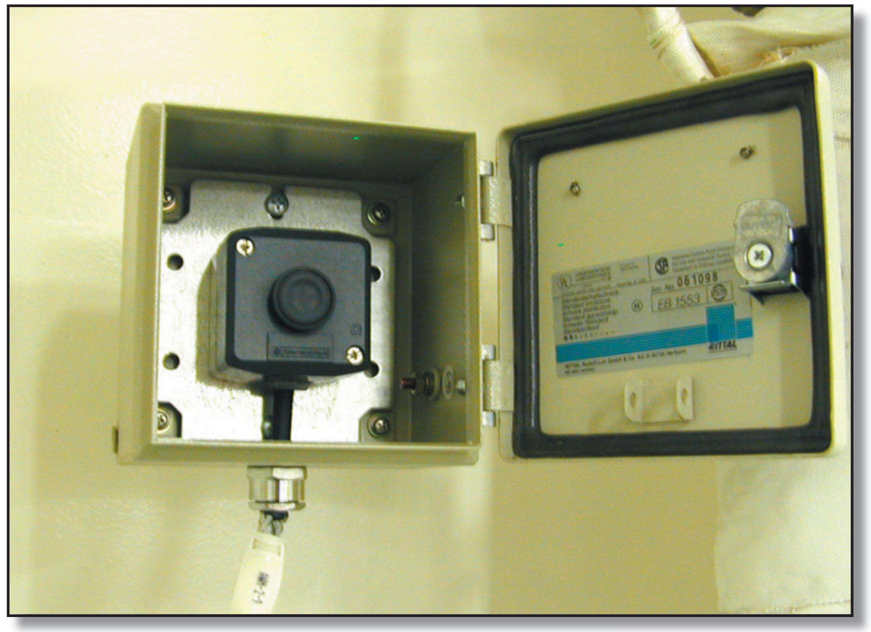
d) The first three N_2 cylinders' discharge pressure will gradually drop to approximately 7.84MPa when the primary valve will open on the second set of N_2 cylinders.

The system has the capacity to discharge fresh water for approximately 20 minutes.

Local Operation

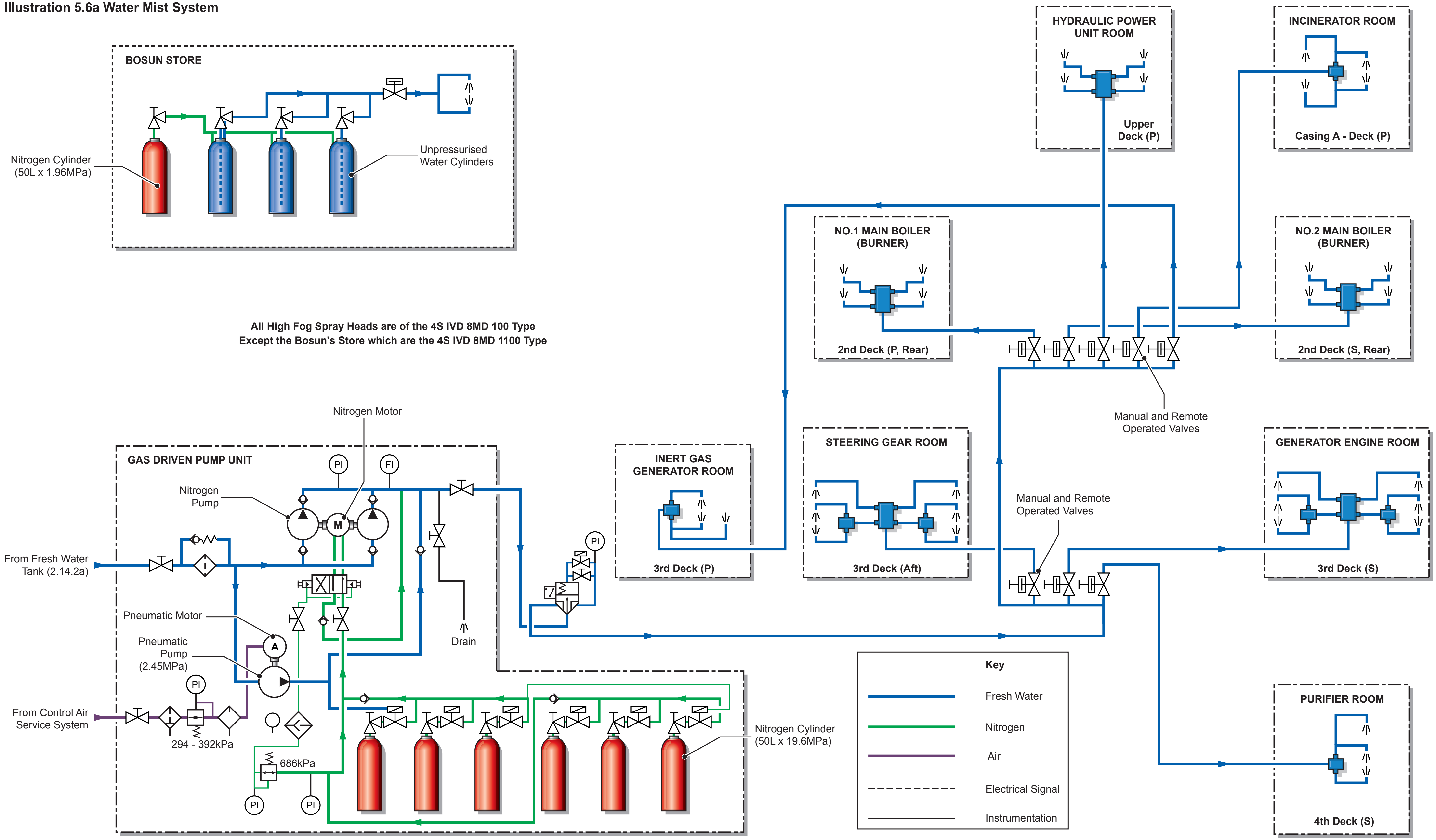
There are local pushbuttons at each protected area and the section valves for each protected area can also be operated locally by turning the valve lever, with finger power only, in the anticlockwise direction.

Water Mist Unit on Engine Room - Starboard Side 4th Deck



Water Mist System Local Operating Pushbutton

Illustration 5.6a Water Mist System



Bosun's Store System

Water mist protection is provided for the emergency fire pump diesel-hydraulic plant on the port side of the bosun's store.

The system consists of a MAU (Machinery space Accumulator Unit) which is connected to two spray heads positioned above the emergency fire pump diesel-hydraulic plant.

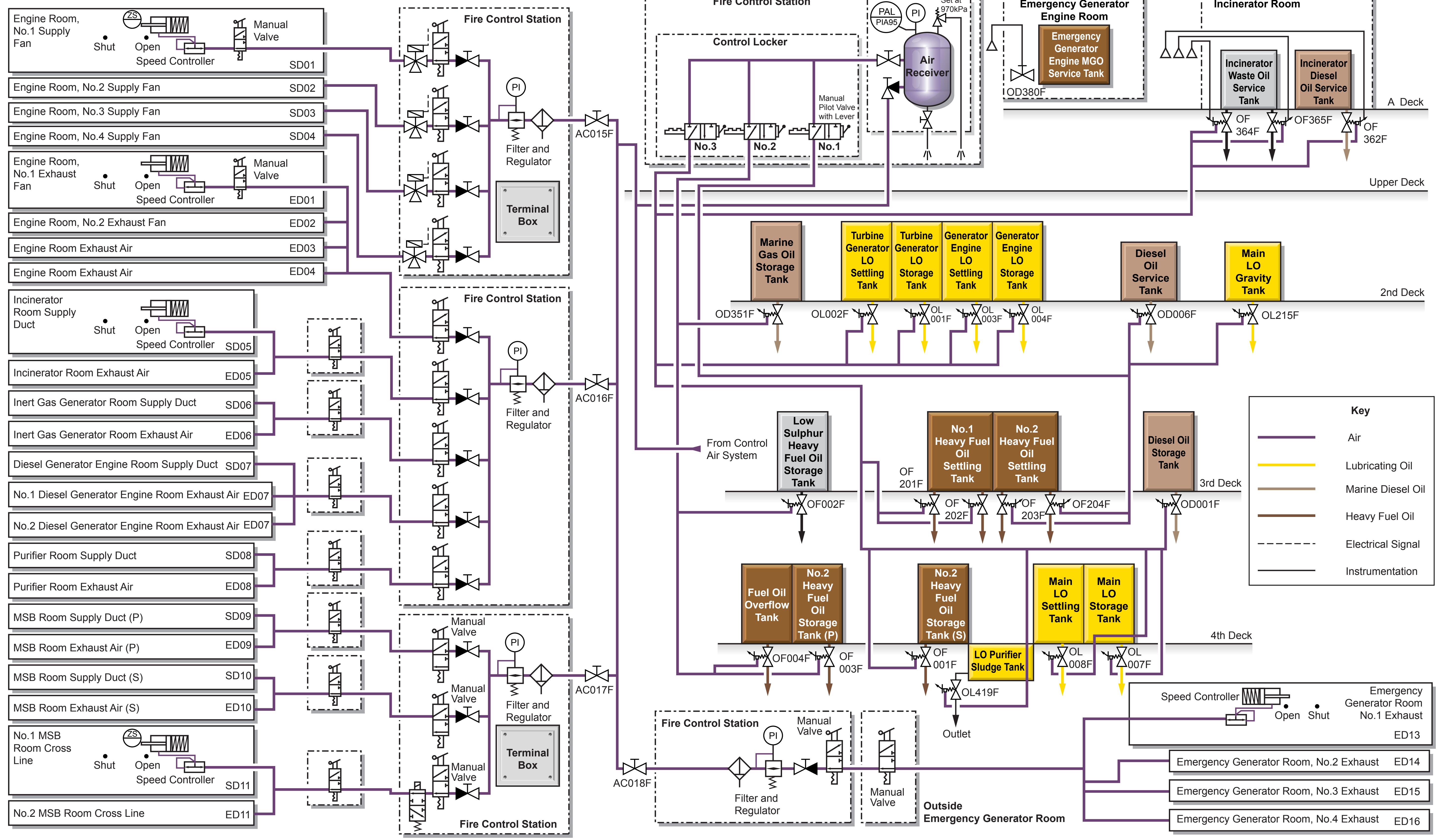
The unit has no moving parts and consists of three unpressurised fresh water cylinders and one N_2 cylinder. The N_2 cylinder pressurises the fresh water cylinders and the fresh water is directed to the spray heads above the emergency fire pump diesel-hydraulic plant.

The control valve on the N_2 cylinder is activated locally. The control valve can be closed by operating the pushbutton a second time.

The N_2 cylinders are sent ashore for recharging.

Water Mist Unit in Bosun's Store

Illustration 5.7a Quick-Closing Valves and Fire Dampers System



5.7 QUICK-CLOSING VALVES AND FIRE DAMPERS SYSTEM

Introduction

All the outlet valves from the fuel oil and lubricating oil tanks, from which oil could flow to feed a fire, are equipped with air operated quick-closing valves, which are controlled from the fire control station. They are supplied from the quick-closing valve air reservoir situated in the fire control station. The reservoir is supplied, at a pressure of 1040kPa, from the control air system. The air supply is direct from the No.1 control air manifold after the dryer and oil filters but there is an inlet valve on the quick-closing valve air reservoir. This valve is locked open. A branch pipe on the supply line to the reservoir supplies air directly to the engine room ventilation fire dampers which are open when under pressure.

The quick-closing valve air reservoir is fitted with a low pressure alarm transmitter which registers on the IAS Machinery Miscellaneous Alarms screen. The oil tank quick-closing valves' actuator lines are grouped into three systems, each with a manual pilot valve and operating lever. In normal operation the supply line to each group of tank valves is vented to atmosphere, but when the pilot valve is actuated air is supplied to pistons which collapse the bridge of each valve in that group, thus causing the valve to close. Operation of a pilot valve will close all valves in that part of the system.

The valves are reset by venting the air supply and operating the valve hand wheel in a closed direction to reset the bridge mechanism and then opening the valve in the normal way.

The emergency generator marine gas oil tank quick-closing valve OD380F is operated by a directly connected wire from outside the emergency generator room. The incinerator waste oil service tank and incinerator DO service tank quick-closing outlet valves OF364F, OF365F and OF362F may be operated by directly connected wires from outside of the incinerator room or from the fire control station via pilot valve No.3.

Engine room fire dampers are arranged in four groups, each with an air supply from an air line supplying the quick-closing valve air reservoir. Air is normally supplied to the damper air cylinder and that keeps the damper open against the action of a counterweight or spring. When the damper cylinder is vented the damper is closed by means of a gravity acting on the counterweight. Damper cylinders may be vented by means of the pilot valve located in the fire control station in the accommodation or by means of a pilot valve located close to each damper. Some damper pilot valves operate a single damper and others operate two or more dampers.

Oil Tank Quick-Closing Valves

CAUTION
Some tanks such as lubricating oil tanks do not have quick-closing apparatus fitted. This is because they are normally closed and only opened for short periods when required. It is important to ensure that these are always closed when not in use.

Tank	Valve
Group 1	
DO service tank	OD006F
Main LO gravity tank	OL215F
No.2 HFO settling tank	OF203F OF204F
Group 2	
MGO storage tank	OD351F
Low sulphur HFO storage tank	OF002F
FO overflow tank	OF004F
No.2 HFO storage tank port	OF003F
Group 3	
Incinerator waste oil service tank	OF364F OF365F
Incinerator DO service tank	OD362F
No.2 HFO storage tank starboard	OF001F
No.1 HFO settling tank	OF201F OF202F
DO storage tank	OD001F
Turbine generator LO settling tank	OL002F
Turbine generator LO storage tank	OL001F
Diesel generator LO settling tank	OL003F
Diesel generator LO storage tank	OL004F
Main LO settling tank	OL008F
Main LO storage tank	OL007F
LO purifier sludge tank	OL419F

Procedure for Operating the Quick-Closing Valve System

a) At the emergency shut off control locker check the quick-closing valve group in which the valve(s) to be closed is/are located.

b) Operate lever of the shut off pilot valve for the valve group concerned in order to supply air to the quick-closing valves.

The quick-closing valves in the selected group will be closed when the air pressure acts on the valve piston. When it is necessary to open the valve again the pilot valve lever should be released so that the air supply line to the valves is vented. The tripped valves must then be closed by turning the valve handle and then opened again in order to reset the trip mechanism.

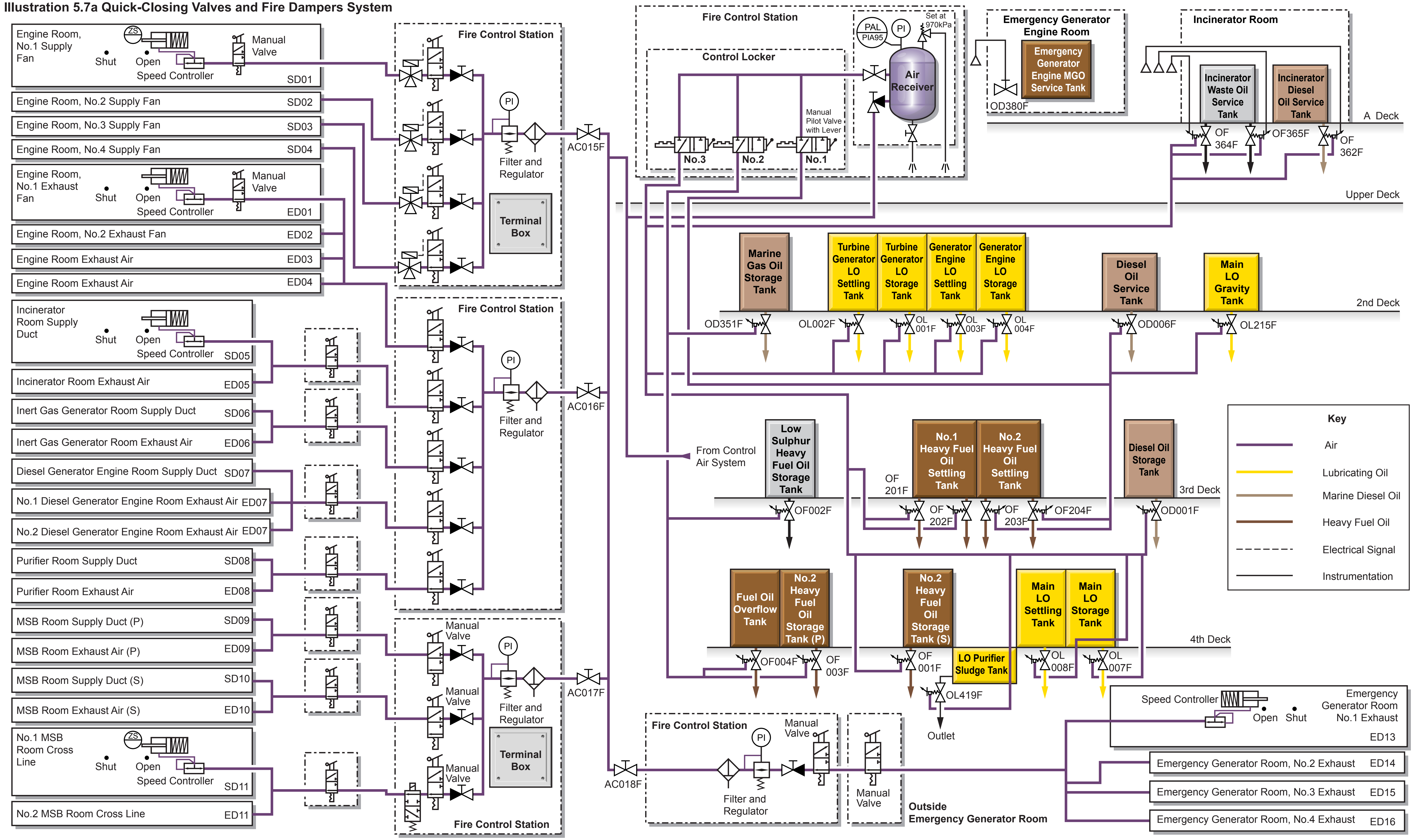
Fire Dampers

Engine room fire dampers operate to close ventilation openings in the event of a fire. The dampers are kept open against a closing force (gravity acting on a counterweight) by means of air pressure acting on the damper cylinder piston. When air pressure is vented the damper or dampers will close. The fire damper pipework is supplied directly from the working air system main pipe and air pressure is constantly applied to the system.

Activation of the pilot control valve at the fire control station control panel will vent the damper air line and cause fire dampers associated with the pilot valve to close. Operation of individual local damper valves will vent each individual damper as required and allow that damper to close.

Fire dampers in group 1 are for engine room supply and exhaust fans. These do not normally have local control pilot valves but do have solenoid valves associated with the fan starters. When the fan is started the solenoid valve allows air to the damper in order to open it and when the fan is stopped the solenoid valve vents the damper air line causing the damper to close.

Illustration 5.7a Quick-Closing Valves and Fire Dampers System



Fire dampers are fitted as follows:

Item	Fire Control Station Valve	
Group 1	Air supply valve AC015F	
		Panel Label
No.1 engine room supply fan		SD01
No.2 engine room supply fan		SD02
No.3 engine room supply fan		SD03
No.4 engine room supply fan		SD04
Group 2	Air supply valve AC016F	
		Panel Label
No.1 engine room exhaust fan		ED01
No.2 engine room exhaust fan		ED02
No.3 engine room exhaust fan		ED03
No.4 engine room exhaust fan		ED04
Incinerator room supply duct		SD05
Incinerator room exhaust air		ED05
IGG room supply duct		SD06
IGG room exhaust air		ED06
Generator room supply duct		SD07
Generator No.1 and 2 rooms exhaust air		ED07
Purifier room supply duct		SD08
Purifier room exhaust air		ED08
Group 3	Air supply valve AC017F	
		Panel Label
MSB room port supply duct		SD09
MSB room port exhaust air		ED09
MSB room starboard supply duct		SD10
MSB room starboard exhaust air		ED10
No.1 MSB room cross line		SD11
No.2 MSB room cross line		ED11
Group 4	Air supply valve AC018F	
		Panel Label
Emergency generator room		ED13, 14, 15 and 16

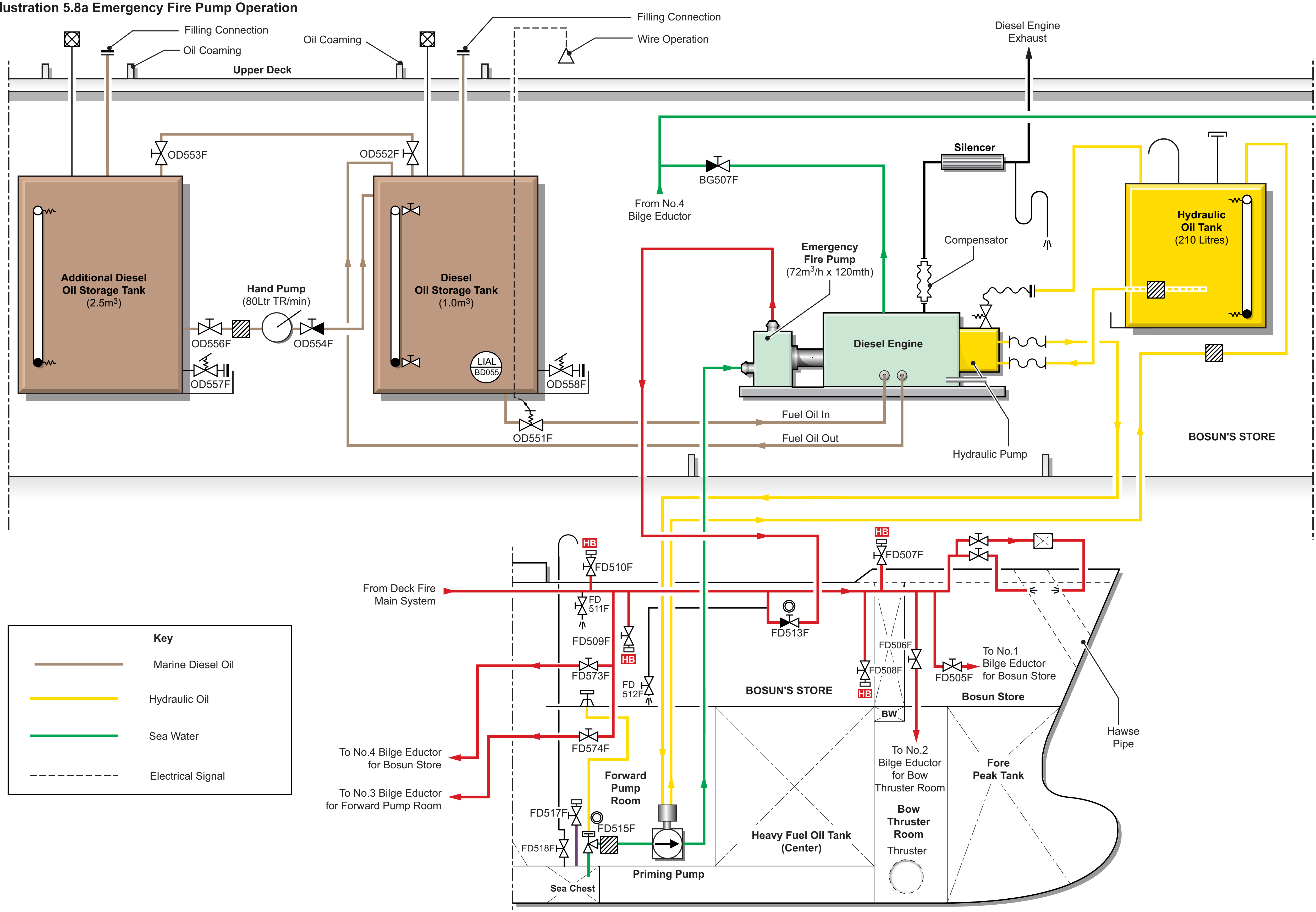
Procedure for Operating the Fire Control Dampers

a) In order to actuate fire dampers the main fire damper pilot valve, located at the emergency shut off cabinet in the fire control station, must be operated by pressing the valve lever in order to vent the air line. Dampers will close under the action of their counterweights when air is vented from their cylinders. Operation of the local pilot valves has the same effect.

b) To open fire dampers the pilot valve lever must be returned to the open position and the dampers will open under the action of compressed air on the cylinder pistons.

Quick-Closing Valves Air Cylinder and Operating Valve Cabinet in Fire Control Station

Illustration 5.8a Emergency Fire Pump Operation



5.8 EMERGENCY FIRE PUMP OPERATION

Fire Pump System

Maker: Ellehammer Laboratorium AS

Diesel Engine

Maker: Cummins
Type: 4B3, 9 - 4 cylinder, 4 stroke, water cooled
Power: 56kW at 2,500 rpm

Main Pump

Maker: Iron Pump A/S
Type: CN100-100/315
Capacity: $72m^3/h$ at 97mth

Priming Pump

Maker: Iron Pump A/S
Type: CNLB 100-100/200
Capacity: $72m^3/h$ at 23mth

Hydraulic Pump

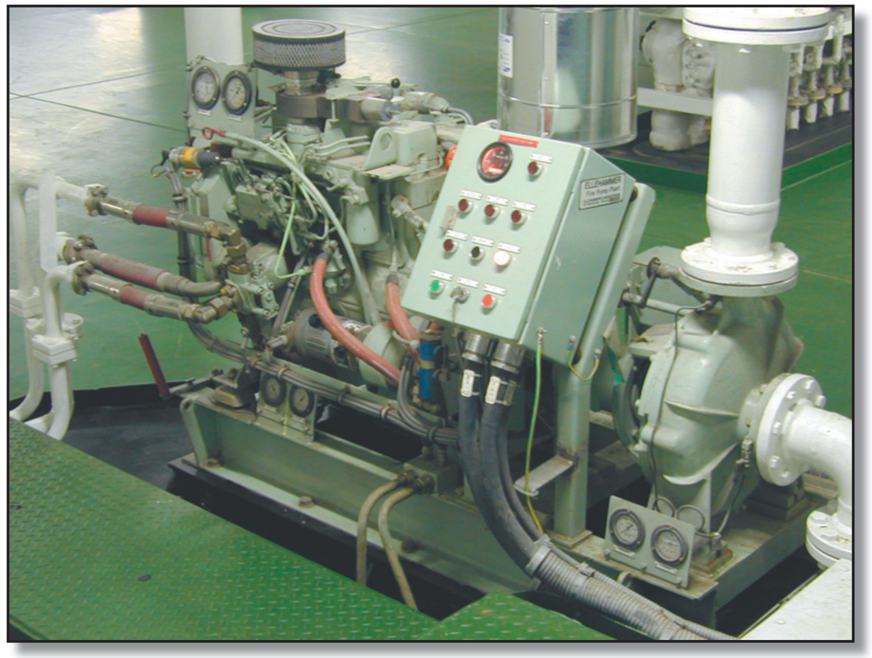
Maker: Denison Hydraulics
Type: TB-008-4-R-01-A-1-01
Working pressure: 12MPa

Hydraulic Motor for Feeding Pump

Maker: Denison Hydraulics
Type: M4C1-024
Working pressure: 12MPa

Safety Valve

Maker: Denison Hydraulics
Type: R5V 06



Emergency Fire Pump

Introduction

The emergency fire pump is located in the bosun's store. The drive unit consists of a diesel engine, which drives the main pump, and the hydraulic pump which powers the hydraulic motor driving the priming pump. The diesel engine, main fire pump, hydraulic pump and oil tank are located in the bosun's store.

The priming pump and its hydraulic drive motor are located at the bottom of the forward pump room below the waterline and it ensures that the main fire pump is supplied with water no matter what the draught of the ship.

The emergency fire pump supplies water to the fire main and wash deck line.

The diesel engine can be started by an electric starter motor which is supplied by a battery, maintained on charge at all times or by a spring inertia starter. The engine is fresh water cooled with a fresh water/sea water heat exchanger cooled via a connection from the main fire pump.

The fire pump engine and hydraulic system are fitted with alarms as follows:

- High engine temperature - 100°C
- Low lubricating oil pressure - 170kPa
- Overspeed - 2,875 rpm
- Heater failure
- Start failure
- Battery charger failure
- High pressure FO pipes leak

The overspeed results in automatic shutdown.

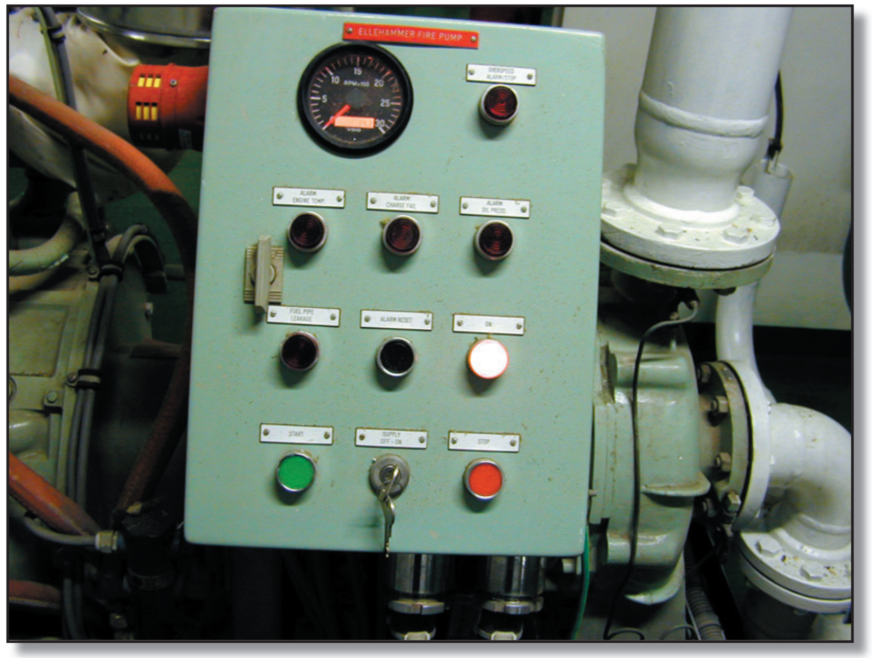
The emergency fire pump may be started locally or remotely from the fire control station and the bridge emergency console. There is no operation from the IAS. When the fire pump starts it also starts the forward pump room ventilation fan.

For the pump to be able to operate in remote mode, the supply key switch at the local control panel must be turned to the ON position.

In order to allow for operation of the emergency fire pump at any time the priming pump sea suction valve FD515F at the bottom of the forward pump room and the main pump discharge valve FD513F must be locked open.

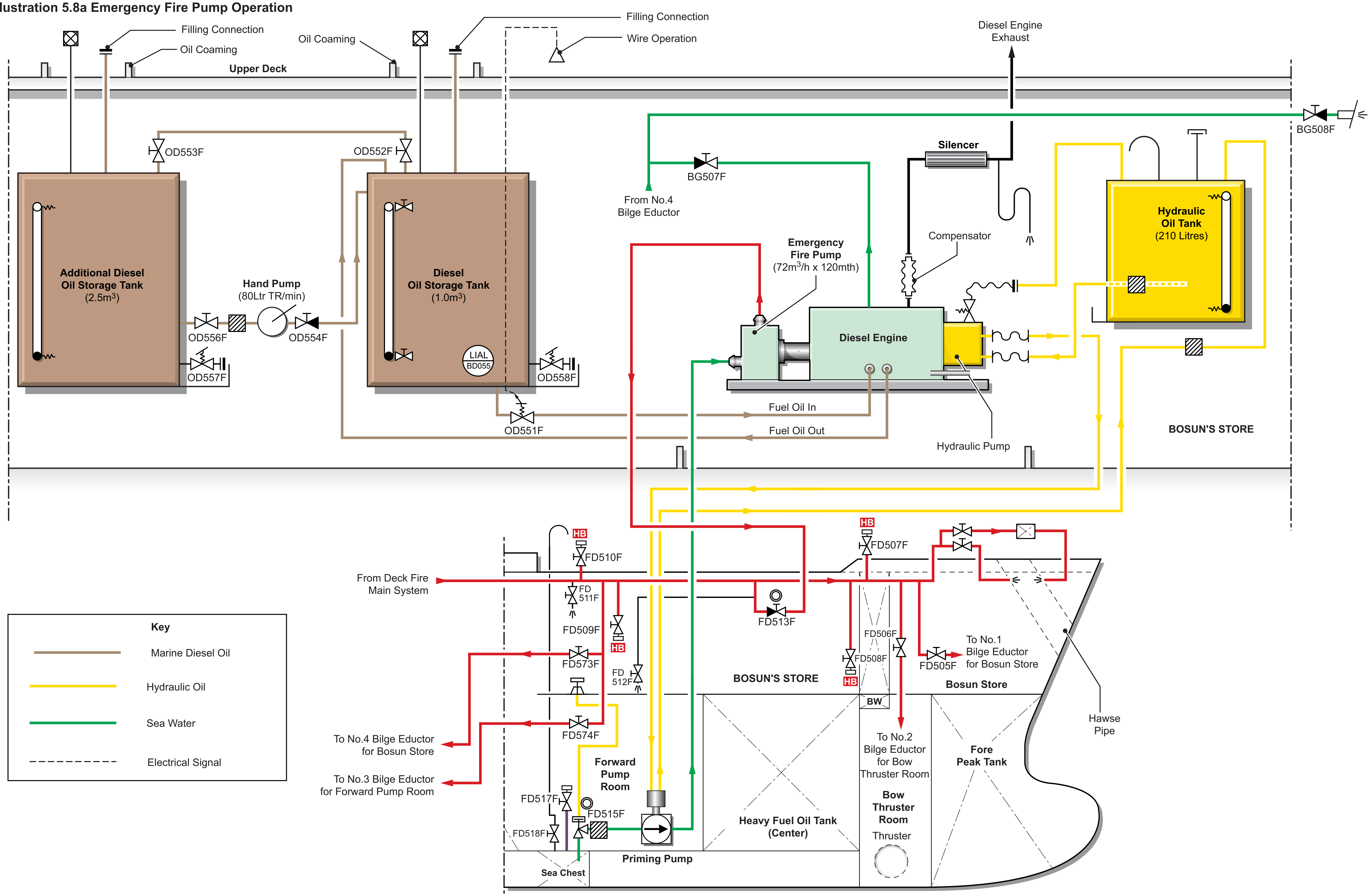
Because the pump may be called upon to operate at any time, it is essential that the drive engine and hydraulic motor/pump system are capable of immediate operation and the following checks must be made at intervals not exceeding one week:

1. The level of fuel in the fuel tank must be checked frequently and the tank replenished as necessary.
2. The hydraulic oil tank must be checked and replenished as required and the hydraulic system checked for leaks.
3. The engine coolant and lubricating oil levels must be checked and the systems checked for leaks.
4. The battery charger is operational and the battery system is fully charged.



Emergency Fire Pump Electric Start Panel

Illustration 5.8a Emergency Fire Pump Operation



Procedure for Local Operation of the Emergency Fire Pump

To Electrically Start the Emergency Fire Pump

a) Check the fuel, oil, water and battery systems and rectify any shortages if necessary.

b) At the starting panel, press the START pushbutton. The engine will continue to crank over whilst the start button is pressed

c) When the engine fires the START pushbutton is released. The engine will run up to speed and the RUNNING lamp will be illuminated.

d) The feeding pump will supply water to the main pump and the main pump will deliver water at the required pressure to the fire main.

At normal running conditions the LO pressure is 380kPa and the cooling water pressure is 200kPa.

To Stop the Emergency Fire Pump

a) Press the STOP button at the local control panel.

In an emergency, if the control system is not operating, the engine may be stopped at the governor control. Move the governor stop lever to the STOP position and keep it there until the engine has stopped.

When the engine has stopped check all systems and replenish fuel, lubricating/ hydraulic oil and cooling water as necessary.

Procedure for Remote Operation of the Emergency Fire Pump

To start the emergency fire pump from either the fire control station or the bridge emergency console.

a) In order for the emergency fire pump to be started remotely, the supply key switch at the local control panel must be turned to the ON position. The REMOTE lamp will illuminate at the control stations.

b) Press the LAMP TEST pushbutton to check the operation of lamps on the remote control panel.

c) In the fire control station and at the bridge emergency console., turn the START key switch to the right, push inwards and turn to the right again. The engine will start, run up to speed and the hydraulic pump will operate. The running lamp will be illuminated.

d) The feeding pump will supply water to the main pump and the main pump will deliver water at the required pressure to the fire main.

To Stop the Emergency Fire Pump

a) Press the STOP button at the local control panel.

Procedure for Starting the Emergency Fire Pump Engine using the Inertia Starter

Assuming that the electric start system is not available, the inertia starter can be used.

(**Note:** Ensure that the engine is not in the decompressed condition before operating the inertia starter.)

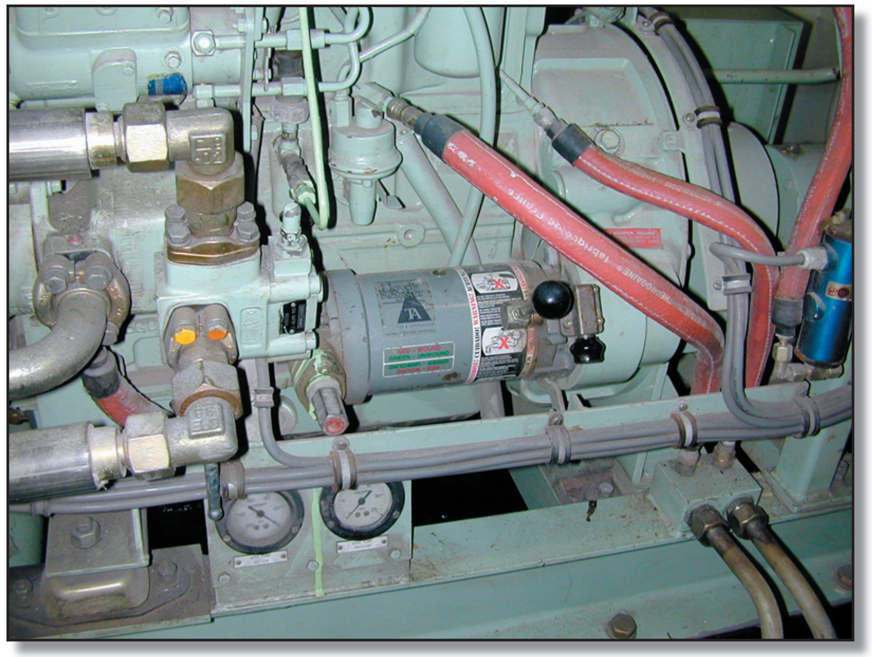
a) Press the RESET pushbutton on the inertia.starter.

b) Fit the crank handle in place and wind in a clockwise direction.

c) The small sight glass on the top of the inertia starter will show green before the winding process starts, but eventually a white line will appear followed by a red line. When the white line is at the centre of the sight glass the inertia starter is fully charged.

d) Remove the handle and pull the operating lever in the downwards direction.

This will cause the engine to turn and start

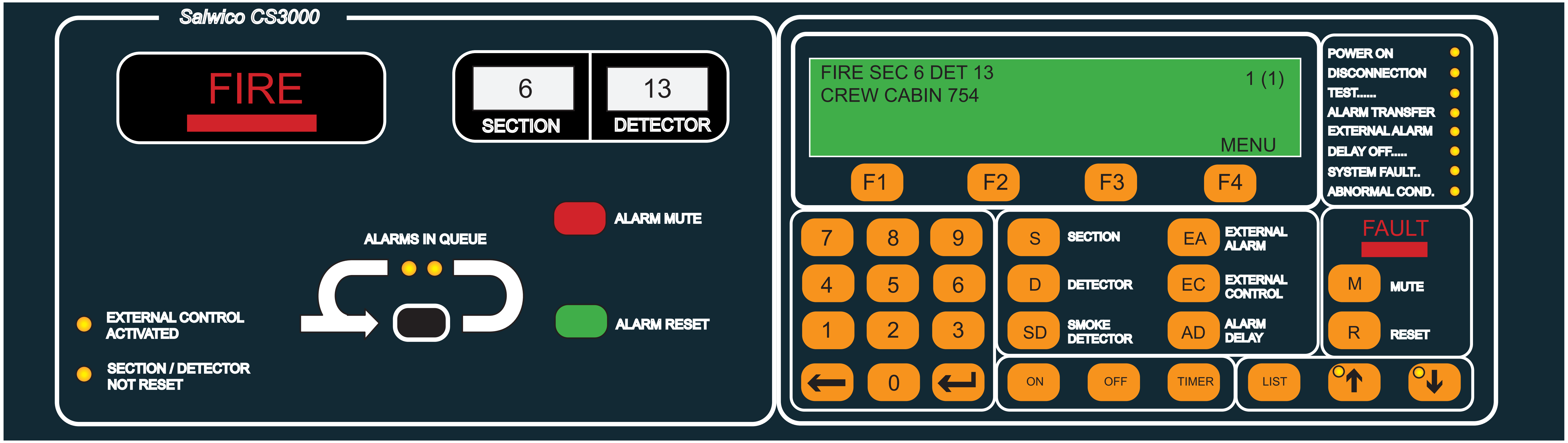


Emergency Fire Pump Inertia Starter

Emergency Fire Pump - Priming Pump in Forward Pump Room

Illustration 5.9a Fire Detection Panel

Central Unit Panel



Fire Alarm Panel

Operating Panel

5.9 FIRE DETECTION SYSTEM

Maker: Consilium Marine
Type: CS 3000 Salwico Fire Detection System

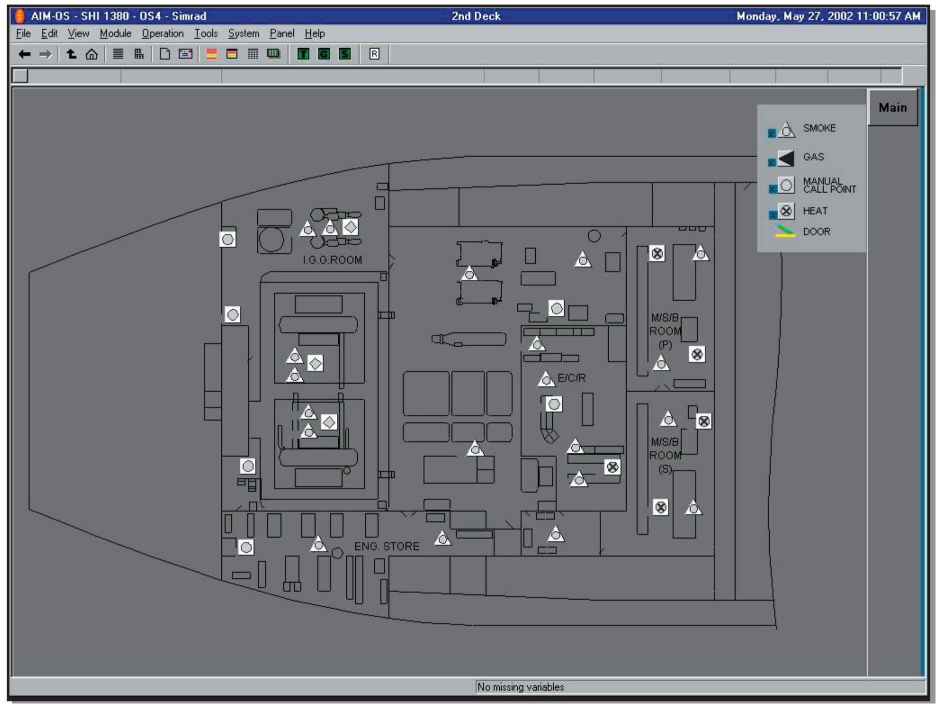
General Description

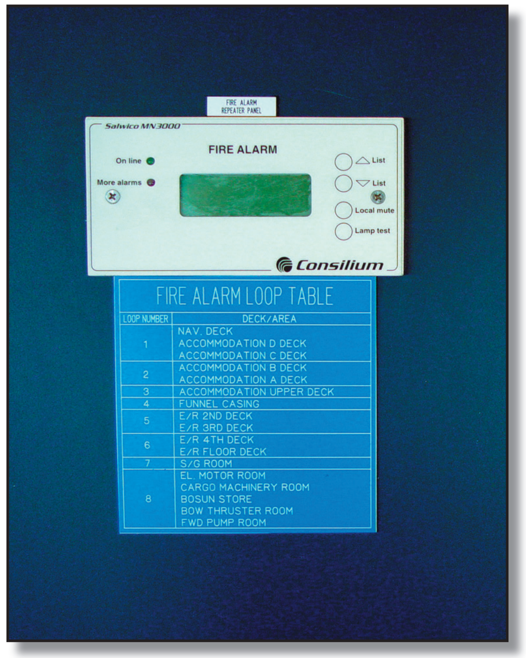
The CS3000 Fire Detection system is a computerised, fully addressable analogue fire alarm system with analogue detectors. The operating panel, control unit and power supply are contained in a central cabinet in the fire control station on the upper deck port side of the accommodation. There are 8 detector loops connected to the system with a 7.2Ah battery back-up in the event of a power failure. The fire detection system has a direct input into the IAS for recording any alarms, faults and disconnections. The digital outputs of the system are used to stop the ventilation fans, release the fire doors and operate the water mist system see section 5.6. The system operates the water spray system when two detectors are activated in a protected area. The system is looped to the gas sampling and alarm system and to the IAS cabinet in the electrical equipment room on A deck.

The Salwico CS3000 comprises a wide range of detectors and sensors to suit different needs and conditions. It includes detectors for different alarm parameters, for example, smoke, heat and flames. Manual call points, short circuit isolators and a timer are connected to the loop where required. A fault in the system or a false alarm is detected immediately since the function of the detectors and other installed loop units are automatically and continuously tested.

The fire alarm repeater alarm unit, type MN3000 is fitted in the wheelhouse safety console. The repeater panel allows the ship's staff to monitor alarms and scroll through alarms in the queue list but not to accept any alarms or perform any disconnections or reconnections. The system can also identify defective detectors in each loop.

The system can be monitored via the IAS and a typical screen display is shown here.





Fire Alarm Repeater Unit on Wheelhouse Safety Console

Central Unit Panel

The central unit panel is divided into two parts, the fire alarm panel and the operating panel. The fire alarm panel is activated when there is a fire alarm in the system. The operator verifies and supervises the system by using the different keys and the display on the operating panel.

Fire Alarm Panel

The fire alarm panel is activated when a fire alarm is detected on the system.

The FIRE indicator flashes and the section number and detector address in alarm are displayed on the numeric display.

Keys	**Operation**
ALARM MUTE:	This key is used to acknowledge the fire alarm and mute the buzzers.
ALARM RESET:	This key is used to reset the fire alarm.
ALARMS IN QUEUE:	LEDs indicate multiple alarms which can be scrolled through using this key. Each alarm is listed in the alphanumeric display.

Indicators	**Description**
EXT. CONTROL ACTIVATED:	LED indicating that an external control output is active.
SECTION/DETECTOR NOT RESET:	LED indicating that an alarm reset has been attempted but failed. (Detector still in alarm)

Operating Panel

The operating panel is used for controlling the system and to display extra information in case of a fire alarm. The alphanumeric display is used as a complement to the numeric display on the fire alarm panel, as a communication medium when operating the system and to display guiding texts for the function keys. Under normal conditions, when the central unit is in normal status, the text ‘Salwico CS3000’ is displayed together with the date and time.

Keys	Operation
F1, F2, F3, F4:	Function keys, used for choosing functions from the menus in the display and for entering certain characters with no keys of their own.
0-9:	Numeric keys.
Correction key:	The last key stroke is erased.
Return key:	The system returns to normal status, 'Salwico CS30000' is displayed.
S, D, SD, EA, AD:	Command keys used to choose the unit (section/detector no. etc) to operate.
MUTE:	Fault handling key used to acknowledge faults and to mute the buzzers.
RESET:	Fault handling key used to reset the faults.
ON, OFF, TIMER:	Operation keys used to choose the operation to perform.
LIST:	List handling keys, the LIST key is used to open the list function. The arrow keys are used to scroll through the lists.

Indicators	Description
POWER ON:	Illuminated when the power is on.
DISCONNECTION:	General disconnection of detectors indicator.
TEST:	Is lit when the central unit is in test mode.
ALARM TRANSFER:	Is lit when the dedicated fire output is activated (steady light) and is flashing when the door is open, the fire output is deactivated.
EXTERNAL ALARM:	Is lit when an external alarm output is disconnected or faulty.
DELAY OFF:	Is lit when the time delay is deactivated.
SYSTEM FAULT:	Is lit when a fault occurs in the system.
ABNORMAL COND:	Is lit when an abnormal condition has occurred.

System Operation

Detection of a Fire Alarm

FIRE lamp is flashing: A fire alarm is detected in the system.

a) Press ALARM MUTE, to mute and acknowledge the fire alarm.

b) The FIRE indicator stops blinking and becomes steady red. The audible fire alarm, including the internal buzzer is permanently silenced when the ALARM MUTE is pressed.

c) The section number and detector address in alarm are displayed on the fire alarm panel and on the alphanumerical display on the operating panel.

d) The section number and the detector address are displayed on the first line and additional information about the location is displayed on the second line, if provided.

ALARMS IN QUEUE lamp is flashing. There is more than one fire alarm in the system.

a) Press ALARM MUTE repeatedly, to mute and acknowledge all the fire alarms.

b) The FIRE and ALARMS IN QUEUE indicators stop flashing and become steady red when all the fire alarms are muted. The audible fire alarm is permanently silenced when the ALARM MUTE is pressed.

c) The section number and detector address in alarm are displayed on the fire alarm panel and on the alphanumerical display on the operating panel.

d) The address of the first fire alarm is displayed on the first line and additional information about the alarming unit is displayed on the second line, if provided. The address of the latest fire alarm is displayed on the third line and additional information about this unit is displayed on the fourth line. The total number of fire alarms is shown to the right on line one.

e) Press the ALARMS IN QUEUE button to display the next fire alarm.

f) The second fire alarm address is displayed both on the fire alarm panel and on the alphanumerical display. The fire alarm is presented on the two first lines on the display. Five seconds after pressing ALARMS IN QUEUE, the first fire alarm is displayed again.

g) If ALARMS IN QUEUE is pressed when the last fire alarm is displayed, the first fire alarm is displayed again and the ALARMS IN QUEUE indicator goes out for 5 seconds.

Reset Fire Alarm

Only one fire alarm can be reset at a time, i.e. the displayed fire alarm.

a) Press the ALARMS IN QUEUE button repeatedly to select the appropriate fire alarm.

b) Press ALARM RESET to reset the fire alarm. The system tries to reset the fire alarm.

c) When a fire alarm is reset it disappears from the display and the fire alarm is moved to the fire alarm history list. The next fire alarm is then displayed or if there are no more fire alarms the system returns to normal status, 'Salwico CS3004' is displayed with date and time.

d) If the fire alarm does not reset, the reason is displayed on line three. The indicator SECTION/DET NOT RESET is displayed. This could be because the detector still detects high levels of smoke, fumes and/or ionisation etc. The actual detector may also be faulty and should be investigated.

Fire Alarms That Do Not Reset

A detector that cannot be reset can be listed in two ways. Press the LIST or ALARMS IN QUEUE key.

The ALARMS IN QUEUE key can only list the non-resettable fire alarms if all fire alarms are acknowledged and reset (ie the ALARMS IN QUEUE LEDs are not lit) and if all faults are acknowledged. If this is not the case, the ALARMS IN QUEUE key will only list the fire alarms that are not reset.

a) Press ALARMS IN QUEUE repeatedly to select the appropriate fire alarm. The fire alarm address is displayed on the fire alarm panel and the operating panel alphanumerical display.

b) Press ALARM RESET. The system tries to reset the fire alarm.

If no key is depressed for about 60 seconds the display returns to the first non-resettable fire alarm. If the fire alarm is reset it disappears from the display and from the fire alarm list. The display then returns to the next fire alarm or if there are no more fire alarms it returns to normal status, 'Salwico CS3004' is displayed. If the alarm does not reset, the reason is displayed on line three. The problem should be investigated. The non-resettable fire alarm is displayed again.

The LIST key can always be used regardless of system status. Pressing LIST shows the fire alarms one by one on the first line of the alphanumerical display. They can then be reset in the normal way one by one. If the alarm does not reset, the reason is displayed on line three. The problem should be investigated. The not resettable fire alarm is displayed again.

Fault Indication

The FAULT indicator is flashing and the internal buzzer is sounding. One or more faults are detected in the system and the latest fault is displayed on the alphanumeric display. The first line displays the word FAULT, a fault code followed by the section number, the detector address, and a fault message. Additional text is displayed on line two, if provided The fault codes are listed in the manufacturer's manual. Only one fault can be acknowledged at a time. Press M in the FAULT field to acknowledge the fault and mute the buzzer.

The FAULT indication stops flashing and becomes steady yellow. The internal buzzer is permanently silenced. The fault is placed in a fault list and the alphanumeric display is erased. The next fault is displayed if there are more faults. Otherwise the display is erased and it returns to its previous status. The number of faults in the system and the order they occurred is displayed on line three. The fault list can be scrolled through by using the up and down arrow keys.

To Reset Faults

a) Press LIST to open the list function, Faults can only be reset from the fault list.

b) Press F2 to select the fault list. The latest fault is always displayed first. The fault list can be scrolled through using the list key. The LED on the arrow key is lit if there are more faults to be listed.

c) Press the arrow keys until the appropriate fault is displayed.

d) Press R in the FAULT field to reset the fault. The system attempts to reset the fault.

e) The fault is reset if it disappears from the list. The next fault is displayed after about 5 seconds. If the fault list is empty, the text LIST EMPTY is displayed, and the system returns to normal status, 'Salwico CS3000' is displayed. If the fault is not reset, the reason is displayed on line three. Investigation is required.

Disconnections

Different parts of the fire alarm system can be disconnected for instance, sections, detectors, manual call points, section units, alarm devices, external control devices and loops. This can be useful when there is welding in a particular section or removal of detectors is required due to structural shipboard work etc. A whole section can be disconnected permanently or for a defined time interval using the timer function. The disconnected section can only be reconnected from the 'Disconnections' list.

When operating the system a mistake can be corrected using the BACK key to erase one step at a time backwards. To interrupt the disconnection function and return to normal status, press the RETURN key . The system returns to normal status and 'Salwico CS3000' is indicated.

Disconnection Process

a) Press S to select the section.

b) Enter a section number and the section menu is displayed.

c) Press OFF to disconnect the section.

d) When the section is disconnected the text on line three is changed to ORDER DONE.

e) The DISCONNECTION LED is lit if this is the first active disconnection in the system.

f) A message is displayed on line three, for about five seconds, if the system cannot disconnect the section. The system then returns to the previous menu.

g) Continue to define the next disconnection or, if finished, return to normal by pressing RETURN.

Further in-depth operations are available from the manufacturer's manual.

Illustration 5.9b Fire Detection Equipment and Alarms on Engine Room 2nd Deck

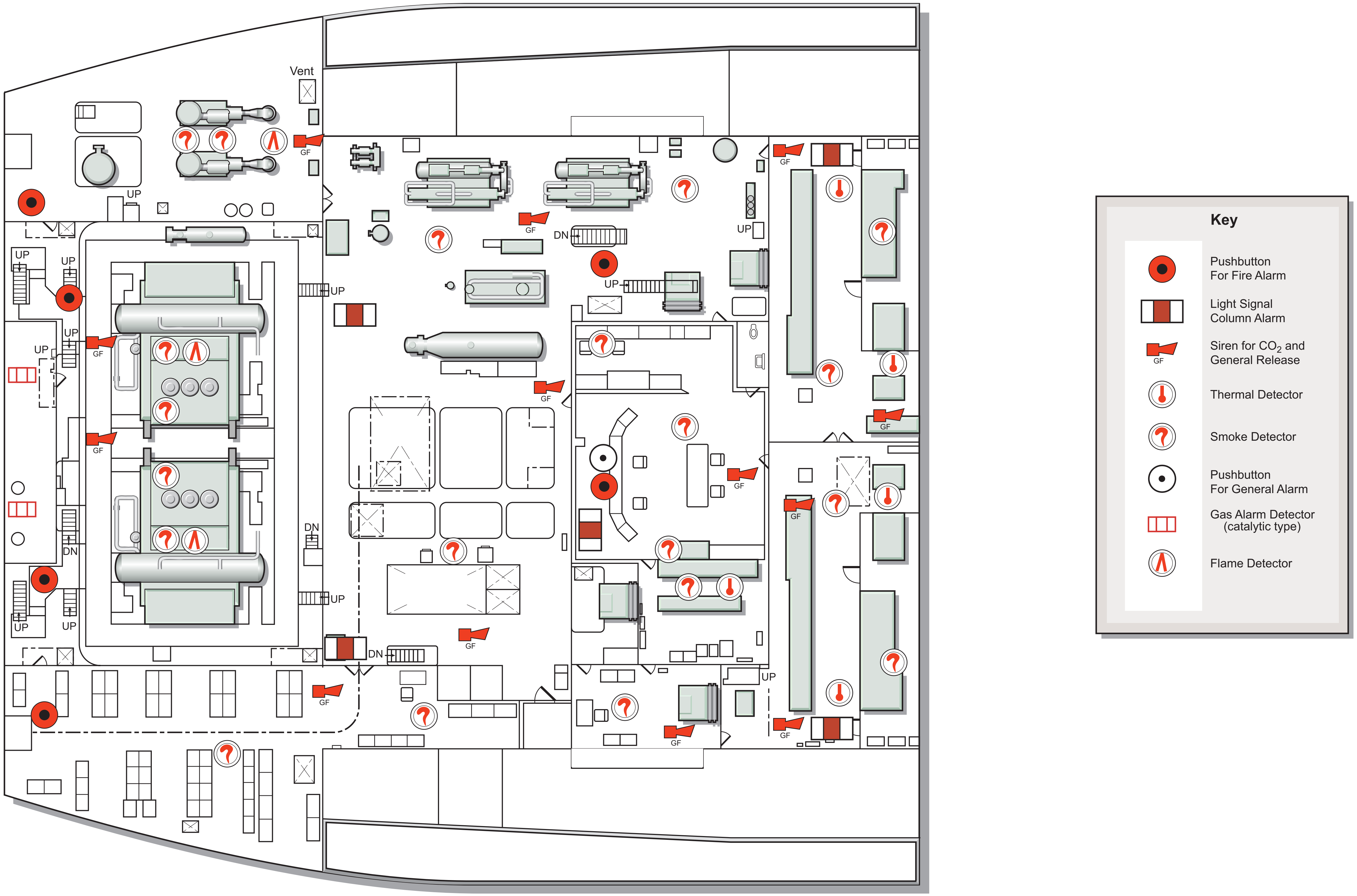


Illustration 5.9c Fire Detection Equipment and Alarms on Engine Room 3rd Deck

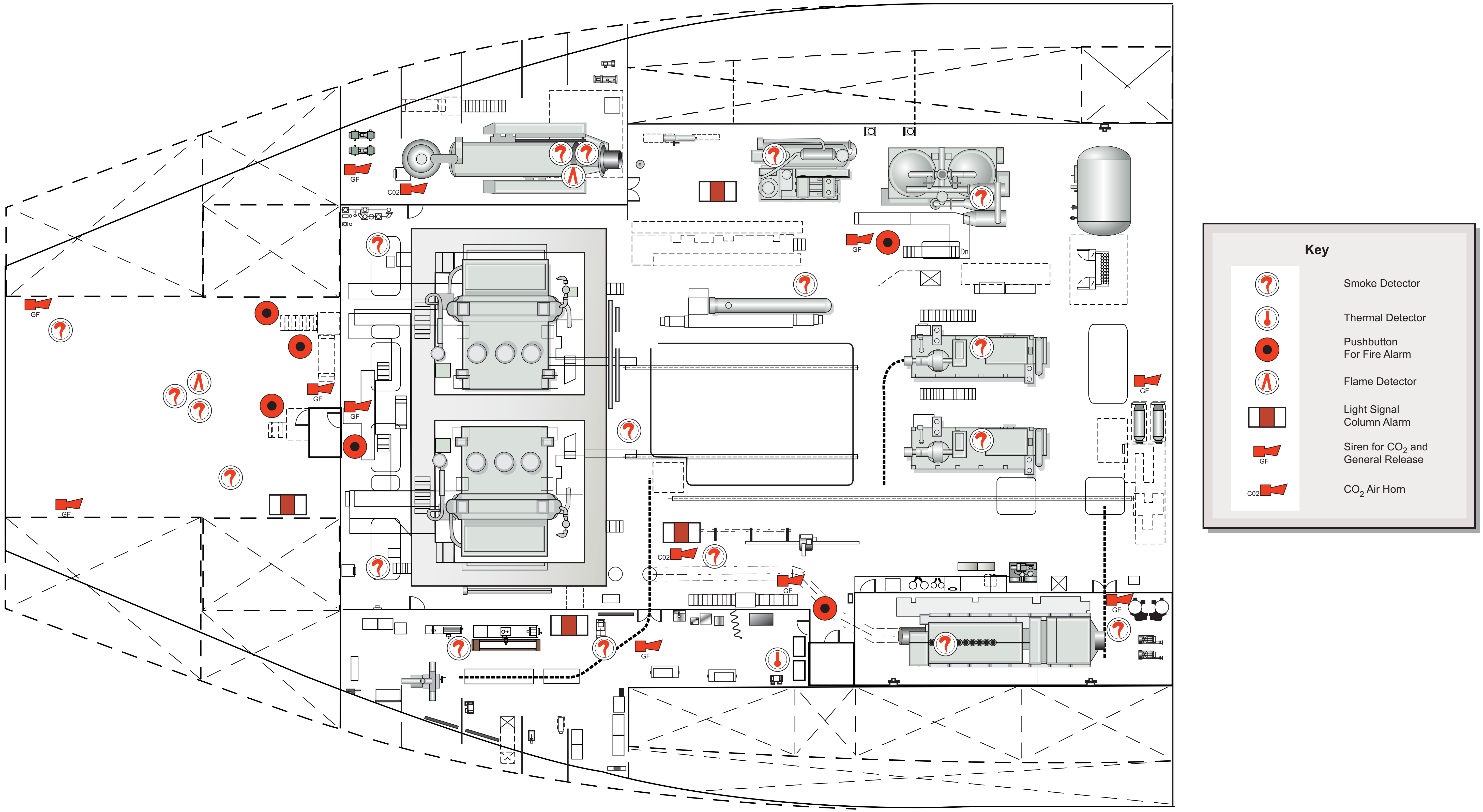
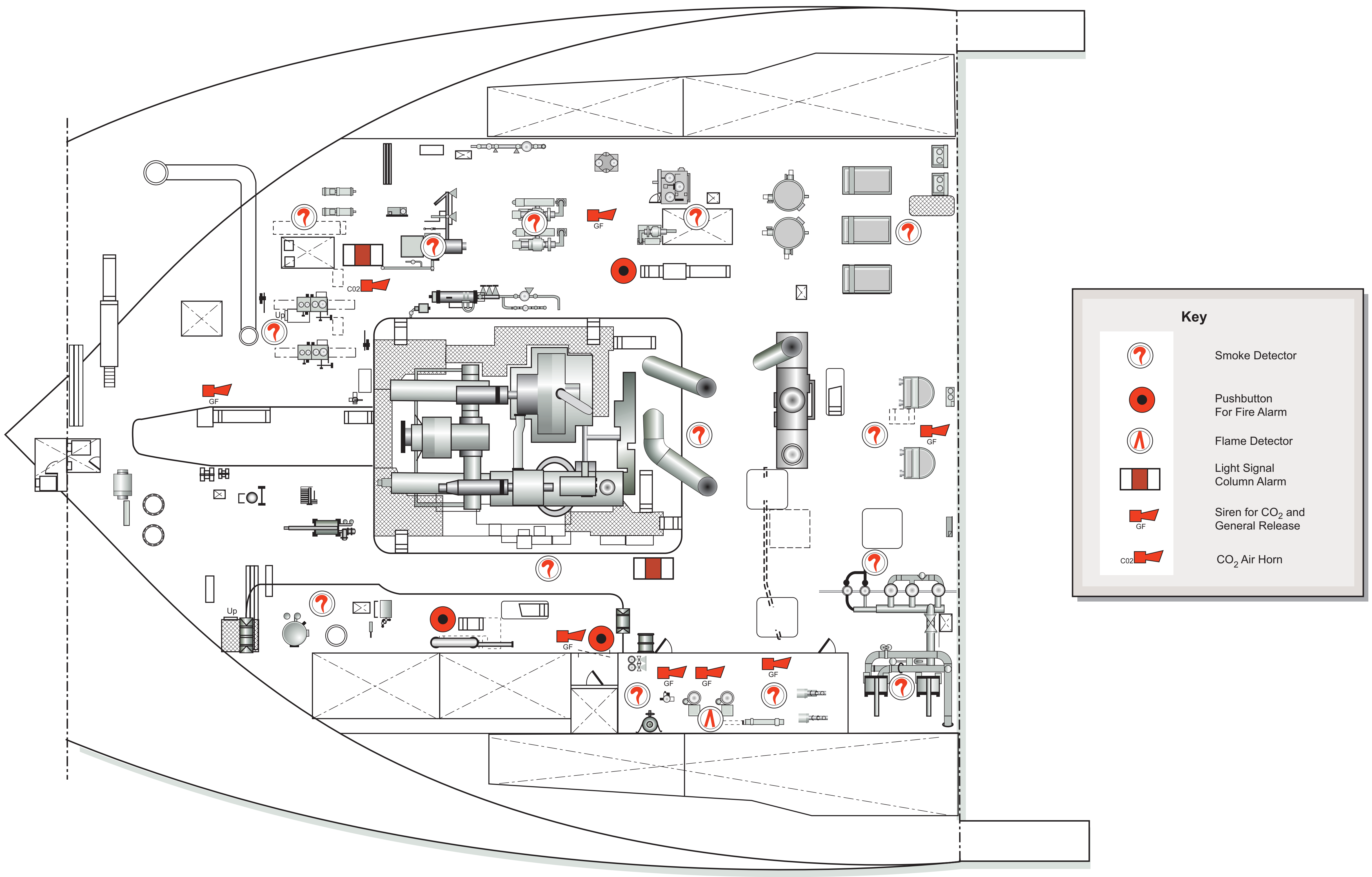


Illustration 5.9d Fire Detection Equipment and Alarms on Engine Room 4th Deck



Engine Room 4th Deck

Illustration 5.9e Fire Detection Equipment and Alarms on Engine Room Floor

5.10 ENGINE ROOM FIRE FIGHTING EQUIPMENT

Illustration 5.10a Fire Fighting Equipment on Engine Room 2nd Deck

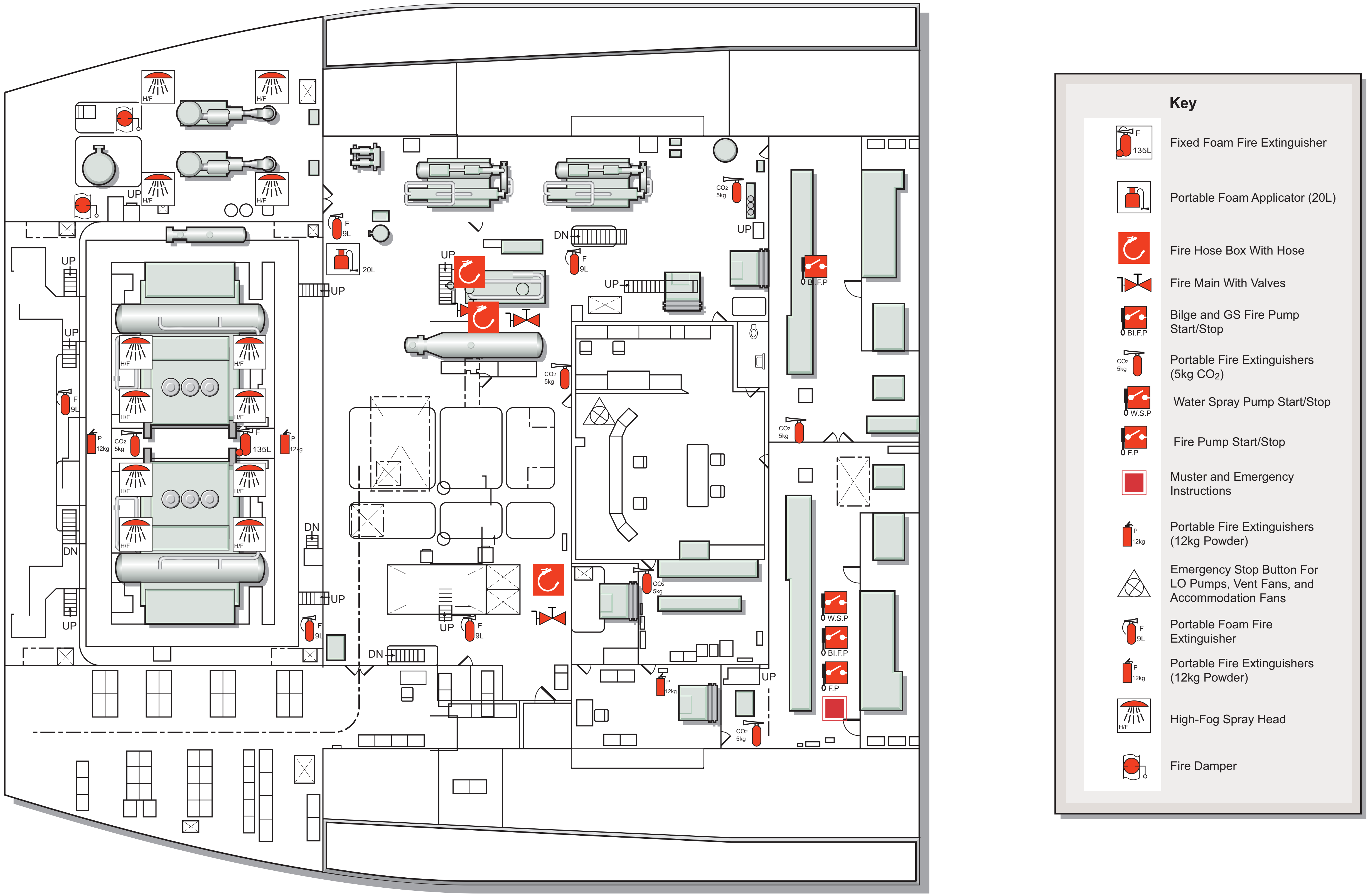


Illustration 5.10b Fire Fighting Equipment on Engine Room 3rd Deck

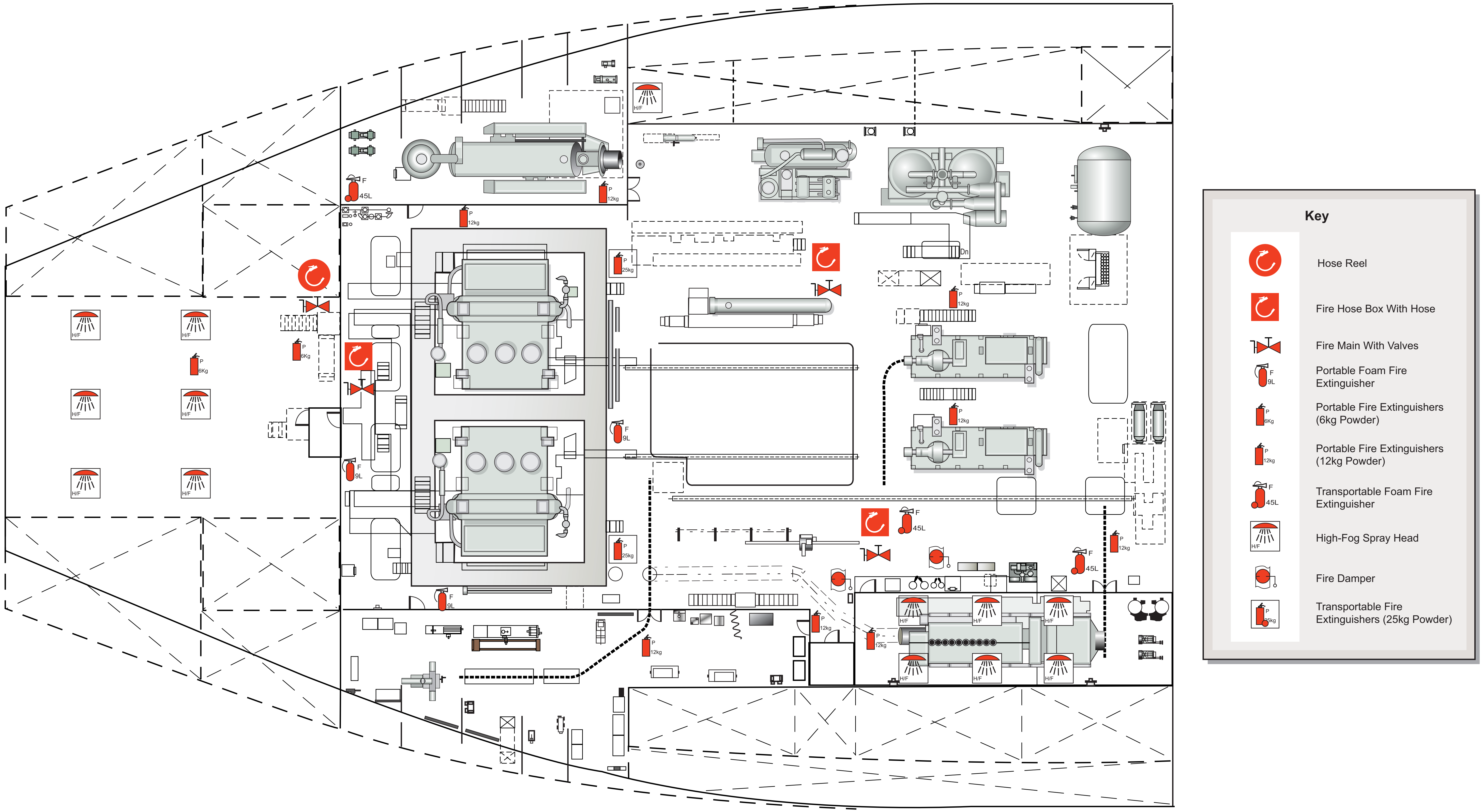
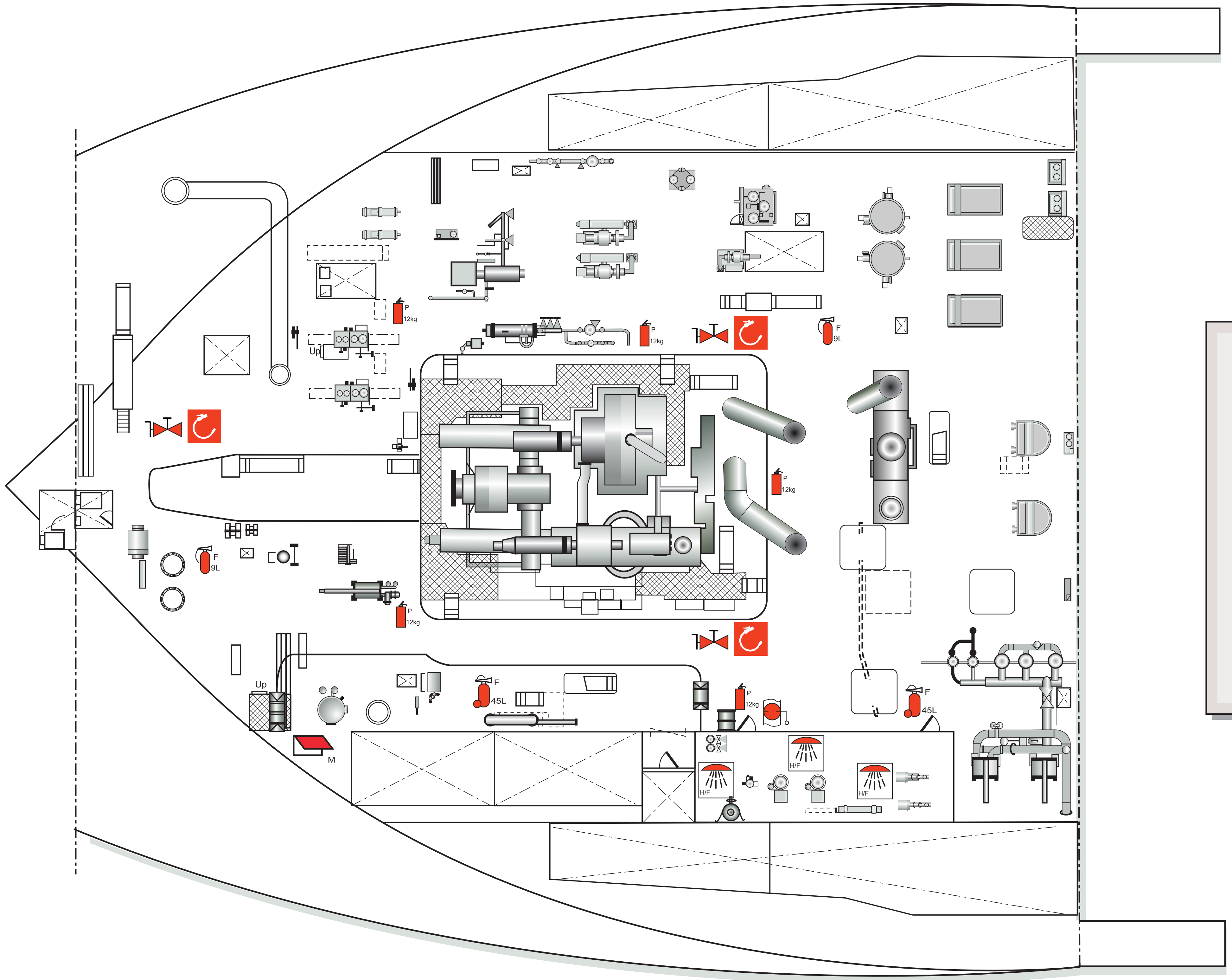
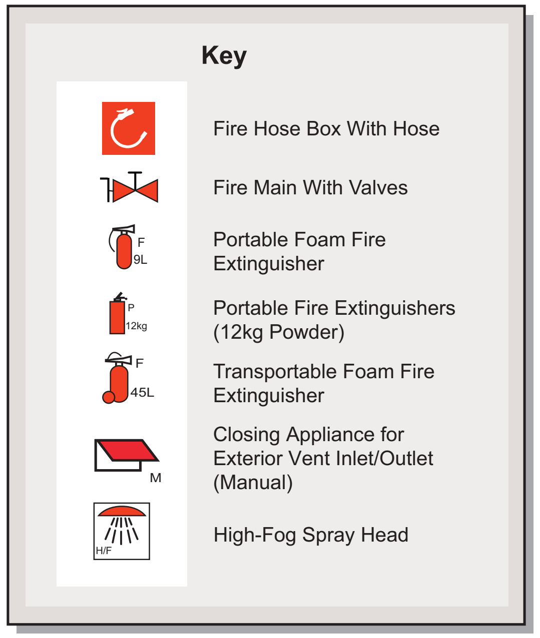


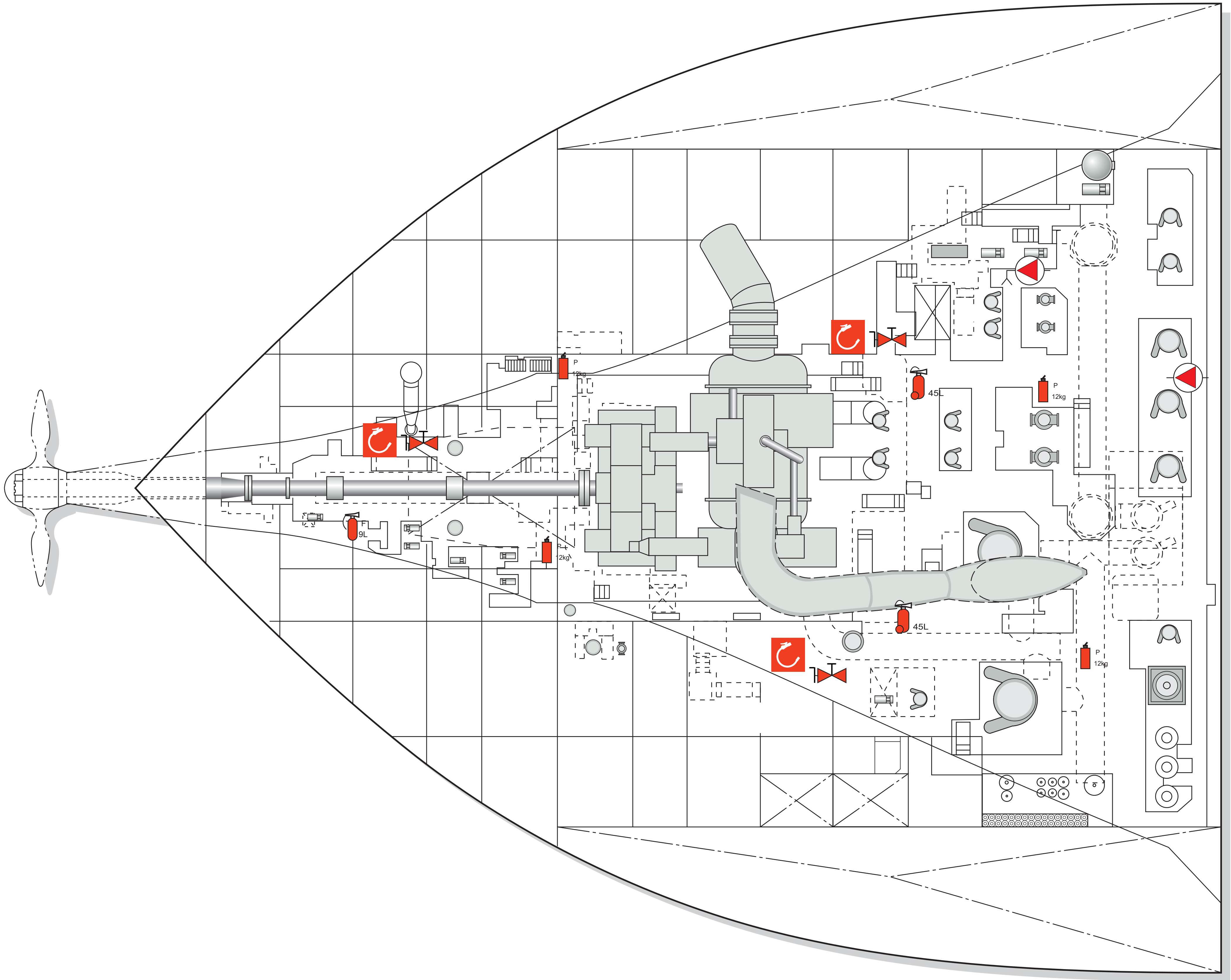
Illustration 5.10c Fire Fighting Equipment on Engine Room 4th Deck





Engine Room 4th Deck

Illustration 5.10d Fire Fighting Equipment on Engine Room Floor



Key

- Portable Foam Fire Extinguisher
- Transportable Foam Fire Extinguisher
- Portable Fire Extinguishers (12kg Powder)
- Fire Hose Box With Hose
- Fire Main With Valves
- Bilge, Fire and G/S Pump (245/150m^3/h x 5/120kg/cm^2)
- Engine Room Bilge Pump (10m^3/h x 4kg/cm^2)

5.11 ENGINE ROOM LIFESAVING EQUIPMENT

Illustration 5.11a Lifesaving Equipment and Escape Routes on Engine Room 2nd Deck

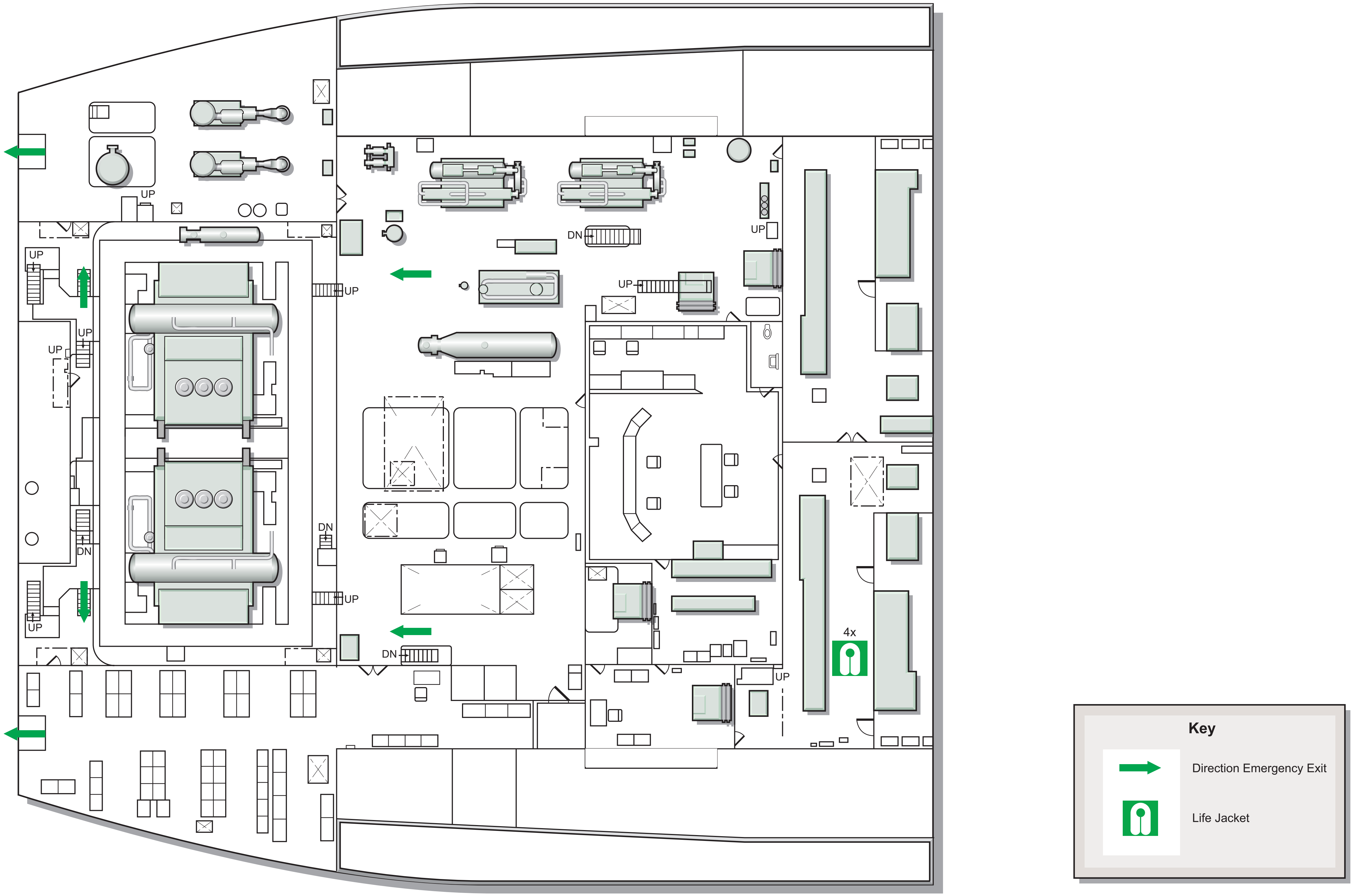


Illustration 5.11b Lifesaving Equipment and Escape Routes on Engine Room 3rd Deck

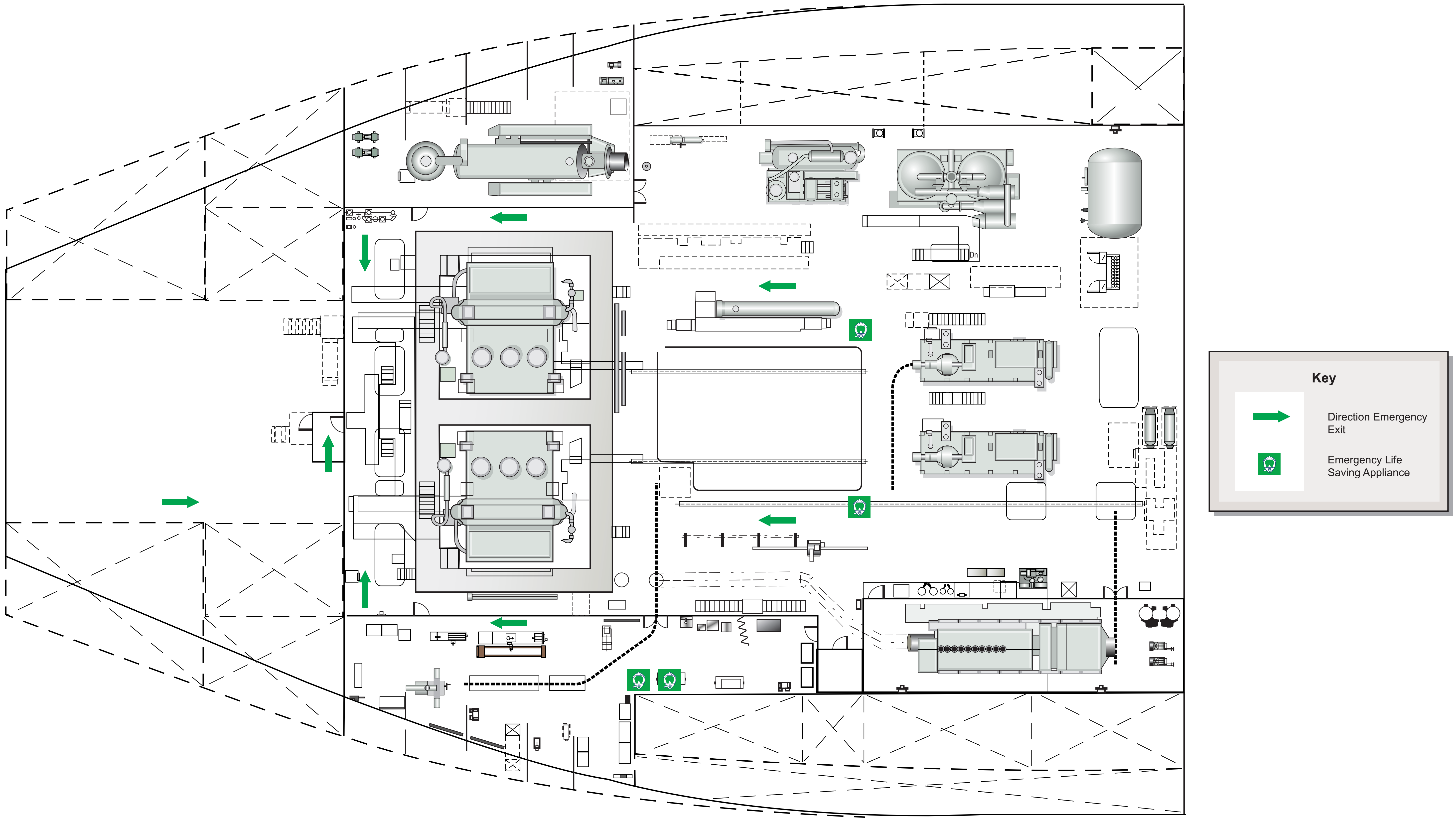
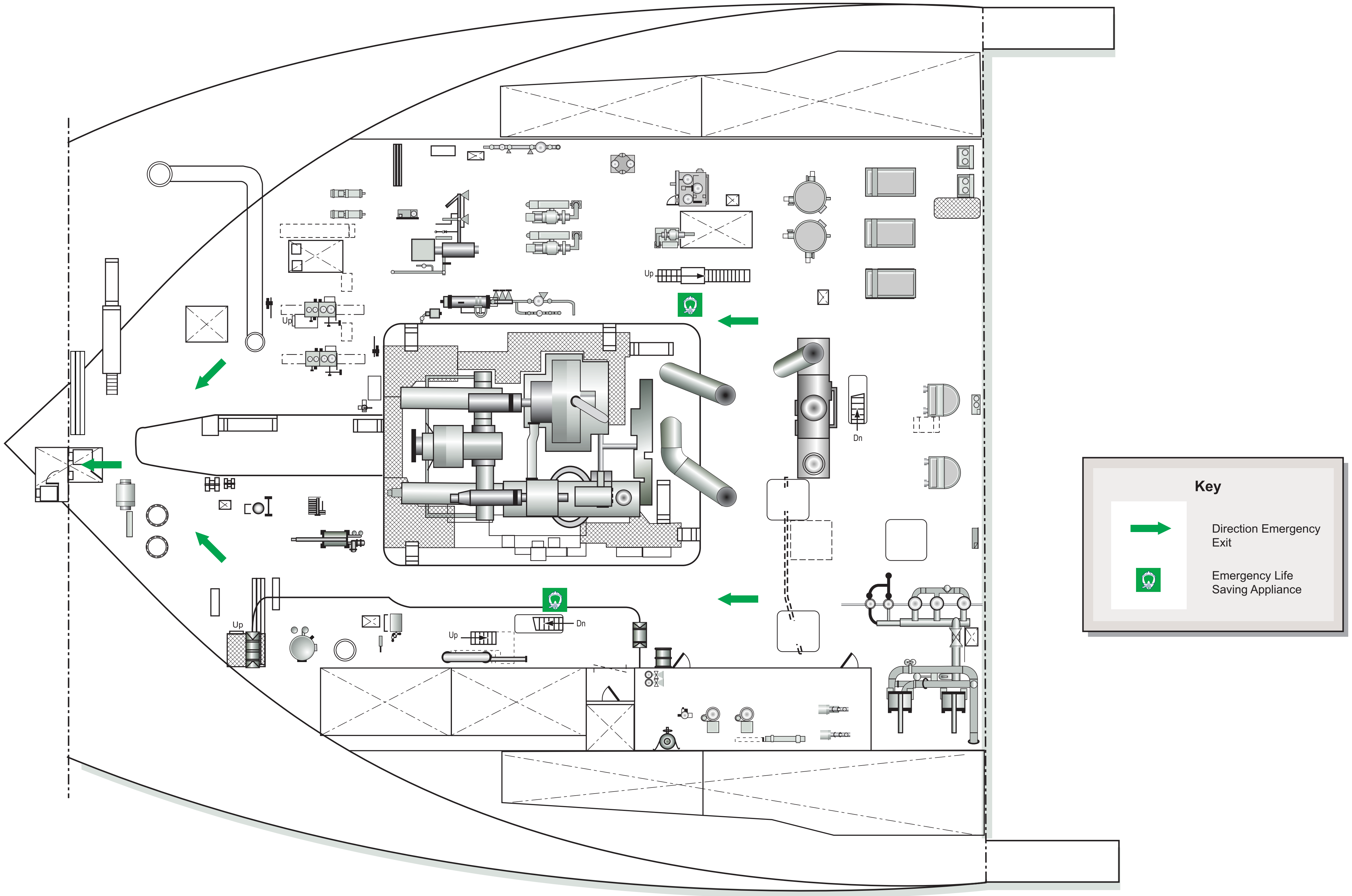


Illustration 5.11c Lifesaving Equipment and Escape Routes on Engine Room 4th Deck



Engine Room 4th Deck

Illustration 5.11d Lifesaving Equipment and Escape Routes on Engine Room Floor

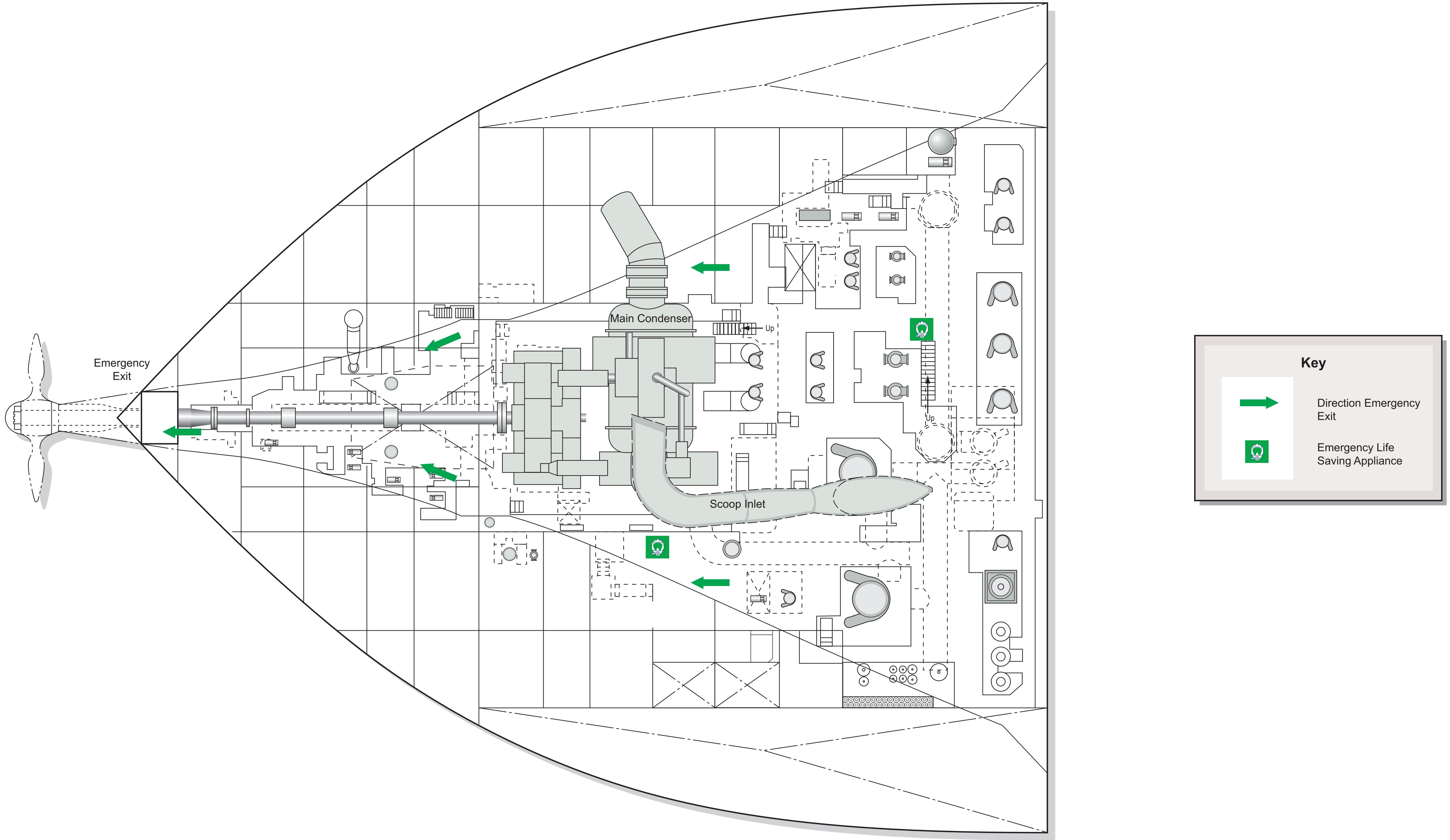
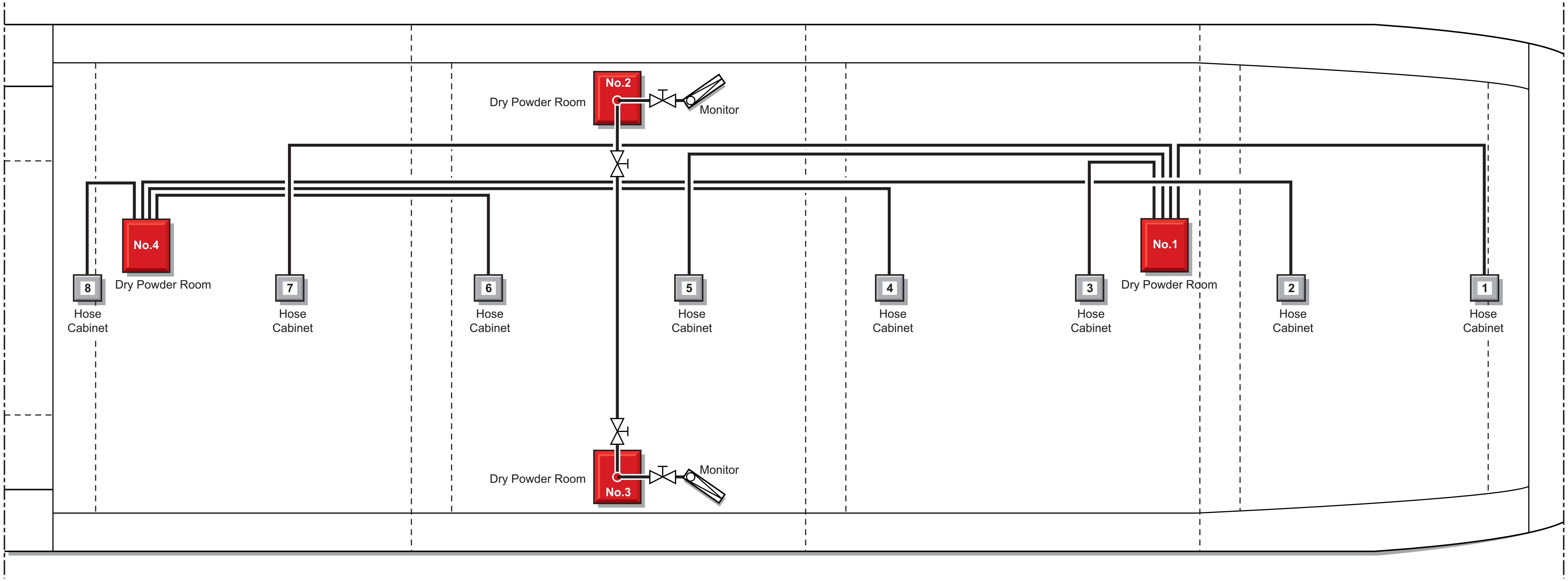


Illustration 5.12a Deck Dry Powder System



TO OPERATE DRY POWDER

Monitor Release Cabinet

1. Open this door.
2. Open one cylinder valve.
3. Open ball valve.
4. Now System is operated.
5. If dry powder did not discharge go to the dry powder unit and follow the emergency operation on the chart.

EMERGENCY OPERATING

1. Open valves (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 "N_2 STOP" position.
   → Stop pressurising 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 agitation valve to "OPEN" position.
6. Set No.2 control valve to "N_2 RELEASE" position. (for about 5 seconds.)
7. Set No.2 control valve "NORMAL" position. (slowly changeover)
8. Set the agitation valve to "CLOSE" position.
9. Set cleaning valve to "CLEANING" position.
10. Set No.2 control valve "N_2 RELEASE" position.
11. Set exhaust valve to "OPEN" position.
12. Return all valves to the normal positions after all nitrogen gas has been dissipated.
13. Recharge N_2 cylinders.
14. Refill dry chemical agents to dry chemical container.

Key	
———	Dry Powder

5.12 DECK 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
N_2 cylinders:	Monitor stations - 8 sets each station
	Hand units 5 sets each station
Location of sets:	Monitors - port and starboard of cargo manifold
	Hand hoses - to port of centreline each hose being 33m in length
Minimum discharge time:	60 seconds with 1 monitor and 4 hoses in operation at their specified discharge rates, this is for each dry powder tank
Capacities:	Monitor - 25kg/sec
	Hand hoses - 3.5kg/sec
	Monitor angular sweep horizontal - 360°
	Vertical - + 80° to - 40°
Monitor release positions:	6

Introduction

Monitor System

The system comprises two tanks containing the sodium bicarbarbonate 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 and 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 as 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 the most susceptable 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 turning valve handle anti-clockwise fully.

e) Open the ball valve to allow CO_2 gas to open the N_2 battery by moving handle downwards. this activates the pressurising 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 condition.

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 be required, the No.1 tank dry powder charge can be discharged via the starboard monitor as follows:

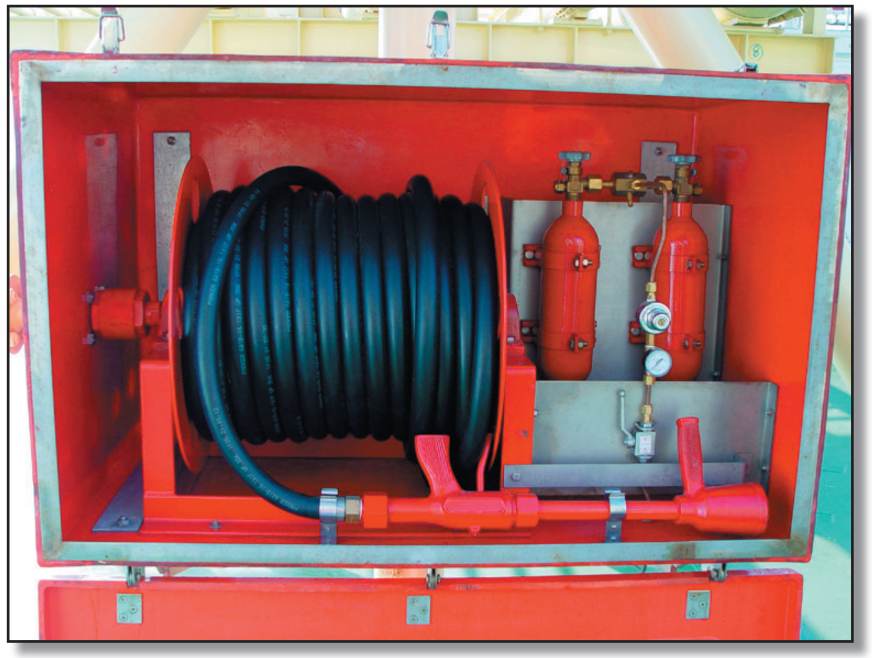
1. Opening the appropriate second starting CO_2 cylinder valve.

2. 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 be required, the No.2 tank dry powder charge can be discharged via the port monitor as follows:

1. Opening the appropriate second starting CO_2 cylinder valve.

2. Open the corresponding valve P~S in either the fire control station, cargo control room or at the port dry powder tank unit.



Deck Dry Powder Hose Cabinet

Procedure for Operating of 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 turning it fully anti-clockwise.

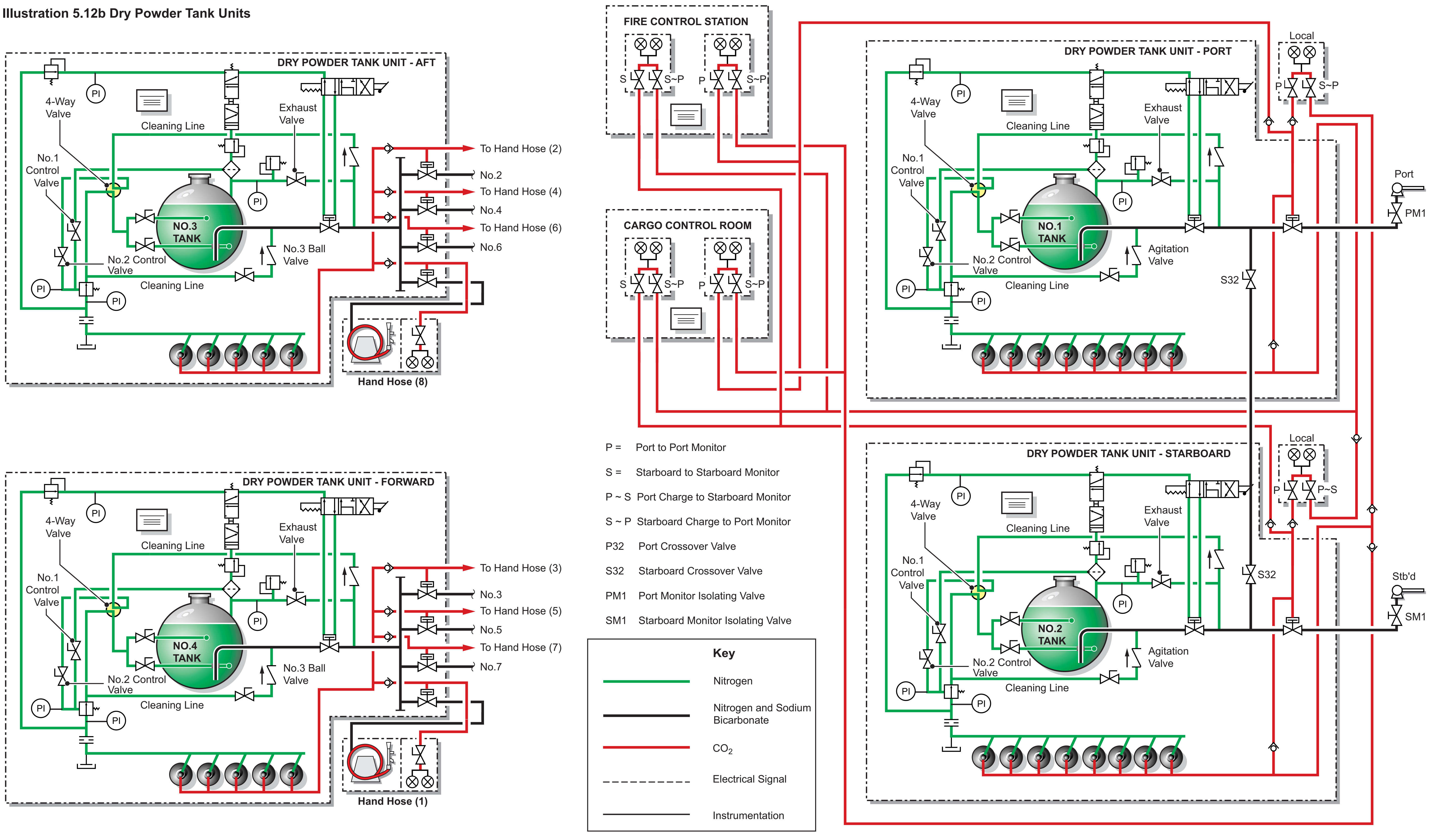
d) Open the ball valve by turning the handle downwards.

e) Pull out a complete length of hose from the drum, about 33 metres.

f) Aim the nozzle at the side of the fire scene and pull the fire nozzle trigger.

g) Sweep the dry powder jet across the fire scene from side to side.

Illustration 5.12b Dry Powder Tank Units



Precautions

- Always wear full fireproof clothing and personal protection equipment
- After opening th cabinet door the operation must begin quickly to prevent the powder caking
- Be aware of the reaction of the nozzle gun on commencing 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 the system is cleaned at once with N_2. This is to prevent any residue powder remaining in the lines thereby causing a blockage to subsequent useage. 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 pressurising 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 No.2 control valve to the N_2 RELEASE position, for about 5 seconds.

g) Set 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 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 minimise 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, again care being taken when doing this.

Closing the Main and Selection Valves

c) As these valves are operated by N_2 and CO_2 respectively to close the valves the manual operating handle is used.

(**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 release of the N_2 in the dry powder tank the tank is refilled with the correct quantity of the dry powder. This should be of the sodium bicarbonate type. No other type of of agent should be used.

e) After refilling the tank through the manhole the tank should be resecured by securing the blind flange to the tank flange. All bolts should be tightened correctly.

d) After recharging the dry powder, carry out the routine for agitating the charge 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, 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.

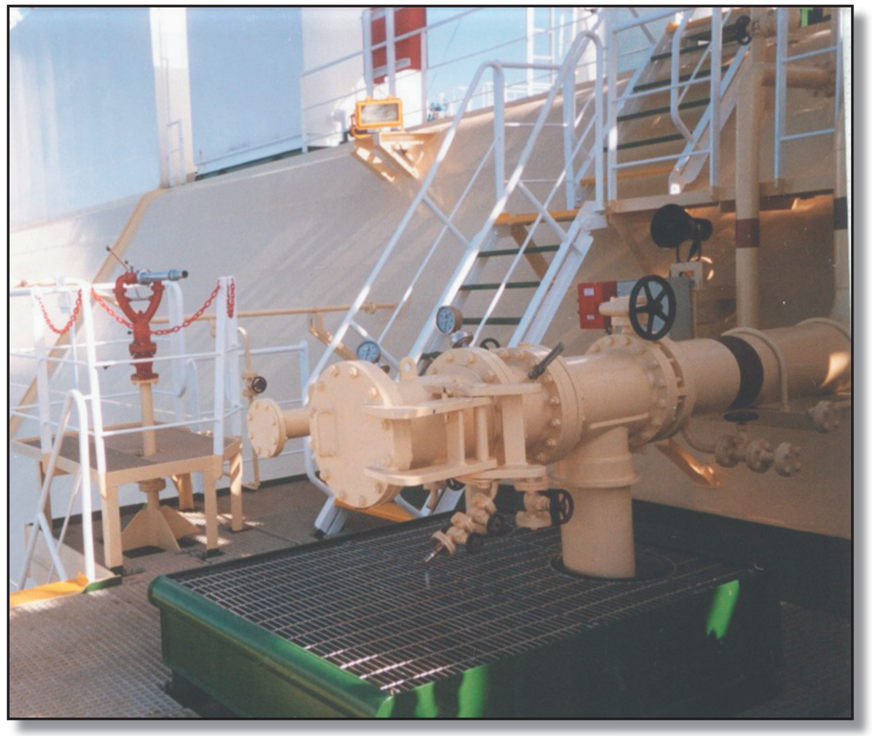
g) Replace the clamping device(s) and leave slack until the bottle is lined up with the piping.

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.

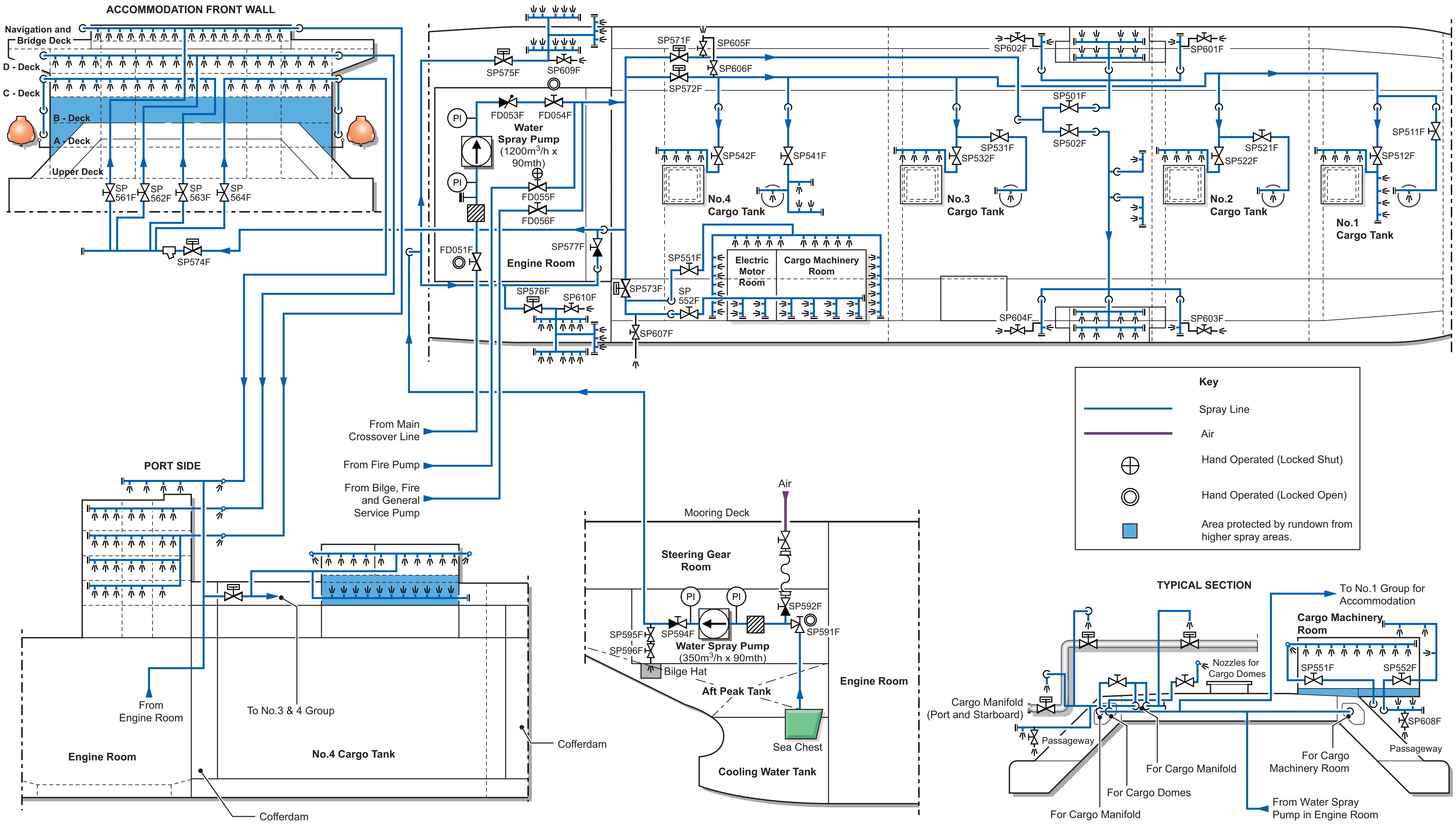
j) Tighten all connections.

k) Replace the actuating cylinder.



Starboard Manifold Area Dry Powder Monitor

Illustration 5.13a Water Spray System



5.13 WATER SPRAY SYSTEM

Introduction

The system can be supplied by the following pumps:

Water Spray (Engine Room)

Maker:	Shinko Industries
Type:	KV 350K
Capacity:	1,200m^3/h at 90mth
Motor:	450kW

Water Spray (Steering Gear Room)

Maker:	Shinko Industries
Type:	RVP200-2MS self-priming
Capacity:	350m^3/h at 90mth
Motor:	150kW

Bilge, Fire and General Service Pump

Maker:	Shinko Industries
No. of sets:	2
Type:	RVP200-2MS self-priming
Capacity:	245m^3/h and 150m^3/h at 35mth and 120mth
Motor:	45kW and 150kW

Fire Pump

Maker:	Shinko Industries
Type:	RVP200-2MS
Capacity:	180m^3/h at 120mth
Motor:	132kW

The pumps supply sea water to the spray nozzles at the following group locations:

- Group 1 - accommodation exterior bulkheads and lifeboat stations
- Group 2 - cargo machinery and electric motor room exterior bulkheads
- Group 3 - cargo manifold area
- Group 4 - cargo tank liquid and gas domes

Each group of spray nozzles has a remotely operated hydraulic isolating valve controlled from the fire control station.

The engine room water spray pump and fire pump are located on the starboard forward side of the engine room floor and the bilge, fire and general service pumps are located on the port forward side of the engine room floor. All take suction from the main sea water crossover pipe and either the high or low sea chest must be open to this suction main at all times. The water spray system can also be supplied by the fire pump and the port and starboard bilge, fire and general service pump, via crossconnecting valve FD055F.

The engine room water spray pump may also be used for operating the ballast stripping eductors, via crossconnecting valve FD056F and the fire main system, via crossconnecting valve FD055F if necessary.

CAUTION
Valve FD055F should normally be locked closed and after operating the ballast eductors, valve FD056F should be closed.

(**Note:** The water spray pump in the steering gear has a dedicated sea chest and only supplies the lifeboat stations. It is isolated from the rest of the system by the non-return valve SP577F positioned forward of the accommodation.)

To maintain the water spray system in the standby condition, the suction and discharge valves of both water spray pumps and the manually operated isolating valves on the groups are normally in the open position.

The pumps may be controlled locally by setting their selector switches to LOCAL, but they are normally operated from the IAS graphic screens and to allow for this their selector switches must be turned to the REMOTE position. At the IAS graphic screen the pumps are started and stopped from their faceplates which are called up by clicking on the pump icon.

The water spray pumps can be started from the IAS graphic screens at the following locations:

- Cargo control room
- Engine control room
- Wheelhouse

In an emergency the water spray pumps can be started using the pushbutton on the emergency panel in the fire control station.

Procedure for Supplying Sea Water to the Water Spray System

It is assumed that the sea water main suction valves at the sea water valve chest(s) are open to provide sea water suction.

a) All intermediate isolating valves along the water spray system on the deck must be open.

b) Set up the group valves as shown in the table below:

Position	Description	Valve
Open	Supply to group 1 water spray system	SP574F
Open	Supply to group 2 water spray system	SP573F
Open	Supply to group 3 water spray system	SP571F
Open	Supply to group 4 water spray system	SP572F
Open	Supply to lifeboat water spray systems	SP5752F, SP576F

c) Start the engine room pump either from the IAS screen or from the emergency panel and supply water to the water spray system. This pump must be selected as REMOTE at the local selector switch in order to allow them to be started from the IAS screen.

The water spray system is now in use and delivering water to all the selected spray nozzles on deck.

Water Spray Pump Situated in Steering Gear Room